NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL AND CONFERENCE OPINION AND MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Title: Endangered Species Act Section 7 Biological and Conference Opinion and Magnsuon-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on United States Coast Guard Federal Aids to Navigation Program

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1 INTRODUCTION

The biological opinion and incidental take statement portions of this document were prepared in accordance with section 7(a)(2) of the Endangered Species Act as amended (ESA; 16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance and was conducted by National Marine Fisheries Service (NMFS) Office of Protected Resources Endangered Species Act Interagency Cooperation Division.

The Magnuson Stevens Fishery Conservation and Management Act (MSA) essential fish habitat (EFH) consultation and EFH conservation recommendations (CRs) were completed in accordance with section 305(b) of the MSA (16 USC 1855(b)), associated implementing regulations (50 C.F.R. §600 subpart K), and agency policy and guidance, and was conducted by NMFS Office of Habitat Conservation. NMFS Office of Protected Resources and NMFS Office of Habitat Conservation are hereafter collectively referred to as "we" in this document.

The action agency for this consultation is the United States Coast Guard (Coast Guard). The Coast Guard proposes to continue to implement the aids to navigation (ATON) program which establishes, maintains, and discontinues advertised signals in the water and on land visible to mariners. This document represents NMFS opinion on the effects of these actions on the species and designated critical habitats listed in Table 4 and Table 10, pursuant to the ESA, as well as NMFS opinion on the effects of these actions on EFH.

This section provides information relevant to the both the ESA section 7 consultations and the EFH consultation is incorporated by reference into Sections 2 and 3 of this document. A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Aids to Navigation (ATON) Background

As described further in section 1.3, the Coast Guard's ATON program includes the establishment, operation, maintenance, and discontinuance of approximately 31,000 federal navigation aids, such as buoys and beacons, in navigable waters of the United States to promote the safety of maritime traffic. The Coast Guard has operated and maintained ATON since the late 1930s, and most existing ATON have been in place for decades.

ESA section 7 and EFH consultations have been done previously on some ATON program activities. For example, NMFS completed a formal programmatic consultation in August 2013 for ATON maintenance activities in Coast Guard sectors Miami, Key West, and San Juan (NMFS 2013a). Additional examples of previously completed ESA section 7 consultations on ATON activities is included in the Coast Guard's 2016 biological evaluation (BE; Tech 2014). All previous consultations concluded that the specific ATON program activities considered were not likely to jeopardize the survival or recovery of ESA-listed species or destroy or adversely modify critical habitat designated for those species. Through previous consultations, NMFS has

also provided guidance to the Coast Guard on how to minimize the effects of some ATON program activities on EFH (e.g., NMFS 2013e). This consultation supersedes all previous consultations on ATON program activities.

1.2 Consultation History

- On May 11, 2015 the Coast Guard requested initiation of formal consultation on Aids to Navigation operations. The initiation request was accompanied by a Biological Evaluation/EFH Assessment which considered the effects of the ATON program on ESA-listed species, designated critical habitat, and EFH.
- On July 2, 2015 NMFS responded to the Coast Guard's May 2015 request to initiate formal consultation and stated that the Biological Evaluation/EFH Assessment does not provide sufficient information to begin formal consultation, as outlined in the regulations governing interagency consultation (50 CFR 402.14 and 50 C.F.R. §600 subpart K).
- On October 16, 2015 the Coast Guard provided a revised Biological Evaluation/EFH Assessment to NMFS that provided additional detail on the proposed action.
- On January 5, 2016 NMFS and Coast Guard staff met to discuss ways to minimize and monitor impacts from the ATON program to ESA-listed resources and EFH.
- On January 14, 2016 NMFS sent a letter to the Coast Guard stating that based on the information provided in the revised biological evaluation and discussions at the January 5th in-person meeting, there was now sufficient information to initiate a combined formal section 7 and EFH consultation. This letter also stated that during the consultation process, NMFS will request additional information from the Coast Guard. Specifically, NMFS determined that the following aspects of the proposed action needed to be better described in order for NMFS to appropriately assess effects and complete the consultation.
    - Best management practices that will be implemented in each Coast Guard District to minimize impacts to ESA-listed resources and avoid, minimize, mitigate, or otherwise offset adverse effects to EFH
    - A monitoring and reporting system for the ATON program so that we may determine if the amount or extent of take is approached or exceeded.
- In the January 2016 letter, NMFS proposed to complete the biological opinion and EFH conservation recommendations by September 30, 2016. This date was contingent on the information described above being provided.
- On January 22, 2016, the Coast Guard replied to NMFS' January 14th letter and agreed to the proposed consultation completion date.
- Between January and October 2016, NMFS and Coast Guard worked to develop operationally feasible best management practices and a monitoring and reporting system for the ATON program.

- On October 4, 2016, the Coast Guard and NMFS mutually agreed to extend the consultation timeline (to an undetermined date) in order to allow sufficient time to develop best management practices and a monitoring and reporting system for the ATON program.
- Between October 2016 and June 2017, NMFS and the Coast Guard continued to communicate via email and telephone to to clarify aspects of ATON operations to help NMFS appropriately assess the effects of the proposed action on ESA-listed resources and EFH.
- On September 5, 2017, NMFS provided the Coast Guard with a draft biological opinion and EFH consultation.
- NMFS received comments from the Coast Guard on the draft biological opinion and EFH consultation on February 2, 2018.
- NMFS and Coast Guard staff met at Coast Guard Headquarters on February 26, 2018 to discuss comments on the draft biological opinion and a path forward for concluding the consultation.
- Upon request, NMFS provided Coast Guard a revised draft biological opinion and EFH consultation on March 16, 2018.
- Coast Guard informed NMFS on April 4, 2018 that they had no additional comments on the biological opinion and EFH consultation.

1.3 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The proposed action for this consultation is the Coast Guard's ATON program (i.e., the operation and maintenance of existing federal ATON, as well as the establishment and discontinuance of federal ATON), as described by the Coast Guard in the May 15, 2015, letter requesting initiation of consultation, the biological evaluation, and EFH assessment dated July 2014, and supplemental information provided by the Coast Guard throughout this consultation.

An ATON[1] is a signal that delivers a message to mariners warning of hazards, defining channels, assisting in track keeping or turning, or providing other information. The Coast Guard develops, maintains, and operates aids to maritime navigation for promotion of safety on and over the high seas and waters subject to the jurisdiction of the United States (14 U.S.C. §2).[2] For federal ATON, the Coast Guard establishes, operates, and maintains the signal as well as the structure or

[1] The term "ATON" refers only to the sound, light, and other features that communicate information to mariners (collectively known as the "signal"); the term ATON does not include the structure on which the signal is placed. As the Coast Guard ATON Program is responsible for both the signals and the structures on which federal ATON are placed, the term is often used to refer to both the structure and the signal for federal ATON. For the purposes of this biological opinion, this distinction is not significant when the term is used to refer to federal ATON. The distinction is significant, however, when the term is used in connection with private (non-federal) ATON, because, in that context, Coast Guard responsibilities extend only to the signal.
[2] The statutory authorities of the Coast Guard's ATON program are fully described in the Coast Guard Aids to Navigation Manual (COMDTINST M16500.7A).

buoy that holds the signal. This does not include any building or structure not owned or leased by the Coast Guard whose owner permits the Coast Guard to place federal ATON on it. There are approximately 31,000 federal navigation aids (excluding those buoys in Western Rivers).[3]

Table 1. Floating and fixed ATON by Coast Guard District.

Coast Guard District	Floating ATON	Fixed ATON	Total ATON
1	4,678	894	5,572
5	2,315	4,379	6,694
7	1,063	5,167	6,230
8	1,420	6,832	8,252
11	326	731	1,057
13	518	1,192	1,710
14	185	209	394
17	467	918	1,385
Total	**10,972**	**20,322**	**31,294**

The Coast Guard is divided into districts (Figure 1). Discussion in this biological opinion is restricted to those districts where ESA-listed species under NMFS jurisdiction occur (i.e., districts 1, 5, 7, 8, 11, 13, 14, and 17).

[3] The Coast Guard also permits the signal and location of approximately 40,000 private (non-federal) ATON (PATON). PATON are monitored and maintained by the private entities that own them, not the Coast Guard. The Coast Guard's federal action to permit PATON are not considered in this consultation.

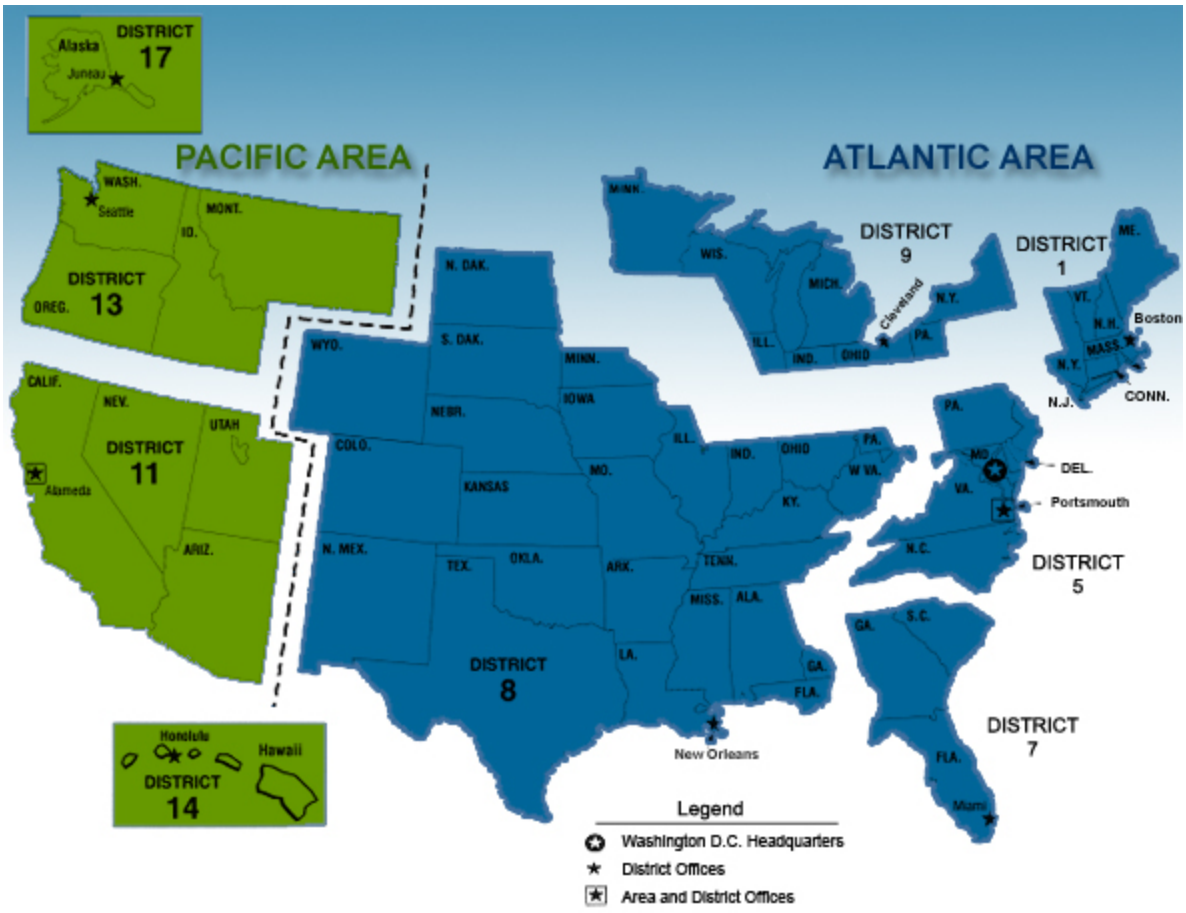


Figure 1. United States Coast Guard Districts.

As described in the Biological Evaluation/EFH Assessment on the Coast Guard ATON program as well as supplemental information provided by the Coast Guard throughout this consultation, the proposed action includes three components:

1) Policies and procedures for establishing new federal navigation aids;
2) Operation and maintenance of federal navigation aids; and
3) Policies and procedures for discontinuance of federal navigation aids.

Because the establishment and discontinuance of individual federal navigation aids will require individual section 7 consultation if ESA-listed species or designated critical habitat may be affected, this is a mixed programmatic consultation, as defined in 50 CFR 402.02. We therefore provide in this opinion an incidental take statement for the operation and maintenance of the program of operation and maintenance, but not for those actions which will require further section 7 consultation. 50 CFR 402.14(i)(6). Each of these components are described in greater detail below.

1.3.1 Policies and Procedures for Establishing New Federal Navigation Aids

Establishment of ATON is the act of physically installing a new navigation aid in its assigned position. The proposed action does not involve the physical establishment of any specific ATON, but includes the policies and procedures in place for such an action. The Coast Guard's general authority to "develop, maintain, establish, and operate, with due regard for the requirements of national defense, aids to maritime navigation for promotion of safety on and over the high seas and waters subject to the jurisdiction of the United States" is provided for by 14 United States Code 2. The Coast Guard establishes ATON to mark channels and other areas as "safe water." Additionally, the dangers, rather than the safe areas, may be marked in areas that have rocks and shoals scattered throughout. ATON are established specifically to enable mariners to transit through an area safely and efficiently while avoiding groundings, obstructions to navigation, and collisions with other vessels (Guard 2005).

The Coast Guard District Commander has the primary responsibility for the establishment, review, and modification of ATON systems. Requests for navigational aids or aid systems may be initiated by user groups, field units, or the District Commander as a result of an analysis of the need for ATON within the district. The Coast Guard also establishes ATON at the request of other federal agencies to mark designated anchorage, quarantine, danger, restricted, and prohibited areas.

1.3.1.1 Decision-making process

Within the confines of delineating "safe water" and marking dangers, the Coast Guard considers several factors when determining the appropriate type and placement of an aid. ATON are primarily focused on the facilitation of marine transportation. The Coast Guard Aids to Navigation Manual describes the process governing the establishment of an Aid to Navigation System. Three criteria guide the decision making process when establishing new ATON: 1) initial justification; 2) system benefit analysis; and 3) system type analysis.

Initial justification involves identification of authority to establish an aid and an evaluation of criteria. The Coast Guard has authority to establish navigational aids in the following areas: a) The United States of America, b) waters above the continental shelf, c) territories and possessions of the United States of America, and d) beyond the territorial jurisdiction of the United States at places where naval or military bases of the United States are or may be located (14 U.S. Code 81). The following criteria are considered when establishing ATON:

- Aiding navigation
- Prevention of disasters
- Prevention of collisions
- Prevention of wrecks
- Serving the needs of commerce
- Amount and nature of the traffic
- Justification in terms of public benefit

- Preservation of natural resources

The system benefit analysis considers whether the navigation aid system will result in benefits that will justify the costs involved in establishing, operating, and maintaining the system. This analysis considers benefits to mariners regarding economics, safety, and convenience. Additionally, the ATON manual emphasizes the need to avoid unnecessary duplication of ATON systems (Guard 2005).

The system type analysis considers the specific need for the ATON and determines which sort of navigation system is most suitable to the particular location. This analysis looks at both the capabilities of the proposed system (e.g., audio-visual versus radar piloting system) and the specific characteristics of the system (e.g., type of visual system [lights versus dayboards]).

1.3.1.2 Environmental compliance for establishing future navigation aids

Any new ATON will require site-specific information on the exact location, type of aid, method of establishment, and other details of the project. In keeping with the Coast Guard's National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts (Guard 2000), a separate consultation would be conducted for each new ATON if the Coast Guard determines that ESA-listed resources may be affected.

Though the project design criteria (PDC) described in Section 1.3.5 of this opinion were developed primarily for ATON maintenance, because the physical actions of establishing new ATON are nearly identical to those of maintaining ATON, the Coast Guard will adhere to applicable PDC when establishing future navigation aids (Andrew Haley, personal communication to Eric MacMillan, NMFS; October 18, 2017).

1.3.2 Operation and Maintenance of Federal Navigation Aids

The proposed action includes both the operation and maintenance of ATON structures and signals. In the context of the proposed action, ATON operation refers to the physical presence of ATON in the environment, as well as any light or sound signals emitted from an ATON. Coast Guard maintenance of federal ATON includes, but is not limited to, the following activities: inspecting and replacing ATON chain, sinkers, buoys, dayboards, ladders, platforms, and pilings; repairing lighting equipment, power systems (batteries and solar panels), and sound signals; responding to and repairing ATON discrepancies; and conducting repairs to structures.

Federal navigation aid maintenance is required either as part of routine maintenance or for emergency repairs. Routine maintenance consists of maintenance and/or repairs that are part of a regular schedule and are necessary due to normal wear and tear of each ATON. Table 2 lists the distribution of navigation aids maintained by the Coast Guard as of summer 2017 and their maintenance intervals.

Table 2. Distribution and servicing intervals of ATON by Coast Guard district.

Number of navigation aids in each Coast Guard district											Maintenance interval	
District		1	5	7	8	11	13	14	17	TOTALS	Minimum (months)	Maximum (months)
Buoys	Lighted	1239	1108	719	439	235	286	103	176	4305	5	36
	Unlighted	3439	1207	344	981	91	232	82	291	6667	4	36
	Buoy total	4678	2315	1063	1420	326	518	185	467	10972		
Beacons	Light	588	1798	1683	3489	554	779	133	636	9660	3	36
	Range light	65	217	283	389	73	238	47	37	1349	3	36
	Range passing light	0	39	26	62	0	1	0	0	128	3	36
	Range daybeacon	0	1	4	2	0	16	6	7	36	3	36
	Daybeacon	241	2363	3196	2952	101	151	23	238	9265	5	36
	Racon/SSIG	0	0	0	0	3	8	0	0	11	3	36
	Beacon Total	894	4379	5166	6832	731	1192	209	918	20321		
TOTAL		5572	6694	6229	8252	1057	1710	394	1385	31293		

ATON maintenance operations are carried out by aid servicing units and are occasionally supported by other Coast Guard units. Aid servicing units consist of buoy tenders, construction tenders, and shore based ATON units made up of 5 to 55 people. ATON maintenance requires approximately 106,000 annual labor hours, split about equally between cutters and small boats. Fewer than 1,000 hours annually are spent using aircraft support. A single service event takes less than an hour, on average. The most time-intensive maintenance activity is replacement of pilings, which may take up to 8 hours. Maintenance work is normally conducted during daylight hours.

ATON are also serviced when a discrepancy has been reported. A discrepancy is the failure of an ATON to provide the advertised light, sound signal, appearance, or position. Discrepancies include loss of buoyancy (for floating ATON), loss of dayboard (for fixed ATON), movement from assigned position, fouling with debris, extinguished lights, discharged batteries, and other issues. The incidence of discrepancies varies seasonally and across Coast Guard districts. Emergency repairs are necessary when an ATON is damaged. A number of reasons including severe weather, other environmental factors (e.g., vegetation growth, damage from animals), boater allisions, equipment malfunction, or vandalism may cause damage requiring emergency repairs. If left unrepaired, a damaged ATON may pose a dangerous hazard to boaters, as might a floating ATON that has been dragged off its assigned position by storm events or for other reasons. Timely regular maintenance and emergency repair of ATON structures is crucial to provide for safe navigation and prevent the loss of human life.

1.3.3 Aids to Navigation Structures and Signals

The Coast Guard maintains lighted and unlighted buoys and lighted and unlighted fixed navigation aids such as day beacons and lights, ranges, and lighthouses.

1.3.3.1 Floating Navigation Aids

Buoys are floating ATON (e.g., Figure 2) of various shapes made of ferrous and non-ferrous materials (e.g., steel, foam, or plastic). Some buoys have attached lights or sound signals such as bells, whistles, and gongs. Others have a radar beacon to make the buoy more distinguishable on radar. Buoys are set by laying a sinker in an assigned position on the bottom to anchor the buoy. The sinker is typically a concrete block weighing between 250 and 20,000 pounds, but could also be a cast-iron pyramid shaped sinker known as a DOR-MOR. Concrete and DOR-MOR sinkers placed on hard bottom such as rock remain almost completely exposed (not buried) after deployment. When they are set on soft bottom such as sand, mud, or clay, the DOR-MOR will typically sink into the substrate so that very little, if any, of its surface area remains exposed. The extent to which a sinker is buried in the substrate depends on the nature of the bottom and currents. Most buoys are attached to the sinker by a chain or wire rope; a synthetic line may be used occasionally. The thickness of the steel in each link of the chain ranges from one-half inch to almost two-inches thick. Wire rope, typically used only in inland waterways, is one-half inch in diameter. The chain or wire rope is long enough to allow the buoy to move up and down with tides, swells, and waves and to assist in anchoring the buoy. Excess chain is free to move about the bottom near the sinker, as the buoy rotates around the sinker in a circular area known as the "watch circle" determined by the length of the chain and the water depth. The chain also moves in a circle beneath the water and may create a circle of scour, known as the "scour area." Buoys are established in waters ranging from two to 855 feet deep.

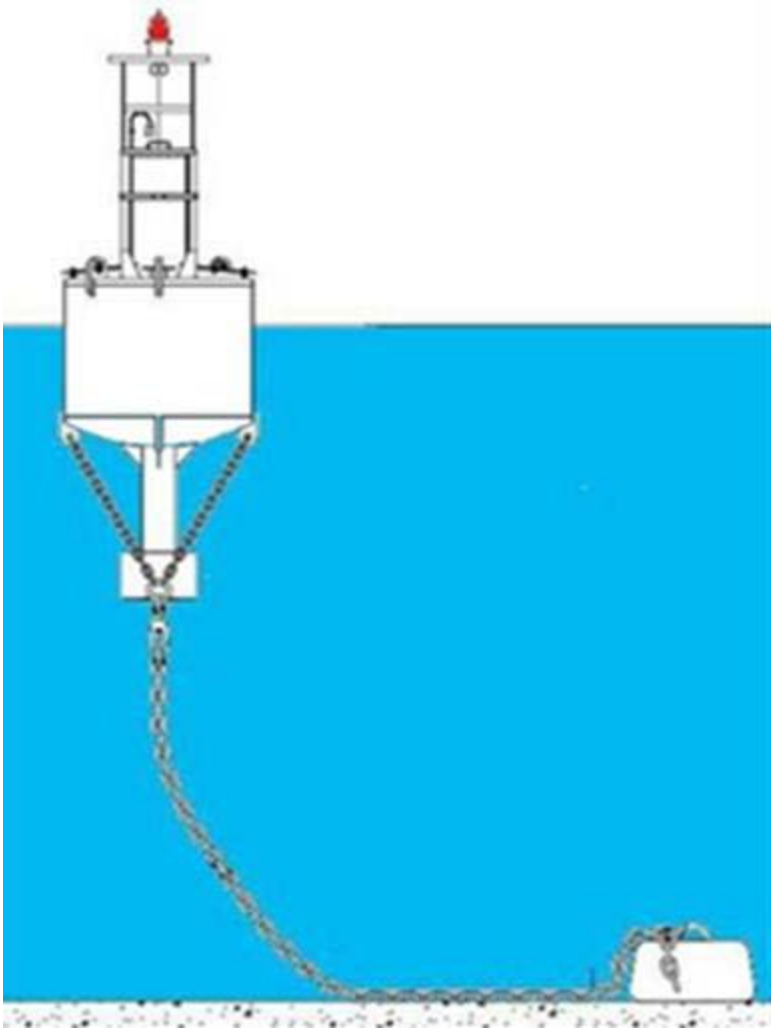


Figure 2. Buoy with chain and sinker.

Maintenance activities for floating ATON include lighting and equipment inspections, mooring inspections, and buoy hull relief.

Routine scheduled servicing visits are primarily focused on ensuring the aid is functioning as intended. During the servicing visit, the ATON unit checks the buoy, ensures the correct operation of the signal hardware, checks and recharges the battery if necessary, inspects the condition of the buoy above the waterline, and verifies the buoy's position. Mooring inspections are focused on the structural integrity of the buoy and sinker assembly. The buoy is typically brought on board during the mooring inspection so that the crew can verify that the buoy and mooring hardware can operate safely until the next scheduled mooring inspection. The underwater portion of the buoy and the chain mooring are also carefully examined during the mooring inspection. The entire chafe section of the mooring chain is brought on deck and inspected. If the chafe section has worn to a certain degree or has noticeable flaws, that section of the chain is replaced. The sinker is also periodically raised for on-board inspection. Following

inspection, the buoy, chain, and sinker are placed back in the water in the same location using the same technique used when the aid was first established (either controlled placement or dropping).

When buoys are out of the water for inspection, they are also cleaned. Heavy marine growth is scraped from the surface of the buoy or removed with a high pressure washer so as not to damage the buoy's coating system. Guano, slime, and salt are removed by a high-pressure water wash. Any organisms removed from the buoy are pushed back into the water at the buoy location. After the buoy is cleaned, touch-up paint is applied if necessary. Touch-up paint is applied only to restore the proper color to a faded or guano-coated buoy, and not to maintain cosmetics. Paint is only applied when the buoy is out of the water. If a buoy requires complete repainting or recoating, it is transported to an on-shore painting facility to minimize the risk of accidental release of paint into the water.

In some areas (e.g., District 7, 14), the chain and sinker may be inspected and serviced by divers rather than being removed from the water. When a buoy must be brought on deck for servicing and maintenance, the divers detach the chain from the sinker. The chain is then suspended in the water using inflatable float bags, and the buoy is floated to a location where the ship can bring it on deck. If the sinker must be replaced, it is floated to the surface or raised using the ship. After maintenance, divers help guide sinkers back down to the original location on the sea floor. Divers are used in areas of District 14 where it is not practical or safe for a buoy tender to approach an aid because of shallow depth, proximity to coral, or other hazard. Divers reduce the risk of a vessel injuring coral and of coral damaging a vessel. Divers may also be using during ATON maintenance in areas where corals do not occur.

When a floating ATON needs repair or servicing beyond what can be accomplished on a vessel, the buoy is "relieved," meaning it is brought to an onshore maintenance facility. Organisms growing on the buoy are removed and pushed back into the water before the buoy is relieved. Buoy relief also occurs in preparation for winter ice or severe weather in Coast Guard districts 1, 5, 9, 13, and 17. Some seasonal buoys are removed from the water and replaced at the end of winter when ice or extreme seas are no longer a danger. Other seasonal buoys are replaced by ice buoys for the duration of winter.

Floating ATON are also serviced when a discrepancy has been reported. A discrepancy is the failure of an ATON to provide the intended light, sound signal, appearance, or position. Discrepancies on floating ATON include loss of buoyancy, movement from assigned position, fouling with debris, extinguished lights, discharged batteries and other issues. Table 3 lists the frequency of ATON discrepancies reported by Coast Guard district.

Table 3. Frequency of ATON discrepancies reported in Coast Guard districts.

Coast Guard District	Discrepancies			
	2010	2011	2012	Mean
1	957	1211	888	1019
5	1377	1798	1326	1500
7	1325	1342	1337	1335
8	2096	2093	2420	2203
11	264	233	187	228
13	293	279	317	296
14	66	90	71	76
17	85	119	145	116

It is Coast Guard policy to survey all aids to verify their proper operation as soon as possible after severe weather such as hurricanes, seismic sea waves, ice conditions or other weather events likely to cause widespread discrepancies or whenever a vessel using the ATON system suffers a collision, allision, or grounding. The Coast Guard District Commander then determines the order of priority of response to discrepant ATON. All ATON units must make every reasonable effort to report or correct discrepancies when they are observed so that the appropriate response action can be conducted. Per Coast Guard regulations, the commanding officer or duly delegated representative makes every effort to observe the functioning of all aids to navigation within the immediate area of the unit. The commanding officer informs the district commander by message of any aid to navigation that is found to be out of order or off station. The message includes information as to any corrective action taken. Crews are expected to note all aids in passing and correct whatever simple discrepancies they encounter; more complex discrepancies must be reported using the Discrepancy Response Action Decision Guide. The nature of the discrepancy, the type of vessel traffic in the area, the magnitude of risk posed by the discrepant aid, and other factors are used to determine the response time for the discrepant aid. The most serious discrepancies are those occurring in sensitive habitat where loss of life or severe vessel damage could result from the discrepancy. If a missing or heavily damaged buoy cannot be replaced immediately, a discrepancy buoy may be placed at the location of the discrepant aid until the buoy can be replaced, especially if the discrepant aid is far from the current location of the servicing unit. Typically a temporary replacement unlighted buoy or temporary replacement lighted buoy will be placed to provide the signal for the mariner. Discrepancy buoys may have less signal capability than the ATON they replace.

1.3.3.2 Fixed navigation aid structures

Beacons are fixed structures established either in the water or on land upon which navigation signals (i.e., lights, dayboards, or rangeboards) are installed. Each beacon consists of a

foundation and the aid itself. The foundation is the lowest support for a structure that fixes it to the terrestrial surface or seabed and transmits its load to the soil or rock where it is embedded. Foundational elements may be wooden, steel, or concrete pilings (though the Coast Guard no longer installs concrete pilings). The visual and audible signal equipment that makes up the functional component of ATON is secured in a fixed location and at a design elevation that establishes the geographical range of the aid. Structures are built in a variety of configurations according to the unique geological and environmental conditions of a given location, as well as the specific nature of the signal required. They can range from simple and inexpensive day beacons to complex and costly offshore lights. Fixed ATON are classified as major ATON structures, minor ATON structures, and lighthouses.

Major ATON structures (e.g., Figure 3) are complex in design and construction, and usually require significant engineering effort. Typically, major ATON structures are customized for a given location. Large offshore lights are an example of a typical major ATON structure.



Figure 3. Example of a major ATON structure.

Minor ATON structures (e.g., Figure 4) are relatively simple in design and construction and can be either lighted or unlighted. These structures are established in waters ranging from zero to 61 feet deep.



Figure 4. Minor ATON structure in the form of a single pile structure.

Lighthouses (e.g., Figure 5) may display visual, audible, or radio signals. These structures are usually made of granite, brick, cast iron plate, monolithic stone, concrete, or steel. They are often located in an offshore, wave-swept, exposed environment, or on a coastline as a landfall object.



Figure 5. Example of a lighthouse.

Fixed ATON are inspected on a rotating schedule determined by their composition, location, and vulnerability to damage from natural events or vandalism. Major fixed ATON are inspected at least once every five years to ensure the integrity of the foundation, structure, and signal. This inspection is in addition to the routine maintenance described below. Field unit inspections may occur at shorter intervals, depending on the location and vulnerability of the ATON to vandalism, fouling with guano, or other event that would require more frequent attention.

Routine maintenance intervals range from three to 60 months (Table 2). During servicing, the ATON is checked to ensure that all visible, audible, and electronic signals are clear and accurate as advertised. Unlike floating ATON, fixed ATON are always serviced in place. During the maintenance visit, consumable components such as batteries and lamps are replaced and properly disposed of according to COMDTINST 16478.11. Exposed portions of the structure may be repainted or recoated.

Fixed ATON onshore (e.g., lighthouses) are often established in vegetated areas visible from the waterway. Plant growth around an aid can obstruct the signal, threaten the integrity of the structure, or restrict access to the aid. Structural supports can also be weakened by termites and other insects, dry rot, tree fall, climbing vines, and other natural causes. Fixed aids on land must be refurbished every few years to restore the integrity of paints and other weatherproofing materials.

Fixed ATON in water are most often compromised by bird nests and guano. The underwater structure may be weakened by rot, wood-boring mollusks, and other processes. Encrusting and attached organisms on submerged portions of the structure are normally allowed to remain in place unless they jeopardize the integrity of the structure. If the exposed portion of a fixed aid must be repainted or recoated, some attached organisms may have to be removed (such as mussels growing on the tidally exposed portion of the structure). All organisms are returned to the water in the immediate location of the ATON. If guano is thick enough to interfere with the light or sound signal, it is removed from the upper part of the aid, often by pressure washing. Washing large amounts of guano from an aid may cause an immediate flux of nitrogen and phosphates in the water adjacent to the aid.

Minor discrepancies on fixed ATON may be corrected during the routine maintenance visit by replacing the day signal (day board), battery, solar panel, or other light equipment component, or repositioning an ATON that has been knocked out of alignment. If an ATON has been heavily damaged or knocked down, the crew may not be able to correct the discrepancy during the service visit. If necessary, they will place a temporary buoy to provide a signal until the original ATON can be repaired or replaced. The crew will return with equipment or additional personnel to restore the ATON to full function, which may require building a new structure. The old structure may be removed or left in place, depending on local conditions.

1.3.4 Aids to Navigation Servicing Units and Vessels

ATON operations are carried out by aid servicing units or contractors and are occasionally supported by other Coast Guard units. Aid servicing units consist of buoy tenders, construction tenders, and Aids to Navigation Teams and boats. Helicopters may also be required to service an ATON. Buoy tenders come in a variety of sizes to meet the needs of specific aid types and operating areas, ranging from 65 to 225 feet long (e.g., Figure 6). Juniper class cutters (225 feet long, 13-foot draft) are seagoing buoy tenders that service the largest buoys and those farthest out at sea. Keeper class coastal buoy tenders (175 feet long, eight-foot draft) typically work closer to shore because they have less lifting capacity and sea keeping ability. Inland buoy

tenders (65 feet with four-foot draft or 100 feet with a five-foot draft) service inland waters or close to shore. River buoy tenders (65 to 75 feet long) push 90- to 130-foot barges to service ATON. A river tender is equipped with a large beam or pole, known as the "spud," that is lowered from the ship to the bottom of the water body to hold the vessel in place. "Spudding down" is similar to more traditional anchoring, but the spuds hold the vessel in a fixed location.



Figure 6. Example of a Coast Guard buoy tender, the 175-foot CGC Katherine Walker.

Construction tenders are 75, 100, and 160 feet long. The 75-foot tenders push construction barges 68 or 84 feet in length, draft four feet, and are driven by twin propellers. The one 100-foot tender, CGC SMILAX, pushes a 70-foot-long barge, drafts five feet, and is driven by twin propellers. The 160-foot tenders are single unit vessels (no barge), draft four feet, and are driven by twin propellers. All construction tenders are equipped with a crane, a diesel impact hammer (for driving piles), and "spuds". A vibratory hammer may be rented and used to install and extract pilings occasionally. Construction tenders service inland and nearshore aids and are specifically designed for establishing and replacing fixed ATON.

Aids to Navigation Teams consist of five to 25 people equipped with at least one ATON boat and a land vehicle with trailer. These units spend most of their time responding to discrepancies, but also perform routine maintenance on aids. The Aids to Navigation Teams travel to aids by boat, land vehicle, or helicopter. ATON boats are smaller than the tenders described above and have a smaller range of operations and aid servicing capacity. Some ATON boats have lifting equipment on deck while other ATON boats are smaller and not suitable for lifting. On occasion, non-ATON units will assist in servicing ATON. For example, 65-foot harbor tugboats in the northeastern United States may service buoys or deploy technicians to perform these operations.



Figure 7. ATON boat with lifting equipment.

ATON operations use helicopters to transport personnel when logistical considerations make water transit impractical (Figure 8). Units may be transported by helicopter to remote locations or to aids that are in places where access by watercraft is difficult or dangerous. Helicopters may also be used when speed is of the essence; if an aid requires immediate attention to remedy a discrepancy, a unit may be carried to the aid by helicopter. Neither the helicopter nor the helicopter crew is directly involved in the servicing operations; they simply provide transportation. In Alaska, helicopters are used in routine servicing operations because many ATON are in extremely remote, nearly inaccessible locations. If a time-critical response to a discrepancy is required, helicopter transport can occur in any district. A helicopter may also be used to recover a buoy that has become detached from its anchor and deposited on shore where boats cannot access it to tow it back into the water. In this situation, a hoist cable is lowered from the helicopter and attached to the buoy. The buoy is then carried over the water and lowered in, where it can float until a boat or ship can recover it.



Figure 8. Helicopter used in support of ATON operations.

1.3.5 Project Design Criteria

Below we identify the PDC the Coast Guard will adhere to during all federal navigation aid activities (i.e., establishment, maintenance, and discontinuance) implemented under this consultation document. These PDC were developed during consultation collaboratively with input from Coast Guard regions and districts and NMFS regional offices and serve to prevent or minimize adverse effects to ESA-listed resources and EFH. For maintenance activities, the PDC limit adverse effects to predictable levels that will not jeopardize the continued existence of ESA-listed species or destroy or adversely modify critical habitat at the individual project level or in the aggregate from all projects implemented under the programmatic opinion. For activities to establish or discontinue ATON, these PDC serve generally to prevent or minimize adverse effects to ESA-listed resources and EFH, but may be modified as appropriate on a project-by-project basis in consultation with NMFS since these actions will all require subsequent ESA section 7 consultation and/or EFH consultation if ESA-listed resources or EFH may be affected.

The first set of PDC is related to both ESA and EFH and will be implemented nationwide (Section 1.3.5.1). The next set of nationwide PDC is specific to minimizing impacts to ESA-listed resources (Section 1.3.5.2). The remaining PDC are organized by Coast Guard District, with separate PDC to minimize adverse effects to ESA-listed resources and EFH (Sections 1.3.5.4 through 1.3.5.12).

Note: Nothing contained in these Project Design Criteria shall preclude the Coast Guard from taking necessary action in response to a safety of life issue or to prevent personal injury.

1.3.5.1 Nationwide – Endangered Species Act and Essential Fish Habitat

Environmental Observers

- At least one designated, trained Environmental Observer must be present during all activities to establish, maintain, or discontinue ATON. Training will include review of district specific job aids describing endangered species and protected habitats within the area of responsibility (AOR). The job aids will be created jointly by Coast Guard and NMFS staff.

- Environmental Observers must be trained to identify ESA-listed marine species, ESA designated critical habitats, and EFH located in their Area of Responsibility (AOR). Environmental observers are not expected to become experts in species identification, but must be able to recognize the various taxa (e.g., whales, turtles, corals) that include protected species in their AOR.
- Crew members must review the AOR Job aide regarding identification of ESA-listed species, sensitive habitats (i.e., coral reef, hardbottom, seagrass, eelgrass, kelp), best management practices (BMPs), and the requirements described here for minimizing impacts to these resources upon reporting to the unit and quarterly thereafter.
- Prior to each ATON patrol, the Environmental Observers must: (a) familiarize themselves with the ESA-listed species, designated critical habitat, and EFH that may be in the action area of the activity, and the potential routes of effects to such species and habitats discussed below; (b) understand the BMPs and project design criteria (PDC) that apply; and (c) discuss species and habitats of concern that may be present in the area during the navigation brief or other brief with ATON personnel.

Spills/Debris/Turbidity

- When operationally feasible, the Coast Guard should lower all objects (e.g., moorings) to the bottom in a controlled manner. Controlled lowering can include the use of buoyancy controls such as lift bags, or the use of cranes, winches, or other equipment that affect positive control over the rate of decent to the seafloor.
- When lowering all objects, an Environmental Observer must ensure any mobile ESA-listed species are not observed within 50 yards of the area where the object will be dropped.
- The Coast Guard must not allow contamination of the marine environment to result from ATON activities. The Coast Guard should take the following precautions:
    - Each Coast Guard vessel engaged in ATON operations must implement protective measures to prevent all excess materials, equipment, and hazardous substances from entering the surrounding environment.
    - In the event debris or other waste enters the surrounding environment, each Coast Guard vessel must attempt to capture this debris or waste. This includes the removal of hardware, pins, and bolts used to secure any equipment. Those that cannot be completely removed must be cut-off flush with the substrate when possible.
    - All packing bands or other debris which may pose an entanglement risk to protected species must be cut and secured for proper disposal shore-side.
    - Any necessary large-scale painting or chemical cleaning of an ATON cannot be completed onboard the servicing unit (or over the water). If any touch-up painting by roller is required while on deck of a Coast Guard vessel, ensure there is no discharge of paint and associated solvents into the water.
    - The Coast Guard must maintain a contingency plan to control toxic materials aboard all Coast Guard ATON service vessels. Appropriate materials and equipment must be stationed on board ATON vessels to contain and clean up any spills.
    - All project-related materials and equipment placed in the water must be free of pollutants. Vessel personnel will perform daily pre-work equipment inspections

for cleanliness and leaks. All heavy equipment operations will be postponed or halted should a leak with the potential to discharge overboard be detected, and will not proceed until the leak is repaired and equipment cleaned.

- Turbidity and siltation from project-related work must be minimized and contained through the appropriate use of effective silt containment devices (if equipped) and the curtailment of work during adverse tidal and weather conditions.
- When practicable, debris from destroyed aids should be recovered.

1.3.5.2 Nationwide – Endangered Species Act

Environmental Observers

- During all aspects of their ATON mission (i.e., in-water activities such as boat operations, maintenance of floating ATON [buoys and moorings] and fixed ATON structures, diving operations, establishment or discontinuance of ATON), all Coast Guard crew members must be constantly vigilant for the presence of ESA-listed marine species. All crew observations must be reported to the designated Environmental Observer.

Vessel handling/Speed

- While underway and on station during ATON operations, all topside Coast Guard crew members must be on lookout for species or habitats of concern such as ESA-listed whales, turtles, pinnipeds, fish, and invertebrates, as well as Johnson's seagrass and coral reefs.
- While underway, vessels shall remain at least 100 yards from observed whales, and at least 50 yards from other observed ESA-listed marine mammals, sea turtles, sturgeon, sawfish, and sharks, if it is safe to do so. Additionally, all in-water work must be postponed or halted when ESA-listed marine mammals, sea turtles, sturgeon, sawfish, and sharks are observed within these specified distances and may be affected by operations. Activities may not resume until the Environmental Observer has observed the protected species move out of the area on their own volition or, if an animal is seen above water then dives below, the Coast Guard or servicing entity will not begin in-water work until enough time has elapsed without a sighting (at least 15 minutes for pinnipeds, sea turtles, and fish, and 30 minutes for cetaceans) to assume the animal has moved beyond these specified distances. ESA-listed marine mammals, sea turtles, sturgeon, sawfish, and sharks must not be encircled or trapped between multiple vessels or between vessels and the shore.[4]
    - Vessel speed must be reduced to less than 10 knots when cetaceans (whales) are observed near an underway vessel, when safety permits. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures should always be exercised.
    - Vessel speed must be reduced to less than 5 knots when sea turtles are observed near an underway vessel and have the potential to be impacted by the vessel, when safety permits.

[4] This PDC does not apply when disturbing Western DPS Steller sea lions in Alaska. As documented in the *Effects* section of this biological opinion and the Incidental Take Statement, the Coast Guard is able to disturb this species when they are hauled out on ATON during maintenance activities.

- ESA-listed species may surface in unpredictable locations or approach vessels. When an animal is sighted in the vessel's path, slowly maneuver the vessel away to the prescribed distance (set forth in the PDC above), if it is safe to do so.
- If an ESA-listed species is observed in close proximity to a moving vessel, reduce speed and shift the engine to neutral and/or declutch if it is operationally safe to do so. Do not engage the engines until all animals are clear of the area.
- While conducting ATON operations, vessels should operate at minimum safe speeds while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. Operate in marked channels whenever possible.
- Environmental Observers must record all instances when direct mitigation measures were necessary to avoid impacts to ESA-listed species that occur during ATON activities, for example, altering course to avoid a whale or turtle. Information collected must include species type; any recognizable individual characteristics if possible to discern; time, location, and approximate distance from the observer to the species; species behavior; any impact the sighting had on work activities such as delays, shutdowns, and whether the species was at a sufficient distance that work continued. Information will be compiled and reported to NMFS staff.

Pile Driving and Removal

- Any creosote treated piles will not be reused and will be disposed of properly, in accordance with Coast Guard policy. Any creosote treated piles that must be replaced, must be replaced with non-creosote treated piles.
- Adhere to seasonal work windows[5] described in Appendices A through F (see section 5) for all routine pile driving operations, including total replacement or establishment. If a unit must work outside the seasonal work window due to operational constraints (scheduling or maintenance issues, etc.), consult with NMFS prior to pile driving to minimize potential impacts. This PDC is not applicable if emergency repairs are required to remedy a navigational hazard.
- If piles break or are damaged, Coast Guard staff, or servicing entity, must attempt to entirely remove the broken piles. If the entire pile cannot be removed, reasonable efforts must be made to cut the remnants without disturbing the sediment.
- When feasible, a vibratory driver must be used instead of an impact hammer for pile driving.
- If an impact hammer is required, pile driving must employ soft-start or ramp-up techniques (slow increase in hammering intensity), at the start of each work day or following any break of more than 30 minutes to allow any undetected ESA-listed animals to voluntarily depart the area.
- Steel piles may not be larger than 18 inches in diameter.
- Structures may not be replaced that consist of more than four steel piles.
- If using an impact hammer, use additional sound attenuation devices (e.g., cushion blocks, dewatered casings or enclosed bubble curtains around each pile to be driven) if feasible.

[5] Note that these work windows are subject to change in consultation with NMFS.

    - If possible, drive piles during low tide periods, preferably when substrates are exposed in intertidal areas.
- Prior to the commencement of pile driving and pile removal, Environmental Observers must perform a visual scan with a radius of 1,000 meters (1,094 yards) around the project site. If any ESA-listed marine mammals, sea turtles, sawfish, sturgeon, or sharks are observed within these safety zones, work will not begin until the Environmental Observers are confident the animal has moved out of the area on its own volition. If an animal is seen above water then dives below, the Coast Guard, or servicing entity will not begin pile driving activities until enough time has elapsed without a sighting (at least 15 minutes for pinnipeds and 30 minutes for cetaceans) to assume the animal has moved beyond the safety zone. Environmental Observers must remain alert for protected species from 30 minutes prior to commencement of work until 30 minutes after shut-down. If ESA-listed marine mammals, sea turtles, sawfish, sturgeon, or sharks move within the safety zone during pile driving and pile removal, Coast Guard or servicing entity must cease the activity when safe to do so and not continue until the Environmental Observers are confident the animal has moved out of the area on its own volition. If an animal is seen above water then dives below, the Coast Guard or servicing entity will not begin pile driving activities until enough time has elapsed without a sighting (at least 15 minutes for pinnipeds and 30 minutes for cetaceans) to assume the animal has moved beyond the safety zone.
- Avoid beginning pile driving or pile removal after dark. If pile driving must occur during periods of darkness, use all available means to allow Environmental Observers to detect marine mammals and sea turtles that may be located within that zone (e.g., use thermal imaging or night vision technology). The entire safety zone must be visible to the Environmental Observer for pile driving to commence.

ESA-Listed Species Interactions

- Coast Guard crew members must not attempt to feed, touch, or otherwise intentionally interact with any ESA-listed species.
- Any collision with and/or injury to any sea turtle, sawfish, marine mammal, or sturgeon must be reported immediately to NMFS's Office of Protected Resources (301-427-8400) or e-mail: cathy.tortorici@noaa.gov. If applicable, the local authorized sea turtle or marine mammal stranding/rescue organization must be contacted as well.
- All Coast Guard crew members must be advised that there are civil and criminal penalties for harming, harassing, or killing species protected under the ESA and the Marine Mammal Protection Act of 1972.
- Any activity that unexpectedly harms or harasses species under NMFS's authority must be reported immediately to NMFS's Office of Protected Resources to aid future consultations.

1.3.5.3 Coast Guard Districts 1 and 5 – Endangered Species Act

- All vessels 65 ft (19.8 m) or longer must travel at 10 knots or less in certain Seasonal Management Areas (http://www.nmfs.noaa.gov/pr/shipstrike/#speedlimit) along the U.S.

Atlantic seaboard at certain times of the year to reduce the threat of ship collisions with critically endangered North Atlantic right whales.

- Environmental Observers are responsible for ensuring that their vessel is entered into the Mandatory Ship Reporting System when transiting through North Atlantic Right Whale critical habitat. Environmental Observers should also check with various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.
- If a North Atlantic right whale is observed, federal regulation prohibits approaching the whale closer than 500 yards unless permitted by NMFS or one of the limited exemptions applies (see 50 CFR 224.103(c)).
- All in-water work shall be postponed or halted, when safe to do so, if a North Atlantic right whale is spotted within 500 yards. Activities may not resume until the whale has departed the project area of its own volition.

1.3.5.4 Coast Guard Districts 1 and 5 – Essential Fish Habitat

General

- If operationally feasible, use seasonal restrictions to avoid impacts to habitat during species critical life history stages (e.g., spawning and egg development periods). Recommended seasonal work windows are generally specific to regional or watershed-level environmental conditions and species requirements. Seasonal restrictions can be found in Appendix G.
- When feasible, use tools (e.g. scuba divers, bottom viewers, high resolution video-equipped remote operating vehicles) when conducting operations in sensitive areas on ATON to verify bottom type and habitats; and to facilitate the removal of the existing ATON or placement of new equipment to minimize adverse effects to these habitats.
- When operationally possible, avoid anchoring vessels on substrate supporting seagrasses, hardbottom, and other sensitive habitats, instead use the dynamic positioning systems on vessels that are equipped with such systems.
- To the extent practicable, avoid placement of ATON in seagrass habitats.
- If floating ATON must be placed in or near seagrass habitats, the size of the floating ATON should be minimized to only what is necessary to meet navigational requirements so that the corresponding footprint of the buoy sinker is only as large as necessary.
- Maximize the accuracy of sinker replacements on or near seagrass habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers.
- To the extent possible, avoid use of drag hooks for recovery of ATON anchors and/or chain in areas where seagrass habitats occur.

Pile Installation

- Avoid the use of treated wood timbers or pilings to the extent practicable. The use of alternative materials such as untreated wood or steel is recommended. Wood and steel pilings are considered to be less damaging, and generally do not release contaminants into the aquatic environment. Please also see Essential Fish Habitat Conservation Recommendation 1 in Section 3.4.

- Use a vibratory hammer to install piles, when possible. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
- To the maximum extent possible, implement measures to attenuate the sound or minimize impacts to aquatic resources during piling installation. Methods to mitigate sound impacts include, but are not limited to, the following:
    - If equipped, surround the pile with an air bubble curtain system or dewatered cofferdam.
    - If possible, drive piles during low water conditions for intertidal areas.

Pile removal

- When possible, remove creosote-coated piles completely rather than cutting at the sediment line or breaking off the pile. Ensure creosote piles are not returned to service and are disposed of as hazardous waste, and in accordance with Coast Guard policy. Replace any creosote treated piles with non-creosote treated piles.
- To the maximum extent practical, minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    - When feasible, remove piles with a vibratory hammer rather than a direct pull or clamshell method.
    - Slowly remove pile to allow sediment to slough off at or near the mudline.
    - Shake or vibrate the pile before pulling to break the bond between the sediment and the pile. Doing so will reduce the likelihood that the pile will break and the amount of sediment sloughed.
    - If equipped, encircle the pile or piles with silt containment devices that extend from the surface of the water to the substrate.
- When practicable, remove broken/cut piling stubs.
- Address the cumulative impacts of past, present, and foreseeable future development activities on aquatic habitats by considering them in the review process for pile driving projects.

1.3.5.5 Coast Guard Districts 5, 7, and 8 – Endangered Species Act

- All vessels 65 feet (19.8 meters) or longer must travel at 10 knots or less in certain Seasonal Management Areas (http://www.nmfs.noaa.gov/pr/shipstrike/#speedlimit) along the U.S. Atlantic seaboard at certain times of the year to reduce the threat of ship collisions with critically endangered North Atlantic right whales.
- Environmental Observers are responsible for ensuring that any Coast Guard vessel entering North Atlantic right whale critical habitat reports into the Mandatory Ship Reporting System. Environmental Observers should also check with various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sighting locations. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.

- If a North Atlantic right whale is observed, federal regulation prohibits approaching a right whale closer than 500 yards unless permitted by NMFS or one of the limited exemptions applies (see 50 CFR 224.103(c)).
- All in-water work must be postponed or halted if a North Atlantic right whale is spotted within 500 yards. Activities may not resume until the whale has departed the project area of its own volition.
- Mangroves are not authorized for removal.
- Prior to establishment, maintenance , or discontinuance of ATON structures, determine if Johnson's seagrass or corals are known to occur in that location or the surrounding area. When seagrass or coral habitat may be present and when feasible (i.e., when divers are onboard or when water clarity allows), the Environmental Observer will use tools (e.g., scuba divers, bottom viewers, high resolution video-equipped remote operating vehicles) to verify bottom type and habitats.
- Minimize spudding down when conducting ATON operations in coral habitats. Additionally, minimize the repositioning of spuds.
- Anchoring of vessels is prohibited on coral habitats during ATON operations. During ATON operations occurring in coral habitat, the Coast Guard must use the dynamic positioning systems on vessels that are equipped with such systems to maintain position rather than anchoring.
- Drag hooks are not permitted for recovery of ATON components (e.g., anchors, chain, pilings) in areas where ESA-listed corals and Johnson's seagrass may occur.
- The Coast Guard will take representative photos of corals found growing on submerged ATON structures when they are brought to the surface for removal (e.g., pilings) or maintenance (e.g., sinkers, buoy chains). Photos are not required for every ATON but rather instances of dense growth and at reasonable intervals during maintenance[6]. These photos should then be forwarded to NMFS Southeast Regional Office for analysis.
- When divers are used during ATON maintenance in coral habitats, the Coast Guard should document coral presence within and outside the chain scour area. The Coast Guard should take representative photos of benthic habitat within and immediately outside the chain scour area. These photos should then be forwarded to NMFS Southeast Regional Office for analysis. Photos are not required for every ATON but rather at reasonable intervals during maintenance[7].
- Coast Guard must maximize the accuracy of sinker replacements on or near reef and seagrass habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers. Additionally, per COMDTINST M16500.1D, all buoys in reef and seagrass habitats must be assigned the minimum positioning tolerance.
- Following ATON maintenance, do not dump debris over habitats with live coral cover or Johnson's seagrass.

[6] Reasonable intervals will be determined by NMFS and the Coast Guard ATON program. The intervals are likely to change through time. More pictures will likely be required during the first few years this consultation is implemented.

[7] Reasonable intervals will be determined by NMFS and the Coast Guard ATON program. The intervals are likely to change through time. More pictures will likely be required during the first few years this consultation is implemented.

- Avoid establishment of ATON in nearshore reproductive habitat within loggerhead turtle designated critical habitat in the Northwest Atlantic Ocean.
- To minimize the number of ESA-listed coral bundles/planula exposed to disturbance during ATON activities, in-water work in areas where ESA-listed corals occur should be minimized during or immediately following mass-spawning events of ESA-listed corals.[8]
- The Coast Guard will adhere to NMFS's *Sea Turtle and Smalltooth Sawfish Construction Conditions* (http://sero.nmfs.noaa.gov/protected_resources/section_7/guidance_docs/documents/sea_turtle_and_smalltooth_sawfish_construction_conditions_3-23-06.pdf)

1.3.5.6 Coast Guard Districts 5, 7, and 8 – Essential Fish Habitat

General

- Impacts to seagrass, oysters, hardbottom, and corals during ATON operations should be avoided to the maximum extent practicable.
- Prior to commencement of ATON operations, ATON structure locations should be compared with available data and maps to determine if seagrasses, hardbottom, or coral reefs occur at the location or in the surrounding area.
- For Coast Guard Districts 5 and 8, to the extent possible, avoid the use of drag hooks for recovery of ATON anchors and/or chain in areas where coral, hardbottom, or seagrass may occur. For Coast Guard District 7, drag hooks are not permitted to be used for recovery of ATON anchors and/or chain in areas where coral, hardbottom, or seagrass may occur. Secondary impacts to seagrass, oyster, hardbottom, and coral habitats should be avoided during ATON operations to the extent practicable. These types of impacts may occur from anchoring ATON service vessels within these habitats, prop dredging of these habitats by service vessels within the project area. To minimize secondary impacts on these habitats Coast Guard activities should incorporate best management practices (BMPs) designed to avoid and minimize impacts to the extent practicable. Example BMPs include:
    - Installing turbidity barriers (if equipped) to minimize sedimentation of adjacent habitats.
    - When equipped with a dynamic positioning system, vessels should use the system during ATON operations occurring in coral, hardbottom or seagrass habitat. However, as practicable, the ATON service vessel should be sited in deeper water, in areas devoid of these habitats.
    - When feasible, use appropriate tools (e.g. in-situ observations made by scuba divers, bottom viewers, high resolution video-equipped remotely operated vehicles) capable of verifying bottom type and habitats; to increase the positional

[8] In Florida and the Caribbean, these events typically occur at night 1-14 days after the full moon in July, August, and/or September. If additional information become available following the issuance of this opinion to inform this PDC, NMFS will inform the Coast Guard.

accuracy of installing equipment; and to facilitate the removal of the existing ATON or placement of new equipment to minimize adverse effects to these habitats.

ATON and Sinker Placement

- The length of the ATON anchor chain should be limited to the shortest practicable length required to hold the buoy in place.
- Coast Guard should maximize the accuracy of sinker replacements on or near coral reef and seagrass habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers.

Pile Installation

- When practicable, use smaller diameter pilings for construction in or close to seagrass, oysters, hardbottom, and corals. However, when this results in a larger number of pilings and pile strikes, the use of larger pilings should be considered.
- Use a vibratory hammer to install piles, to the extent practicable. When conditions require impact hammers (for reasons of seismic stability or substrate type) it is recommended the pile first be driven as deep as possible with a vibratory hammer prior to the use of an impact hammer.
- To the extent practicable implement measures to attenuate the sound or minimize impacts to aquatic resources during piling installation. Methods to mitigate sound impacts include, but are not limited to, the following:
    - Surround the pile with an air bubble curtain system, dewatered cofferdam, or isolation casings.
    - Use cushion blocks for additional sound attenuation. Consider the size of the piling when choosing the cushion block material. Larger pilings should not use wood cushion blocks, as the driving energy and heat generated in a cushion may cause a fire.

Pile removal

- When possible, remove creosote-coated piles completely rather than cutting at the sediment line or breaking off the pile. Ensure creosote piles are not returned to service and are disposed of as hazardous waste, and in accordance with Coast Guard policy. Replace any creosote treated piles with non-creosote treated piles.
- To the maximum extent practical, minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    - When practicable, remove piles with a vibratory hammer rather than with the direct pull or clamshell method.
    - Hit or vibrate the pile first to break the bond between the sediment and pile to minimize the potential for the pile to break, as well as reduce the amount of sediment sloughing off the pile during removal.

- Remove the pile slowly to allow sediment to slough off at or near the mudline.
- Encircle the pile or piles with silt containment devices that extend from the surface of the water to the substrate.
- When practicable, remove broken/cut piling stubs.

1.3.5.7 Coast Guard Districts 11 and 13 – Endangered Species Act

- If a North Pacific Right Whale is observed, do not approach the animal head-on or within 500 yards unless permitted by NMFS. If in areas where right whales may occur, assume all whales are right whales unless the animal is positively identified as another species.
- All in-water work shall be postponed or halted if a North Pacific right whale is spotted within 500 yards. Activities may not resume until the protected species has departed the project area of its own volition.
- If a Southern Resident Killer Whale is observed, do not approach the animal head-on or within 200 yards unless permitted by NMFS. If in areas where Southern Resident Killer whales may occur, assume all whales are Southern Resident Killer whales unless the vessel is in an area where a North Pacific Right whale may occur or unless the animal is positively identified as another species.
- When safe to do so, all in-water work shall be postponed or halted if a Southern Resident Killer whale is spotted within 200 yards. Activities may not resume until the protected species has departed the project area of its own volition.
- When conducting ATON operations in critical habitat for salmonids, ATON location must be compared with available data and maps to determine if eelgrass is known to occur in that location or the surrounding area.
- Avoid anchoring of vessels on eelgrass habitat.
- During ATON operations occurring in eelgrass habitat, the Coast Guard must use the dynamic positioning systems on vessels that are equipped with such systems to maintain position rather than anchoring.
- In areas where eelgrass may occur, do not use drag hooks unless necessary to detect and remove a navigational hazard. If possible, use side scan sonar to detect submerged hazards instead of drag hooks.
- Coast Guard should maximize the accuracy of sinker replacements on or near eelgrass habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers.
- When conducting ATON operations in designated critical habitat for Puget Sound/Georgia Basin rockfish, ATON location must be compared with available data and maps to determine if kelp is known to occur in that location or the surrounding area.
- Avoid anchoring of vessels on kelp habitat.
- During ATON operations occurring in kelp habitat, the Coast Guard must use the dynamic positioning systems on vessels that are equipped with such systems to maintain position rather than anchoring.

- In areas where kelp may occur, do not use drag hooks unless necessary to detect and remove a navigational hazard. If possible, use side scan sonar to detect submerged hazards instead of drag hooks.
- Coast Guard should maximize the accuracy of sinker replacements on or near kelp habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers.
- For ATON maintenance within the range of white or black abalone, Coast Guard crew should be vigilant in their search for abalone attached to ATON structures.
    - If an abalone is observed during maintenance activities on an ATON component that does not need to be replaced, the individual must not be harmed or touched, a photograph should be taken of the animal, and the location of the ATON should be noted. NMFS WCR staff should then be notified of the sighting via the following email address (susan.wang@noaa.gov) or telephone number (562-980-4199).[9]
    - If an abalone is observed on an ATON component (e.g., buoy hull, chain, or sinker) that must soon be replaced, delay doing so until the abalone has been relocated by individuals permitted to do so (only if doing so would not pose a navigational hazard).
    - Prior to removing and replacing pilings in black abalone critical habitat, conduct a dive or snorkel survey of the piling to determine if an individual of the species is attached. If a black abalone is observed attached to the piling, the individual must not be harmed or touched, a photograph should be taken of the animal, and the location of the ATON should be noted. NMFS WCR staff should then be notified of the sighting via the email address or telephone number listed above. Unless delaying removal and replacement of the piling causes a navigational hazard, the piling should not be removed until the abalone has been relocated by individuals permitted to do so.
- To the extent practicable, avoid establishment of ATON within black abalone critical habitat.

1.3.5.8 Coast Guard Districts 11 and 13 – Essential Fish Habitat

General

- In District 11, California, ATON operations should follow eelgrass monitoring requirements put forth in the California Eelgrass Mitigation Policy (CEMP) (found in Appendix I), and the Caulerpa Control Protocol (found in Appendix I), whenever possible.

[9] If this contact information changes, NMFS will notify the Coast Guard in writing.

- Coast Guard will take steps to minimize any adverse effects to any eelgrass that may be present within the action area of any ATON establishment, maintenance and discontinuance activities.
- When operationally possible, use seasonal restrictions (found in Appendices H and J) to avoid impacts to habitat during species critical life history stages (e.g., spawning and egg development periods). Recommended seasonal work windows are generally specific to regional or watershed-level environmental conditions and species requirements.
- Coast Guard should maximize the accuracy of sinker replacements on or near eelgrass habitats through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers.

Pile Installation

- Avoid the use of treated wood timbers or pilings to the extent practicable. The use of alternative materials such as untreated wood or steel is recommended. Wood and steel pilings are generally considered to be less damaging and generally do not release contaminants into the aquatic environment.
- Use a vibratory hammer to install piles, when possible. Under those conditions where impact hammers are required (i.e. substrate type and seismic stability) the pile should be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer. This will minimize noise impacts.
- To the maximum extent possible, implement measures to attenuate the sound or minimize impacts to aquatic resources during piling installation. Methods to mitigate sound impacts include, but are not limited to, the following:
    - If equipped, surround the pile with an air bubble curtain system, or other suitable sound attenuation measure, when impact driving hollow steel piles larger than 16-inches in diameter.
    - If possible, drive piles during low tide periods, preferably when substrates are exposed in intertidal areas. This minimizes the direct impacts to fish from sound waves and minimizing the amount of sediments re-suspended in the water column.

Pile Removal

- When possible, remove creosote-coated piles completely rather than cutting at the sediment line or breaking off the pile. Ensure creosote piles are not returned to service and are disposed of as hazardous waste, and in accordance with Coast Guard policy. Replace any creosote treated piles with non-creosote treated piles.
- Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    - When feasible, remove piles with a vibratory hammer rather than a direct pull or clamshell method.
    - Slowly remove pile to allow sediment to slough off at or near the mudline.

  - Shake or vibrate the pile before pulling to break the bond between the sediment and the pile. Doing so will reduce the likelihood that the pile will break and the amount of sediment sloughed.
  - If equipped, encircle the pile with a silt curtain that extends from the surface of the water to the substrate, where appropriate and feasible.
- When practicable, remove broken/cut piling stubs.

1.3.5.9 Coast Guard District 14 – Endangered Species Act

- In AORs where ESA-listed corals have been documented, anchoring of vessels is prohibited on coral habitats during ATON operations. During ATON operations occurring in coral habitat in AORs where ESA-listed corals have been documented, the Coast Guard must use the dynamic positioning systems on vessels that are equipped with such systems to maintain position rather than anchoring.
- In AORs where ESA-listed corals have been documented, minimize spudding down on coral habitats during ATON operations . Additionally, minimize the repositioning of spuds.
- Drag hooks are not permitted for recovery of ATON components (e.g., anchors, chain, pilings) in areas where ESA-listed corals have been documented.
- In AORs where ESA-listed corals have been documented, the Coast Guard will take representative photos of corals found growing on submerged ATON structures when they are brought to the surface for removal (e.g., pilings) or maintenance (e.g., sinkers, buoy chains). These photos should be then be forwarded to NMFS Pacific Islands Regional Office for analysis on a quarterly basis. Photos are not required for every ATON but rather at reasonable intervals during maintenance[10].
- When divers are used during ATON maintenance in AORs where ESA-listed corals have been documented, the Coast Guard should document coral presence within and outside the chain scour area. The Coast Guard should take representative photos of benthic habitat within and immediately outside the chain scour area. These photos should then be forwarded to NMFS Pacific Islands Regional Office for analysis. Photos are not required for every ATON but rather at reasonable intervals during maintenance[11].
- Coast Guard must maximize the accuracy of sinker replacements in AORs where ESA-listed corals have been documented through utilization of the ship's most accurate navigation and positioning systems and the careful lowering of sinkers. Additionally, per

[10] Reasonable intervals will be determined by NMFS and the Coast Guard ATON program. The intervals are likely to change through time. More pictures will likely be required during the first few years this consultation is implemented.
[11] Reasonable intervals will be determined by NMFS and the Coast Guard ATON program. The intervals are likely to change through time. More pictures will likely be required during the first few years this consultation is implemented.

COMDTINST M16500.1D, all buoys in reef and seagrass habitats must be assigned the minimum positioning tolerance.

- Following ATON maintenance, avoid dumping debris over habitats with live coral cover.

1.3.5.10 Coast Guard District 14 – Essential Fish Habitat

General

- When divers are used during ATON operations in AORs, determine and document (with digital images) coral presence within and outside the chain scour area. The Coast Guard should take representative photos of benthic habitat within and immediately outside the chain scour area. These photos should then be forwarded to NMFS Pacific Islands Regional Office for analysis. When Coast Guard divers are not available, and when possible, look for ways to coordinate with other federal and state agencies to determine and document coral presence within and outside the chain scour area of ATON.
- Avoid, wherever possible, re-deployment of ATON structures and associated chain scour on or immediately adjacent to substrate colonized by seagrass or coral.
- Relocate, wherever possible, assigned positions of ATON currently installed on or directly adjacent to substrate colonized by coral and seagrass.
- Use SCUBA divers where and whenever possible to conduct operations on ATONs located on live reef environments.
- Implement ATON design alternatives that avoid and minimize ATON associated impacts to coral and seagrass habitat.
- Avoid anchoring of vessels on coral and seagrass substrates.
- Place sinkers as close to assigned positions as possible through utilization of the ship's most accurate navigation and dynamic positioning systems and appropriate chain and sinker weighting.
- Avoid ATON failure through appropriate maintenance frequency.
- Time ATON post replacements to coincide with calm ocean conditions and ensure barge stabilization and post replacement avoids/minimizes impacts to corals and seagrass.
- Avoid dragging hooks or other structures for ATON sinkers and/or chain recovery in areas where coral and/or seagrass occur.
- Work with NMFS PIRO to establish and implement a D14 coral relocation plan for corals encountered on ATON structures during establishment, maintenance, and discontinuance activities. Once the plan is finalized, it will be appended to these BMPs, and/or EFH Conservation Recommendations.

Pile Installation

- Avoid the use of treated wood timbers or pilings to the extent practicable. The use of alternative materials such as untreated wood or steel is recommended. Wood and steel pilings are generally considered to be less damaging and generally do not release contaminants into the aquatic environment.
- Use a vibratory hammer to install piles, when possible. Under those conditions where impact hammers are required (i.e. substrate type and seismic stability) the pile should be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer. This will minimize noise impacts.

- To the maximum extent possible, implement measures to attenuate the sound or minimize impacts to aquatic resources during piling installation. Methods to mitigate sound impacts include, but are not limited to, the following:
    - If equipped, surround the pile with an air bubble curtain system, or other suitable sound attenuation measure, when impact driving hollow steel piles larger than 16-inches in diameter.
    - If possible, drive piles during low tide periods, preferably when substrates are exposed in intertidal areas. This minimizes the direct impacts to fish from sound waves and minimizing the amount of sediments re-suspended in the water column.

Pile Removal

- When possible, remove creosote-coated piles completely rather than cutting at the sediment line or breaking off the pile. Replace any creosote treated piles with non-creosote treated piles.
- When possible, barges used to transport piles and debris should be equipped with a basin to contain all attached sediment and runoff water after removal. The contaminated sediments and water should be disposed of at an approved upland facility.
- To the maximum extent practicable, minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    - When feasible, remove piles with a vibratory hammer rather than a direct pull or clamshell method.
    - Slowly remove pile to allow sediment to slough off at or near the mudline.
    - Shake or vibrate the pile before pulling to break the bond between the sediment and the pile. Doing so will reduce the likelihood that the pile will break and the amount of sediment sloughed.
    - If equipped, encircle the pile with a silt curtain that extends from the surface of the water to the substrate, where appropriate and feasible.
- When practicable, remove broken/cut piling stubs.

1.3.5.11 Coast Guard District 17 – Endangered Species Act

- If a North Pacific Right Whale or Beluga whale is observed, do not approach the animal head-on or within 500 yards unless permitted by NMFS. If in areas where these species may occur, assume all whales are either right or Beluga whales unless the animal is positively identified as another species.
- All in-water work shall be postponed or halted when safe if a North Pacific right or Beluga whale is spotted within 500 yards. Activities may not resume until the protected species has departed the project area of its own volition.
- When using a helicopter and unless operationally required, do not approach known haulouts and rookeries of Western DPS Steller sea lions within 1,500 feet.
    - When servicing the navigation on Sea Lion Rock in the southeastern Bering Sea, avoid flying over the rookery to the extent practicable, and approach the island

from the northwest and depart to the northwest, as the rookery is located along the south and southeastern shores. Additionally, service the aid from early May through the end of July, which includes the peak of the reproductive season when sea lions are particularly sensitive. If operationally feasible, service the aid in August or September. This PDC is not applicable if emergency repairs are required to remedy a navigational hazard.

- To minimize impacts to Cook Inlet Beluga whales, nearshore pile driving should occur within two hours of low tide (or when dewatered). Additionally, no pile driving is permitted from April 15 to October 15 in the Susitna Delta Sensitive Area (see Figure 9).

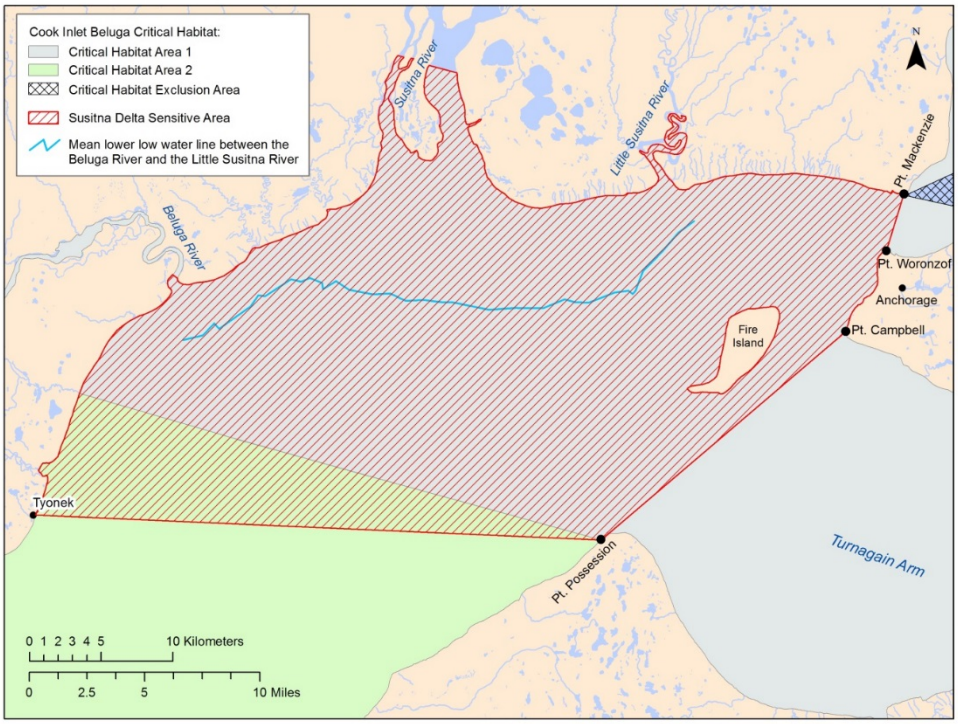


Figure 9. Susitna Delta Sensitive Area in Cook Inlet.

1.3.5.12 Coast Guard District 17 – Essential Fish Habitat

General

- Avoid anchoring vessels on substrate supporting seagrasses and other sensitive habitats.

Pile Installation

- When possible, drive piles during low tide when they are located in intertidal and shallow subtidal areas.
- If available, use a vibratory hammer to install piles, when possible. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.

- Implement measures to attenuate the sound should SPLs exceed the 180 dB (re: 1 ΦPa) threshold. If sound pressure levels are anticipated to exceed acceptable limits, implement appropriate mitigation measures when practicable. Methods to reduce the sound pressure levels include, but are not limited to, the following:
    - If equipped, surround the pile with an air bubble curtain system or dewatered cofferdam.
    - Because the sound produced has a direct relationship to the force used to drive the pile, use a smaller hammer to reduce sound pressures.
    - Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
    - Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

Pile Removal

- Minimize the suspension of sediments and disturbance of the substrate when removing piles. Measures to help accomplish this include, but are not limited to, the following:
    - When practicable, remove piles with a vibratory hammer, rather than using the direct pull or clamshell method.
    - Remove the pile slowly to allow sediment to slough off at, or near, the mudline.
    - The operator should first hit or vibrate the pile to break the bond between the sediment and the pile to minimize the potential for the pile to break, as well as to reduce the amount of sediment sloughing off the pile during removal.
    - If equipped, encircle the pile, or piles, with a containment device, such as a containment curtain, that extends from the surface of the water to the substrate/seafloor.
- When possible, remove creosote-coated piles completely rather than cutting at the sediment line or breaking off the pile. Ensure creosote piles are not returned to service and are disposed of as hazardous waste, and in accordance with Coast Guard policy. Replace any creosote treated piles with non-creosote treated piles.
- If available, place piles on a barge equipped with a basin to contain attached sediment and runoff water after removal. Creosote-treated timber piles, and associated debris should be disposed of properly in a contained upland area, far removed from where surface run-off could then re-introduce toxins back into flowing or marine waters.

1.3.6 Policies and Procedures for Discontinuance of Federal Navigation Aids

Discontinuance means the permanent removal of a navigation aid. The proposed action does not involve the discontinuance of specific ATON, but includes the policies and procedures in place for such an action. Primary responsibility for deciding to discontinue ATON lies with the Coast Guard Commandant. The Commandant discontinues ATON that are considered redundant and potentially confusing to mariners and ATON established where no current need exists. ATON

may also be discontinued for economic reasons, such as when the benefit to mariners is outweighed by the costs of maintenance.

Environmental compliance for the discontinuance of a federal navigation aid

Any specific ATON to be removed will require site-specific information on the exact location, type of aid, method of discontinuance, and other details of the project. If ESA-listed resources may be affected by the removal of that particular ATON, a separate consultation would be conducted for each instance where an ATON is to be discontinued. Though the PDC described in Section 1.3.5 of this opinion were developed for ATON maintenance, the Coast Guard will also adhere to these PDC when discontinuing navigation aids to the extent practicable.

Though the PDC described in Section 1.3.5 of this opinion were developed primarily for ATON maintenance, because the physical actions of discontinuing ATON are nearly identical to those of maintaining ATON, the Coast Guard will adhere to applicable PDC when discontinuing navigation aids (Andrew Haley, email communication to Eric MacMillan, NMFS; October 18, 2017).

1.3.7 Monitoring, Reporting, and Review of Program Activities

The activities described above will be carried out on an as-needed basis over a period of years. All individual maintenance events must incorporate applicable PDC (see section 1.3.5), and must not exceed the predicted take outlined in the incidental take statement in this opinion. For any maintenance activities that do not meet these conditions, a separate consultation would be required. Any specific ATON to be established or discontinued will require a separate consultation if ESA-listed resources may be affected.

The Coast Guard will provide NMFS with an annual report that documents key aspects of the ATON program relevant to assessing impacts of the program on ESA-listed resources. The report will include information on maintenance activities conducted, as well as information on ATON established and discontinued. For maintenance activities that adhered to the PDC described in this opinion and for which take is exempted, the information described below will be provided, as well as a tabulation by the Coast Guard of the amount or extent of take of ESA-listed species during that reporting period.

- Aid name and location (Coast Guard Distict and lat/long)
- Were all PDC met?
- If pile driving/removal was conducted:
    - Number, size, and material of piles replaced
    - Installation method – impact or vibratory hammer
    - Were sound attenuation devices used (e.g., dewatered casings or enclosed bubble curtains around each pile to be driven)?
    - Were any pile driving shutdowns or delays required due to the presence of protected species?
    - Were the work windows adhered to?
- When in ESA-listed coral or Johnson's seagrass habitat:

  - Position of sinker relative to the required position of the aid for a representative number of floating aids serviced annually[12].
  - Area of chain scour (based on water depth and chain length).
  - If applicable, number and size of spuds used.
  - Were corals found growing on submerged ATON structures when brought to the surface for removal (e.g., pilings) or maintenance (e.g., sinkers, buoy chains)? Were photos taken of the structures and forwarded to NMFS?
  - Were divers used during the maintenance event and if so, were representative photos of benthic habitat within and immediately outside the chain scour area taken and forwarded to NMFS?
- Were Western DPS Steller sea lions harassed at Sea Lion Rocks in District 17? If so, how many?
- Were black or white abalone observed on ATON components?

In addition, the annual report will include information on maintenance events that were implemented without adhering to the PDC described in this opinion and for instances where ATON were established or discontinued. For these instances, a separate section 7 consultation is required if ESA-listed resources may be affected. Information included in the annual report on ATON program activities includes the following:

- Aid name and location,
- For maintenance activities, a description of deviance from PDC described in this opinion,
- Conclusions from consultation with NMFS (i.e., informal, no jeopardy/no adverse mod, jeopardy/adverse mod with reasonable and prudent alternative).

The annual report will also include the Coast Guard's evaluation on if the PDC are being complied with and are effective. Following the Coast Guard's submission and NMFS' review and evaluation of the annual report, the two agencies will confer and determine if changes need to be made to the PDC or to other aspects of the ATON program. In this manner, implementation of the ATON program will follow an adaptive management framework (e.g., Williams 2011) in which policies and operations can be adjusted iteratively as needed. This process will ensure the Coast Guard continues to fulfill their obligations under the ESA through time.

1.4 Action Area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02). The action area includes all waters of the United States that are marked by navigation aids with ESA-listed resources under NMFS jurisdiction. The Coast Guard mainly operates ATON throughout the territorial sea, from shore to 12 nm out to sea. The action area includes territorial sea of the continental United States,

[12] The representative number of floating aids will be determined by NMFS and Coast Guard. This number will likely change through time.

Puerto Rico, Virgin Islands, Hawaii, Alaska, Guam and the Mariana Islands, Midway Islands, Samoa Islands, Rota Island, Saipan, and Tinian. The Coast Guard also maintains ATON located in bays, harbors, ports, rivers, and the Gulf Intracoastal Waterway. The distribution of ATON in each Coast Guard district is presented in Figure 10 through Figure 18.

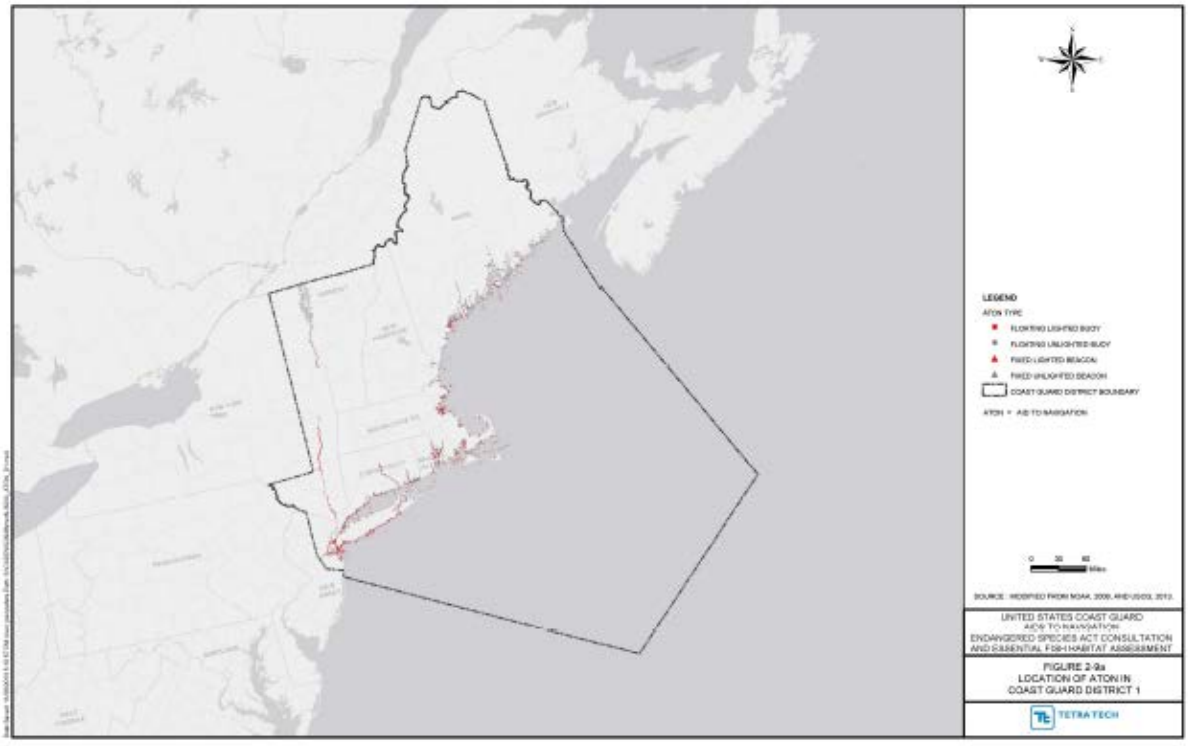


Figure 10. Location of ATON in Coast Guard District 1.

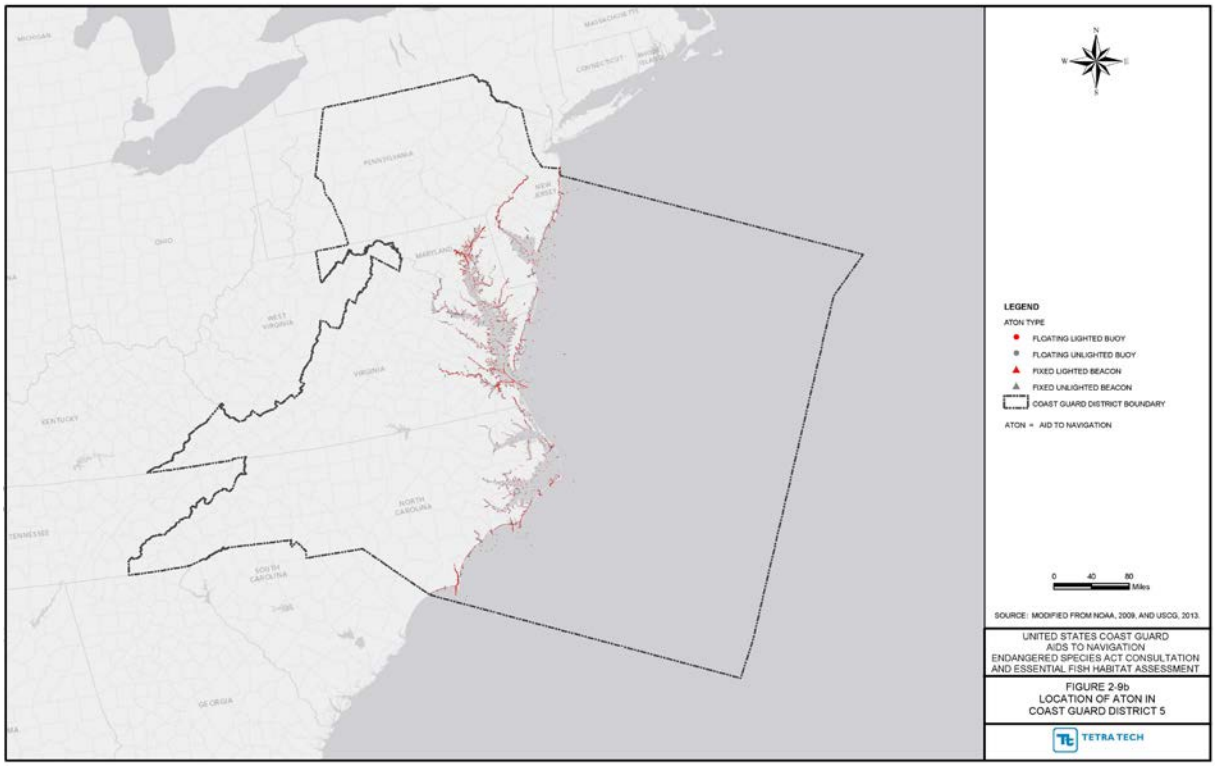


Figure 11. Location of ATON in Coast Guard District 5.

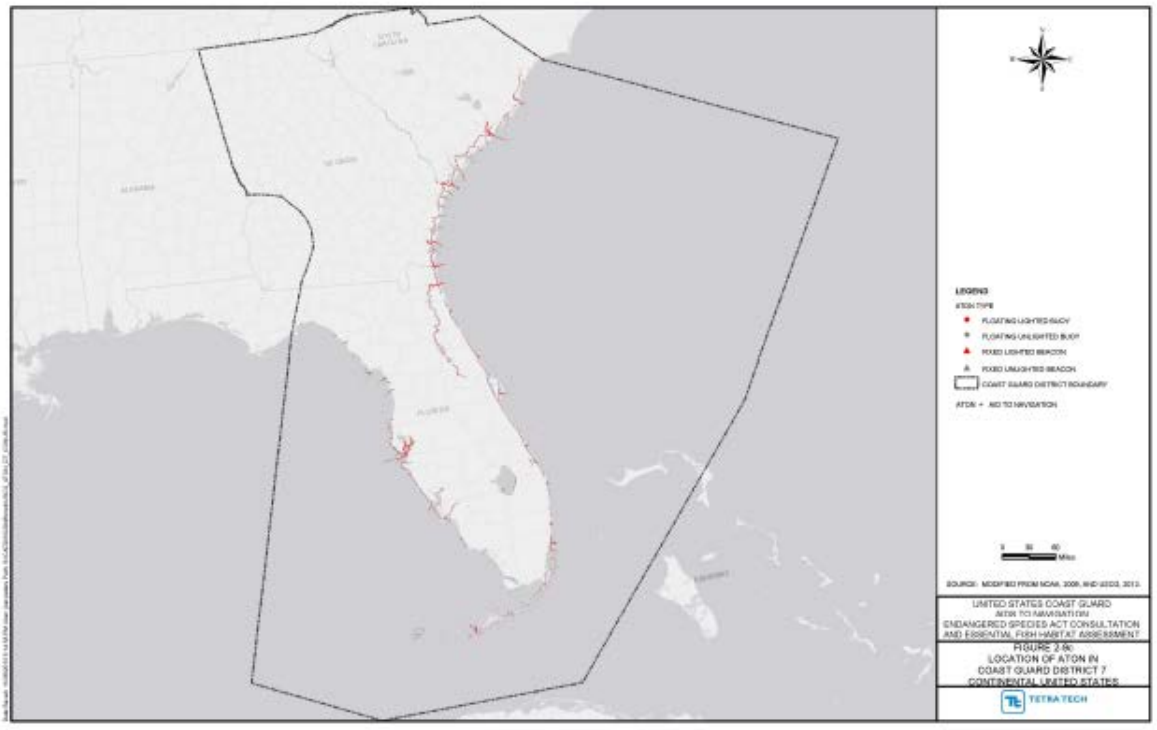


Figure 12. Location of ATON in Coast Guard District 7 in the continental United States.

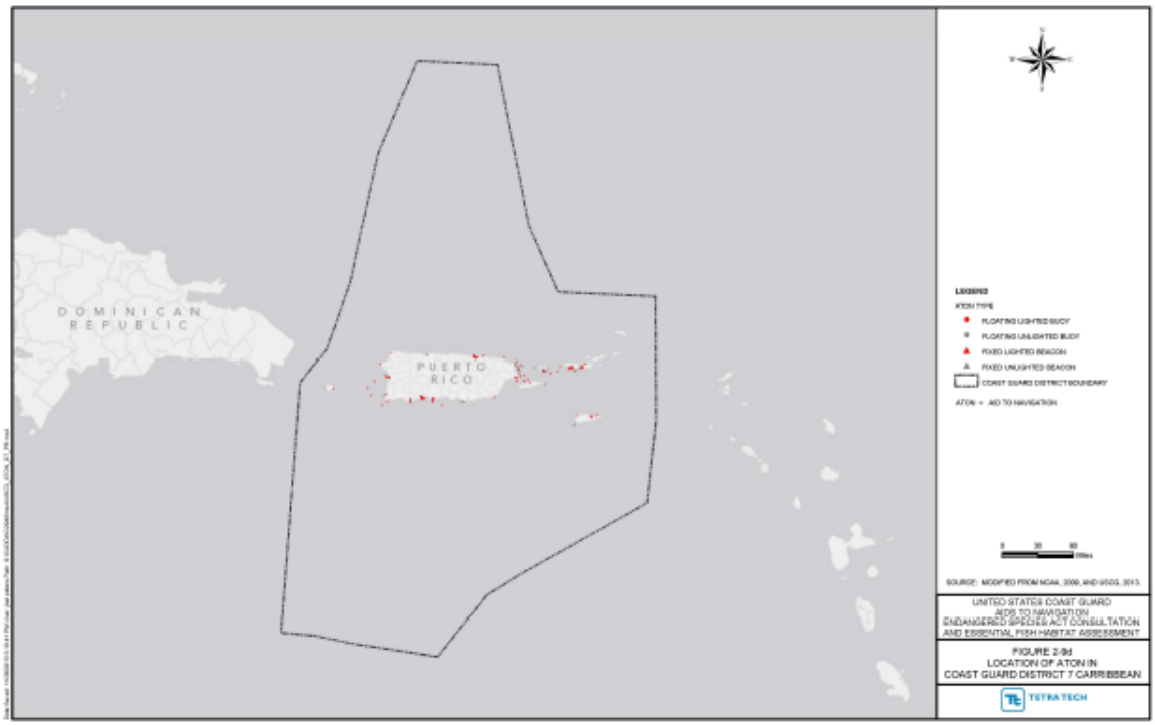


Figure 13. Location of ATON in Coast Guard District 7 in the Caribbean Sea.

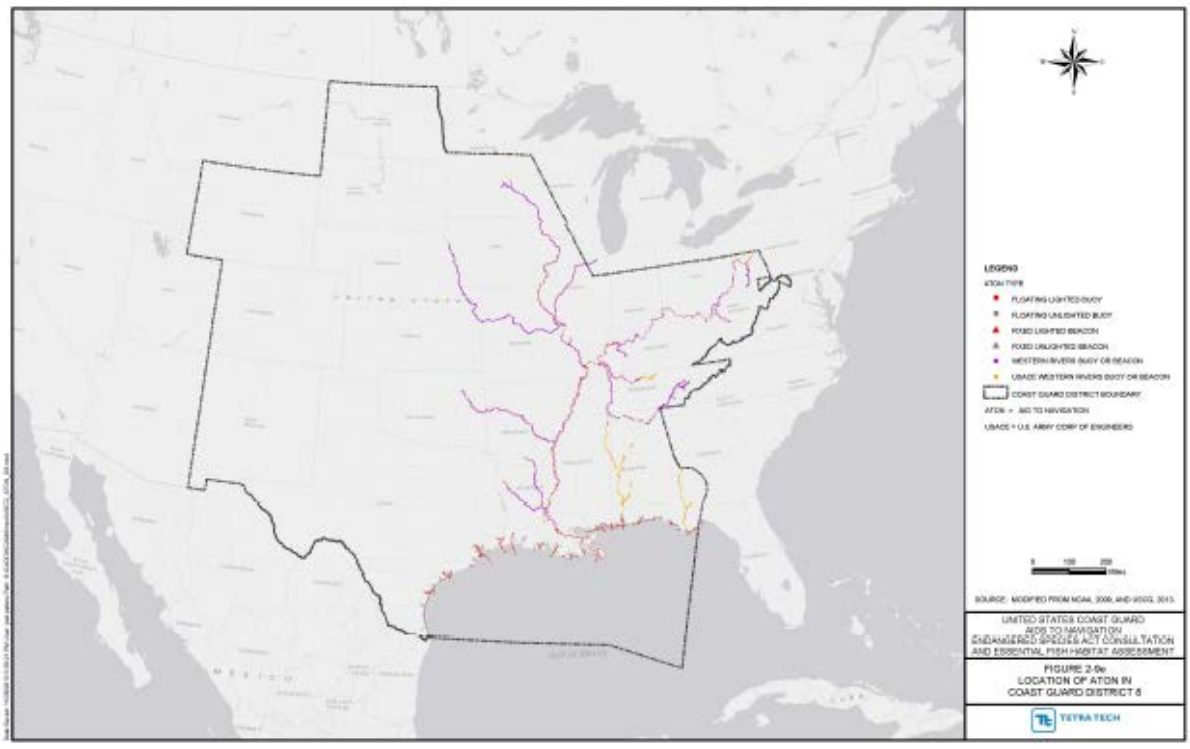


Figure 14. Location of ATON in Coast Guard District 8.



Figure 15. Location of ATON in Coast Guard District 11.

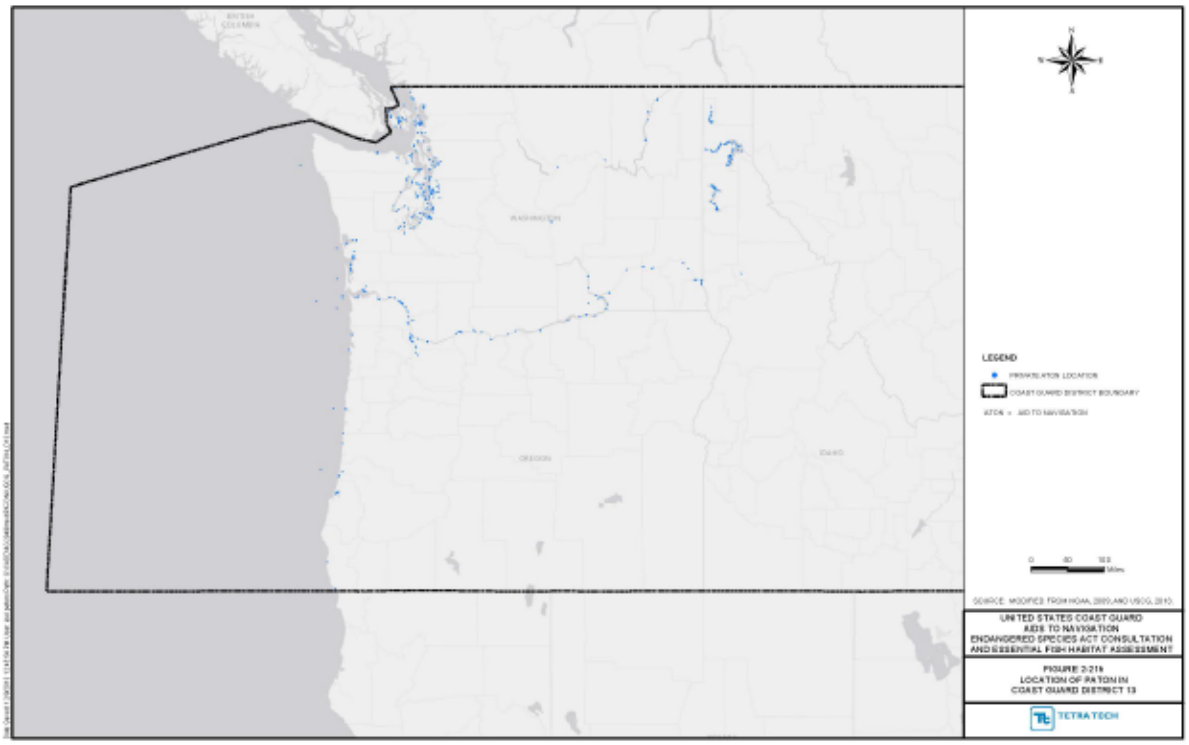


Figure 16. Location of ATON in Coast Guard District 13.

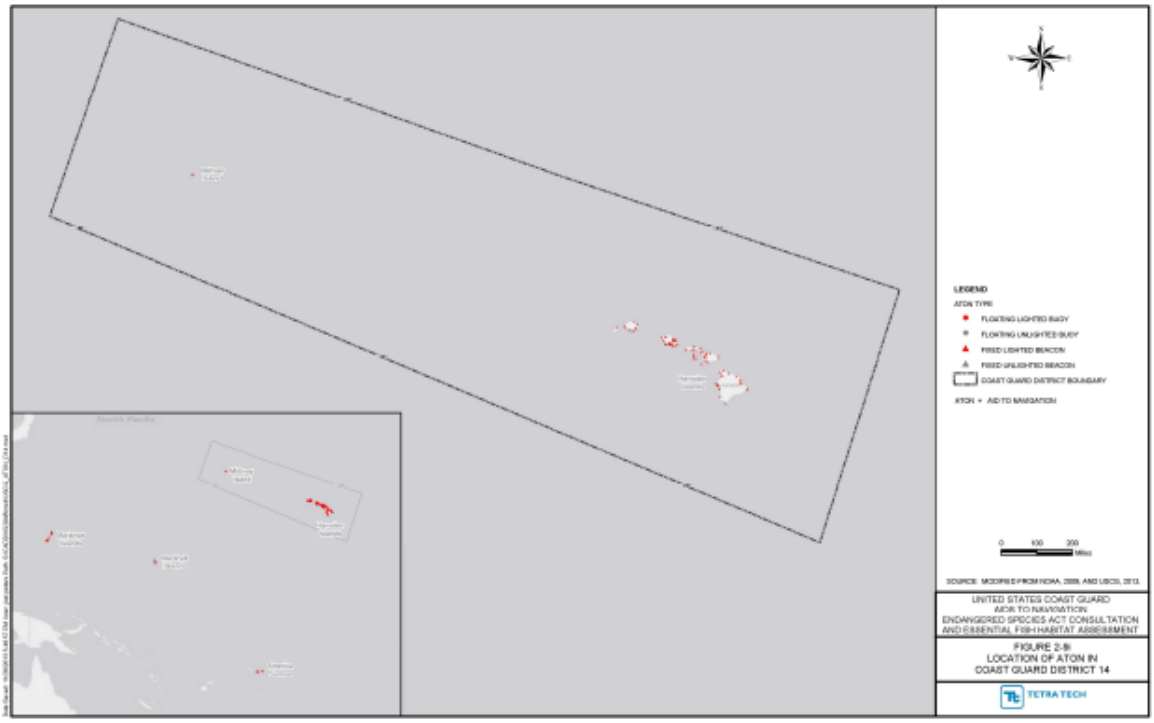


Figure 17. Location of ATON in Coast Guard District 14.

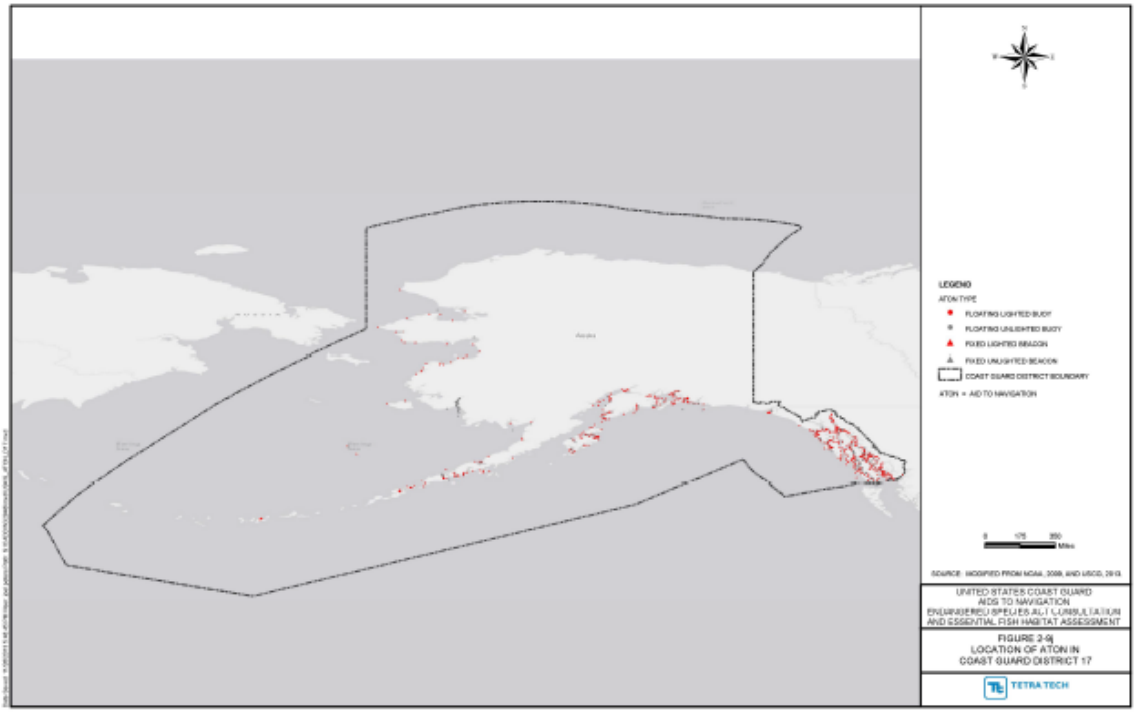


Figure 18. Location of ATON in Coast Guard District 17.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with NMFS for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concurs with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

The Federal action agency shall confer with NMFS for species under NMFS jurisdiction on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 C.F.R. §402.10)[13]. If requested by the Federal agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in §402.14.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

This consultation, biological and conference opinion, and incidental take statement were completed in accordance with section 7(a)(2) of the ESA (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance and was conducted by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division. The action agency for this consultation is the United States Coast Guard. As described further in Section 1.3, the Coast Guard proposes to continue to implement the ATON program.

[13] As described further in section 2.3.4, this consultation considers the potential effects of ATON activities on the Chambered nautilus, which was proposed for listing under the ESA on October 23, 2017 (82 FR 48948).

2.1 Assessment Framework for the Section 7 Consultation

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. §402.02.

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02). An ESA section 7 assessment involves the following steps:

1) We identify the proposed action and those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on the physical, chemical, and biotic environment within the action area, including the spatial and temporal extent of those stressors.

2) We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time, and describe the status of those species that are likely to be adversely affected.

3) We describe the environmental baseline in the action area including: past and present impacts of Federal, state, or private actions and other human activities in the action area; anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation, impacts of state or private actions that are contemporaneous with the consultation in process.

4) We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. This is our exposure analysis for ESA-listed species.

5) We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. This is our response analyses for ESA-listed species.

6) We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis for ESA-listed species.

7) The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat using the same exposure, response, and risk framework.

8) We describe any cumulative effects of the proposed action in the action area.

9) We integrate and synthesize the above factors by considering the effects of the action to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

   a) Reduce appreciably the likelihood of both survival and recovery of the ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or

   b) Reduce the conservation value of designated or proposed critical habitat.

10) We state our conclusions regarding jeopardy and the destruction or adverse modification of designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative to the action that would allow the action to proceed in compliance with ESA section 7(a)(2). The reasonable and prudent alternative also must meet other regulatory requirements.

In addition, we include an incidental take statement that specifies the impact of the "take," described below, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures. ESA section 7 (b)(4); 50 C.F.R. §402.14(i). ESA section (7)(o)(2) provides that compliance by the action agency with the terms and conditions exempts any incidental take from the prohibitions of take in ESA section 9(b) and regulations issued pursuant to ESA section 4(d).

"Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. NMFS has not yet defined "harass" under the ESA in regulation. However, on December 21, 2016, NMFS issued interim guidance on the term "harass," defining it as an action that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering" (NMFS 2016g; https://www.fisheries.noaa.gov/webdam/download/64690357). For purposes of this consultation, we relied on NMFS' interim definition of harassment to evaluate when the proposed activities

are likely to harass ESA-listed species. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

We also provide discretionary conservation recommendations that may be implemented by the action agency. 50 C.F.R. §402.14(j). Finally, we identify the circumstances in which reinitiation of consultation is required. 50 C.F.R. §402.16.

To comply with our obligation to use the best scientific and commercial data available, we conducted electronic literature searches throughout the consultation, including within NMFS Office of Protected Resource's electronic library. We examined the Coast Guard's Biological Evaluation, the literature that was cited in the Coast Guard's Biological Evaluation, and any articles we collected through our electronic searches. These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

Programmatic analysis

The section 7 regulatory definition of federal action includes federal agency programs (*see* 50 CFR §402.02). Such programs may include a collection of activities of a similar nature, a group of different actions proposed within a specified geographic area, or an action adopting a framework or policies for the development of future actions. NMFS uses programmatic consultations to evaluate the expected effects of groups of related agency actions expected to be implemented in the future.

The following elements were included in our programmatic consultation to ensure its consistency with ESA section 7 and its implementing regulations.

- The PDC or standards that will be applicable to future projects implemented under the consultation document. The PDC serve to prevent adverse effects to listed species or designated critical habitat, or to limit adverse effects to predictable levels;
- A description of the manner in which projects to be implemented under the programmatic consultation may affect ESA-listed species and critical habitat and evaluation of expected effects from covered projects;
- A process for evaluating expected, and tracking actual aggregate or net additive effects of all projects expected to be implemented under the programmatic consultation. The programmatic consultation document must demonstrate that when the PDC are applied to each project, the aggregate effect of all projects will not adversely affect ESA-listed species or designated critical habitat, or will not jeopardize ESA-listed species or destroy or adversely modify designated critical habitat, as applicable;
- Procedures for monitoring projects and validating effects predictions; and
- A comprehensive review of the program.

This programmatic consultation includes, where sufficient information is available, an analysis of the likely effects of future actions implemented under the ATON program on ESA-listed resources. For these actions, this consultation identifies PDC and includes an incidental take statement where appropriate (i.e., if take is anticipated). For other actions under the ATON program where the Coast Guard does not currently have enough site specific information to conduct a full analysis of effects on ESA-listed resources, this consultation includes an evaluation of the policies of the ATON program to ensure that the Coast Guard will not implement actions that adversely affect individuals or designated critical habitats to the degree that could jeopardize the survival or recovery of any species or result in destruction or adverse modification of designated critical habitat. Any incidental take resulting from these actions subsequently authorized, funded, or carried out under the program will be addressed in subsequent section 7 consultations, as appropriate.

2.2 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent utility apart from the action under consideration. NMFS determined that there are no interrelated or interdependent actions to the proposed action of the implementation of the Coast Guard's ATON program.

2.3 Species and Critical Habitat Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed or critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-listed species in Table 4 and we summarize our results below.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial, insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but

will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

The species in Table 4 occur within the action area, but are not likely to be adversely affected by ATON activities that incorporate applicable PDC (see section 1.3.5).

Table 4. Species and critical habitat occurring in the action area that are not likely to be adversely affected by ATON activities.

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Beluga Whale (*Delphinapterus leucas*) – Cook Inlet DPS	E – 73 FR 62919	76 FR 20179	82 FR 1325
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998
Bowhead Whale (*Balaena mysticetes*)	E – 35 FR 18319	-- --	-- --
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	-- --	-- --
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	75 FR 47538
Gray Whale (*Eschrichtius robustus*) Western North Pacific	E – 35 FR 18319	-- --	-- --
Gulf of Mexico Bryde's Whale (*Balaenoptera edeni*)	E – 81 FR 88639 (Proposed)	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 FR 62259	-- --	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Western North Pacific DPS	E – 81 FR 62259	-- --	11/1991
Killer Whale (*Orcinus orca*) – Southern Resident DPS	E – 70 FR 69903	71 FR 69054	73 FR 4176
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	59 FR 28805 and 81 FR 4837	70 FR 32293
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 FR 12024	59 FR 28805 and 73 FR 19000	78 FR 34347
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584
Marine Mammals – Pinnipeds			
Bearded Seal (*Erignathus barbatus*) – Beringia DPS	T – 77 FR 76739	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 FR 51252	-- --	-- --
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 FR 51611	80 FR 50925, 53 FR 18988, and 51 FR 16047	72 FR 46966
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359
Green Turtle (*Chelonia mydas*) – Central West Pacific DPS	E – 81 FR 20057	-- --	63 FR 28359
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	10/1991
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 FR 20057	-- --	63 FR 28359
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	63 FR 28359 and 57 FR 38818
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	9/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	63 FR 28359 and 10/1991
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 FR 58868	-- --	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39856*	74 FR 2995
Olive Ridley Turtle (*Lepidochelys olivacea*) All Other Areas	T – 43 FR 32800	-- --	-- --
Olive Ridley Turtle (*Lepidochelys olivacea*) Mexico's Pacific Coast Breeding Colonies	E – 43 FR 32800	-- --	63 FR 28359
Marine Invertebrates			
Black Abalone (*Haliotis cracherodii*)	E – 74 FR 1937	76 FR 66805	-- --
White Abalone (*Haliotis sorenseni*)	E – 66 FR 29046	66 FR 29046 (Not Prudent)	73 FR 62257
Chambered nautilus (*Nautilus pompilius*) - Proposed	T – 82 FR 48948	-- --	-- --

*All federally authorized or permitted aids to navigation within the legal boundaries of loggerhead critical habitat are not included in the critical habitat designation.

The Sections below summarize our analysis and conclusion of not likely to adversely affect the ESA-listed species in Table 4. During consultation we found that the exposure, response, are risk to ESA-listed species would be similar across taxonomic groups at the class or order level. Hence, we summarize our findings below by species class.

2.3.1 Marine Mammals

Marine mammals have the potential to be affected either by the presence of ATON or during the maintenance, establishment, or discontinuance of ATON. Potential stressors to marine mammals from ATON maintenance, establishment, and discontinuance include vessel strike, pile driving, vessel and general construction noise, and displacement from habitat[14]. Potential stressors to marine mammals from the presence of ATON include sound signals and entanglement.

Vessel strike

Vessel strikes from commercial, recreational, and military vessels are known to affect large whales and have resulted in serious injury and occasional fatalities to cetaceans (Berman-Kowalewski et al. 2010; Calambokidis 2012; Douglas et al. 2008; Laggner 2009; Lammers et al. 2003). Reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (e.g., Jensen and Silber 2004; Laist et al. 2001). The ability of any ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and manning, as well as the behavior of the animal. Records of collisions date back to the early 17th century, and the worldwide number of collisions appears to have increased steadily during recent decades (Laist et al. 2001; Ritter 2012). Vessel speed and size appears to be particularly important in predicting collision rates and their outcomes (Neilson et al. 2012). For example, Silber et al. (2010) determined that during close encounters with whales, reduced ship speeds decreased the probability of a collision. Laist et al. (2001) determined that most ship strikes resulting in death or serious injury involved ships traveling 14 knots or faster and ships greater than 80 m in length.

The Coast Guard's biological evaluation limits the proposed action to vessel operations in the immediate vicinity of an ATON and transit between adjacent ATON.[15] Therefore, only vessel operations occurring at the ATON maintenance site or between adjacent ATON sites are considered in this opinion. Generally, vessel speed at the maintenance site or between adjacent ATON sites is relatively slow due to the precision with which vessels must operate during these activities. There has never been a documented instance where a vessel associated with ATON activities (i.e., vessel operations in the immediate vicinity of the ATON and transit between adjacent ATON) has struck an ESA-listed whale or pinniped.[16] Further, per the PDC described in section 1.3.5, the Coast Guard will implement a number of measures to minimize the likelihood that a vessel will strike a marine mammal. These measures include having topside crew members on the lookout for ESA-listed marine mammals, remaining at least 100 yards from all observed cetaceans and 50 yards from all observed pinnipeds while vessels are underway, and reducing

[14] Note: Effects to Western DPS steller from buoy maintenance and ATON maintenance at Sea Lion Rocks in the Eastern Aleutian Islands are discussed in section 2.6.2.1of this opinion.
[15]According to the Coast Guard's biological evaluation, transit from homeports to the ATON site are not part of the proposed action considered in this consultation because the Coast Guard categorizes this transit time as law enforcement or other activities as opposed to ATON activities.
[16] The Coast Guard biological evaluation cites several instances where Coast Guard vessels have struck ESA-listed species, but none of the collisions involved an ATON vessel.

vessel speed to 10 knots when marine mammals are observed near an underway vessel (if the animal has the potential to be impacted by the vessel).

While it is possible for a vessel to strike an ESA-listed marine mammal during the course of ATON activities, we do not believe that an ATON vessel strike is reasonably certain to occur. As stated previously, the Coast Guard has been conducting ATON activities in the action area for years and no such incident has occurred. Additionally, the Coast Guard employs minimization measures to reduce the likelihood for a strike to an marine mammals. Consequently, NMFS has determined that the likelihood of vessel strike of an ESA-listed marine mammals during Coast Guard ATON activities is so low as to be discountable. For this reason, vessel strike is not likely to adversely affect ESA-listed marine mammals and will not be considered further in this opinion.

Pile driving

Potential effects of underwater sound from pile driving on marine mammals include injury, threshold shift, masking, and behavioral disturbance (e.g., Nowacek et al. 2007; Richardson et al. 1995a; Southall et al. 2007). The type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer all influence the sounds produced during pile driving. Though the Coast Guard drives a large number of piles in some districts (e.g., Coast Guard districts 7 and 8), most fixed structures are built with a small number of piles that are relatively small in diameter, limiting the potential for Coast Guard pile driving activities to adversely affect ESA-listed marine mammals. The vast majority of fixed structures built each year by the Coast Guard that involve pile driving (98 percent) consist of four or fewer piles. Most structures (85 percent) consist of a single pile. The standard Coast Guard pile structure consists of either 12 or 18 inch wood or hollow steel piles. Per the PDC described in section 1.3.5 of this opinion, pile driving using piles larger than 18 inches in diameter or with more than four steel piles will require a separate consultation under section 7 of the ESA.

Non-auditory physiological effects or injuries that theoretically could occur in marine mammals exposed to strong underwater sound include stress, neurological effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007). Such effects, if they occur at all, would be limited to short distances from the sound source and to activities that extend over a prolonged period. When marine mammals are exposed to high intensity sound repeatedly or for prolonged periods they may also experience auditory physiological effects such as hearing threshold shift, which is the loss of hearing sensitivity at certain frequency ranges (Finneran et al. 2005; Finneran et al. 2002; Kastak et al. 1999; Schlundt et al. 2000). Threshold shift can be permanent (PTS), in which case the loss of hearing sensitivity is not recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall et al. 2007). Marine mammals depend on acoustic cues for vital biological functions (e.g., orientation, communication, finding prey, avoiding predators). The impact of a TTS depends on the frequency and duration of a TTS, as well as the biological context in which it occurs. A TTS of

limited duration, occurring in a frequency range that does not coincide with that used for recognition of important acoustic cues, would have little to no effect on an animal's fitness. A PTS, in the unlikely event that it occurred, would constitute injury, but a TTS is not considered injury (Southall et al. 2007).

Masking, the inability of a subject to recognize the occurrence of an acoustic stimulus as a result of the interference of another acoustic stimulus, may also result from pile driving activities (Clark et al. 2009). Introduced underwater sound may, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant amount of the time (Richardson et al. 1995a). Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Therefore, under certain circumstances, marine mammals whose acoustic sensors or environment are being severely masked could be impaired from continuing normal behavior patterns. The degree of masking increases with increasing noise levels. A noise that is just-detectable over ambient levels is unlikely to actually cause any substantial masking, whereas a louder noise may mask sounds over a wider frequency range. In addition, a continuous sound would have more potential for masking than an intermittent sound source.

Finally, marine mammals may exhibit behavioral responses to sound generated by pile driving (e.g., Dahl et al. 2015). Such responses can range from startle responses, changes in behavioral state (e.g., from resting to traveling), to habitat displacement. Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices, but also including pile driving) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; Nowacek et al. 2007; Thorson and Reyff 2006; Wartzok et al. 2003). Responses to continuous sound, such as vibratory pile installation, have not been documented as well as responses to pulsed sounds. Potential behavioral responses of marine mammals to anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure or how close the animal is to the source). For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (NRC 2003; Richardson et al. 1995a; Wartzok et al. 2003). Behavioral responses also depend on species, state of maturity, experience, reproductive state, auditory sensitivity, and time of day (Richardson et al. 1995a; Southall et al. 2007; Wartzok et al. 2003). Animals may also habituate to a sound source. This could occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2003).

Any instances of behavioral disruption have the potential to interrupt life functions such as feeding, resting, traveling, or socializing. Disruptions of such functions resulting from reactions to stressors such as sound are more likely to be significant and impact an animal's growth,

reproduction, or survival if they last for prolonged periods relative to an animal's life history or recur on subsequent days. A behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe (Southall et al. 2007) and would not be expected to impact an animal's fitness.

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions to specific sound levels exposures. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007). Most low-frequency cetaceans (mysticetes) observed in studies avoided sound sources starting at levels of greater than or equal to 160 dB re 1 µPa. Mid-frequency cetaceans (e.g., sperm and beluga whales) generally tolerated non-impulsive sounds in excess of 170 dB re 1 µPa before showing behavioral reactions, such as avoidance or erratic swimming.

To evaluate the potential for underwater noise from Coast Guard pile driving to result in adverse effects to ESA-listed marine mammals, we considered the sound levels created during impact or vibratory pile driving, quantitative thresholds used by NOAA to assess the likelihood of injury to, or behavioral disturbance of, marine mammals of different hearing groups, animal behavior, and the mitigation measures that will be implemented by the Coast Guard.

In August 2016, NOAA released its *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing*, which provided guidance on thresholds for predicting auditory injury (i.e., permanent threshold shift (PTS)) (NOAA 2016b). The Technical Guidance also provided guidance on thresholds for predicting the onset of less severe auditory effects (i.e., temporary threshold shift). For impulsive sounds (e.g., impact pile driving), dual metric acoustic thresholds were derived, one for cumulative sound exposure level (SEL_{cum}) and one for peak sound level. For non-impulsive sounds (e.g., vibratory pile driving), only a cumulative sound exposure level threshold was derived. In developing the Technical Guidance, NOAA compiled, interpreted, and synthesized scientific information currently available on the effects of anthropogenic sound on marine mammals. In association with the Technical Guidance, NMFS released a companion spreadsheet that provides a set of tools and weighting factor adjustments to allow NMFS or action agencies with different levels of exposure modeling capabilities to be able to apply NMFS' acoustic thresholds. As described further in the Technical Guidance, the thresholds and weighting factor adjustments vary by hearing group (i.e., low, mid, and high-frequency cetaceans, phocid and otariid pinnipeds). The Coast Guard did not conduct acoustic exposure modeling analyses for this consultation, so we used this spreadsheet to predict the range to PTS for marine mammals.

Since 1997, NMFS has used generic sound exposure thresholds (i.e., not specific to a particular hearing group) to determine whether an activity produces underwater sounds that might result in behavioral disturbance of marine mammals (70 FR 1871). NMFS uses the following

conservative thresholds of underwater sound pressure levels (SPL), expressed in root mean square (rms), from broadband sounds that can cause behavioral disturbance:

- Impulsive sound (e.g., impact pile driving): 160 decibel (dB) re 1 microPascal ($\mu Pa)_{rms}$
- Non-impulsive sound (e.g., vibratory pile driving): 120 dB re 1 μPa_{rms}

It should be noted that these behavioral disturbance thresholds, particularly for non-impulsive sounds, are conservative, and in many cases, animals would not be disturbed if exposed at these received levels. For example, as indicated above, Southall et al. (2007) found that cetaceans were more likely to exhibit a behavioral response starting at levels of greater than or equal to 160 dB re 1 µPa, 40 dB higher than the 120 dB threshold for non-impulsive sound. Additionally, several authors have noted that the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure and the distance the animal is from the source) is important in determining whether or not an animal will respond behaviorally and whether or not that response will be meaningful. For these reasons, our analysis of the potential for behavioral disturbance to adversely affect ESA-listed marine mammals is not solely based on potential received sound levels, but also the duration of potential exposure, animal behavior, and whether or not behavioral disturbance caused by the Coast Guard's activities would be expected to result in meaningful consequences to the animal.

We used a protective approach to select source levels for analyzing impacts to ESA-listed marine mammals. We reviewed available information from various pile driving studies and selected the most relevant data to the proposed action in terms of pile type and size. Table 5 identifies sources chosen and the peak, root mean square (rms), and sound exposure level (SEL) values used to model the injury and disturbance thresholds for marine mammals.

Table 5. Summary of information used in pile driving analysis including underwater source levels used.

Pile characteristics (size; material)	Installation method	Strikes per pile	Source level		
			dB peak[1]	dB RMS[1]	Single Strike SEL[2]
12 inch; wood	Impact	200	180	170	155
	Vibratory[3]	--	165	150	150
18 inch; hollow steel	Impact	500	198	185	169
	Vibratory[4]	--	175	160	160

[1]Measured at 10 m; referenced to 1 µPa.

[2]Measured at 10 m; referenced to 1 µPa2*sec.

[3]Underwater sound levels from vibratory driving of 12 inch wood piles is not available. We used noise levels collected during vibratory driving of a 12 inch steel pile as a proxy, though we would expect sound levels from a wood pile to be much lower (CalTrans 2012).

[4]Underwater sound levels from vibratory driving of 18-inch hollow steel piles is not available. We used typical noise levels collected during vibratory driving of a 24-inch steel pile as a proxy, but we would expect sound levels from an 18 inch pile to be lower (CalTrans 2012).

Some marine mammals listed under the ESA could be found in the vicinity of Coast Guard pile driving activities and be exposed to elevated underwater sound. Pile driving will occur in relatively shallow water, nearshore habitats (i.e., over 95 percent of already established fixed navigation aids that may require pile driving occur in less than 20 feet of water), so the marine mammal species most likely to be exposed to elevated underwater noise from Coast Guard pile driving are the species that occur in these habitat types. Species that can occur in both offshore and nearshore habitats could be exposed when occupying the nearshore. Species that primarily reside in deeper, offshore waters are much less likely to be exposed. Table 6 lists the marine mammal species considered during this consultation and the Coast Guard districts where they occur.

Table 6. ESA-listed marine mammal species considered in this consultation and the Coast Guard districts where they occur and could be exposed to elevated underwater noise from Coast Guard pile driving.

Species	Hearing group	Coast Guard District
Beluga whale – Cook Inlet DPS	Mid-frequency cetacean	17
Blue Whale	Low-frequency cetacean	All
Fin Whale	Low-frequency cetacean	All
Humpback Whale (listed DPSs that occur in US waters)	Low-frequency cetacean	11, 13, 14, 17
North Atlantic Right Whale	Low-frequency cetacean	1, 5, 7
North Pacific Right Whale	Low-frequency cetacean	11, 13, 17
Killer whale – Southern resident DPS	Mid-frequency cetacean	11, 13, 17
False Killer Whale – Main Hawaiian Islands Insular DPS	Mid-frequency cetacean	14
Sei Whale	Low-frequency cetacean	All
Bowhead Whale	Low-frequency cetacean	1, 17
Sperm Whale	Mid-frequency cetacean	All
Gray whale – Western North Pacific DPS	Low-frequency cetacean	17
Guadalupe fur seal	Otariid pinnipeds	11
Hawaiian monk seal	Phocid pinnipeds	14
Steller sea lion – Western DPS	Otariid pinnipeds	17
Bearded seal – Beringia DPS	Phocid pinnipeds	17

The limited duration of Coast Guard pile driving events reduces the potential for marine mammals to be exposed. Coast Guard pile driving will not result in prolonged periods of elevated underwater sound since each pile driving event only lasts, at most, a few hours. For example, the vast majority of Coast Guard structures requiring pile driving have four or fewer

piles and a typical pile only takes approximately 20 minutes to drive. Additionally, per the PDC described in section 1.3.5 of this opinion, the Coast Guard will employ a 1,000-meter safety zone around each pile. If any marine mammals are observed within this safety zone, pile driving may not commence or must be shut down until the Environmental Observer is confident that the animal has moved out of the area on its own volition. These safety zones are based on the estimated ranges to effects as listed in Table 7 and sightability of marine mammals at distance. Barkaszi et al. (2012) found that the median distance to sighting baleen whales (e.g., blue whales) ranged from 600 to 1,000 meters and the median distance to sighting sperm whales ranged from 1,000 to 1,800 meters, depending on whether the noise source was powered on or not during the sighting (i.e., whales were observed at greater distances when the source was turned on).

The peak sound level PTS threshold would not be exceeded for any marine mammal hearing group during Coast Guard pile driving activities considered in this opinion, so only the cumulative sound exposure level threshold is considered further for PTS. Table 7 details the calculated range in meters to the PTS and TTS cumulative sound exposure level threshold for each marine mammal hearing group and the distance to the behavioral threshold, expressed in RMS for behavioral disturbance.

Table 7. Estimated range to effects for each marine mammal hearing group from impact and vibratory pile driving. The scenarios (i.e., hearing group and pile driving combination) where the range to effects exceeds the shutdown zone are in bold.

Hearing group	Pile characteristics ((# piles; pile size; material)	Impact pile driving			Vibratory pile driving		
		Distance to PTS (m)	Distance to TTS (m)	Distance to behavioral threshold (m)	Distance to PTS (m)	Distance to TTS (m)	Distance to behavioral threshold (m)
Low-frequency cetaceans	1; 12”; wood	4.0	39.8	46.4	0.6	70.7	1,000
	4; 12”; wood	10.0	100.3		1.5	178.3	
	12; 12”; wood	20.9	208.7		3.2	370.8	
	1; 18”; steel	73.3	733.5	464.2	2.8	328.3	**4,641.6**
	4; 18”; steel	184.8	**1848.2**		7.1	827.4	
Mid-frequency cetaceans	1; 12”; wood	0.1	1.4	46.4	0.1	4	1,000
	4; 12”; wood	0.4	3.6		0.1	10	
	12; 12”; wood	0.7	7.4		0.3	20.7	
	1; 18”; steel	2.6	26.1	464.2	0.2	18.4	**4,641.6**
	4; 18”; steel	6.6	65.7		0.6	46.3	
Phocid pinnipeds	1; 12”; wood	2.1	21.3	46.4	0.4	43	1,000
	4; 12”; wood	5.4	53.7		0.9	108.3	
	12; 12”; wood	11.2	111.7		1,9	225.4	
	1; 18”; steel	39.3	392.5	464.2	1.7	199.6	**4,641.6**
	4; 18”; steel	98.9	989.1		4.3	502.9	
Otariid pinnipeds	1; 12”; wood	0.2	21.3	46.4	0.0	3.0	1,000
	4; 12”; wood	0.4	53.7		0.1	7.6	
	12; 12”; wood	0.8	111.7		0.1	15.8	
	1; 18”; steel	2.9	28.6	464.2	0.1	14	**4,641.6**
	4; 18”; steel	7.2	72.0		0.3	35.3	

As detailed in Table 7, the 1,000-meter safety zone that will be implemented by the Coast Guard encompasses the entire PTS zone for both impact and vibratory pile driving for all marine mammal hearing groups. Mid-frequency cetaceans and pinnipeds would need to be within 99 meters (or closer) of a pile being driven with an impact hammer, and remain within that distance from the pile during the duration of the pile driving event, in order to suffer PTS. We would not expect this to occur due to the use of soft-start or ramp-up procedures which are expected to result in animals moving away from the pile before the sound becomes loud enough to be injurious, the shutdown zones that will be implemented by the Coast Guard, and the high likelihood that any individuals that may enter the safety zone undetected would quickly leave

due to the loud sounds within that zone. The ranges to PTS for low-frequency cetaceans and phocid pinnipeds are larger (i.e., as high as 184.8 meters), but still within the observable shutdown zone for impact pile driving. Due to the high sightability of low-frequency cetaceans (i.e., median sighting distance of 600 meters from the source according to Barkaszi et al. 2012), particularly in the shallow water areas where pile driving is conducted, ramp-up procedures, the safety zones employed by the Coast Guard during pile driving, and the assumption (based on empirical evidence that low-frequency cetaceans avoid loud sounds; e.g.,Morton and Symonds 2002; Nowacek et al. 2007; Thorson and Reyff 2006; Wartzok et al. 2003) that any low-frequency cetaceans and phocid pinnipeds within these zones would leave shortly after entering, we would not expect low-frequency cetaceans or phocid pinnipeds to suffer PTS. Additionally, any more severe injuries to marine mammals (e.g., lung injury) would only be expected to occur at even closer distances than the ranges to effect for PTS, if they could occur at all. Because we do not expect PTS, we also would not expect more severe injuries to occur. For these reasons, the likelihood of any ESA-listed marine mammal suffering auditory or non-auditory injuries from Coast Guard pile driving activities is discountable.

Note that as discussed above, a less serious auditory effect than PTS is TTS. The safety zone encompasses the TTS zone for all pile driving activities and all hearing groups with the exception of four-pile steel structures driven in areas where low-frequency cetaceans could occur. The low-frequency cetacean species considered in this opinion have large geographic ranges and can travel long distances on a daily basis, so would not likely remain in close proximity to a pile driving event for the duration of a pile driving event or an extended period of time. Additionally, ESA-listed low-frequency cetaceans are highly visible, particularly in relatively shallow water coastal habitats where pile driving will be conducted, increasing the likelihood that these species would be observed by Coast Guard Environmental Observers. For a marine mammal to suffer TTS from Coast Guard pile driving, an individual would need to remain within the range to TTS for the duration of the pile driving event. Due to the high sightability of low-frequency cetaceans particularly in the shallow water areas where pile driving is conducted, ramp-up procedures, the safety zones employed by the Coast Guard during pile driving that would significantly reduce the likelihood of high level exposures to the point of being discountable, and the assumption (based on empirical evidence that low-frequency cetaceans avoid loud sounds; e.g.,Morton and Symonds 2002; Nowacek et al. 2007; Thorson and Reyff 2006; Wartzok et al. 2003) that any low-frequency cetaceans within these zones would leave shortly after entering, we would not expect low-frequency cetaceans to suffer TTS. For these reasons, the likelihood of a low-frequency cetacean experiencing TTS from Coast Guard pile driving is discountable.

The safety zone encompasses the entire behavioral disturbance zone for impact pile driving and a portion of the behavioral disturbance zone for vibratory pile driving. While we would expect Coast Guard Environmental Observers to detect many marine mammals that may enter the estimated zones of disturbance, some may enter undetected, particularly during vibratory pile driving where the disturbance zone extends beyond where we can reasonably assume marine

mammals could be sighted. Below we evaluate the potential for ESA-listed marine mammals to be exposed to sound from Coast Guard pile driving that could cause behavioral disturbance and then discuss whether any instances of exposure would be expected to result in harassment under the ESA.

Some ESA-listed marine mammals considered in this opinion would not be exposed to underwater noise from Coast Guard pile driving because their range does not overlap with areas where pile driving will occur. Both sperm and Main Hawaiian Islands Insular false killer whales reside in deep, offshore waters where Coast Guard pile driving would not occur. Bearded and ringed seals occur in areas with sea ice, locations without fixed aids so they would also not be exposed to noise from pile driving. Other ESA-listed large whale species considered in this opinion (i.e., blue, fin, humpback, North Atlantic right, North Pacific right, Sei, Western North Pacfic gray, Bowhead whales) could be exposed to underwater sound when they occur in coastal habitats, though these animals have large geographic ranges and can travel long distances on a daily basis, so would not likely remain in close proximity to a pile driving event for an extended period of time. Additionally, ESA-listed large whales are highly visible, particularly in relatively shallow water coastal habitats where pile driving will be conducted, increasing the likelihood that these species would be observed by Coast Guard Environmental Observers.

Guadalupe fur seals, Hawaiian monk seals, and Western DPS Steller sea lions spend substantial time in nearshore, coastal habitats where pile driving activities occur, and are less visible than large whales at distance. This indicates that these species would be more likely to be exposed to underwater sounds from Coast Guard pile driving activities. However, the Coast Guard drives a limited number of piles annually in each of these species' range, limiting the likelihood of exposure. During maintenance, the Coast Guard averages 20 piles annually in Coast Guard district 11 where Guadalupe fur seals reside, 3 piles annually in District 14 where Hawaiian monk seals reside, and up to 15 piles[17] in District 17 where Western DPS Steller sea lions reside. Further, only a subset of pile driving events occurring in each district would occur in the geographic range of each of these species.

Cook Inlet beluga whales also occur in shallow water habitats and have a restricted geographic range (i.e., Cook Inlet). However, as described in the PDC in section 1.3.5 of this opinion, the Coast Guard will implement both a tidal and seasonal timing window for all pile driving activities in Cook Inlet in order to minimize the potential effects of pile driving on belugas. In Cook Inlet, nearshore pile driving will occur within two hours of low tide (or when dewatered) and when pile driving is required in the Susitna Delta Sensitive Area, no pile driving can be conducted from April 15 to October 15. Implementation of these measures will minimize the

[17] The Coast Guard's biological evaluation states that on average, only one pile is driven in District 17 annually. However, Coast Guard District 17 staff note that up to 15 piles may be driven each year (David Seris, Coast Guard, personal communication to Sadie Wright, NMFS, August 8, 2017). Either way, this is a limited number of pile driven in this Coast Guard district during maintenance.

likelihood of exposing Cook Inlet belugas to underwater noise from pile driving. Additionally, during maintenance, a very limited number of piles are driven each year in District 17 as a whole (i.e., average annual number of piles driven is one), and not all piles driven in District 17 will be in Cook Inlet.

Southern Resident killer whales spend spring, summer, and fall in the inland waters of Washington state in Coast Guard District 13, but their range extends south to central California and north to Southeast Alaska in winter. This species would most likely co-occur with Coast Guard pile driving activities in the inland waters of Puget Sound. However, during maintenance only a limited number of piles are driven in the inland waters of Puget Sound annually (i.e., a subset of the 30 driven annually in District 13) limiting the likelihood that a pile driving event would occur in close proximity to Southern Resident killer whales. Further, Southern Residents are highly visible, travel in groups, and would most likely be observed by the Coast Guard (or their contractors) if the animals came in close proximity to pile driving. Per the PDC, if the animals were observed in close proximity, pile driving would be shut down until the animals left the area.

In summary, this information suggests that all ESA-listed marine mammals considered in this opinion, with the exception of those that occur only in offshore waters or the northern portions of Coast Guard district 17 where pile driving will not occur, have the potential to be exposed to underwater sounds from Coast Guard pile driving. Those that reside primarily in coastal habitats are more likely to be exposed, though a limited number of piles are driven in areas where these species reside. No ESA-listed marine mammals that spend most of their time in nearshore, coastal habitats occur in the areas where the vast majority of Coast Guard pile driving activity will take place (i.e., Coast Guard districts 5, 7, and 8).

For impact hammer pile driving, the ranges to behavioral disturbance are within the shutdown zone that will be implemented by the Coast Guard. Per the PDC, we would expect impact pile driving operations to be shut down if a marine mammal enters this zone so behavioral disturbance would not be anticipated unless a marine mammal entered the zone undetected. The ranges to behavioral disturbance for marine mammals during vibratory pile driving are equal to or extend beyond the shutdown zones required. As such, there is a greater probability that marine mammals will be exposed to pile driving noise that could cause behavioral disturbance if the Coast Guard uses a vibratory hammer. If marine mammals are exposed to pile driving noise within either zone, it may result in masking or a behavioral response. However, as explained further below, any instances of masking or a behavioral response from Coast Guard pile driving are not expected to create the likelihood of injury to affected animals by annoying them to such an extent as to significantly disrupt normal behavioral patterns.

Any masking that could occur from Coast Guard pile driving would be temporary, lasting only as long as the duration of the pile driving event (i.e., less than a few hours). Coast Guard pile driving will not result in prolonged periods of time when masking could occur, reducing the likelihood of the proposed action causing masking that could result in any meaningful impacts to

ESA-listed marine mammals. For this reason, the effect of any masking that could be caused by Coast Guard pile driving is insignificant and is not likely to adversely affect ESA-listed marine mammals.

Animals within the behavioral disturbance zone may experience short-term behavioral responses (e.g., a startle response, changes in respiration, alteration of swim speed or direction) or temporary habitat displacement. However, any instances of disturbance are expected to be temporary, with the animal resuming normal behaviors or returning to the area shortly after pile driving is complete (i.e., only a few hours at the most). In instances where a marine mammal avoids the area where pile driving is occurring, this is expected to result in an energy expenditure to move away from the construction area and possibly, the temporary loss of use of a preferred habitat. However, the distance the animal would need to travel would be short (see Table 7) and the energetic cost would be minimal and similar to that typically incurred while an animal is seeking optimal habitat for foraging or sheltering. If an animal avoids an area where they had previously been feeding or resting, pile driving also has the potential to result in lost feeding or resting opportunities. However, to result in fitness consequences for the animal, we would have to assume that an individual marine mammal could not compensate for the short loss in feeding opportunities by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since foraging habitat would still be available in the environment following the cessation of acoustic exposure. Similarly, if an animal's rest was disrupted, we would expect the individual would be able to resume resting immediately after the pile driving ends or rest in alternative locations once the animal moves from the area.

Some marine mammals may elect to remain in the behavioral disturbance zone despite the sound levels due to sufficient impetus to remain in that area to continue foraging in the presence of a desired prey field. While these animals may be exposed to sound for longer durations, we do not expect they will experience significant energetic costs associated with avoidance or foregone prey, as they will continue to feed. Unless the increased duration of exposure leads to some injury or physical effect that could lead to reductions in fitness, this situation is not likely to lead to significant effects. However, as discussed previously, we determined the risks of auditory injury or any other physical effects that could affect an individual's fitness are highly unlikely given that animals would have to remain in close proximity to the pile driving activity for a significant period of time, the short duration of Coast Guard pile driving activities, and the safety zone that will be implemented by the Coast Guard during pile driving.

In conclusion, even if ESA-listed marine mammals are temporarily disturbed and/or displaced from localized areas from avoidance of underwater pile driving sound, individual animals will not experience energetic costs that lead to measurable or biologically meaningful impacts that could affect the fitness of individuals with respect to survival, growth, and reproduction. We expect the effects of disturbance and avoidance from this proposed action to be temporary and inconsequential. For these reasons, we do not expect Coast Guard pile driving to create the likelihood of injury to ESA-listed marine mammals by annoying any individuals to such an

extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. In NMFS' interim guidance on the ESA term "Harass," a significant disruption in normal behavior patterns is defined as a change in the animal's behavior that could increase the risk of injury. An injury in the context of analyzing behavioral responses could be a physical injury or a physiological or other impact that would reasonably be expected to negatively affect the animal's growth, health, reproductive success or ability to survive. As indicated above, behavioral disturbances resulting from short-term Coast Guard pile driving activities would not reasonably be expected to increase the risk of injury to ESA-listed marine mammals. As a result, we conclude that the risks associated with exposure to underwater pile driving sound leading to short term disturbance are insignificant.

As detailed above, the potential effects of Coast Guard pile driving activities on ESA-listed marine mammals are either discountable or insignificant. Therefore, Coast Guard pile driving for ATONs is not likely to adversely affect ESA-listed marine mammals.

Vessel noise

Sound emitted from large vessels, such as shipping and cruise ships, is the principal source of low-frequency noise in the ocean today, and marine mammals are known to react to or be affected by that noise (Foote et al. 2004; Hatch and Wright 2007; Hildebrand 2005a; Holt et al. 2008; Kerosky et al. 2013; Melcon et al. 2012; Richardson et al. 1995b). Coast Guard vessels used during ATON activities are a small component of overall vessel traffic and vessel noise in most areas where they operate.

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals may engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Amaral and Carlson 2005; Au and Green 2000; Bain et al. 2006; Bauer 1986; Bejder et al. 1999; Bejder and Lusseau. 2008; Bejder et al. 2009; Bryant et al. 1984; Corkeron 1995; Erbe 2002; Félix 2001; Goodwin and Cotton 2004; Lemon et al. 2006; Lusseau 2003; Lusseau 2006; Magalhaes et al. 2002; Nowacek et al. 2001; Richter et al. 2003; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002b; Wursig et al. 1998). Many investigations have reported that animals tended to reduce their visibility at the water's surface and move horizontally away from the source of disturbance or adopt erratic swimming strategies (Corkeron 1995; Lundquist et al. 2012; Lusseau 2003; Lusseau 2004; Nowacek et al. 2001; Van Parijs and Corkeron 2001; Williams et al. 2002a; Williams et al. 2002b). In the process, dive times may increase, vocalizations and jumping may be reduced (with the exception of beaked whales), individuals in groups may move closer together, swimming speeds may increase, and their direction of travel may take them away from the source of disturbance (Baker and Herman 1989; Edds and Macfarlane 1987; Evans et al. 1992; Kruse 1991). Some individuals also dove and remained motionless, waiting until the vessel moved past their location. Most animals finding themselves in confined spaces, such as shallow bays, during vessel approaches tended to

move towards more open, deeper waters (Kruse 1991). We assume that this movement would give them greater opportunities to avoid or evade vessels as conditions warranted.

Researchers have noted changes in resting and surface behavior states of cetaceans in response to the presence and movement of vessels (Acevedo 1991; Aguilar Soto et al. 2006; Arcangeli and Crosti 2009; Au and Green 2000; Christiansen et al. 2010; Erbe 2002; Noren et al. 2009; Stensland and Berggren 2007; Stockin et al. 2008; Williams and Noren 2009). Noren et al. (2009) conducted research in the San Juan Islands in 2005 and 2006 and their findings suggested that close approaches by vessels impacted the whales' behavior and that the whale-watching guideline minimum approach distance of 100 m may be insufficient in preventing behavioral responses. Most studies of this type are opportunistic and have only examined the short-term response to vessel sound and vessel traffic (Magalhaes et al. 2002; Noren et al. 2009; Richardson and Wursig 1995; Watkins 1981b).

Some studies have documented instances where cetaceans did not respond, or had minimal responses, to the presence of vessels. Watkins (1981a) documented that humpback whales did not exhibit any avoidance behavior but did exhibit minor behavioral reactions to vessel presence. Vessels that remain 328 ft. (100 m) or farther from fin and humpback whales were largely ignored in one study where whale watching activities are common (Watkins 1981a). Other studies have shown when vessels are near, some but not all, whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Au and Green 2000; Castellote et al. 2012; Richter et al. 2003; Williams et al. 2002b). In the presence of approaching vessels, blue whales perform shallower dives accompanied by more frequent surfacing, but otherwise do not exhibit strong reactions (Calambokidis et al. 2009). Minke whales in the Antarctic did not show any apparent response to a survey vessel moving at normal cruising speeds (about 12 knots) at a distance of 5.5 nm; however, when the vessel drifted or moved at very slow speeds (about 1 knot), many whales approached it (Leatherwood et al. 1982). North Atlantic right whales tend not to respond to the sounds of oncoming vessels (Nowacek et al. 2004) and therefore might provide insight to behavioral responses of other baleen whales. North Atlantic right whales continue to use habitats in high vessel traffic areas (Nowacek et al. 2004). Studies show that North Atlantic right whales demonstrate little if any reaction to sounds of vessels approaching or the presence of the vessels themselves (Nowacek et al. 2004; Terhune and Verboom 1999). Although this may minimize potential disturbance from passing ships, it does increase the whales' vulnerability to potential ship strike. The regulated approach distance for North Atlantic right whales is 500 yards (yd.) (457 m) (NMFS 1997). Sperm whales generally react only to vessels approaching within several hundred meters; however, some individuals may display avoidance behavior, such as quick diving (Magalhaes et al. 2002; Wursig et al. 1998).

A study by Lundquist (2012) on dusky dolphins concluded that repeated disturbance from tour vessel traffic may interrupt social interactions, and postulated that those repeated disturbances may carry energetic costs, or otherwise affect individual fitness. However, they were unable to

determine if such disturbances were likely to cause long-term harm. Long-term and cumulative implications of vessel sound on marine mammals remains largely unknown. Clark et al. (2009) provided a discussion on calculating the cumulative impacts of anthropogenic noise on baleen whales and estimated the noise from the passage of two vessels could reduce the optimal communication space for North Atlantic right whales by 84 percent (see also (Hatch et al. 2012). For behavioral responses to result in energetic costs that result in long-term harm, such disturbances would likely need to be sustained for a significant duration or extent where individuals exposed would not be able to select alternate habitat to recover and feed. Coast Guard ATON activities would not likely result in such prolonged exposures and preclusion of individuals from feeding, breeding, or sheltering habitat.

Little is known about pinniped reactions to vessel noise. In a review of reports on reactions of pinnipeds to small craft and ships, Richardson et al. (1995a) note that information on pinniped reactions is limited and most reports are based on anecdotal observations. Specific case reports in Richardson et al. (1995a) vary based on factors such as routine anthropogenic activity, distance from the vessel, engine type, wind direction, and ongoing subsistence hunting. As with reactions to sound reviewed by Southall et al. (2007), pinniped responses to vessels are affected by the context of the situation and by the animal's experience. In summary, pinniped's reactions to vessels are variable and reports include a wide entire spectrum of possibilities from avoidance and alert to cases where animals in the water are attracted and cases on land where there is lack of significant reaction suggesting "habituation" or "tolerance" of vessels (Richardson et al. 1995a). A study of reactions of harbor seals hauled out on ice to cruise ship approaches in Disenchantment Bay, Alaska revealed that animals are more likely to flush and enter the water when cruise ships approach within 1,640 ft. (500 m) and four times more likely when the cruise ship approaches within 328 ft. (100 m) (Jansen et al. 2010).

The vessel activity associated with the proposed action (and the noise emitted from those vessels) is infrequent, of short duration, and a small component of overall vessel traffic and vessel noise in most areas where they operate. Further, the available information suggests that ESA-listed marine mammals are either not likely to respond to vessel noise from ATON vessels or are not likely to measureably respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Any behavioral responses to vessel noise are expected to be temporary (e.g., a startle response, brief avoidance behavior, brief change in vocalization) and we do not expect these reactions to have any measurable effects on any individual's fitness. We expect individuals that exhibit a temporary behavioral response will return to baseline behavior immediately following exposure to the vessel noise. Therefore, the effects of vessel noise on ESA-listed marine mammals is insignificant and not likely to adversely affect them.

Habitat exclusion

Marine mammals in the immediate area of an ATON that is about to be serviced, established, or discontinued would likely move from the immediate area of the aid as the vessel approaches the

aid or area where the aid is to be established.[18] Responses to vessels approaching an aid are expected to be similar to those described in the previous section of this opinion on the potential effects of vessel noise. The animal would likely exhibit an initial startle reaction and then move away from the immediate vicinity of the aid or area where the aid is to be established. In such circumstances, ATON activities may result in marine mammals temporarily avoiding the immediate area of the aid during maintenance activities or while the aid is being established or discontinued. The animals would be expected to move a short distance away (meters) from the ATON site to an area with similar habitat. This response would not be expected to create or increase the likelihood of injury by annoying affected animals to such an extent as to significantly disrupt normal behavioral patterns. Further, we expect that once in-water work is completed at an ATON (usually less than an hour), ESA-listed marine mammals will be able to return to the area around the aid should they choose to do so. Due to the temporary and localized nature of habitat exclusion associated with ATON activities, the effects of temporary and localized habitat exclusion on ESA-listed marine mammals are considered insignificant and not likely to adversely affect them.

ATON sound signals

Most sound signals from floating ATON are generated by the buoy activating a gong, bell, or whistle. In situations where wave actuated signals are not feasible (i.e., calm waters), a battery powered electronic horn is used. On floating ATON, the emitted sound signal is typically 850 hertz at about 120 to 125 A-weighted decibels. On fixed ATON, sounds are produced by electronic devices at either 300 or 500 hertz, at levels ranging between 118 and 140 A-weighted decibels. Due to the air-water interface that constitutes a substantial sound barrier (i.e., sound waves in the water are reduced in intensity by a factor of more than a thousand when they cross the air-sea boundary) (Hildebrand 2005b), we do not expect marine mammals that reside only underwater (i.e., cetaceans) to be exposed to sound signals from ATON that would be detectable. Therefore, the potential effects of ATON sound signals on ESA-listed cetaceans are insignificant. Pinnipeds hauled out of the water could be exposed to detectable levels of sound from ATON signals. However, the sound pressure levels are not expected to be high enough to produce auditory effects to the animals exposed. Further, many pinniped species haul out on ATON, indicating that the sound signal produced by the ATON is not a deterrent for the animal to use the area (Tech 2014). If it were a deterrent, the animal would be expected to simply avoid the immediate area where the ATON is located and seek alternative habitat a short distance away. For these reasons, the potential effects of sound signals emitted from ATON on pinnipeds are insignificant.

Entanglement

NMFS does not believe the heavy chain connecting a buoy to a sinker has the potential to affect marine mammals by entanglement because of the weight, mass, and taut solid nature of the metal

[18] Note: This discussion does not apply to potential habitat exclusion resulting from pile removal and pile driving activities, which was discussed previously in this section.

links and chain. To our knowledge, there has never been a documented instance where a marine mammal has been entangled in an ATON. Therefore the risk of entanglement is discountable and entanglement from ATON components is not likely to adversely effect ESA-listed marine mammals.

Conclusion on ESA-listed marine mammals

Assuming the Coast Guard implements the PDC described in section 1.3.5, the analysis above indicated that the potential effects of the stressors associated with the proposed operation and maintenance of ATON, as well as the establishment and discontinuance of ATON, are either insignificant or discountable. For this reason, the proposed action is not likely to adversely effect ESA-listed marine mammals.

2.3.2 Sea Turtles

Sea turtles have the potential to be affected either by the presence of ATON or during the maintenance, establishment, or discontinuance of ATON. Potential stressors to sea turtles from ATON maintenance, establishment, and discontinuance include vessel strike, pile driving, vessel and general construction noise, and habitat exlusion. Potential stressors to sea turtles from the presence of ATON include sound signals[19] and entanglement.

Vessel strike

Vessel strike of sea turtles is poorly studied (Work et al. 2010). Sea turtles must surface to breath and several species are known to bask at the surface for long periods. Sea turtles may not be able to move out of the way of vessels moving at more than 4 km/hr (Hazel et al. 2007; Work et al. 2010). The Coast Guard's biological evaluation limits the proposed action to vessel operations in the immediate vicinity of an ATON and transit between adjacent ATON.[20] Therefore, only vessel operations occurring at the ATON site or between adjacent ATON sites are considered in this opinion. Generally, vessel speed at the ATON site or between adjacent ATON sites is relatively slow due to the precision with which vessels must operate during these activities. There has never been a documented instance where a vessel associated with ATON activities (i.e., vessel operations in the immediate vicinity of the ATON and transit between adjacent ATON) has struck an ESA-listed sea turtle.[21] Further, the Coast Guard will implement a number of measures to minimize the likelihood that a vessel will strike a sea turtle. As described in section 1.3.5, these measures include, having topside crew members on the lookout for ESA-listed turtles, remaining at least 50 yards from all observed sea turtles while vessels are underway, and reducing vessel speed to 5 knots when sea turtles are observed near an underway vessel (if the animal has the potential to be impacted by the vessel). For these reasons, while it is

[19] Note: This consultation does not consider the potential effect of ATON light signals that illuminate sea turtle nesting beaches because the US Fish and Wildlife Service has jurisdiction of sea turtles on nesting beaches.
[20] According to the Coast Guard's biological evaluation, transit from homeports to the ATON site are not part of the proposed action considered in this consultation because the Coast Guard categorizes this transit time as law enforcement or other activities as opposed to ATON activities.
[21] The Coast Guard biological evaluation cites several instances where Coast Guard vessels have struck ESA-listed species, but none of the collisions involved an ATON vessel.

possible for a vessel associated with ATON activities to strike a sea turtle, we do not believe that a vessel strike is likely to occur. The Coast Guard has been conducting ATON activities in the action area for years and no such incident has been documented. Additionally, the Coast Guard employs minimization measures to reduce the likelihood for a strike to a sea turtle. Consequently, NMFS has determined that the likelihood of vessel strike of a sea turtle during Coast Guard ATON activities is so low as to be discountable. For this reason, vessel strike is not likely to adversely affect sea turtles and will not be considered further in this opinion.

Pile driving

Little is known about the how sea turtles may respond to acoustic disturbance (e.g., from pile driving). The response of a sea turtle to an anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound, as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away could also affect the way a sea turtle responds. Potential behavioral responses to anthropogenic sound could include startle reactions, disruption of feeding, disruption of migration, changes in respiration, alteration of swim speed, alteration of swim direction, and area avoidance. In addition to the potential for behavioral response, higher sound exposure levels could lead to physiological effects (e.g., temporary threshold shift).

Studies of sea turtle responses to sounds are limited, though a few studies examined sea turtle reactions to airguns, which produce broadband impulse sound. O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic airguns. They reported that loggerhead turtles kept in a 984 ft by 148 ft (300 m by 45 m) enclosure in a 10 m deep canal maintained a distance of 98 ft (30 m) from airguns fired every 15 seconds, with the strongest sound components within the 25 Hz to 1,000 Hz frequency range. McCauley et al. (2000) estimated that the received level at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175 to 176 dB re 1 µPa root mean square. Moein Bartol et al. (1995) investigated the use of air guns to repel juvenile loggerhead sea turtles from hopper dredges. Sound frequencies of the airguns ranged from 100 Hz to 1,000 Hz at three levels: 175, 177, and 179 dB re 1 µPa at 1 m. The turtles avoided the airguns during the initial exposures (mean range of 24 m), but additional trials several days afterward did not elicit statistically significant avoidance. They concluded that this was due to either habituation or a temporary shift in the turtles' hearing capability. DeRuiter and Larbi Doukara (2012) conducted a field study involving a large sample size involving observations of free-ranging sea turtles exposed to airgun noise. This study reported ten percent of disturbance behaviors began at received levels of 171 dB re: 1 µPa (peak), 30 percent at 179 dB re: 1 µPa (peak), and 50 percent at 191 dB re: 1 µPa (peak).

McCauley et al. (2000) exposed caged green and loggerhead sea turtles to an approaching-departing single air gun to gauge behavioral responses. The trials showed that above a received level of 166 dB re 1 µPa root mean square, the turtles noticeably increased their swimming activity compared to non-operational periods, with swimming time increasing as air gun levels

increased during approach. Above 175 dB re 1 µPa root mean square, behavior became more erratic, possibly indicating the turtles were in an agitated state (McCauley et al. 2000). The authors noted that the point at which the turtles showed erratic behavior and exhibited possible agitation would be expected to approximately equal the point at which active avoidance would occur for unrestrained turtles (McCauley et al. 2000).

In their sound exposure guidelines for pile driving, Popper et al. (2014b) recommended using the sound levels for fish that do not hear well for injury and mortality thresholds for sea turtles (i.e., 210 dB SEL_{cum} and >207 dB_{peak}). We use this threshold to evaluate the potential for Coast Guard pile driving activities to injure or kill sea turtles, though the authors noted that because of their rigid anatomy, it is possible that sea turtles are highly protected from impulsive sound effects (Popper et al. 2014b). Popper et al. (2014b) did not provide a quantitative threshold for the onset of TTS in sea turtles, but qualitatively assessed the relative risk of a sea turtle experiencing such an effect. Lacking specific data on the sound levels that could cause TTS in sea turtles, we will use the sound levels for fish for a TTS threshold for sea turtles (i.e., 186 dB SEL_{cum}). For other potential impacts (e.g., behavioral disturbance), Popper et al. (2014b) also did not establish quantitative thresholds but qualitatively assessed the relative risk of a sea turtle experiencing an effect. Popper et al. (2014b) determined that the relative risk of a sea turtle experiencing a behavioral response was high when the animal was close to the pile being driven, and low when the animal was far away from the pile. Although information regarding the behavioral response of sea turtles to acoustic stressors is generally lacking, McCauley et al. (2000) provides an indication that 175 dB re 1 µPa root mean square is a reasonable threshold criterion in the absence of more rigorous experimental or observational data. The 175 dB re 1 µPa root mean square threshold criterion for behavioral take in sea turtles may change with more information in the future, but currently is the best available science.

To evaluate the potential for underwater noise from Coast Guard pile driving to result in adverse effects to ESA-listed sea turtles, we considered the sound levels created during impact or vibratory pile driving, the quantitative thresholds described above to assess the likelihood of injury, TTS, or behavioral disturbance of sea turtles, sea turtle behavior, and the mitigation measures that will be implemented by the Coast Guard. We used the source levels detailed in Table 5 to analyze impacts to ESA-listed sea turtles from Coast Guard pile driving. The peak sound level injury threshold for sea turtles will not be exceeded during Coast Guard pile driving activities considered in this opinion, so only the cumulative sound exposure level threshold is considered further for injury and mortality. Table 8 details the calculated range to the injury/mortality cumulative sound exposure level threshold for sea turtles and the distance to the TTS and behavioral disturbance thresholds.

Table 8. Estimated range to effects for sea turtles from impact and vibratory pile driving.

Pile characteristics (# piles; pile size; material)	Impact pile driving			Vibratory pile driving		
	Distance to injury/mortality (m)	Distance to TTS (m)	Distance to behavioral threshold (m)	Distance to injury/mortality (m)	Distance to TTS (m)	Distance to behavioral threshold (m)
1; 12”; wood	0.1	2.9	4.6	0.0	4.5	0.1
4; 12”; wood	0.1	7.4		0.1	11.3	
12; 12”; wood	0.3	15.4		0.1	23.6	
1; 18”; steel	1.2	46.3	46.0	0.1	20.9	0.2
4; 18”; steel	2.9	116.8		0.2	52.6	

As detailed in Table 8, the maximum range to the injury/mortality threshold was 2.9 meters (i.e., for a 4 pile structure using 18” steel piles). The maximum range to TTS was 116.8 meters. This indicates that for a sea turtle to be killed, injured, or suffer TTS by Coast Guard pile driving activities, a turtle would have to remain within 3 (for injury or mortality) or 117 meters (for TTS) of the structure being built for the duration of the construction action for the turtle to experience that effect. We do not believe this is reasonably certain to occur. First, turtles are mobile organisms and are known to avoid and move away from anthropogenic sounds (e.g., McCauley et al. 2000). Additionally, per the PDC described in section 1.3.5 of this opinion, the Coast Guard will employ a 1,000-meter safety zone around each pile while pile driving is occurring. These impact distances for mortality, injury, and TTS are well within these safety zones. If any sea turtles are observed within these safety zones, pile driving may not commence or must be shut down until the Environmental Observer is confident that the animal has moved out of the area on its own volition. For these reasons, we believe the likelihood a sea turtle suffering an injury, dying, or another physiological effect (e.g., TTS) from Coast Guard ATON pile driving activities is discountable.

The maximum range to the sea turtle behavioral disturbance threshold during pile driving was 46 meters. This distance is also well within the shutdown zones that will be implemented by the Coast Guard, so in most cases, we would not expect a sea turtle to enter this zone while pile driving is occurring. Even if a sea turtle were to enter this safety zone undetected, sea turtles are mobile organisms and would be expected to avoid the construction area once they detect pile driving and other project related construction noise (e.g., McCauley et al. 2000). Similarly, a sea turtle could avoid the immediate project area as a result of exposure to vessel noise or other general construction noise during ATON activities. Avoidance of this small area of habitat for a short duration (i.e., at most, a few hours) would not have a meaningful impact on the animal because they could simply select alternative habitat a short distance (i.e., meters) away. We expect individuals that exhibit a temporary behavioral response will return to baseline behavior immediately following exposure to the underwater noise from ATON activities. W

expect these short term behavioral reactions or brief avoidance behaviors to increase the

Therefore, the effect of pile driving noise that may result in behavioral reactions is insignificant and is not likely to adversely affect the ESA-listed sea turtle species considered in this opinion.

Vessel and other general construction noise

Vessel and general construction noise (i.e., not pile driving) also has the potential to impact sea turtles present in the action area either by masking or causing behavioral response. Based on knowledge of their sensory biology (Bartol and Ketten 2006; Moein Bartol and Musick 2003), sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al. 2007). Similarly, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996a; Lohmann and Lohmann 1996b) and light (Avens and Lohmann 2003). Additionally, they are not known to produce sounds underwater for communication. Any potential masking from Coast Guard ATON vessels would be temporary as both the sea turtle and vessel would be transiting the action area (likely at different speeds and in different directions) or the sea turtle would avoid the immediate area where the ATON activities are occurring. For these reasons, we do not expect any short-term instances of masking to have any fitness consequences for any individual sea turtles. In addition to masking, vessel activity and construction noise may result in temporary changes in sea turtle behavior (Popper et al. 2014a). However, any behavioral responses are expected to be temporary (e.g., a startle response, brief avoidance behavior) lasting only as long as the vessel is in close proximity (or as long as the maintenance event lasts) and we do not expect these reactions to have any measurable effects on any individual's fitness. We expect individuals that exhibit a temporary behavioral response will return to baseline behavior immediately following exposure. W

Therefore, the effect of vessel or other project-related noise is insignificant and is not likely to adversely affect the ESA-listed sea turtle species considered in this opinion.

Habitat exclusion

Potential effects to sea turtles within the action area also include being temporarily unable to use a site for forage and refuge habitat due to potential avoidance of construction activities and related noise. These effects are insignificant due to the small size of ATON activity action areas and the limited time it will take to complete each action (i.e., typically a few hours). Because the

effects of temporary habitat exclusion during ATON maintenance are insignificant to ESA-listed sea turtles, temporary habitat exclusion is not likely to adversely effect ESA-listed sea turtles.

Sound signals

The sounds signals emitted by ATON are discussed in section 2.3.1. Because sea turtles are able to detect low-frequency sound (Popper et al. 2014b), they would likely be able to detect the acoustic signal, if exposed. However, because the air-sea interface constitutes a substantial sound barrier (i.e., sound waves in the water are reduced in intensity by a factor of more than a thousand when they cross the air-sea boundary) (Hildebrand 2005c) and the sound signals produced by ATON are of relatively low intensity, injury or physiological effects are not expected. If turtles were exposed to a sound signal (i.e., most likely while at the surface) and if they were to respond at all, the most likely response would be a temporary behavioral reaction or avoidance of the immediate area of the ATON. The effect of such a reaction is not expected to not be meaningful for the animal given the short term nature of a startle reaction (i.e., lasting a few seconds with the animal returning to normal behaviors shortly thereafter) and the small area of habitat that may be avoided around the ATON site. For these reasons, the effect of sound signals emitted by ATON on ESA-listed sea turtles is considered insignficiant and sound signals are not likely to adversely affect ESA-listed sea turtles.

Entanglement

NMFS does not believe the heavy chain connecting a buoy to a sinker has the potential to affect sea turtles by entanglement because of the weight, mass, and taut solid nature of the metal links and chain. To our knowledge, there has never been a documented instance where a sea turtle has been entangled in an ATON. Therefore the risk of entanglement is discountable and entanglement from ATON components is not likely to adversely effect ESA-listed sea turtles.

Conclusion on ESA-listed sea turtles

Assuming the Coast Guard implements the PDC described in section 1.3.5, the analysis above indicated that the potential effects of the stressors associated with the proposed operation and maintenance of ATON, as well as the establishment and discontinuance of ATON, are either insignificant or discountable. For this reason, the proposed action is not likely to adversely effect ESA-listed sea turtles.

2.3.3 Black and White Abalone

Black and white abalone are marine snails with a univalve shell, an anterior head, and a large muscular foot used for movement as well as to clamp down onto hard substrates to avoid being dislodged by wave action (Cox 1960).

Historically, black abalone occurred from Crescent City (Del Norte County, California) to southern Baja California (Geiger 2004), but the current range is from Point Arena, California, to Bahia Tortugas, Mexico (74 FR 1937, 14 January 2009). Black abalone occupies rocky intertidal habitats from the upper intertidal to 6 meters depth. Black abalone are most commonly observed in the middle and lower intertidal, in habitats with complex surfaces and deep crevices that

provide shelter for juvenile recruitment and adult survival (Cox 1960; Douros 1985; Douros 1987; Haaker et al. 1995; Leighton 1959; Leighton 2005; Leighton and Boolootian 1963; Miller and Lawrenz-Miller 1993; VanBlaricom et al. 1993). They are able to withstand extreme variations in temperature, salinity, moisture, and wave action, and are usually strongly aggregated with some individuals stacking two or three on top of each other (Cox 1960; Leighton 2005).

White abalone occur on the North American West Coast along offshore islands and banks (particularly Santa Catalina and San Clemente Islands) and along the mainland coast from Point Conception, California, south to Punta Abreojos, Baja California, Mexico (Bartsch 1940; Cox 1960; Cox 1962; Leighton 1972). White abalone adults occupy open, low relief rocky reefs or boulder habitat surrounded by sand (Hobday et al. 2001). Because suitable habitat is patchy, the distribution of white abalone is also patchy (NMFS 2008c). White abalone are the deepest living abalone species on the North American West Coast, occupying depths from 5-60m (Cox 1960). Current remnant populations are most common between 30-60 m depth and recent surveys by Butler et al. (2006) and Stierhoff et al. (2012) found the highest densities at depths of 40-50 m.

The stressors that have the potential to affect black and white abalone include underwater noise from pile driving, water quality effects of increased turbidity from underwater work, and physical disturbance of individual animals. Additionally, abalone have the potential to be impacted by chain scour from floating aids.

The Coast Guard will implement measures to minimize the likelihood of injuring black and white abalone. First, prior to the replacement of any piles associated with fixed structures in black abalone critical habitat, the Coast Guard will conduct dive surveys to determine if abalone are present on the structure (see the PDC for additional detail). If black abalone are found on the structure (which as we describe below, is unlikely), pile replacement will be delayed until the animal is relocated or brought in to captivity by entities that are permitted to do so. Additionally, the Coast Guard will not anchor or spud down in areas of known abalone occurrence (Tech 2014). Also, per the PDC, Coast Guard crews will be trained in the identification of white and black abalone and the Coast Guard will remain vigilant in their search for individuals attached to ATON components during maintenance activities. If a white or black abalone is observed and if doing so would not create a navigational hazard, the animal will be left undisturbed and the sighting will be reported to NMFS West Coast Region staff.

Additionally, it is worth noting that federal navigation aids provide a benefit to abalone due to their role in preventing groundings of large vessels. Vessel groundings have been identified as an activity that could threaten the quality of abalone habitat (NMFS 2011g).

If black or white abalone were to occur in relatively close proximity (e.g., a few hundred meters) to Coast Guard pile driving for fixed navigation aids, these individuals could be exposed to elevated levels of underwater sound. Although abalone do not have ears, abalone do contain organs called statocysts that are believed to function primarily as gravity sensors, allowing the

individual to determine up from down (Hubbard 1960; Lovell et al. 2005). In some species of invertebrates, these organs also function in rudimentary sound reception (Lovell et al. 2005; Mooney and coauthors 2010). Where information on marine invertebrate hearing exists, sensitivity in low frequency ranges seems to be prevalent. We were not able to identify information to support high frequency hearing. Low frequency sound has been found to cause larvae to swim in the direction of or away from the sound source (Jeffs et al. 2003; Radford et al. 2007; Simpson et al. 2011; Stanley et al. 2009; Vermeij et al. 2010). However, invertebrate responses to sound appear to be highly species and situationally specific (Stocks et al. 2012). Other potential responses include startle responses, as has been observed in squid (Mooney and coauthors 2010). Based upon available information, we expect that any black or white abalone exposed to noise from pile driving may respond via a stress response and in ways resembling startles such as those observed in other marine invertebrates. Black and white abalone grow so slowly that the period over which Coast Guard pile driving would occur (i.e., a few hours) would not result in appreciable differences in growth versus normal conditions. Larvae are very small, and tidal or other currents would immediately overcome any attempt by larvae to swim toward or away from pile driving noise. Therefore, NMFS considers the effects of sound on black and white abalone from Coast Guard pile driving to be insignificant.

During detachment or placement of ATON sinkers and chains, during removal and driving of pilings, and while Coast Guard ATON vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). Increased sediments in the water column could clog an abalone's gills and inhibit respiration if the effect persisted. However, increases in turbidity would be expected to quickly subside following completion of the in-water activity and would be localized. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels. For these reasons, water quality impacts resulting from increases in turbidity during ATON activities are insignificant.

Below we independently discuss the potential for the proposed action to physically disturb, and potentially injure or kill, black and white abalone.

Black Abalone

Overall, populations of black abalone throughout southern California and as far north as Cayucos have declined in abundance by more than 80 percent. Populations south of Point Conception have declined by more than 90 percent (Neuman et al. 2010). Historical abalone harvest contributed to some degree, but the primary cause of these declines has been withering syndrome, a disease caused by a Rickettsiales-like organism that affects the animal's digestion and causes starvation leading to foot muscle atrophy, lethargy, and death (Braid et al. 2005; Friedman et al. 2003). Withering syndrome results in rapid (within a few weeks) and massive (reductions of over 80 percent) mortalities in affected populations (Neuman et al. 2010). Most

black abalone populations affected by withering syndrome remain at low densities, below the estimated levels needed to support successful reproduction and recruitment (0.34 abalone per m^2) (Neuman et al. 2010). Data for 2002-2006 indicate that population densities exceed this threshold value in areas not yet affected by the disease (north of Cayucos; densities range from 1.1 to 10.5 abalone per m^2), whereas population densities fall below this threshold value, many significantly so, in areas affected by the disease (south of Cayucos; densities range from 0 to 0.5 abalone per m^2) (Neuman et al. 2010). Despite these low densities, however, researchers have observed evidence of recent recruitment and increases in abundance at several locations throughout southern California, including the Palos Verdes Peninsula, Laguna Beach, Santa Cruz Island, San Miguel Island, and San Nicolas Island (Eckdahl 2015; Richards and Whitaker 2012; unpublished data by Glenn VanBlaricom, U.S. Geological Survey, 22 June 2015).

Only four federal navigation aids (one floating buoy and three fixed aids) occur in black abalone critical habitat (Tech 2014). One of the fixed aids is located off the eastern shore of Santa Catalina Island, another fixed aid is located at the edge of a pier in Half Moon Bay, and there are two aids in Bodega Bay (one fixed and one floating). Black abalone are most likely to co-occur with these navigation aids. However, black abalone have not previously been observed on fixed or floating ATON and NMFS is aware of only two instances where black abalone have been observed on artificial substrates. In April 2012, researchers with the Monterey Bay National Marine Sanctuary found several juvenile black abalone (~20 mm in shell length) on the plastic float underside of a floating dock in an area primarily covered with crustose coralline algae (NMFS 2016e). In 2015, biologists surveyed a number of pilings in close proximity and not find any black abalone (NMFS 2016e). Additionally, in 2014, surveys were conducted on a several hundred foot pier on the east tip of San Nicolas Island. In the first survey, three juvenile black abalone were observed (from size 40 mm to 15 mm). In the second survey of the pier conducted approximately nine months later, one juvenile of about 25 mm in length was observed. All abalone were observed on cement pylons. The biologist who surveyed the pier suggested that wave action likely scours off large abalone due to lack of protective fissures and cracks (William Hoyer, personal communication to Susan Wang, NMFS; November 16, 2016). Similarly, fixed and floating ATON lack suitable refuge habitat in the form of deep cracks and crevices more often found in natural rocky reef habitat. This information suggests that the likelihood of a black abalone successfully settling on ATON components is extremely low. Because of this and the low number of navigation aids in areas where black abalone occur, and the infrequency in which piles supporting fixed aids must be replaced, the likelihood for Coast Guard activities to physically disturb black abalone during maintenance or discontinuance of fixed aids is discountable.

Chains from floating navigation aids move in a circle beneath the water and create a circle of scour on the seafloor. The chain portion of a floating ATON may crush and displace organisms that settle in the scour radius surrounding the sinker. However, as mentioned above, only one floating ATON occurs in black abalone critical habitat (in the south end of Bodega Bay, CA). Considering the low abundance of black abalone, the large geographic area in which this small

number of animals occurs (e.g., black abalone critical habitat covers approximately 360 km^2), and the relatively small area of habitat affected by chain scour (i.e., <0.0002 km^2), the likelihood of black abalone being impacted by chain scour from the single floating navigation aid in areas where black abalone have been recently observed is discountable.

If ATON were to be established on or in close proximity to black abalone, the sinker or chain portion of floating ATON, or a fixed aid may crush and displace black abalone. However, as noted above, there is a very small number of ATON in black abalone critical habitat, indicating that the establishment of new ATON in areas where black abalone could occur will be extremely infrequent. If the Coast Guard were to propose to construct additional ATON in black abalone critical habitat (i.e., not follow the PDC established for this consultation), subsequent consulation under section 7 of the ESA would be required.

As described above, we determined that the potential effects of the proposed action on black abalone are either insignificant or discountable. For these reasons, the proposed action is not likely to adversely affect black abalone and this species will not be considered further in this opinion.

White abalone

The estimated abundance and density of white abalone in the wild has declined significantly from estimated levels in the mid-1900s, prior to the modern commercial white abalone fishery. Overfishing in the 1960s and 1970s led to reduced local densities such that remaining animals may be too far apart to successfully reproduce. Because of the difficulty in detecting smaller animals, estimates only account for emergent (adult) individuals and may not reflect the true abundance of the population. However, the trends in estimates clearly show that white abalone abundance and density have declined and are critically low compared to pre-exploitation levels.

Abundance estimates for southern California indicate population numbers have declined by several orders of magnitude since the 1960s. Estimates for the late 1960s to early 1970s ranged from about 600,000 to 1.7 million white abalone (Rogers-Bennet et al. 2002), whereas estimates for the 1990s were around 2,000 white abalone (Hobday et al. 2001). Hobday and Tegner (2000) estimated a total abundance of less than 2,600 white abalone in California and Mexico, about 0.1 percent of estimated pre-exploitation numbers. More recent survey data indicate that the population is likely larger than previously estimated, based primarily on updated habitat data showing greater amounts of suitable habitat than previously thought. In 2002-2004, Butler et al. (2006) conducted remote operating vehicle surveys off southern California at Tanner Bank, Cortes Bank, and San Clemente Island and found 258 individual white abalone, with the highest estimated density at Tanner Bank in 2002 (approximately 0.002 abalone per m^2). Abundance estimates for each area were: 12,819 ±3584 (SE – standard error) in 2002 and 5,883 ±3324 (SE) in 2004 for Tanner Bank; 7,366 ±5,340 (SE) in 2003 for Cortes Bank; and 1,938 ±1,598 (SE) in 2004 for San Clemente Island (Butler et al. 2006). Although these abundance estimates contain a

high degree of error, they generally indicate population numbers are likely greater than estimated by Hobday and Tegner (2000).

Additional remote operating vehicle surveys have been conducted at Tanner Bank since 2002 and show continued decline in white abalone abundance and density over the period from 2002-2010 (Stierhoff et al. 2012). The total number of white abalone observed declined from 194 in 2002 to 39 in 2010; the total estimated abundance at Tanner Bank declined from 15,323 ±5,362 (SEM – standard error of the mean) in 2002 to 3,375 ±1,396 (SEM) in 2010 (Stierhoff et al. 2012). The size distribution indicates that individuals are getting larger and older with little recruitment. Across all survey years, most (77-89 percent) of the white abalone observed were considered singletons (i.e., more than 2 m from other white abalone), with only 5-8 percent of the animals observed in groups of two and only one group of five observed in 2002 and one group of three observed in 2010 (Stierhoff et al. 2012). Thus, although numbers are likely higher than previously estimated, white abalone populations in the wild have experienced severe declines. Field observations since 2013 indicate recruitment is occurring in the wild in southern California, but likely at a rate that is too low to sustain and rebuild the population without human intervention (e.g., captive propagation and field planting).

There are no fixed navigation aids within the depth distribution where current remnant populations of white abalone are most common (i.e., 30 to 60 meters). Additionally, in surveys conducted to date, white abalone have not been observed on piling structures in the southern California bight (Jonathan Williams, Occidental College, personal communication to Melissa Neumann, NMFS; March 2016). Given there are no fixed aids within the geographic area where this species has recently been observed, that the species has not previously been documented on pilings in southern California, and the low abundance of the species, the likelihood of white abalone co-occurring with fixed navigation aids and being physically disturbed during maintenance or discontinuance of fixed aids is discountable. Since there are currently no fixed navigation aids within this depth distribution, we also do not anticipate the Coast Guard will establish fixed aids in this depth range in the future. Therefore, the likelihood of white abalone being impacted by the future establishment of fixed ATONs in insignificant.

Chains from floating navigation aids move in a circle beneath the water and create a circle of scour on the seafloor. The chain portion of a floating ATON may crush and displace organisms that settle in the scour radius surrounding the sinker. There are seven floating aids within the depth distribution where current remnant populations of white abalone are most common (i.e., 30 to 60 meters). We would not expect white abalone to be able to successfully settle in the scour radius of a floating ATON because the scour area is continuously disturbed. There is the potential for juvenile or adult abalone to attempt to traverse the area of scour leaving the animals vulnerable to being crushed or displaced. However, considering the low abundance of white abalone, the large geographic area in which this small number of animals occurs, the low number of floating aids in areas where white abalone have recently been documented, and the relatively small area of habitat affected by chain scour from each floating aid (i.e., <0.0002 km^2), the

likelihood of white abalone being impacted by chain scour from floating navigation aids is so low as to be discountable. If floating ATON were to be established on or in close proximity to white abalone, the sinker or chain portion of the ATON may crush and displace organisms under the sinker or in the scour radius. However, based on the low number of floating ATON currently present within the depth distribution in southern California where current remnant populations of white abalone are most common, we anticipate the establishment of new ATON in areas where white abalone could occur will be extremely infrequent. For this reason, coupled with the low abundance of this species, we consider the likelihood of the Coast Guard establishing a floating ATON in close enough proximity to crush or displace individual white abalone to be discountable.

As described above, we determined that the potential effects of the proposed action on white abalone are either insignificant or discountable. For these reasons, the proposed action is not likely to adversely affect white abalone and this species will not be considered further in this opinion.

2.3.4 Chambered Nautilus (proposed)

NMFS proposed to list the chambered nautilus as a threatened species under the ESA on October 23, 2017. The chambered nautilus is a cephalopod found in tropical, coastal reef, deep-water habitats of the Indo Pacific (Miller 2017). Cephalopods are distinguished from other marine mollusks by such features as a buoyancy mechanism, which facilitates movement, and a beak, which facilitates a carnivorous diet (Miller 2017). The species most often occurs at depths ranging between 100 and 500 meters, though in areas where water temperatures drop seasonally, chambered nautilus will range into much shallower water nocturnally. The species is mobile, traveling up to 6 km per day. Chambered nautilus do not swim through open water, but live in close association with reef slopes and bottom substrate (Miller 2017).

The species is only known to occur in the American Samoa portion of the action area (Miller 2017). The Coast Guard currently has 19 ATON in waters surrounding American Samoa (6 floating, 13 fixed), though this number is expected to change through time as the Coast Guard discontinues or establishes ATON within the range of chambered nautlitus. The stressors associated with the proposed action that have the potential to effect chambered nautilus include effects of to their habitat from increased sedimentation during and following underwater work, and disturbance of individual animals.

During detachment or placement of ATON sinkers and chains, during removal and driving of pilings, and while Coast Guard ATON vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). Though effects to chambered nautilus from increased sedimentation are speculative or largely unavailable (Miller 2017), the species could be impacted if an action were to increase sedimentation to a degree that compromises the health and coral community on the reef, destroying habitat (citation; ISRS

2004). However, any increases in turbidity from ATON activities would be expected to quickly subside following completion of the in-water activity and would be localized. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels. For these reasons, impacts resulting from increases in sedimentation during ATON activities are insignificant.

We do not expect chambered nautilus to co-occur with Coast Guard activities to maintain, establish, or discontinue fixed ATON in American Samoa because these activities occur during the day in relatively shallow waters, and the species is not known to venture into these shallow water habitats except nocturnally. Therefore, we do not expect in-water work associated with fixed ATON to disturb chambered nautilus. Chambered nautilus in close proximity to the sinker of a floating ATON could be disturbed when the sinkers is lifted from, or dropped onto, the seafloor. Any behavioral responses to chambered nautilus from sinker movement are expected to be temporary (e.g., a startle response, brief avoidance behavior) and we do not expect these reactions to have any measurable effects on any individual's fitness. We expect individuals that exhibit a temporary behavioral response will return to baseline behavior immediately after the ATON is lifted from, or dropped onto, the seafloor. We do not expect these short term behavioral reactions to rise to the level of take. For these reasons, the effect of ATON activities that may result in behavioral reactions is insignificant and is not likely to adversely affect chambered nautilus.

As described above, we determined that the potential effects of the proposed action on chambered nautilus are insignificant. For this reason, the proposed action is not likely to adversely affect chambered nautilus and this species will not be considered further in this opinion.

2.3.5 Critical Habitat

Designated critical habitat for several ESA-listed species occurs within the action area and may be affected by the proposed action. Each critical habitat is characterized by physical and biological features (previously referred to by NMFS as primary constituent elements) that are essential to the conservation of the ESA-listed species for which the habitat was designated. Below we describe physical and biological features of each critical habitat, and then evaluate the effects that the proposed action may have on these physical and biological features. In determining if designated critical habitat is likely to be adversely modified or destroyed, we assess whether the proposed action would appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02). If the proposed action would not appreciably diminish the conservation value of designated critical

habitat, we conclude that the proposed action is not likely to adversely modify or destroy the designated critical habitat and do not consider that critical habitat further.[22]

Designated critical habitat contains a variety of physical and biological features deemed essential to the conservation of the ESA-listed species for which they were designated. Table 9 lists these features and also highlights those that may be affected by the proposed action (i.e., features that may be affected by the proposed action are in boldface in Table 9). With a few exceptions as noted below, the features that may be affected by the proposed action can be grouped into the following categories:

1) Waters free from obstruction,
2) Habitat with sufficient water quality,
3) Habitat with adequate availability of prey resources,
4) Habitat with adequate availability of quality substrate, and
5) Areas free from disturbance.

Additionally, smalltooth sawfish critical habitat includes the presence of red mangroves, loggerhead sea turtle critical habitat includes waters free of artificial lighting to allow transit through the surf zone and outward toward open water and waters with minimal manmade structures that could promote predators, and Johnson's seagrass critical habitat includes sufficient water transparency and stable, unconsolidated sediments.

[22] Note that the federal register notices for some designated critical habitat discussed in this section are listed in Table 10.

Table 9. Physical and biological features of designated critical habitat that are essential to the conservation of the species (DPS or Evolutionarily Significant Units – ESUs). Biological features which may be affected by the proposed action are in boldface.

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
Invertebrates and Plants		
Elkhorn Coral & Staghorn Coral	**Substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments**	4
Black abalone	**Rocky substrate, including rocky benches, crevices, and large boulders; food resources, including bacterial and diatom films, and algae**; **Juvenile settlement habitat, including rocky habitat with coralline algae and/or crevices, and cryptic biogenic structures; suitable water quality;** Suitable nearshore circulation patterns	2, 3, 4
Johnson's seagrass	**Adequate water quality**, salinity levels, **water transparency** **Stable, unconsolidated sediments**	2, other
Reptiles		
Leatherback Turtle	**Forage species, primarily Scyphomedusae (*Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development** **Migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas**	1, 3
Green Turtle Florida & Mexico Pacific coast breeding colonies; all other areas Hawksbill Turtle	Activities requiring special management considerations include: **Vessel traffic** Coastal construction Point and non-point source pollution Fishing activities Dredge and fill activities Habitat restoration	5

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
Loggerhead turtle – Northwest Atlantic Ocean *Note that all federally authorized or permitted aids to navigation were excluded from the critical habitat designation for loggerhead sea turtles.	*Nearshore Reproductive Habitat** Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km (1 mile) offshore; **Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water.** **Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures),** disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. *Winter Habitat* Water temperatures above 10° C from November through April; Continental shelf waters in proximity to the western boundary of the Gulf Stream; and Water depths between 20 and 100 m. *Breeding Habitat* High densities of reproductive male and female loggerheads; Proximity to primary Florida migratory corridor; and Proximity to Florida nesting grounds. *Migratory Habitat* Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and **Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas**. *Sargassum Habitat* Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the Sargassum community in water temperatures suitable for the optimal growth of Sargassum and inhabitance of loggerheads; **Sargassum in concentrations that support adequate prey abundance and cover;** **Available prey and other material associated with Sargassum habitat including, but not limited to, plants and cyanobacteria and animals native to the Sargassum community such as hydroids and copepods; and** Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by Sargassum for post-hatchling loggerheads,	3, 5, other

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	i.e., >10 m depth.	
Marine Mammals		
Beluga whale – Cook Inlet DPS	Intertidal and subtidal waters of Cook Inlet with depths less than 30 feet (MLLW) (9.1 m) and within 5 miles (8 km) of high and medium flow anadromous fish streams. **Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.** Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales. **Unrestricted passage within or between the critical habitat areas.** **Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales.**	1, 3, 5
Steller Sea Lion – Eastern and Western DPSs (Eastern DPS delisted, but CH still in effect; see 78 FR 66139)	**Terrestrial, air, and aquatic areas that support: Reproduction, foraging, rest, refuge**	2, 3, 5
Ringed Seal – Arctic DPS (proposed)	Sea ice habitat suitable for the formation and maintenance of subnivean birth lairs used for sheltering pups during whelping and nursing, which is defined as seasonal landfast (shorefast) ice, except for any bottom-fast ice extending seaward from the coast line in waters less than 2 m deep, or dense, stable pack ice, that has undergone deformation and contains snowdrifts at least 54 cm deep. Sea ice habitat suitable as a platform for basking and molting, which is defined as sea ice of 15 percent or more concentration, except for any bottom-fast ice extending seaward from the coast line in waters less than 2 m deep. **Primary prey resources to support Arctic ringed seals, which are defined to be Arctic cod, saffron cod, shrimps, and amphipods.**	3
Killer Whale – Southern Resident	**Water quality to support growth and development;** **Forage species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and** **Passage conditions to allow for migration, resting, and foraging.**	1, 2, 3

Species DPS or ESU		Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
North Atlantic right whale	Foraging habitat	The physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate *C. finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes Low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins **Late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region** **Diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region**	3
	Calving habitat	Calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale Sea surface temperatures from a minimum of 7 °C, and never more than 17 °C Water depths of 6 to 28 meters, where these features simultaneously co-occur over contiguous areas of at least 231 nm^2 of ocean waters during the months of November through April	None
North Pacific Right Whale		The presence of large zooplankton for feeding; in particular, copepods and a euphausiid whose very large size, high lipid content.	3
Hawaiian monk seal		Terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing **Marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging** Significant areas used by monk seals for hauling out, resting, or molting	3
Fish			
Green Sturgeon - Southern		*Freshwater areas*: **Abundant prey items for larval, juvenile, subadult, and adult life stages.** Substrate type or size (i.e., structural features of substrates) A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages. **Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.** **A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (e.g., an unobstructed river or**	1, 2, 3

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	dammed river that still allows for safe and timely passage). Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. *Estuarine areas*: **Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.** Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds. **Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.** **A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.** A diversity of water depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants *Coastal Marine Areas*: **A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.** Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon). **Abundant prey items for subadults and adults, which may include benthic invertebrates and fish.**	
Eulachon - Southern	**Freshwater spawning and incubation sites with water flow, quality, and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles.** A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of	1, 2, 3, 4, 5

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	freshwater discharge over time) that supports spawning, and survival of all life stages. **Water quality suitable for spawning and viability of all eulachon life stages.** Sublethal concentrations of contaminants affect the survival of aquatic species by increasing stress, predisposing organisms to disease, delaying development, and disrupting physiological processes, including reproduction. Suitable water temperatures, within natural ranges, in eulachon spawning reaches. **Spawning substrates for eulachon egg deposition and development**. **Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted.** **Safe and unobstructed migratory pathways for eulachon adults to pass from the ocean through estuarine areas to riverine habitats in order to spawn, and for larval eulachon to access rearing habitats within the estuaries and juvenile and adults to access habitats in the ocean.** A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) that supports spawning migration and outmigration of larval eulachon from spawning sites. **Water quality suitable for survival and migration of spawning adults and larval eulachon.** Water temperature suitable for survival and migration. **Prey resources to support larval eulachon survival.** **Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival.** **Prey items, in a concentration that supports foraging leading to adequate growth and reproductive development for juveniles and adults in the marine environment.** **Water quality suitable for adequate growth and reproductive development.**	
Puget Sound rockfish	*Adults* **Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities,** **water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities, and** the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.	2, 3

Species DPS or ESU		Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
		Juvenile boccacio **Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and** **water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.**	
Atlantic salmon		*Spawning and Rearing* Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during summer while they await spawning in the fall. **Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.** **Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.** Freshwater rearing sites with space to accommodate growth and survival of Atlantic parr. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production. *Migration* **Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult seeking spawning grounds needed to support recovered populations.** Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult Atlantic salmon. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation. **Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.** Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.	4, 5
Atlantic	Gulf of Maine	**Hard bottom substrate** (*e.g.*, rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.*, 0.0-0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early	1, 2, 4

Species DPS or ESU		Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
sturgeon	New York Bight Chesapeake Bay	life stages Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.*, sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development **Water of appropriate depth and absent physical barriers to passage (*e.g.*,locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: Unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults.** Water depths in main river channels must also be deep enough (*e.g.*, at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river, and **Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the** temperature, salinity, and **oxygen values that, combined, support: Spawning; annual and interannual adult, subadult, larval, and juvenile survival**; and larval, juvenile, and subadult growth, development, and recruitment (*e.g.*, 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 mg/L or greater DO for juvenile rearing habitat).	
	Carolina South Atlantic	**Hard bottom substrate (*e.g.*, rock, cobble, gravel, limestone, boulder, etc.)** in low salinity waters (*i.e.*, 0.0-0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages; Aquatic habitat inclusive of waters with a gradual downstream gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.*, sand, mud) between the river mouths and spawning sites for juvenile foraging and physiological development; **Water** of appropriate depth **and absent physical barriers to passage (*e.g.*,locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) Unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults and spawning condition adults.** Water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. **Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with** temperature and **oxygen values that support: (1) Spawning; (2) annual and inter-annual adult, subadult, larval, and juvenile survival; and**	1, 2, 4

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	(3) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25 °C. In temperatures greater than 26 °C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26 °C likely support spawning habitat.	
Gulf sturgeon	**Abundant food items, such as detritus, aquatic insects, worms, and/or molluscs, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages.** Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay; Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions; A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging; **Water quality, including** temperature, salinity, pH, hardness, **turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;** Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and **Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage).**	1, 2, 3
Smalltooth sawfish	**Red mangroves**, adjacent shallow euryhaline habitats and the nursery area functions they provide to facilitate recruitment of juveniles into the adult population.	Other

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
Chinook Salmon - Puget Sound, Lower Columbia River, Upper Columbia River, Upper Willamette River Chum Salmon – Lower Columbia River, Hood Canal summer-run Coho Salmon - Lower Columbia River Steelhead - Upper Columbia River, Snake River, Middle Columbia River, Upper Willamette River, Lower Columbia River	**Freshwater spawning sites with water quantity** and quality conditions **and substrate supporting spawning, incubation and larval development;** **Freshwater rearing sites with**: Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; **Water quality and forage supporting juvenile development**; Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. **Freshwater migration corridors free of obstruction** and excessive predation **with water quantity and quality conditions** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; **Estuarine areas free of obstruction and excessive predation with: Water quality,** water quantity, and salinity **conditions supporting juvenile and adult physiological transitions between fresh & saltwater**; Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; **Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.** **Nearshore marine areas free of obstruction** and excessive predation **with: Water quality** and quantity **conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation**; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. **Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.**	1, 2, 3, 4
Coho Salmon - Central California Coast, Southern Oregon/Northern California Coast	**Adequate substrate**, **water quality**, water quantity, water temperature, water velocity, cover/shelter, **food**, riparian vegetation, space, **safe passage**	1, 2, 3, 4
Steelhead - Puget Sound Coho Salmon - Lower Columbia River	**Freshwater spawning sites with water** quantity and **quality conditions and substrate supporting spawning, incubation and larval development.** **Freshwater rearing sites with** water quantity and **floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development**; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. **Freshwater migration corridors free of obstruction with** water quantity and **quality conditions** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks	1, 2, 3, 4

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	and boulders, side channels, and undercut banks **supporting juvenile and adult mobility and survival.** **Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater**; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; **and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.** **Nearshore marine areas free of obstruction with water quality** and quantity **conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation;** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. **Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.**	
Steelhead – Northern California, California Central Valley, Central California Coast, South-Central California Coast, Southern California	**Freshwater spawning sites with water** quantity and **quality conditions and substrate supporting spawning, incubation and larval development.** **Freshwater rearing sites with** water quantity and **floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development**; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. **Freshwater migration corridors free of obstruction with water** quantity and **quality conditions** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting **juvenile and adult mobility and survival.** **Estuarine areas free of obstruction with water quality,** water quantity, and salinity conditions **supporting juvenile and adult physiological transitions between fresh- and saltwater;** natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and **juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.** **Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation**; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. **Offshore marine areas with water quality conditions and forage, including aquatic**	1, 2, 3, 4

Species DPS or ESU	Physical or Biological Features Essential for the Conservation of the Species	Category for Evaluation
	invertebrates and fishes, supporting growth and maturation.	
Coho Salmon - Oregon Coast	**Freshwater spawning sites with water** quantity and **quality conditions and substrate supporting spawning, incubation, and larval development.** **Freshwater rearing sites with** water quantity **and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development;** and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. **Freshwater migration corridors free of obstruction with water** quantity and **quality conditions** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks **supporting juvenile and adult mobility and survival.** **Estuarine areas free of obstruction with water quality,** water quantity, and salinity **conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;** natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and **juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.** **Nearshore marine areas free of obstruction with water quality** and quantity **conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation;** and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. **Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.**	1, 2, 3, 4
Chinook Salmon - Snake River fall-run, Snake River spring/summer run	**Juvenile rearing areas include adequate: spawning gravel, water quality**, water quantity , water temperature, cover/shelter, **food**, riparian vegetation, space **Juvenile and adult migration corridors include adequate**: Substrate, **water quality**, water quantity, water temperature, water velocity, cover/shelter, **food**, riparian vegetation, space, **safe passage conditions**	1, 2, 3
Sockeye Salmon - Snake River	**Spawning and juvenile rearing areas**: spawning gravel, **water quality**, water quantity, water temperature, **food**, riparian vegetation, **access** **Juvenile migration corridors**: substrate, **water quality**, water quantity, **water temperature**, water velocity, cover/shelter, **food**, riparian vegetation, space, **safe passage conditions** **adult migration corridor has the same essential features, excluding "food"	1, 2, 3

As described further in the Coast Guard's biological evaluation (Tech 2014), ATON occur in each of the critical habitats evaluated in this opinion. Therefore, each critical habitat has the potential to be exposed to stressors associated with the proposed action. Below, we evaluate the possible effects the proposed action may have on the physical and biological features of the essential features of critical habitat in order to determine if the proposed action is likely to modify or destroy the designated critical habitat.

Possible stressors from the proposed action that may affect the physical and biological features of designated critical habitat include turbidity increases during maintenance, establishment, or discontinuance, cleaning of ATON components during maintenance, vessel traffic and noise, pile driving and general construction noise, and the physical presence of floating and fixed aids within critical habitats. However, as further outlined below, the effects of these stressors on the identified physical and biological features were determined to be either insignificant or discountable based on the nature of the feature and the stressor. As mentioned above, most of the physical and biological features of designated critical habitat can be grouped into categories 1 through 5 (see Table 9). We evaluate the potential effects of the proposed action on these categories below and for any features that do not fall into these categories (i.e., "other" in Table 9), a separate analysis is presented.

1 – Waters free from obstruction: The proposed action will not result in obstructions to migratory pathways for any species in areas of designated critical habitat. While the project may result in individual animals temporarily avoiding a small area during a maintenance event or when an ATON is being established or discontinued (e.g., due to pile driving or construction noise) in critical habitat, the avoidance will be temporary (i.e., lasting a few hours) and localized. During the short time period that an ATON is being maintained, discontinued, or established, any animals in the vicinity of an ATON will be able to slightly alter course and access preferred habitats a short distance away from the ATON activities. Further, while a transiting animal may need to slightly alter course (i.e., by a few meters) to avoid running into an ATON while transiting critical habitat, the presence of ATON does not prevent animals from accessing preferred habitat areas. For these reasons, the presence, maintenance, establishment, and discontinuance of ATON is expected to have an insignificant effect on essential features of designated critical habitat related to obstructions and migratory pathways.

2 – Habitat with sufficient water quality: Impacts to water quality in designated critical habitat could occur during ATON operations. During detachment or placement of ATON sinkers and chains, during removal and driving of piles, and while Coast Guard ATON vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in temporary increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). The lateral extent and duration of increased turbidity would also depend on substrate type and water movement in the area. However, increases in turbidity caused by resuspension of sediment from installation of structures on the seafloor, spudding, and/or vessel propellers would be expected to quickly subside (i.e., within hours) following completion of the ATON activity. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels. Additionally, the Coast Guard will

implement measures to minimize the resuspension of sediment including, when operationally feasible, lowering all objects to the bottom in a controlled manner, operating at minimum safe speeds while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom, operating vessels in marked channels whenever possible, and avoiding spudding down or anchoring in certain critical habitats (i.e., elkhorn and staghorn coral, Johnson's seagrass) when conducting ATON operations. Further, per the PDC, the Coast Guard will implement a number of minimization measures to reduce the likelihood of impacting water quality including, but not limited to, preventing all excess materials and hazardous substances from entering the marine environment, completing painting and chemical cleaning on land, maintaining a contingency plan to control toxic materials aboard all ATON vessels, and ensuring all project-related materials and equipment placed in the water is free from pollutants. For these reasons, impacts of the proposed action on essential features related to water quality are insignificant.

3 – Habitat with adequate availability of prey resources: Prey resources in the immediate vicinity of an ATON or attached to ATON components could be displaced or harmed during a maintenance event or when an ATON is established or discontinued (e.g., due to underwater noise from pile driving or because animals attached to an ATON component were removed during maintenance). However, impacts to prey resources would be highly localized and infrequent, only occurring when maintenance is performed on a particular ATON or when the Coast Guard establishes or discontinues an ATON. The area of potential adverse effects to prey items (i.e., individual prey items on ATON structures and within a few meters of the ATON could be injured during maintenance, establishment or discontinuance) is infinitesimally small when compared with the area of designated critical habitat for each species that could contain prey resources for these animals. Further, any displaced and uninjured prey items would be able to return to the area of the ATON immediately after the ATON operations conclude. For these reasons, effects to prey resources from the proposed action are insignificant.

4 – Habitat with adequate availability of quality substrate: Substrate quality in the vicinity of ATON could be impacted by the presence of ATON, particularly from the scour associated with floating ATON (though a small area of substrate would be affected during spudding down, anchoring, and pile replacement). However, the area of substrate effected is infinitesimally small compared with the total area of each designated critical habitat. For example, as described in greater detail in section 2.6.2.4, we estimate that 3,267 m^2 (0.003 km^2) of habitat is continuously impacted by scour from each floating buoy in District 7 where elkhorn and staghorn critical habitat occurs. Based on the total number of floating aids in elkhorn and staghorn critical habitat, a total of 633,798 m^2 (0.634 km^2) of elkhorn and staghorn critical habitat is continuously impact by scour. Within this area of impact, the substrate is not expected to be of suitable quality and availability to support successful larval settlement and recruitment, and reattachement and recruitment of fragments. Additionally, as described in further detail in section 2.6.2.4, coral habitat could be impacted from pile replacement and spudding down. We estimated that an average area of impact for every structure that needs to be replaced (including pile replacement and spudding down) is 3.12 m^2. Since structures in District 7 (including areas of elkhorn and

staghorn critical habitat) are replaced approximately 8.35 percent of the time, this means approximately 20 structures are replaced annually in elkhorn and staghorn critical habitat (8.35 percent x 241 fixed structures = ~20 structures/year), and an average area of impact of 62.4 m^2 (0.0000624 km^2) from replacement of fixed structures in elkhorn and staghorn critical habitat. Elkhorn and staghorn coral critical habitat covers an area of approximately 7,663 km^2. Therefore, the total substrate area impacted by scour and ATON structure replacement is approximately 0.000000814 percent of the available critical habitat for elkhorn and staghorn coral. We consider this area of impact to be insignificant and this area of impact would not effect the conservation value of substrates in elkhorn and staghorn critical habitat. A similar proportion of substrate is expected to be affected in other areas of critical habitat. For these reasons, the effect of the proposed action on essential features related to the availability of quality substrate is insignificant.

5 – Habitat free from disturbance: While Coast Guard ATON vessels are transiting designated critical habitats and during ATON operations occurring in critical habitats, disturbance could occur. The area of disturbance would be highly localized, occurring only within close proximity to the transiting vessel or the ATON being maintained, established or discontinued. The largest of area of disturbance would occur during pile driving activities when underwater noise at levels detectable to individual animals could travel a few kilometers from the pile being driven. However, in all cases, disturbance would be temporary, lasting only as long as the ATON operations (i.e., typically an hour or so, but up to eight hours when pile driving is required) or as long as the vessel is present. Due to the localized nature of potential disturbance and the infrequency in which ATON are serviced, discontinued, or established, the proposed action would not result in long-term disturbance that would be expected to impact the conservation value of any designated critical habitats occurring in the action area. For this reason, the effect of the proposed action on disturbance related essential features of designated critical habitat is insignificant.

Smalltooth sawfish: One of the essential features of smalltooth sawfish critical habitat is the presence of red mangroves. However, per the PDC, mangroves will not be impacted by ATON operations in District 7 where smalltooth saw fish critical habitat occurs. For this reason, the likelihood of the proposed action affecting red mangroves in smalltooth sawfish critical habitat is discountable.

Loggerhead turtle: The essential features of loggerhead sea turtle critical habitat includes waters free of artificial lighting to allow transit through the surf zone and outward toward open water and waters with minimal manmade structures that could promote predators. In-water ATON do contain lights and ATON are manmade in-water structures which have the potential to promote predators. However, as noted above, all federally authorized or permitted aids to navigation within the legal boundaries of loggerhead critical habitat are not included in the critical habitat designation. Additionally, per the PDC, the Coast Guard will avoid establishment of new navigation aids in nearshore reproductive habitat of designated loggerhead critical habitat. For this reason, the likelihood of the proposed action affecting the essential features of loggerhead sea turtle designated critical habitat is discountable. If the Coast Guard were to propose to

construct additional ATON to loggerhead sea turtle critical habitat, subsequent consulation under section 7 of the ESA would be required.

Johnson's seagrass: The essential features of Johnson's seagrass critical habitat includes sufficient water transparency and stable, unconsolidated sediments. The primary activity associated with the proposed action that could affect these essential features is the detachment or placement of ATON sinkers and chains, removal and driving of pilings, and the operation of vessels in shallow water. These activities could result in the destabilization and resuspension of sediment in the vicinity of the ATON and temporary decreases in water transparency. The lateral extent and duration of sediment destabilization and increased turbidity would depend on substrate type and water movement in the area. However, increases in turbidity caused by the destablization of sediment from installation of structures on the seafloor, spudding, and/or vessel propellers would be expected to quickly subside (i.e., within hours) following completion of the maintenance activity. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels. Additionally, per the PDC, the Coast Guard will implement measures to minimize the resuspension of sediment including, when operationally feasible, lowering all objects to the bottom in a controlled manner, operating at minimum safe speeds while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom, operating vessels in marked channels whenever possible, and avoiding spudding down when conducting ATON operations in Johnson seagrass habitat. Due to the PDC that will be implemented by the Coast Guard, the temporary duration of impacts to water transparency and sediments, and the infrequent nature of ATON operations in Johnson's seagrass critical habitat, the effects of the proposed action on the essential features of Johnson's seagrass critical habitat are insignificant.

Conclusion on Critical Habitat

In conclusion, with the PDC that will be implemented by the Coast Guard, we find that the effects of ATON operations on the essential features of the designated critical habitat listed in Table 9 are either insignificant or discountable. As such, ATON operations are not likely to destroy or adversely modify designated critical habitat under NMFS jurisdiction and we will not discuss designated critical habitat further.

2.4 Status of Species Likely to be Adversely Affected

This section examines the status of each species that are likely to be affected by the proposed action. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on these NMFS Web sites: [e.g., http://www.nmfs.noaa.gov/pr/species/index.htm, http://www.fpir.noaa.gov/PRD/prd_coral.html].

Table 10. ESA-listed species occurring in the action area that are likely to be adversely affected by the proposed action.

Species	ESA Status	Critical Habitat*	Recovery Plan
Marine Mammals – Pinnipeds			
Steller Sea Lion (*Eumetopias jubatus*) – Western DPS	E – 55 FR 49204 and T – 62 FR 24345	58 FR 45269	73 FR 11872
Fishes			
Atlantic Salmon (*Salmo salar*) – Gulf of Maine DPS	E – 74 FR 29344 and 65 FR 69459	74 FR 29300	70 FR 75473 and 81 FR 18639 (Draft)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 FR 5913	82 FR 39160	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake DPS	E – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Gulf of Maine DPS	T – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – New York Bight DPS	E – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 FR 5913	82 FR 39160	-- --
Bocaccio (*Sebastes paucispinis*) – Puget Sound/Georgia Basin DPS	E – 75 FR 22276 and 82 FR 7711	79 FR 68041	81 FR 54556 (Draft)
Chinook Salmon (*Oncorhynchus tshawytscha)* – California Coastal ESU	T – 70 FR 37160	70 FR 52488	81 FR 70666
Chinook Salmon (*Oncorhynchus tshawytscha)* – Central Valley Spring-Run ESU	T – 70 FR 37160	70 FR 52488	79 FR 42504
Chinook Salmon (*Oncorhynchus tshawytscha)* – Lower Columbia River ESU	T – 70 FR 37160	70 FR 52629	78 FR 41911
Chinook Salmon (*Oncorhynchus tshawytscha)* – Puget Sound ESU	T – 70 FR 37160	70 FR 52629	72 FR 2493
Chinook Salmon (*Oncorhynchus tshawytscha)* – Sacramento River Winter-Run ESU	E – 70 FR 37160	58 FR 33212	79 FR 42504
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Fall-Run ESU	T – 70 FR 37160	58 FR 68543	80 FR 67386 (Draft)
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Spring/Summer Run ESU	T – 70 FR 37160	64 FR 57399	81 FR 74770 (Draft)
Chinook Salmon (*Oncorhynchus tshawytscha)* – Upper Columbia River Spring-Run ESU	E – 70 FR 37160	70 FR 52629	72 FR 57303
Chinook Salmon (*Oncorhynchus tshawytscha)* – Upper Willamette River ESU	T – 70 FR 37160	70 FR 52629	76 FR 52317

Species	ESA Status	Critical Habitat*	Recovery Plan
Chum Salmon (*Oncorhynchus keta*) – Columbia River ESU	T – 70 FR 37160	70 FR 52629	78 FR 41911
Chum Salmon (*Oncorhynchus keta*) –Hood Canal Summer-Run ESU	T – 70 FR 37160	70 FR 52629	72 FR 29121
Coho Salmon (*Oncorhynchus kisutch*) – Central California Coast ESU	E – 70 FR 37160	64 FR 24049	77 FR 54565
Coho Salmon (*Oncorhynchus kisutch*) – Lower Columbia River ESU	T – 70 FR 37160	81 FR 9251	78 FR 41911
Coho Salmon (*Oncorhynchus kisutch*) – Oregon Coast ESU	T – 73 FR 7816	73 FR 7816	81 FR 90780
Coho Salmon (*Oncorhynchus kisutch*) – Southern Oregon and Northern California Coasts ESU	T – 70 FR 37160	64 FR 24049	79 FR 58750
Eulachon (*Thaleichthys pacificus*) –Southern DPS	T – 75 FR 13012	76 FR 65323	81 FR 72572 (Draft)
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 FR 17757	74 FR 52300	2010 (Outline)
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	68 FR 13370	09/1995
Giant Manta Ray (*Manta birostris*)	T- 83 FR 2916	-- --	-- --
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS	T – 79 FR 38213	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Eastern Pacific DPS	E – 79 FR 38213	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Indo-West Pacific DPS	T – 79 FR 38213	-- --	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 FR 4001	-- --	63 FR 69613
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 FR 15674	74 FR 45353	74 FR 3566
Sockeye Salmon (*Oncorhynchus nerka*) – Ozette Lake ESU	T – 70 FR 37160	70 FR 52630	74 FR 25706
Sockeye Salmon (*Oncorhynchus nerka*) – Snake River ESU	E – 70 FR 37160	58 FR 68543	80 FR 32365
Steelhead Trout (*Oncorhynchus mykiss*) – California Central Valley DPS	T – 71 FR 834	70 FR 52487	79 FR 42504
Steelhead Trout (*Oncorhynchus mykiss*) – Central California Coast DPS	T – 71 FR 834	70 FR 52487	81 FR 70666
Steelhead Trout (*Oncorhynchus mykiss*) – Lower Columbia River DPS	T – 71 FR 834	70 FR 52629	78 FR 41911

Species	ESA Status	Critical Habitat*	Recovery Plan
Steelhead Trout (*Oncorhynchus mykiss*) – Middle Columbia River DPS	T – 71 FR 834	70 FR 52629	74 FR 50165
Steelhead Trout (*Oncorhynchus mykiss*) – Northern California DPS	T – 71 FR 834	70 FR 52487	81 FR 70666
Steelhead Trout (*Oncorhynchus mykiss*) – Puget Sound DPS	T – 72 FR 26722	81 FR 9251	-- --
Steelhead Trout, (*Oncorhynchus mykiss*) – Snake River Basin DPS	T – 71 FR 834	70 FR 52629	81 FR 74770 (Draft)
Steelhead Trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS	T – 71 FR 834	70 FR 52487	78 FR 77430
Steelhead Trout (*Oncorhynchus mykiss*) – Southern California DPS	E – 71 FR 834	70 FR 52487	77 FR 1669
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Columbia River DPS	T – 71 FR 834	70 FR 52629	72 FR 57303
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Willamette River DPS	T – 71 FR 834	70 FR 52629	76 FR 52317
Yelloweye Rockfish (*Sebastes rubberimus*) – Puget Sound/Georgia Basin DPS	T – 75 FR 22276 and 82 FR 7711	79 FR 68041	81 FR 54556 (Draft)
Marine Invertebrates and Plants			
Acropora globiceps Coral	T – 79 FR 53851	-- --	-- --
Acropora jacquelineae Coral	T – 79 FR 53851	-- --	-- --
Acropora retusa Coral	T – 79 FR 53851	-- --	-- --
Acropora speciosa Coral	T – 79 FR 53851	-- --	-- --
Seriatopora aculeata Coral	T – 79 FR 53851	-- --	-- --
Euphyllia paradivisa Coral	T – 79 FR 53851	-- --	-- --
Isopora crateriformis Coral	T – 79 FR 53851	-- --	-- --
Elkhorn Coral (*Acropora palmata*)	T – 79 FR 53851	73 FR 72210	80 FR 12146
Lobed Star Coral (*Orbicella annularis*)	T – 79 FR 53851	-- --	-- --
Mountainous Star Coral (*Orbicella faveolata*)	T – 79 FR 53851	-- --	-- --
Rough cactus coral (*Mycetophyllia ferox*)	T – 79 FR 53851	-- --	-- --
Boulder star coral (*Orbicella franksi*)	T – 79 FR 53851	-- --	-- --
Pillar Coral (*Dendrogyra cylindrus*)	T – 79 FR 53851	-- --	-- --
Staghorn Coral (*Acropora cervicornis*)	T – 79 FR 53851	73 FR 72210	80 FR 12146
Johnson's Seagrass (*Halophila johnsonii*)	T – 63 FR 49035	65 FR 17786	67 FR 62230

* Note that the potential effects of the proposed action on designated critical habitat is presented in section 2.3.4 of this opinion.

2.4.1 Steller Sea Lion: Western Distinct Population Segment (DPS)

The Steller sea lion ranges from Japan, through the Okhotsk and Bering Seas, to central California. It consists of two morphologically, ecologically, and behaviorally separate distinct population segments: the Eastern, which includes sea lions in Southeast Alaska, British Columbia, Washington, Oregon and California; and the Western, which includes sea lions in all other regions of Alaska, as well as Russia and Japan (Figure 19).

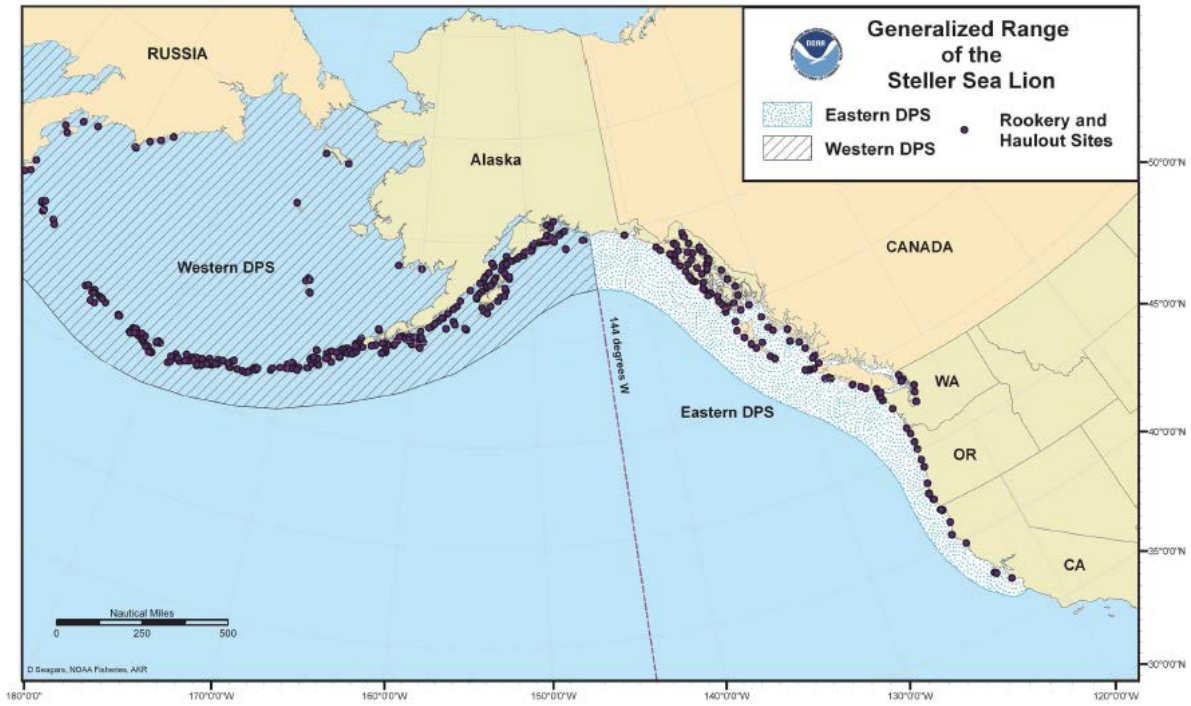


Figure 19. Map identifying the range of the endangered western distinct population segment Steller sea lion. From NMFS.

Steller sea lions adults are light blonde to reddish brown and slightly darker on the chest and abdomen (Figure 20). At the time of their initial listing, Steller sea lions were considered a single population listed as threatened (55 FR 29793). On May 5, 1997, following a status review, NMFS delineated two DPSs of Steller sea lions, and issued a final determination to list the Western DPS as endangered under the ESA and to list the Eastern DPS as threatened (62 FR 24345). The Eastern DPS was delisted on November 4, 2013, and the Western DPS retained its endangered status (78 FR 66139).

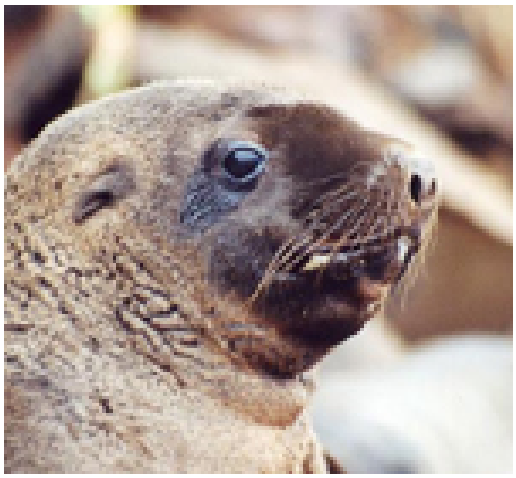


Figure 20. Steller sea lion. Photo: NOAA National Marine Mammal Laboratory.

We used information available in the final listing (62 FR 24345), the revised Recovery Plan (NMFS 2008e) and the

2015 stock assessment report (Muto 2016) to summarize the status of the Western DPS, as follows.

Life History

Within the Western DPS, pupping and breeding occurs at numerous major rookeries from late May to early July. Male Steller sea lions become sexually mature at three to seven years of age. They are polygynous, competing for territories and females by age ten or eleven. Female Steller sea lions become sexually mature at three to six years of age and reproduce into their early twenties. Most females breed annually, giving birth to a single pup. Pups are usually weaned in one to two years. Females and their pups disperse from rookeries by August to October. Juveniles and adults disperse widely, especially males. Their large aquatic ranges are used for foraging, resting, and traveling. Steller sea lions forage on a wide variety of demersal, semi-demersal, and pelagic prey, including fish and cephalopods. Some prey species form large seasonal aggregations, including endangered salmon and eulachon species. Others are available year round.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Western DPS of the Steller sea lion.

As of 2015, the best estimate of abundance of the western Steller sea lion DPS in Alaska was 12,189 for pups and 37,308 for non-pups (total N_{min} = 49, 497) (Muto 2016). This represents a large decline since counts in the 1950s (N = 140,000) and 1970s (N = 110,000).

Steller sea lion Western DPS site counts decreased forty percent from 1991 to 2000, an average annual decline of 5.4 percent; however, counts increased three percent between 2004 and 2008, the first recorded population increase since the 1970s (NMFS 2008e). However, there are regional differences in population growth rate, with positive trends in the eastern portion of the range, and negative trends west of Samalga Pass (~170°W) (Muto 2016). These trends indicate that overall, the Western DPS may be stable or exhibiting a slight negative trend as a whole.

Based on the results of genetic studies, the Steller sea lion population was reclassified into two distinct population segments: western and eastern. The data which came out of these studies indicated that the two populations had been separate since the last ice age (Bickham et al. 1998). Further examination of the Steller sea lions from the Gulf of Alaska (i.e., the Western DPS) revealed a high level of haplotypic diversity, indicating that genetic diversity had been retained despite the decline in abundance (Bickham et al. 1998).

Steller sea lions are distributed mainly around the coasts to the outer continental shelf along the North Pacific Ocean rim from northern Hokkaiddo, Japan through the Kuril Islands and Okhotsk Sea, Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California (Figure 19). The Western DPS includes Steller sea lions that reside in the central and western Gulf of Alaska, Aleutian Islands, as well as those that inhabit the coastal waters and breed in Asia (e.g., Japan and Russia).

Status

The species was listed as threatened in 1990 because of significant declines in population sizes (55 FR 49204). At the time, the major threat to the species was thought to be reduction in prey availability. To protect and recover the species, NMFS established the following measures: prohibition of shooting at or near sea lions; prohibition of vessel approach to within three nautical miles of specific rookeries, within 0.5 miles on land, and within sight of other listed rookeries; and restriction of incidental fisheries take to 675 sea lions annually in Alaskan waters. In 1997, the Western DPS was reclassified as endangered because it had continued to decline since its initial listing in 1990 (62 FR 24345). In recent years, there has been strong evidence that Western DPS Steller sea lion populations are increasing (Fritz et al. 2015; Fritz et al. 2016; Muto et al. 2016), though there are strong regional differences across the range in Alaska, with positive trends east of Samalga Pass in the Gulf of Alaska and eastern Bering Sea and negative trends to the west in the Aleutian Islands (Muto et al. 2016).

Recovery Goals

See the 2008 Revised Recovery Plan for the Steller sea lion for complete down listing/delisting criteria for each of the following recovery goals (NMFS 2008e).

- Baseline population monitoring
- Ensure adequate habitat and range for recovery
- Protect from over-utilization for commercial, recreational, scientific or educational purposes
- Protect from diseases, contaminants and predation
- Protect from other natural or anthropogenic actions and administer the recovery program

2.4.2 Atlantic Salmon: Gulf of Maine DPS

The Atlantic salmon is an anadromous fish, occupying freshwater streams in North America. There are three Atlantic salmon distinct population segments in the United States: Long Island Sound, Central New England, and the Gulf of Maine (Fay et al. 2006). The Gulf of Maine DPS Atlantic salmon are found in watersheds throughout Maine (Figure 19).

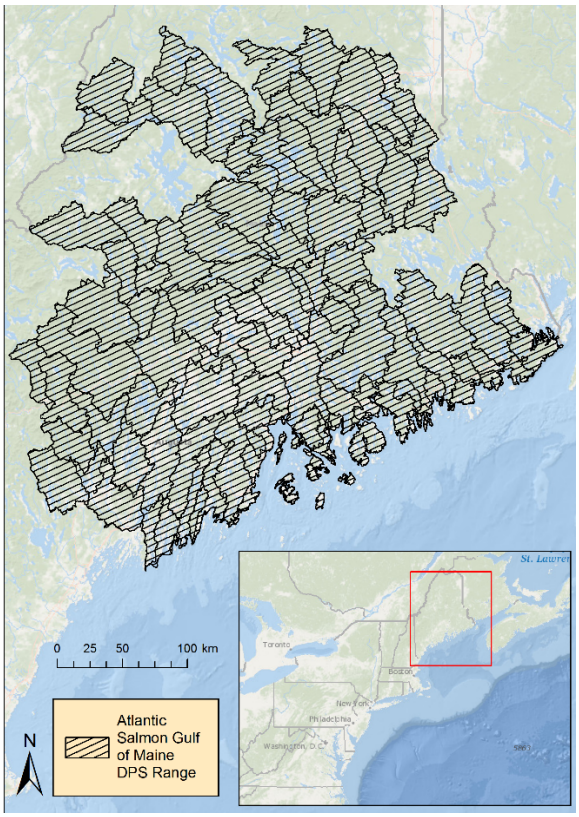


Figure 21. Map identifying the range of the Atlantic salmon Gulf of Maine distinct population segment.

Adult Atlantic salmon are silver-blue with dark spots (Figure 20). The Gulf of Maine DPS was first listed as endangered by the U. S. Fish and Wildlife Service and NMFS on November 17, 2000 (65 FR 69459). The listing was refined by the Services on June 19, 2009 (74 FR 29344) to include all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment (Figure 21).



Figure 22. Atlantic salmon. Photo: U.S. Fish and Wildlife Service, William Hartley.

We used information available in the status review (Fay et al. 2006) and recent scientific publications to summarize the life history, population dynamics and status of the species, as follows.

Life History

Adult Atlantic salmon typically spawn in early November and juveniles spend about two years feeding in freshwater until they weigh approximately two ounces and are six inches in length. Smoltification (the physiological and behavioral changes required for the transition to salt water) usually occurs at age two for Gulf of Maine DPS Atlantic salmon. Gulf of Maine DPS Atlantic

salmon migrate more than 4,000 km in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. The majority of Gulf of Maine DPS Atlantic salmon (about ninety percent) spend two winters at sea before reaching maturity and returning to their natal rivers, with the remainder spending one or three winters at sea. At maturity, Gulf of Maine DPS Atlantic salmon typically weigh between eight to fifteen pounds and average thirty inches in length.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Gulf of Maine DPS Atlantic salmon.

The conservation hatchery program plays a significant role in the persistence of Gulf of Maine DPS Atlantic salmon. In 2015, four million juvenile salmon (eggs, fry, parr and smolts) and 4,271 adults were stocked in the Connecticut, Merrimack, Saco, Penobscot and five other coastal rivers in Maine (USASAC 2016). The total number of returns to U.S. rivers was 921, and the majority (eighty percent) of the adult returns were of hatchery origin. The fact that so few of the returning adults are naturally-reared is concerning to managers; the reliance on hatcheries can pose risks such as artificial selection, inbreeding depression and outbreeding depression (Fay et al. 2006).

Adult returns of Gulf of Maine DPS Atlantic salmon captured in six Maine rivers from 1997 to 2004 ranged from 567 to 1,402. These counts include both wild and hatchery origin fish. Each year, the majority (ninety-two to ninety-eight percent) of adult returns were found in the Penobscot River; the Narraguagus River supported between 0.8 to 4.1 percent of adult returns during those years (Fay et al. 2006).

There is no population growth rate available for Gulf of Maine DPS Atlantic salmon. However, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016a).

The Gulf of Maine DPS Atlantic salmon is genetically distinct from other Atlantic salmon populations in Canada, and can be further delineated into stocks by river. The Downeast Coastal stocks include the Dennys, East Machias, Machias, Pleasant and Narraguagus rivers. The Penobscot Bay stock and the Merrymeeting Bay (Sheepscot). The hatchery supplementation programs for the Penobscot and Merrymeeting Bays stocks use river-specific broodstock (USASAC 2016).

Gulf of Maine DPS Atlantic salmon can be found in at least eight rivers in Maine: Dennys River, East Machias River, Machias River, Pleasant River, Narraguagus River, Ducktrap River, Sheepscot River, Cove Brook, Penobscot River, Androscoggin River and the Kennebec River.

Status

Historically, Atlantic salmon occupied U.S. rivers throughout New England, with an estimated 300,000 to 500,000 adults returning annually (Fay et al. 2006). Of the three DPSs found in the U.S., native salmon in the Long Island Sound and Central New England DPSs were extirpated in the 1800s. Several rivers within these DPSs are presently stocked with Gulf of Maine DPS

salmon. The Gulf of Maine DPS Atlantic salmon was listed as endangered in response to population decline caused by many factors, including overexploitation, degradation of water quality and damming of rivers, all of which remain persistent threats (Fay et al. 2006). Coastal development poses a threat as well, as artificial light can disrupt and delay fry dispersal (Riley et al. 2013). Climate change may cause changes in prey availability and thermal niches, further threatening Atlantic salmon populations (Mills et al. 2013). Even with current conservation efforts, returns of adult Atlantic salmon to the Gulf of Maine DPS rivers remain extremely low, with an estimated extinction risk of nineteen to seventy-five percent in the next one hundred years (Fay et al. 2006). Based on the information above, the species would likely have a low resilience to additional perturbations.

Recovery Goals

See the 2016 Draft Recovery Plan for the Gulf of Maine DPS Atlantic Salmon, for complete down listing/delisting criteria for each of their respective recovery goals. The following items were the top recovery actions identified to support in the Draft Recovery Plan:

- Enhance connectivity between the ocean and freshwater habitats important for salmon recovery
- Maintain the genetic diversity of Atlantic salmon populations over time.
- Increase adult spawners through the conservation hatchery program.
- Increase adult spawners through the freshwater production of smolts.
- Increase Atlantic salmon survival through increased ecosystem understanding and identification of spatial and temporal constraints to salmon marine productivity to inform and support management actions that improve survival.
- Consult with all involved Tribes on a government-to-government basis.
- Collaborate with partners and engage interested parties in recovery efforts for the Gulf of Maine DPS.

2.4.3 Shortnose Sturgeon

Shortnose sturgeon occur in estuaries and rivers along the east coast of North America (Vladykov and Greeley 1963). Their northerly distribution extends to the Saint John River, New Brunswick, Canada, and their southerly distribution historically extended to the Indian River, Florida (Evermann and Bean 1898; Scott and Scott 1988) (Figure 23).

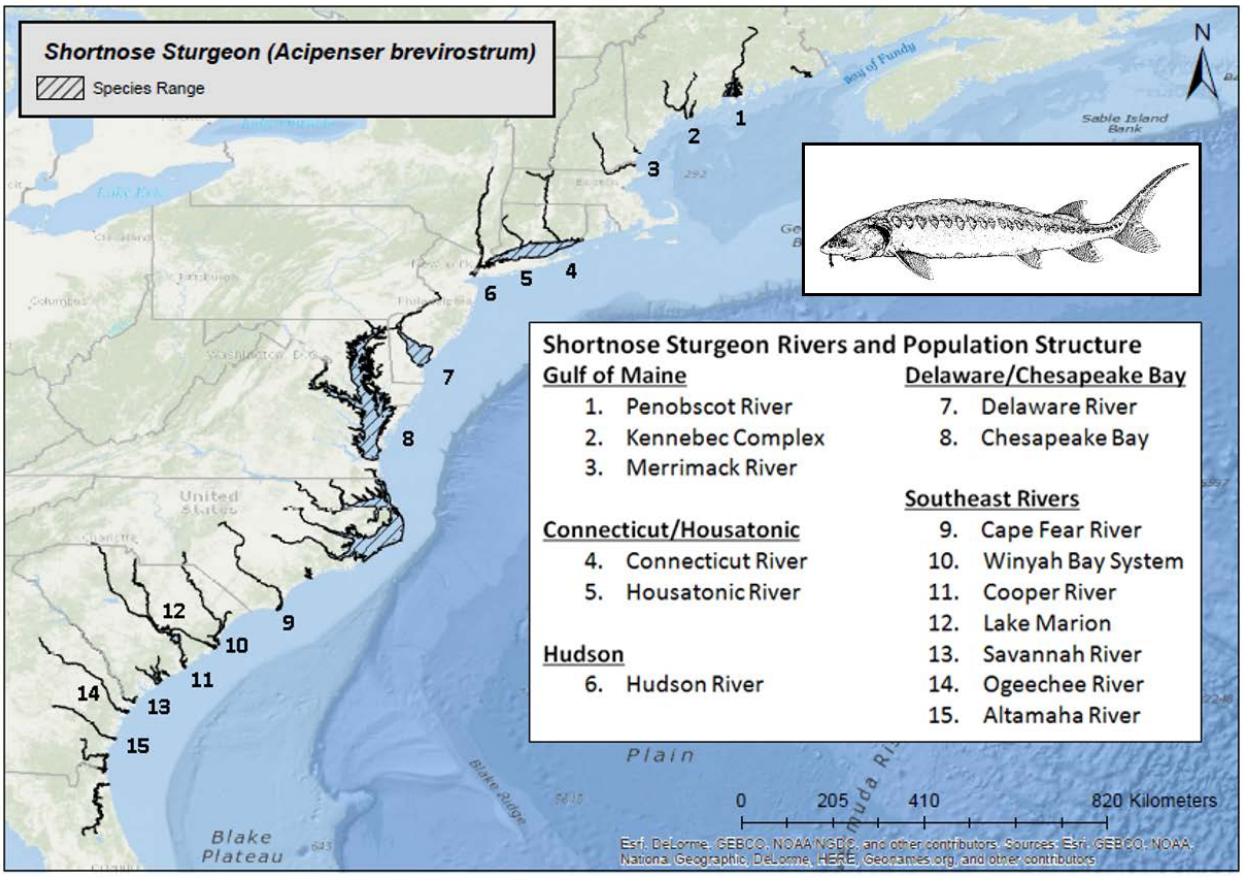


Figure 23. Geographic range of shortnose sturgeon.

The shortnose sturgeon (*Acipenser brevirostrum*) is the smallest of the three sturgeon species that occur in eastern North America. It has a benthic fusiform body and its head and snout are smaller while its mouth is larger relative to Atlantic sturgeon (Dadswell 1984). Shortnose sturgeon vary in color but are generally dark brown to olive/black on the dorsal surface, lighter along the row of lateral scutes and nearly white on the ventral surface (Gilbert 1989). The shortnose sturgeon was listed as endangered on March 11, 1967 (32 FR 4001). Shortnose sturgeon remained on the endangered species list with the enactment of the ESA in 1973.

Life history

Shortnose sturgeon are relatively slow growing, late maturing and long-lived. Growth rate, maximum age and maximum size vary with latitude; populations in southern areas grow more rapidly and mature at younger ages but attain smaller maximum sizes than those in the north (Dadswell et al. 1984). In general, females reach sexual maturity in the south as early as age 4 and in the north as late as age 18, and males display similar difference in latitudinal development, maturing between ages 2 and 11 (NMFS 2010c). Shortnose sturgeon overwinter in the lower portions of rivers and migrate upriver to spawn in the spring. Spawning periodicity is poorly understood, but males seem to spawn more frequently than females. Dadswell (Dadswell) estimated that Saint John River males spawned at 2-year intervals; females at 3-5 year intervals. Spawning females deposit their eggs over gravel, rubble, and/or cobble often in the farthest

accessible upstream reach of the river (Kynard 1997). After spawning, adult shortnose sturgeon move rapidly to downstream feeding areas where they forage on benthic insects, crustaceans, mollusks, and polychaetes (Buckley and Kynard 1985; Dadswell 1984; Kieffer and Kynard 1993; O'herron et al. 1993).

Upon hatching, shortnose sturgeon shelter in dark substrate or are found in schools swimming against the current. Around 4-12 days after hatching individuals begin to feed exogenously and are dispersed downstream. These larvae are often found in the deepest water, usually within the channel (Kieffer and Kynard 1993; O'Connor et al. 1981; Parker and Kynard 2014; Taubert and Dadswell 1980). Young-of-the-year remain in freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984; Kynard 1997). The age at which juveniles begin to utilize habitat associated with the salt/fresh water interface varies with river system from age one to eight (Collins et al. 2002; Dadswell 1979a; Flournoy et al. 1992). Overwintering habitat and behavior of shortnose sturgeon varies with latitude: fish in northern rivers form tight aggregations with little movement and will inhabit either freshwater or saline reaches of the river, while fish in the south are more active and are found predominantly near the fresh/saltwater interface (Collins and Smith 1993; Kynard et al. 2012; Weber et al. 1998).

The general pattern of coastal migration of shortnose sturgeon indicates movement between groups of rivers proximal to each other across the geographic range (Altenritter et al. 2015; Dionne et al. 2013; Quattro et al. 2002; Wirgin et al. 2005). NMFS' 2010 biological assessment of shortnose sturgeon grouped the species into five regional population clusters: Gulf of Maine, Connecticut/Housatonic rivers, Hudson River, Delaware River/Chesapeake Bay, and Southeast. King et al. (King et al.) identified three metapopulations: 1) Maine rivers, 2) Delaware River and Chesapeake Bay proper, and 3) the Southeast assemblage. The shortnose sturgeon status review team recommends that recovery and management actions consider each riverine population as a management/recovery unit (NMFS 2010c).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to shortnose sturgeon.

The 2010 biological assessment of shortnose sturgeon identified five regional population clusters of shortnose sturgeon. See Table 11 for abundance estimates for populations within each of these population clusters.

Table 11. Shortnose sturgeon populations and estimated abundances

Regional Population Cluster	Location[a]	Abundance Estimate (Upper/Lower 95% CI)[b]	(Source) Year of Collection Data
Gulf of Maine	Penobscot River	1,049 (673 / 6,939)	(NMFS 2012a) 2006 – 2007
	Kennebec Complex	9,488 (6,942 / 13,358)	(Squiers 2004) 1998 – 2000
	Merrimack River	2000 (NA)	(NMFS 2010c) 2009
Connecticut and Housatonic Rivers	Connecticut River – upper*	143 (14 / 360)	(Kynard et al. 2012) 1994 – 2001
	Connecticut River – lower*	1,297 (NA)	(Savoy 2004) 1996 – 2002
Hudson River	Hudson River	30,311 (NA)	(NMFS 2010c) 1980
Delaware River/Chesapeake Bay	Delaware River	12,047 (10,757 / 13,580)	(Brundage III 2006) 1999 – 2003
Southeast Rivers	Cape Fear River	50 (NA)	(NMFS 2010c) NA
	Cooper River	301 (150 / 659)	(Cooke et al. 2004) 1996 – 1998
	Lake Marion	Unknown (NA)	(NMFS 2010c) NA
	Savannah River	940 adults (535 / 1753)	(Bahr and Peterson 2017) 2015
	Ogeechee River	147 (104 / 249)	(Fleming et al. 2003) 1999 – 2000
	Altamaha River	1,209 (556 / 2759)	(Bednarski 2012) 2004 – 2010

[a]Locations listed here are those for which population estimates are available. Additional waterbodies with confirmed shortnose sturgeon include Piscataqua River, Housatonic River, Chesapeake Bay, Susquehanna River, Potomac River, Roanoke River, Chowan River, Tar/Pamlico River, Neuse River, New River, North River, Santee River, ACE Basin – Edisto (Smith et al. 2002), Satilla River, St. Mary's River, St. Johns River (NMFS 2010c).

[b]Abundance estimates are established using different techniques and should be viewed with caution. Estimates listed here are those identified by NMFS in the 2010 Biological Assessment of Shortnose Sturgeon (NMFS 2010c).

**The Connecticut River population of shortnose sturgeon is separated into an upstream and downstream segment bisected by the Holyoke Dam.*

Genetic diversity estimates for shortnose sturgeon have been shown to be moderately high in both mitochondrial (Quattro et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010) and nuclear genomes (King et al. 2014). The mitochondrial DNA and nDNA studies performed to date suggest that dispersal is a very important factor in maintaining these high levels of genetic diversity.

Shortnose sturgeon occur along the East Coast of North America in rivers, estuaries and the sea. They were once present in most major rivers systems along the Atlantic coast (Evermann and Bean 1898; Scott and Scott 1988). Their current distribution extends north to the Saint John River, New Brunswick, Canada, and south to the St. Johns River, Florida (NMFS 1998b). Currently, the distribution of shortnose sturgeon across their range is disjunct, with northern populations separated from southern populations by a distance of about 400 kilometers near their geographic center in North Carolina and Virginia. Some river systems host populations which

rarely leave freshwater while in other areas coastal migrations between river systems are common. Spawning locations have been identified within a number of river systems (NMFS 2010c).

Status

The decline in abundance and slow recovery of shortnose sturgeon has been attributed to pollution, overfishing, bycatch in commercial fisheries, and an increase in industrial uses of the nation's large coastal rivers during the 20th century (e.g., hydropower, nuclear power, treated sewage disposal, dredging, construction) (NMFS 2010c). In addition, the effects of climate change may adversely impact shortnose sturgeon by reducing the amount of available habitat, exacerbating existing water quality problems, and interfering with migration and spawning cues (NMFS 2010c). Without substantial mitigation and management to improve access to historical habitats and water quality of these systems, shortnose sturgeon populations will likely continue to be depressed. This is particularly evident in some southern rivers that are suspected to no longer support reproducing populations of shortnose sturgeon (NMFS 2010c). The number of river systems in which spawning has been confirmed has been reduced to around 12 locations (NMFS 2010c).

Recovery Goals

The long-term recovery objective for the shortnose sturgeon is to recover all 19 populations to levels of abundance at which they no longer require protection under the ESA. Each population may become a candidate for downlisting when it reaches a minimum population size that: 1) is large enough to prevent extinction, and 2) will make the loss of genetic diversity unlikely. The minimum population size for each population segment has not yet been determined (NMFS 1998b; NMFS 2010c).

2.4.4 Atlantic Sturgeon

Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004). The Atlantic sturgeon is a long-lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). Atlantic sturgeon were listed under the ESA on February 6, 2012. The listing defined four DPSs as endangered (New York Bight, Chesapeake Bay, Carolina, and South Atlantic) and one as threatened (Gulf of Maine). The life history and status information presented below is relevant to all Atlantic sturgeon DPSs and the remaining sections present additional detail on the distribution and population dynamics of each DPS.

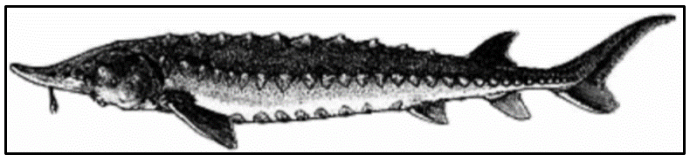


Figure 24. Adult Atlantic Sturgeon.

Life history

Atlantic Sturgeon size at sexual maturity varies with latitude. Spawning adults generally migrate upriver in May-July in Canadian systems (Bain 1997; Caron et al. 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000b; Smith 1985) and 2-5 for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997a; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007a). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 to 5 percent of the pre-collapse peak until Atlantic States Marine Fisheries Commission (ASFMC) placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the

populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007a). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007a). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

2.4.4.1 Gulf of Maine DPS

The Gulf of Maine DPS includes all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, Massachusetts (Figure 25).

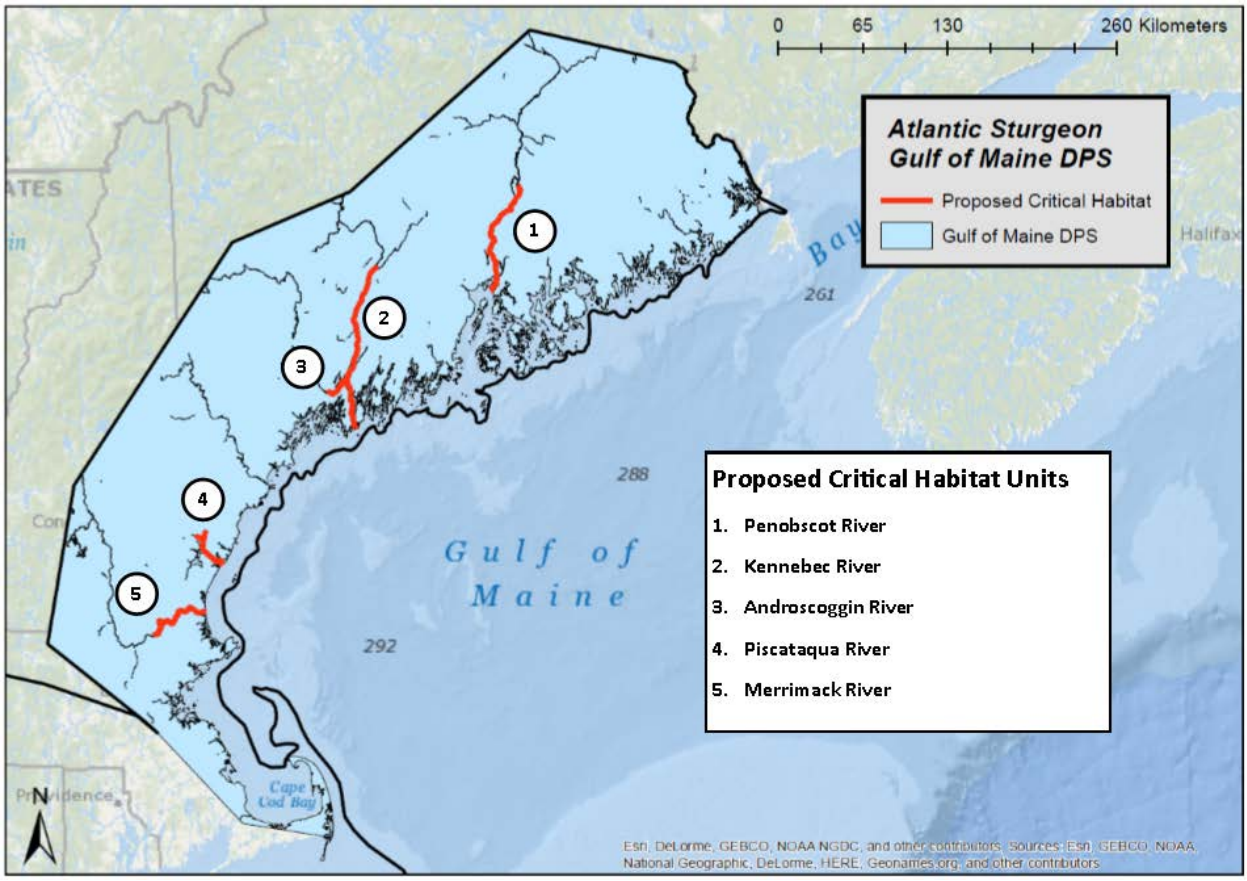


Figure 25. Geographic range and proposed designated critical habitat for Atlantic sturgeon, Gulf of Maine DPS.

Historically, the Gulf of Maine DPS likely supported more than 10,000 spawning adults (ASSRT 2007; KRRMP 1993; Secor 2002; NMFS 2007). The current abundance is estimated to be 1 to 2 orders of magnitude smaller than historical levels (ASSRT 2007).

There are some positive signs for the Gulf of Maine DPS, which include observations of Atlantic sturgeon in rivers from which sturgeon observations have not been reported for many years (Saco, Presumpscot, and Charles rivers) and potentially higher catch-per-unit-effort levels than in the past (Kennebec) (NMFS 2007d). Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot rivers. Spawning still occurs in the Kennebec and Androscoggin Rivers, and may occur in the Penobscot River. Atlantic sturgeon have more recently been observed in the Saco, Presumpscot, and Charles rivers.

2.4.4.2 New York Bight DPS

The natal river systems of the New York Bight DPS span from the Connecticut River south to the Delaware River (Figure 26).

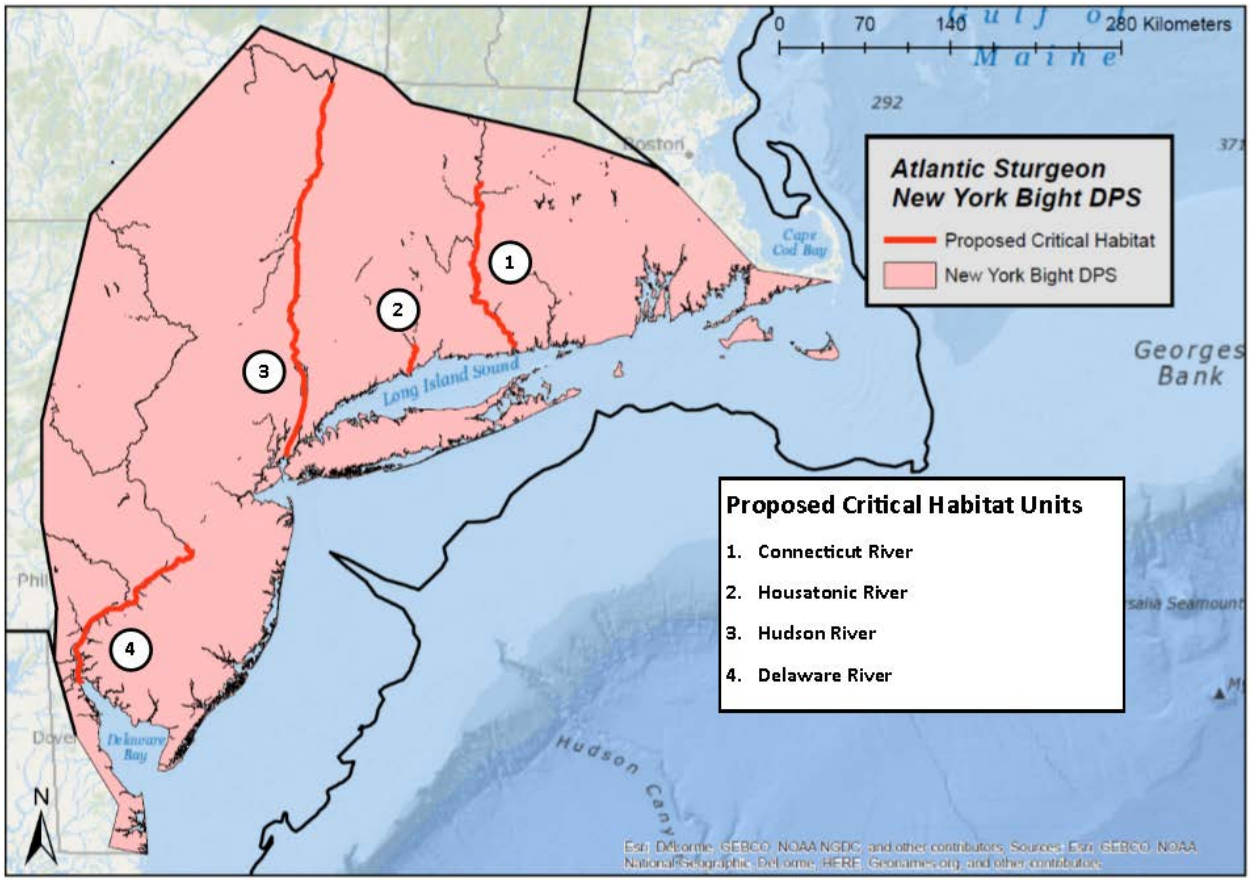


Figure 26. Geographic range and proposed designated critical habitat of Atlantic sturgeon, New York Bight.

The New York Bight, ranging from the Delmarva Peninsula to Cape Cod, historically supported four or more spawning populations. Currently, this DPS only supports two spawning populations, the Delaware and Hudson River. Numbers of Atlantic Sturgeon in the New York Bight DPS are extremely low compared to historical levels and have remained so for the past 100 years. The spawning populations of this DPS are thought to be one to two orders of magnitude below historical levels.

Historically the Delaware River is believed to have supported around 180,000 individuals (Secor 2002). In 2007, NMFS status review estimated that the population had declined to fewer than 300 individuals. In 2014 Hale et al. (2016) estimated that 3,656 (95 percent CI = 1,935-33,041) early juveniles (age 0-1) utilized the Delaware River estuary as a nursery. Based on commercial fishery landings from the mid 1980s to the mid 1990s. the total abundance of adult Hudson River Atlantic sturgeon was estimated to be 870 individuals (Kahnle et al. 2007). Based on the juvenile assessments from Peterson et al. (2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium to allow the populations to recover. Long-term juvenile surveys indicate that the Hudson River population supports successful annual year classes since 2000 and the annual production has been stable and/or slightly increasing in abundance (NMFS 2007d). Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Recently, juvenile Atlantic sturgeon collected in the Connecticut River suggest at least one successful colonizing spawning event may have occurred (Savoy et al. 2017). Around the same time, a dead 213cm Atlantic sturgeon was recovered on the banks of the Connecticut River (http://www.wfsb.com/story/25392783/rare-sturgeon-found-along-connecticut-riverin-lyme).

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The Connecticut River has long been known as a seasonal aggregation area for subadult Atlantic sturgeon, and both historical and contemporary records document presence of Atlantic sturgeon in the river as far upstream as Hadley, MA (Savoy and Shake, 1993; Savoy and Pacileo, 2003; NMFS and USFWS, 2007). The upstream limit for Atlantic sturgeon on the Hudson River is the Federal Dam at the fall line, approximately river kilometer 246 (Dovel and Berggren, 1983; Bain, 1998; Kahnle et al., 1998; Everly and Boreman, 1999). In the Delaware River, there is evidence of Atlantic sturgeon presence from the mouth of the Delaware Bay to the head-of-tide at the fall line near Trenton on the New Jersey side and Morrisville on the Pennsylvania side of the River, a distance of 220 river kilometers (Breece et al., 2013).

2.4.4.3 Chesapeake Bay DPS

The natal river systems of the Chesapeake Bay DPS span from the Susquehanna River south to the James River (Figure 27).

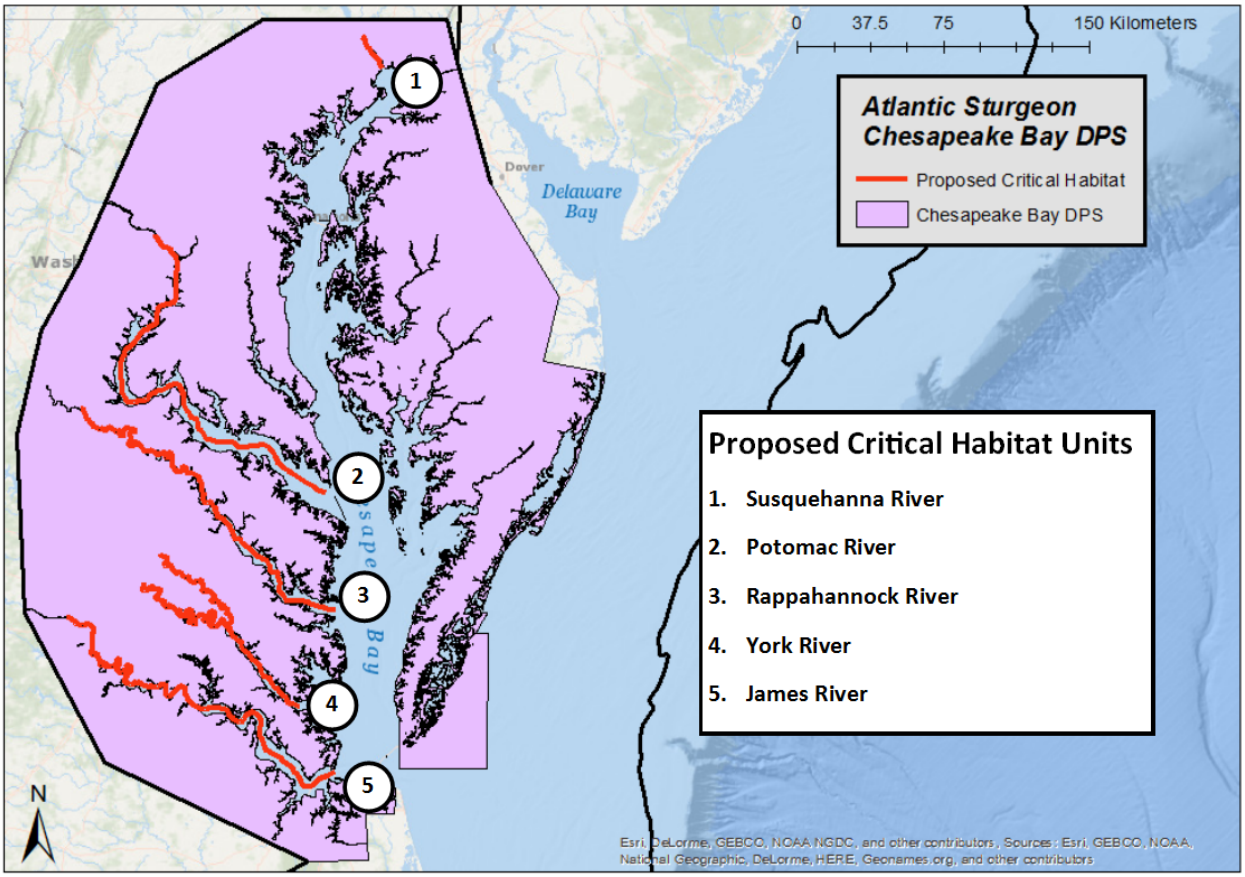


Figure 27. Geographic range and proposed designated critical habitat of Atlantic sturgeon, Chesapeake Bay DPS.

Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle et al. 1998, Wharton 1957, Bushnoe et al. 2005). At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (NMFS and USFWS, 2007; Hager, 2011; Balazik et al., 2012). Since the listing, spawning has been confirmed to occur in the Pamunkey River, a tributary of the York River (Hager et al., 2014; Kahn et al., 2014) and is suspected to be occurring in Marshyhope Creek, a tributary of the Nanticoke River. The historical and contemporary accounts of Atlantic sturgeon in the York, Rappahannock, Susquehanna, and Potomac Rivers (NMFS and USFWS, 1998; NMFS and USFWS, 2007; ASSRT, 2007), as well as the presence of the features necessary to support reproduction and recruitment in this river indicate that there is the potential for spawning to occur.

The Chesapeake Bay once supported at least six historical spawning populations; however, today the bay is believed to support at the most, four to five spawning populations. Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. The status review team (NMFS and USFWS, 2007) concluded that the populations in the James and York Rivers are at a moderate and moderately high risk of extinction.

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998).

Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

2.4.4.4 Carolina DPS

The natal river systems of the Carolina DPS span from the Roanoke River, North Carolina south to the Santee-Cooper system in South Carolina (Figure 28). The Carolina DPS ranges from the Santee-Cooper River to the Albemarle Sound and consists of seven extant populations; one population (Sampit) is believed to be extirpated.

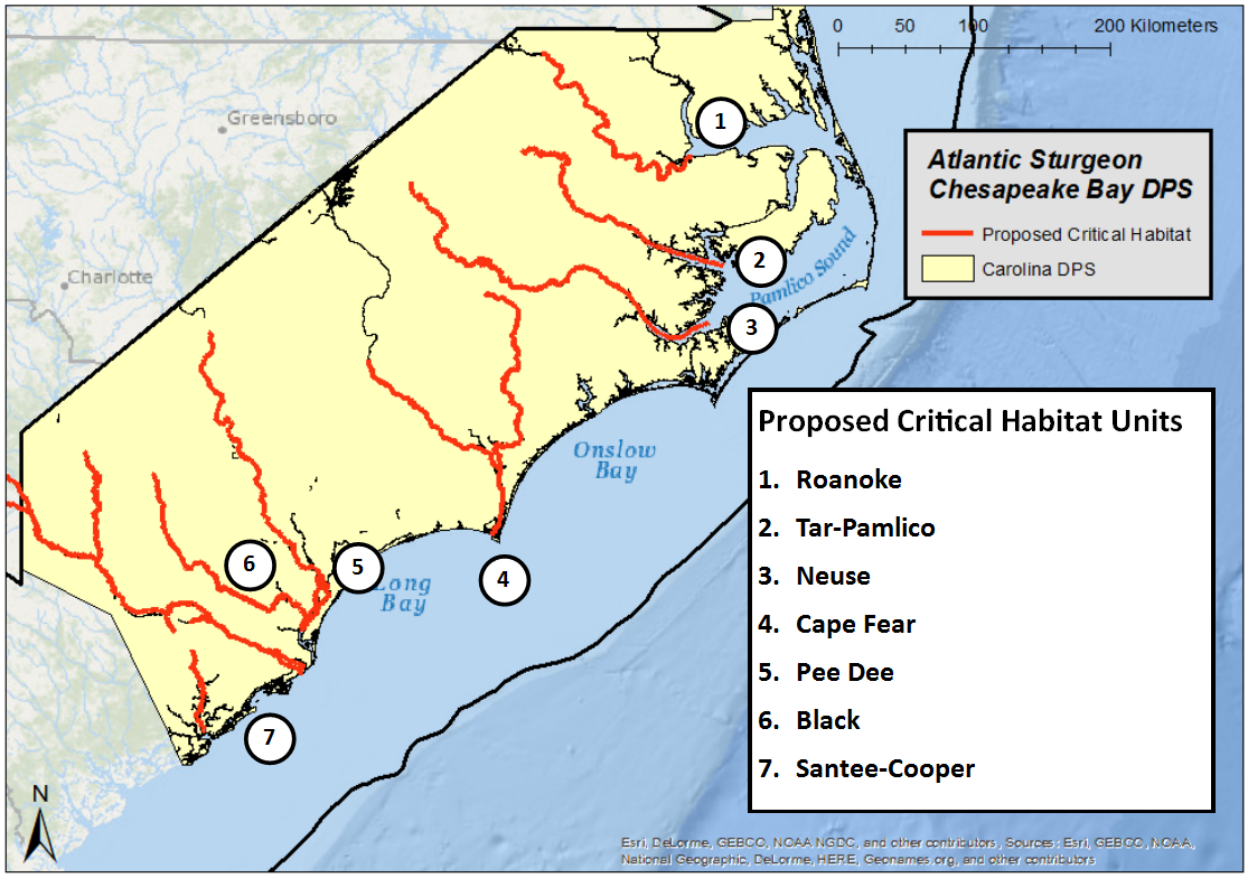


Figure 28. Geographic range and proposed designated critical habitat of Atlantic sturgeon, Carolina DPS.

The spawning populations are estimated to be at less than 3 percent of their historic levels. Prior to 1890, there were estimated to be 7,000 – 10,500 adult female Atlantic sturgeon in North Carolina and approximately 8,000 adult females in South Carolina. Currently, the existing spawning populations in each of the rivers in the Carolina DPS are thought to have less than 300 adults spawning each year.

Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. The status review team (ASSRT 2007a) concluded that the populations in the

Roanoke, Tar/Pamlico, Neuse, Waccamaw, and Pee Dee river systems are at a moderate extinction risk and the populations in the Cape Fear and Santee-Cooper river systems are at a moderately high risk of extinction.

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

2.4.4.5 South Atlantic DPS

The natal river systems of the South Atlantic DPS span from Edisto south to the St. Mary's River (Figure 29).

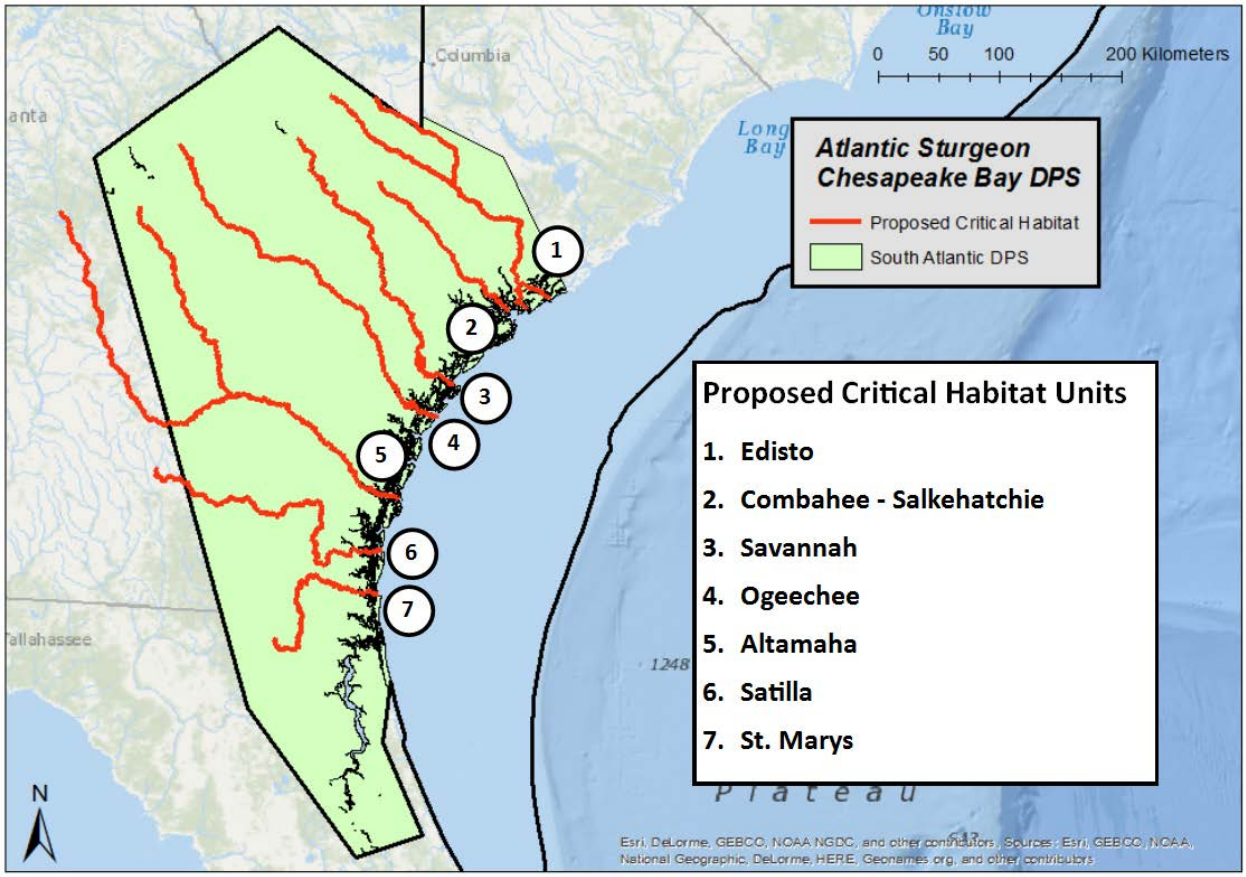


Figure 29. Geographic range and proposed designated critical habitat of Atlantic sturgeon, South Atlantic DPS.

The South Atlantic DPS historically supported eight spawning populations ranging from the St. Johns River, Florida to the Ashepoo, Combahee, and Edisto (ACE) Basin in South Carolina. Currently, this DPS supports five extant spawning populations. Of these populations, the Altamaha is believed to support the largest number of spawning adults. The current abundance of

the Altamaha population is suspected to be less than 6 percent of historical abundance, extrapolated from the 1890s commercial landings (Secor 2002). Few captures have been documented in other populations within this DPS and are suspected to be less than 1 percent of their historic abundance (less than 300 spawning adults).

Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. During the last two decades, Atlantic sturgeon have been observed in most South Carolina coastal rivers, although it is not known if all rivers support a spawning population (Collins and Smith 1997). The status review team (ASSRT 2007) found that, overall, the South Atlantic DPS had a moderate risk (great than 50 percent chance) of becoming endangered over the next 20 years.

The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Seventy-six Atlantic sturgeon were tagged in the Edisto River during a 2011 to 2014 telemetry study (Post et al. 2014). Fish entered the river between April and June and were detected in the saltwater tidal zone until water temperature decreased below 25° C. They then moved into the freshwater tidal area, and some fish made presumed spawning migrations in the fall around September–October. Atlantic sturgeon in the Savannah River were documented displaying similar behavior three years in a row—migrating upstream during the fall and then being absent from the system during spring and summer. Forty three Atlantic sturgeon larvae were collected in upstream locations (river kilometer [RKM] 113 to 283) near presumed spawning locations (Collins and Smith, 1997). The Altamaha River supports the healthiest Atlantic sturgeon populations in the South Atlantic DPS. In a telemetry study by Peterson et al. (2006), most tagged adult Atlantic sturgeon were found between RKM 215 and 420 in October and November when water temperatures were appropriate for spawning.

2.4.5 Gulf Sturgeon

The current range of the Gulf of Mexico sturgeon *Acipenser oxyrinchus desotoi* (Gulf sturgeon) extends from Lake Pontchartrain in Louisiana east to the Suwannee river system in Florida. Within that range, seven major rivers are known to support reproducing populations: Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee (USFWS 2009b).

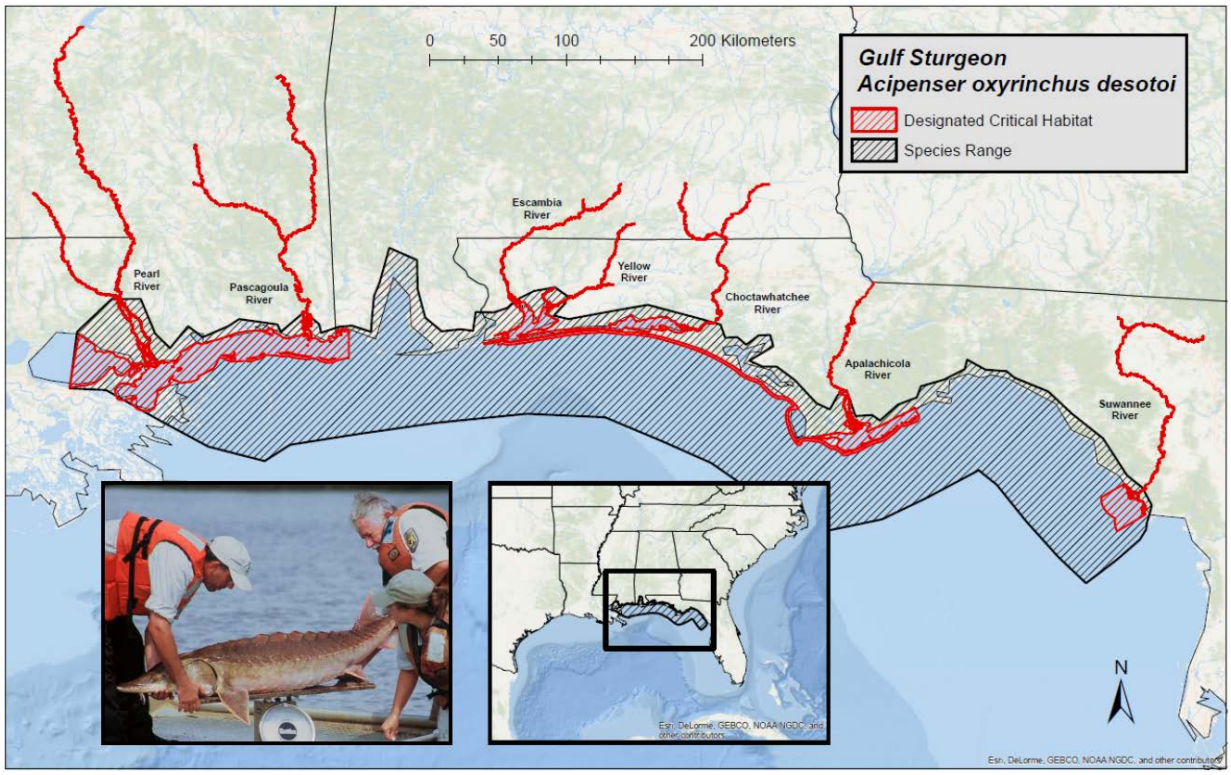


Figure 30. Geographic range and designated critical habitat of the Gulf sturgeon.

Gulf sturgeon are benthic fusiform fish with an extended snout, vertical mouth, five rows of scutes (bony plates surrounding the body), four barbels (slender, whisker-like feelers anterior to the mouth used for touch and taste), and a heterocercal (upper lobe is longer than lower) caudal fin. Adults range from 6-8 feet in length and weigh up to 200 pounds; females grow larger than males (USFWS 2009b). The Gulf sturgeon was listed as Threatened on September 30, 1991 .

Life history

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age. Surveys in the Suwannee River suggest that a more common maximum age may be around 25 years (Sulak and Clugston 1999). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff 1975). In general, gulf sturgeon spawn up-river in spring, spend winter months in near-shore marine environments, and utilize pre- and post-spawn staging and nursery areas in the lower rivers and estuaries (Heise et al. 2005; Heise et al. 2004). There is some evidence of autumn spawning in the Suwannee River, however there is uncertainty as to whether this spawning is due to environmental conditions or represents a genetically distinct population (Randall and Sulak 2012). Gulf sturgeon spawn at intervals ranging from 3-5 years for females and 1-5 years for males (Fox et al. 2000; Smith 1985). The spring migration to up-river spawning sites begins in mid-February and continues through May. Fertilization is external; females deposit their eggs in the upper reaches of and show preference for hard, clean substrate (e.g. bedrock covered in gravel and small cobble).

Upon hatching from their eggs, gulf sturgeon larvae spend the first few days of life sheltered in interstitial spaces at the spawning site (Kynard and Parker 2004). At the onset of feeding, age-0 gulf sturgeon disperse and are often found on shallow sandbars and rippled sand shoals (<4 meters depth) (Sulak and Clugston 1998). Young-of-the-year spend 6-10 months slowing working their way downstream feeding on aquatic insects (e.g., mayflies and caddisflies), worms (oligochaetes), and bivalve molluscs, and arrive in estuaries and river mouths by mid-winter (Sulak and Clugston 1999) where they will spend their next 6 years developing. After spawning, adult gulf sturgeon migrate downstream to summer resting and holding areas in the mid to lower reaches of the rivers where they may hold until November (Wooley and Crateau 1985). While in freshwater adults lose a substantial amount of their weight, but regain it upon entering the estuaries. Sub adult and non-spawning adults also spend late spring through fall in these holding areas (Foster and Clugston 1997). By early December all adult and sub-adult gulf sturgeon return to the marine environment to forage on benthic (bottom dwelling) invertebrates along the shallow nearshore (2-4 meter depth), barrier island passes, and in unknown off-shore locations in the gulf (Carr et al. 1996; Fox et al. 2002; Huff 1975; Ross et al. 2009). Juvenile gulf sturgeon overwinter in estuaries, river mouths, and bays; juveniles do not enter the nearshore/offshore marine environments until around age 6 (Sulak and Clugston 1999). Gulf sturgeon show a high degree of river-specific fidelity (Rudd et al. 2014). Adult and sub-adult gulf sturgeon fast while in freshwater environments and are almost entirely dependent on the estuarine/marine environment for food (Gu et al. 2001; Wooley and Crateau 1985). Some juveniles (ages 1-6) will also fast in the freshwater summer holding areas, but the majority feed year round in the estuaries, river mouths, and bays (Sulak et al. 2009).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Gulf sturgeon.

Currently, seven rivers are known to support reproducing populations of Gulf sturgeon. The most recent abundance estimates reported in the 5-Year Review (USFWS 2009b) (Table 12).

Table 12. Gulf sturgeon abundance estimates by river and year, with confidence intervals (CI) for the 7 major rivers with reproducing populations. Table modified from USFWS (2009b).

River	Year of Data Collection	Abundance Estimate[a]	Lower/Upper 95% CI[b]	Source
Pearl	2001	430	323/605	(Rogillio et al. 2001)
Pascagoula	2000	216	124/429	(Ross et al. 2001)
Escambia	2006	451	338/656	(USFWS 2007)
Yellow	2003 fall	911	550/1550	(Berg et al. 2007)
Choctawhatchee	2008	3314	not reported	(USFWS 2009a)
Apalachicola	2004	350	221/648	(USFWS 2004)
Suwannee	2007	14,000	not reported	(USFWS 2009b)

[a] Estimates refer to numbers of individuals greater than a certain size, which varies between studies depending on sampling gear, and in some cases, numbers of individuals that use a particular portion of the river. Refer to original publication for details.

[b] Large confidence intervals (CI) around the mean estimates reflect the low number of captures in mark-recapture survey.

Gulf sturgeon abundance trends are typically assessed on a riverine basis. In general, gulf sturgeon populations in the eastern portion of the range appear to be stable or slightly increasing, while populations in the western portion are associated with lower abundances and higher uncertainty (USFWS 2009b). Pine and Martell (2009) reported that, due to low recapture rates and sparse data, the population viability of gulf sturgeon is currently uncertain.

When grouped by genetic relatedness, five regional or river-specific stocks emerge: (1) Lake Pontchartrain and Pearl River; (2) Pascagoula River; (3) Escambia, Blackwater and Yellow Rivers; (4) Choctawhatchee River; and (5) Apalachicola, Ochlocknee and Suwanee Rivers (Rudd et al. 2014; Stabile et al. 1996). Gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998).

Status

The decline in the abundance of gulf sturgeon has been attributed to targeted fisheries in the late 19th and early 20th centuries, habitat loss associated with dams and sills, habitat degradation associated with dredging, de-snagging, and contamination by pesticides, heavy metals, and other industrial contaminants, and certain life history characteristics (e.g. slow growth and late maturation) (56 FR 49653). Effects of climate change (warmer water, sea level rise and higher salinity levels) could lead to accelerated changes in habitats utilized by Gulf sturgeon. The rate that climate change and corollary impacts are occurring may outpace the ability of the Gulf sturgeon to adapt given its limited geographic distribution and low dispersal rate. In general, gulf sturgeon populations in the eastern portion of the range appear to be stable or slightly increasing, while populations in the western portion are associated with lower abundances and higher uncertainty (USFWS 2009b).

Recovery Goals

The 1995 Recovery Plan outlined three recovery objectives: (1) to prevent further reduction of existing wild populations of Gulf sturgeon within the range of the subspecies; (2) to establish population levels that would allow delisting of the Gulf sturgeon by management units (management units could be delisted by 2023 if required criteria are met); (3) to establish, following delisting, a self-sustaining population that could withstand directed fishing pressure within management units (USFWS 1995). The most recent Gulf sturgeon 5-year review recommended that criteria be developed in a revised recovery plan (USFWS 2009b).

2.4.6 Green Sturgeon: Southern DPS

The North American green sturgeon, *Acipenser medirostris*, is an anadromous fish that occurs in the nearshore Eastern Pacific Ocean from Alaska to Mexico (Moyle 2002a). Green sturgeon occupy the entire west coast of the US (Figure 31).

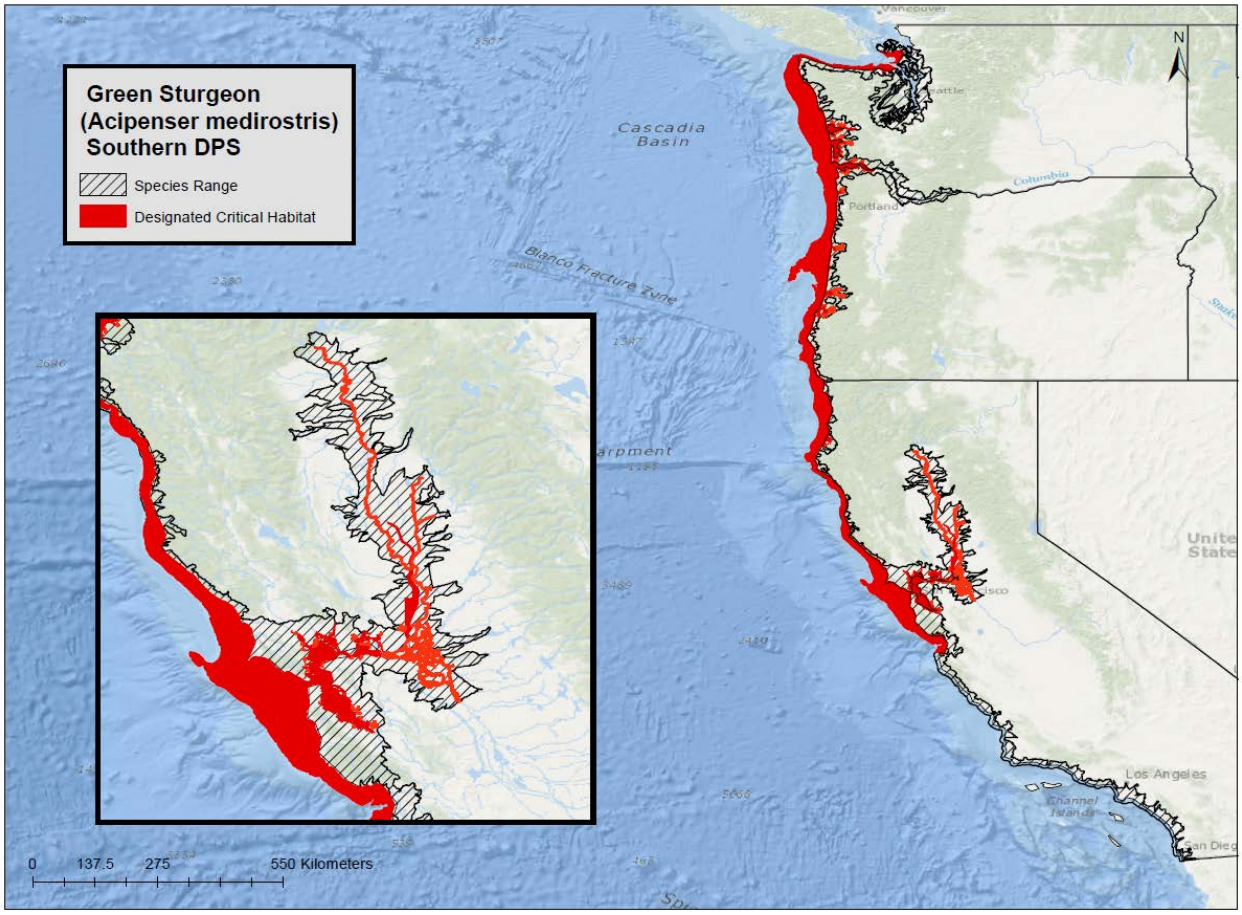


Figure 31. Geographic range (within the contiguous US) and designated critical habitat for green sturgeon, southern DPS.



Green sturgeon are long-lived, late-maturing, iteroparous, anadromous species that spawn infrequently in natal streams, and spend substantial portions of their lives in marine waters. Although they are members of the class of bony fishes, the skeleton of sturgeons is composed mostly of cartilage. Sturgeon have five rows of characteristic bony plates on their body (called scutes). Green sturgeon have an olive green to dark green back, a yellowish green-white belly, and a white stripe beneath the lateral scutes (Adams et al. 2002) (Figure 32). NMFS has identified two distinct population segments (DPS) of green sturgeon; northern and southern (Israel et al. 2009). In 2006, NMFS determined that the southern DPS green sturgeon warranted listing as a threatened species under the ESA (71 FR 17757). Green sturgeon have been observed in large concentrations in the summer and autumn within coastal bays and estuaries along the west coast of the US, including the Columbia River estuary, Willapa Bay, Grays Harbor, San Francisco bay and Monterey bay.

Life history

Green sturgeon reach sexual maturity at approximately fifteen years of age (Van Eenennaam et al. 2006), and may spawn every three to five years throughout their long lives (Tracy 1990). Southern DPS green sturgeon spawn in cool (14-17ºC), deep, turbulent areas with clean, hard substrates. Six discrete spawning sites have been identified in the upper Sacramento River between Gianella Bridge (RK 320.6) and the Keswick dam (RK 486) (Poytress et al. 2013). Spawning has also been confirmed in the Feather River near the Thermalito Afterbay Outlet (RK 95) (Seesholtz et al. 2015). Adult diet includes shrimp, mollusks, amphipods, and even small fish (Houston 1988; Moyle et al. 1992). Juveniles in the Sacramento River delta feed on opossum shrimp, *Neomysis mercedis*, and *Corophium* amphipods (Radtke 1966).

In preparation for spawning, adult Southern DPS green sturgeon enter San Francisco Bay between mid-February and early-May, and migrate rapidly (on the order of a few weeks) up the Sacramento River (Heublein et al. 2009). Spawning occurs from April through early July, with peaks of activity that depend on a variety of factors including water temperature and water flow rates (Poytress et al. 2009; Poytress et al. 2010). Post-spawn fish typically congregate and hold for several months in a few deep pools in the upper mainstem Sacramento River near spawning sites and migrate back downstream when river flows increase in fall. They re-enter the ocean during the winter months (November through January) and begin their marine migration north along the coast (California Fish Tracking Consortium database).

Green sturgeon larvae are different from all other sturgeon because of the absence of a distinct swim-up or post-hatching stage. Larvae grow fast; young fish grow to 74 mm 45 days after hatching (Deng 2000). Larvae and juveniles migrate downstream toward the Sacramento-San Joaquin Delta/Estuary, where they rear for one to four years before migrating out to the Pacific Ocean as subadults (Nakamoto et al. 1995). Once at sea, subadults and adults occupy coastal waters to a depth of 110 m from Baja California, Mexico to the Bering Sea, Alaska (Hightower

2007). Seasonal migrations are known to occur. Fish congregate in coastal bays and estuaries of Washington, Oregon, and California during summer and fall. In winter and spring, similar aggregations can be found from Vancouver Island to Hecate Strait, British Columbia, Canada (Lindley et al. 2008)

Population dynamics

Population dynamics of southern DPS green sturgeon focus on abundance; intrinsic growth rates (λ); genetic diversity, drift, and natural selection. Preliminary results from 2010-14 surveys indicated the presence of the following number of adult Southern DPS green sturgeon in the Sacramento River (with 95 percent confidence interval): 2010: 164 ± 47; 2011: 220 ± 42; 2012: 329 ± 57; 2013: 338 ± 61; 2014: 526 ± 64. Based on these numbers and estimates of mean spawning periodicity, the total number of adults in the Southern DPS population is estimated to be 1,348 ± 524 (Mora 2015; NMFS 2015d).

Attempts to evaluate the status of southern DPS green sturgeon have been met with limited success due to the lack of reliable long term data. No estimate of λ is available for southern DPS green sturgeon.

The available genetic data do not change the status of the species or the imminence or magnitude of any threat; data only confirm the DPS structure and add detail to the DPS composition in different estuaries during the sampling periods (NMFS 2015d). Green sturgeon stocks from the DPSs have been found to be genetically differentiated (Israel et al. 2009; Israel et al. 2004).

Status

Attempts to evaluate the status of southern DPS green sturgeon have been met with limited success due to the lack of reliable long term data, however based on available scientific data (Adams et al. 2007) and ongoing conservation efforts, NMFS concluded in the final rule designating this species that southern DPS green sturgeon were likely to become endangered in the foreseeable future throughout all of its range. The final rule listing Southern DPS green sturgeon indicates that the principal factor for the decline in the DPS is the reduction of spawning to a limited area in the Sacramento River caused primarily by impoundments, but they also face threats from water temperature, water flow, and commercial and recreational bycatch (71 FR 17757). Climate change has the potential to impact Southern DPS green sturgeon in the future, but it is unclear how changing oceanic, nearshore and river conditions will affect the Southern DPS overall (NMFS 2015d).

Recovery Goals

The final recovery plan for Southern DPS green sturgeon has not been released. The recovery outline (NMFS 2010b) indicates that the recovery potential for Southern DPS green sturgeon is considered moderate to high; however, certain life history characteristics (e.g., long-lived, delayed maturity) indicate recovery could take many decades, even under the best circumstances. According to the recovery outline key recovery needs and implementation measures identified include additional spawning and egg/larval habitat as well as additional research and monitoring (NMFS 2010b).

2.4.7 Giant Manta Ray

The giant manta ray is a large bodied, planktivorous ray with a terminal mouth and long cephalic fins (Miller and Klimovich 2016). The species is diamond-shaped, with wing-like pectoral fins. NMFS listed the species as threatened under the ESA on January 22, 2018 (83 FR 2916). We used information available in the status review (Miller and Klimovich 2016) to summarize the life history, population dynamics, and status of the species, as follows.

Life History

The giant manta ray is circumglobal, but individual populations are scattered and highly fragmented. In the United States, the species has been found as far north as southern California on the west coast and as far north as New Jersey on the east coast. Sightings of the species in US waters are sporadic, with the exception of areas around Kona, Hawaii and the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. The species is typically observed offshore, in oceanic waters, and near productive coastlines, but has also been observed in estuarine waters near oceanic inlets, with use of these waters as potential nursery grounds. The giant manta ray is considered to be a migratory species, with estimated distances travelled of up to 1,500 km, though recent tagging data suggest that while the species may be capable of occasional long-distance movements, it may be more typical for these species to exhibit a high degree of residency.

Manta rays feed primarily on planktonic organisms, but some studies have documented consumption of small fishes. Manta rays are slow to mature and also have low reproductive rates. Females are only able to produce between 5 and 15 pups in a lifetime. Giant manta rays have been found to have one of the lowest maximum population growth rates of all elasmobranchs.

The 2017 NMFS status review concluded that given the species' life history traits and productivity estimates, giant manta rays are inherently vulnerable to depletions.

Population Dynamics and Status

There are no current or historical global abundance estimates for the giant manta ray. Additionally, subpopulation abundance estimates are anecdotal and subject to bias. Subpopulation abundance estimates range between 100 and 1,500 individuals. The most significant threat to the species is overutilization for commercial purposes. The species is targeted by some fisheries, and also caught as bycatch. In areas where the species is not subject to fishing, populations abundance may be stable. In areas where the species is actively targeted or caught as bycatch (e.g., Phillipines, Mexico, Sri Lanka, Indonesia), populations appear to be decreasing.

Recovery Goals

There is currently no recovery plan for the giant manta ray.

2.4.8 Boccacio: Puget Sound/Georgia Basin DPS

The bocaccio is a long-lived, large species of rockfish, occupying the eastern Pacific Ocean in waters from California to Alaska. Puget Sound/Georgia Basin DPS bocaccio are those that reside in the Puget Sound/Georgia Basin (Figure 19).

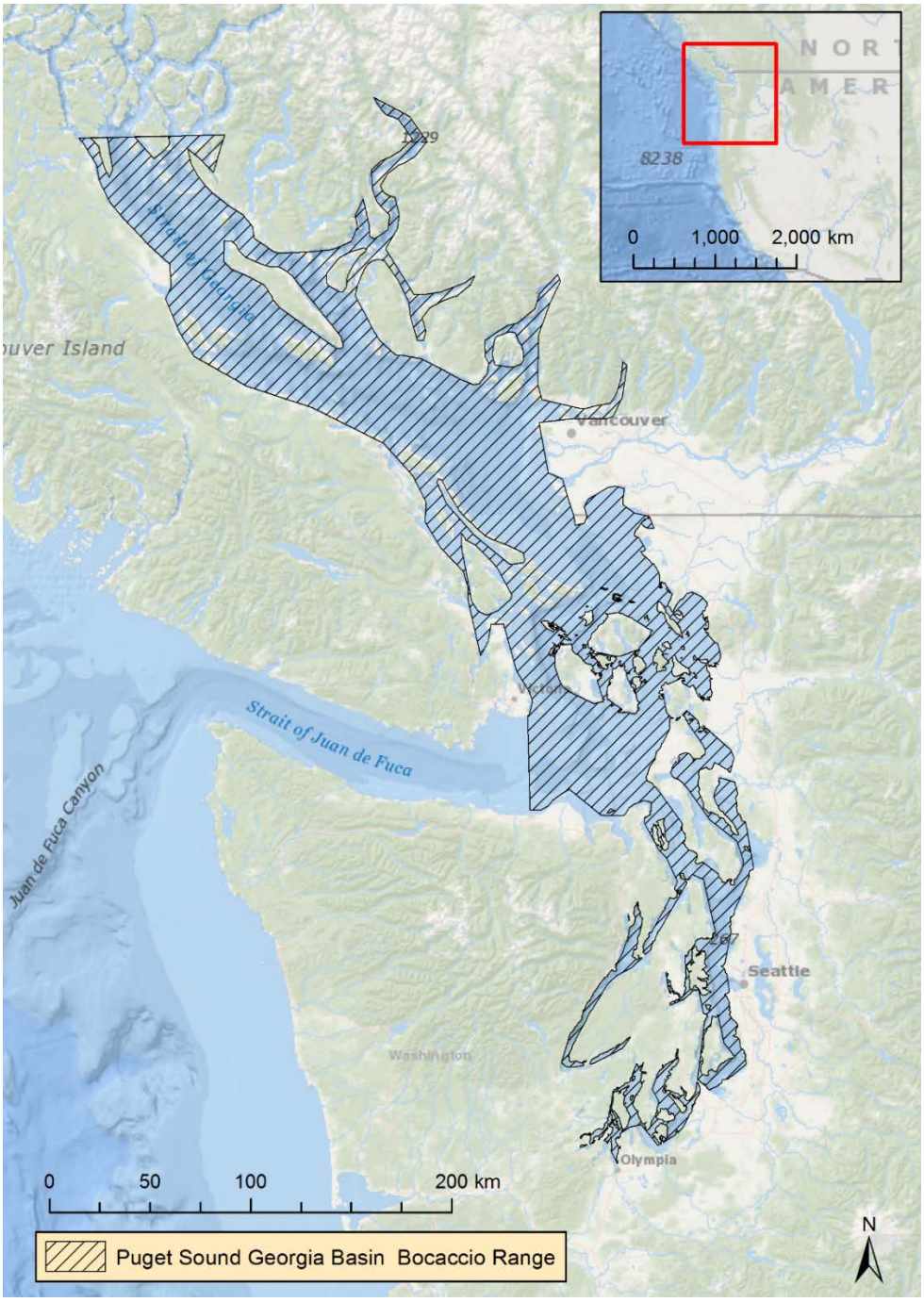


Figure 33. Map identifying the range of the Puget Sound/Georgia Basin distinct population segment bocaccio.



Bocaccio are a large (three feet, one meter) Pacific rockfish, olive to burnt orange-brown, with a distinctively long jaw (Figure 20). The Puget Sound/Georgia Basin DPS was first listed as endangered by NMFS on April 28, 2010 (75 FR 22276). The listing was updated on January 23, 2017 (82 FR 7711), when NMFS amended the listing description to include fish residing within the Puget Sound/Georgia Basin rather than fish originating from the Puget Sound/Georgia Basin.

We used information available in the status review (NMFS 2016k) and recent scientific publications to summarize the life history, population dynamics, and status of the species, as follows.

Life History

Bocaccio larvae and young juveniles tend to be found in offshore regions (1 to 148 kilometers offshore), associated with the surface and occasionally with floating kelp mats (NMFS 2016k). As adults, fish move into waters 18 to 30 meters deep and occupy rocky reefs (Carr 1983; Eschmeyer et al. 1983; Feder et al. 1974; Johnson 2006; Love and Yoklavich 2008). As adults, bocaccio may be found in depths of 12 to 478 meters, but tend to remain in shallow waters on the continental shelf (20 to 250 meters), still associating mostly with reefs or other hard substrate, but may move over mud flats.

Bocaccio are live-bearers with internal fertilization. Once females become mature (at 54 to 61 centimeters total length), they produce 20,000 to 2.3 million eggs annually, with the number increasing as females age and grow larger (Echeverria 1987; Hart 1973; Love et al. 2002). However, either sex has been known to attain sexual maturity as small as 35 centimeters or three years of age. In recent years as populations have declined, average age at sexual maturity may have declined as well (Echeverria 1987; Hart 1973; Love et al. 2002; MacCall 2002). Mating occurs between August and November, with larvae born between January and April (NMFS 2016k).

Upon birth, bocaccio larvae measure four to five millimeters in length. These larvae move into pelagic waters as juveniles when they are 1.5 to three centimeters and remain in oceanic waters from 3.5 to 5.5 months after birth (usually until early June), where they grow at ~0.5 to one millimeter per day (NMFS 2016k). However, growth can vary from year-to-year (Woodbury and Ralston 1991). Once individuals are three to four centimeters in length, they return to nearshore waters, where they settle into bottom habitats. Females tend to grow faster than males, but fish may take five years to reach sexual maturity (MacCall 2003). Individuals continue to grow until they reach maximum sizes of 91 centimeters, or 9.6 kilograms, at an estimated maximum age of 50 years (Andrews et al. 2005; Eschmeyer et al. 1983; Halstead et al. 1990; Love et al. 2002; Piner et al. 2006; Ralston and Ianelli 1998). Prey of bocaccio vary with fish age, with bocaccio larvae starting with larval krill, diatoms, and dinoflagellates. Pelagic juveniles consume fish

larvae, copepods, and krill, while older, nearshore juveniles and adults prey upon rockfishes, hake, sablefish, anchovies, lanternfish, and squid (Love et al. 2002; Reilly et al. 1992).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Puget Sound/Georgia Basin DPS bocaccio.

There is no current population abundance estimate for the Puget Sound/Georgia Basin DPS bocaccio. There is a lack of long-term information on the Puget Sound/Georgia Basin DPS bocaccio abundance, although among rockfish of the Puget Sound, bocaccio appear to have undergone a particular decline. This was likely because of the removal of the largest, most fecund individuals of the population due to overfishing and the frequent failure of recruitment classes, possibly because of unfavorable climactic/oceanographic conditions (MacCall and He 2002).

The rate of decline for rockfish in Puget Sound has been estimated at 3.1 to 3.8 percent annually for the period 1977 to 2014 (NMFS 2016k).

Puget Sound/Georgia Basin DPS bocaccio are distinct from bocaccio elsewhere in its range, likely due to its inhabitance of a geographically isolated area. There is no genetic information available for bocaccio in Puget Sound/Georgia Basin (NMFS 2016k).

Puget Sound/Georgia Basin bocaccio occupy the inland marine waters east of the Strait of Juan de Fuca and south of the northern Strait of Georgia.

Status

Bocaccio resistance to depletion and recovery is also hindered by demographic features (Love et al. 1998a). Bocaccio are long-lived fishes, taking several years to reach sexual maturity and becoming more fecund with age (Dorn 2002). As harvesting targeted the largest individuals available, bocaccio have become less capable of recovering population numbers (Love et al. 1998b). At present, in the complete absence of directed or bycatch fishing pressure, it is estimated that bocaccio populations would have to have frequent good recruitment to restrain their present decline (Tolimieri and Levin 2005). In addition, bocaccio reproduction appears to be characterized by frequent recruitment failures, punctuated by occasional high success years (Love et al. 1998b; MacCall and He 2002). Over the past 30 years, 1977, 1984, and 1988 are the only years in which recruitment appears to have been significant successes. Recruitment success appears to be linked to oceanographic/climactic patterns and may be related to cyclic warm/cool ocean periods, with cool periods having greater success (Love et al. 1998b; MacCall 1996; Moser et al. 2000; Sakuma and Ralston 1995). Harvey *et al.* (2006) suggested that bocaccio may have recently diverted resources from reproduction, potentially resulting in additional impairment to recovery.

Recovery Goals

See the 2016 Draft Rockfish Recovery Plan: Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*), for complete down listing/delisting

criteria for each of their respective recovery goals (NMFS 2016d). The following items were the top recovery objectives identified to support in the Draft Recovery Plan:

- Improve our knowledge of the current and historical status of the yelloweye rockfish and bocaccio and their habitats.
- Reduce or eliminate existing threats to listed rockfish from fisheries/anthropogenic mortality.
- Reduce or eliminate existing threats to listed rockfish habitats and restore important rockfish habitat.

2.4.9 Yelloweye Rockfish: Puget Sound/Georgia Basin DPS

Yelloweye rockfish occur throughout most of the eastern Pacific Ocean ranging from northern Baja California to the Aleutian Islands, Alaska. The Puget Sound/Georgia Basin DPS is located along the coastal/inlet waters off the state of Washington and province of British Columbia and is the only DPS listed under the ESA.

Yelloweye rockfish is one of the largest species belonging to the genus *Sebastes*. They are orange-red to orange-yellow in color and may have black fin tips with bright yellow eyes. Adults usually have a light to white stripe on the lateral line; juveniles have two light stripes, one on the lateral line and a shorter one below the lateral line (Yamanaka et al. 2006).

Life history

Yelloweye rockfish larvae are born at 4-5 millimeters in length and maintain a pelagic existence for the first 2 months of life, before moving to nearshore habitats and settling into rocky reef habitat at about 25 millimeters in length (DeLacy et al. 1964; Love et al. 2002; Matarese et al. 1989; Moser 1996). However, individuals shift to deeper habitats as they age. Juveniles tend to begin life in shallow rocky reefs and graduate to deeper rocky habitats as adults. Once adult habitat is established, individuals tend to remain at a particular site (Coombs 1979; Love 1978; DeMott 1983). Yelloweye growth is thought to vary by latitudinal gradient, with individuals in more northerly regions growing faster and larger. Year class strength appears to be most strongly linked to survival of the larval stage (Laidig et al. 2007). In general, sexual maturity appears to be reached by 50 percent of individuals by 15-20 years of age and 40-50 centimeters in length (Yamanaka and Kronlund 1997). As with other rockfish, yelloweyes can be long-lived (reported oldest age is 118 years) (Munk 2001). Maximum size has been reported as 910 centimeters, but assymptotic size in Alaskan waters for both males and females was estimated to be 690 centimeters and 659-676 millimeters along British Columbia (Clemens and Wilby 1961; Love et al. 2005; Rosenthal et al. 1982; Westrheim and Harling 1975; Yamanaka et al. 2006).

Population Dynamics

The apparent steep reduction of ESA-listed rockfish in Puget Sound proper (and their consequent fragmentation) has led to concerns about the viability of these populations (Drake et al. 2010).

Recreationally caught yelloweye rockfish in the 1970s spanned a broad size range. By the 2000s, fewer older fish in the population were observed (Drake et al. 2010). However, overall fish

numbers in the database were also much lower, making it difficult to determine if clear size truncation occurred. With age truncation, the reproductive burden may have shifted to younger and smaller fish. This could alter larval release timing and condition, which may create a mismatch with habitat conditions and potentially reduce offspring viability (Drake et al. 2010).

Spatial distribution provides a protective measure from larger scale anthropogenic changes that damage habitat suitability, such as oil spills or hypoxia, which can occur within one basin but not necessarily the other basins. When localized depletion of rockfish occurs, it can reduce stock resiliency, especially when exacerbated by the natural hydrologic constrictions within Puget Sound (Levin 1998, Hilborn et al. 2003, Hamilton 2008). Combining this with limited adult movement, yelloweye rockfish population viability may be highly influenced by the probable localized loss of populations within the DPS, thus decreasing spatial structure and connectivity.

Rockfish diversity characteristics include fecundity, larvae release timing, larvae condition, morphology, age at reproductive maturity, physiology, and molecular genetic characteristics. The leading factors affecting diversity are the relatively small home ranges of juveniles and subadults (Love et al. 2002) and low population size of all life stages. Yelloweye rockfish spatial structure and connectivity are likely threatened by the apparently severe reduction of fish numbers throughout Hood Canal and South Puget Sound. At 2,330 square km, Puget Sound is a small geographic area compared with the entire yelloweye rockfish range in the northeastern Pacific.

Results from a recent genetic study comparing yelloweye rockfish individuals from within the Puget Sound/Georgia Basin DPS (n=52) to those outside the DPS (n=52) provided multiple results (Tonnes et al. 2016). First, yelloweye rockfish in inland Canadian waters as far north as Johnstone Strait were genetically similar to those within the Puget Sound/Georgia Basin DPS. Currently, these areas are not included within the boundaries of the DPS. Second, a significant genetic difference exists between individuals (1) outside the DPS and (2) within the DPS and north of the DPS in inland Canadian waters to as far north as Johnstone Strait. Lastly, individuals within Hood Canal are genetically differentiated from the rest of the DPS; thereby indicating a previous unknown degree of population differentiation within the DPS (Tonnes et al. 2016).

Yelloweye rockfish were 2.4 percent of the rockfish harvest in the North Sound during the 1960s, 2.1 percent of the harvest during the 1980s, and further decreased to an average of one percent from 1996 to 2002 (Palsson et al. 2009). In Puget Sound proper, yelloweye rockfish were 4.4 percent of the rockfish harvest during the 1960s, 0.4 percent during the 1980s, and 1.4 percent from 1996 to 2002 (Palsson et al. 2009). By the 2000s, evidence of fewer older fish in the population prevailed. Since overall fish numbers in the database were also much lower, it is difficult to determine if size truncation occurred.

In 2008, fishery-independent estimate surveys conducted by Washington Department of Fish and Wildlife estimated that 47,407 yelloweye rockfish are present in the in the San Juan Islands basin (Table 31). Since this estimate only includes the San Juan Island basin, this estimate is considered a conservative estimate of actual Puget Sound/Georgia Basin yelloweye rockfish abundance. Though yelloweye rockfish were detected via bottom trawl surveys in Puget Sound

proper, we do not consider the Washington Department of Fish and Wildlife estimate of 600 fish to be a complete estimate. Since juvenile yelloweye rockfish are less dependent on rearing in shallow nearshore environments than canary rockfish and bocaccio, the drop camera surveys were not expected to result in any detections.

Productivity measures a population's growth rate through all or a portion of its life-cycle. Yelloweye rockfish life-history traits suggest generally low inherent productivity levels because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Tolimieri and Levin 2005, Drake et al. 2010). Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and may not move to find suitable mates. So as the density of mature fish has decreased, productivity may have also been impacted by Allee effects. Further, past commercial and recreational fishing may have depressed the DPS to a threshold beyond which optimal productivity is unattainable (Drake et al. 2010). Also, historic over-fishing may have had dramatic impacts on population size or age structure.

Status

Puget Sound/Georgia Basin yelloweye rockfish were listed under the ESA as threatened on April 28, 2010 (75 FR 22276). Puget Sound/Georgia Basin yelloweye rockfish abundance is much less than it was historically. The fish face several threats including bycatch in commercial and recreational harvest, non-native species introductions, and habitat degradation. Results from a recent genetic study comparing yelloweye rockfish individuals from within the Puget Sound/Georgia Basin DPS to those outside the DPS concluded that a significant genetic difference exists between individuals (1) outside the DPS and (2) within the DPS and north of the DPS in inland Canadian waters to as far north as Johnstone Strait (Tonnes et al. 2016). Further, individuals within Hood Canal are genetically differentiated from the rest of the Puget Sound/Georgia Basin DPS; thereby indicating a previous unknown degree of population differentiation within the DPS (Tonnes et al. 2016). NMFS has determined that this DPS is likely to be in danger of extinction in the foreseeable future throughout all of its range; and in its 2016 status review (Tonnes et al. 2016), NMFS has recommended no change in the Puget Sound/Georgia Basin yelloweye rockfish's threatened classification.

2.4.10 Eulachon: Southern DPS

The eulachon is a small, cold-water species of anadromous fish, occupying the eastern Pacific Ocean in nearshore waters to depths of about 1,000 feet (300 meters) from California to the Bering Sea. Eulachon will return to their natal river spawn. Southern DPS eulachon are those that spawn in rivers south of the Nass River in British Columbia to the Mad River in California (Figure 35) (NMFS 2016b).

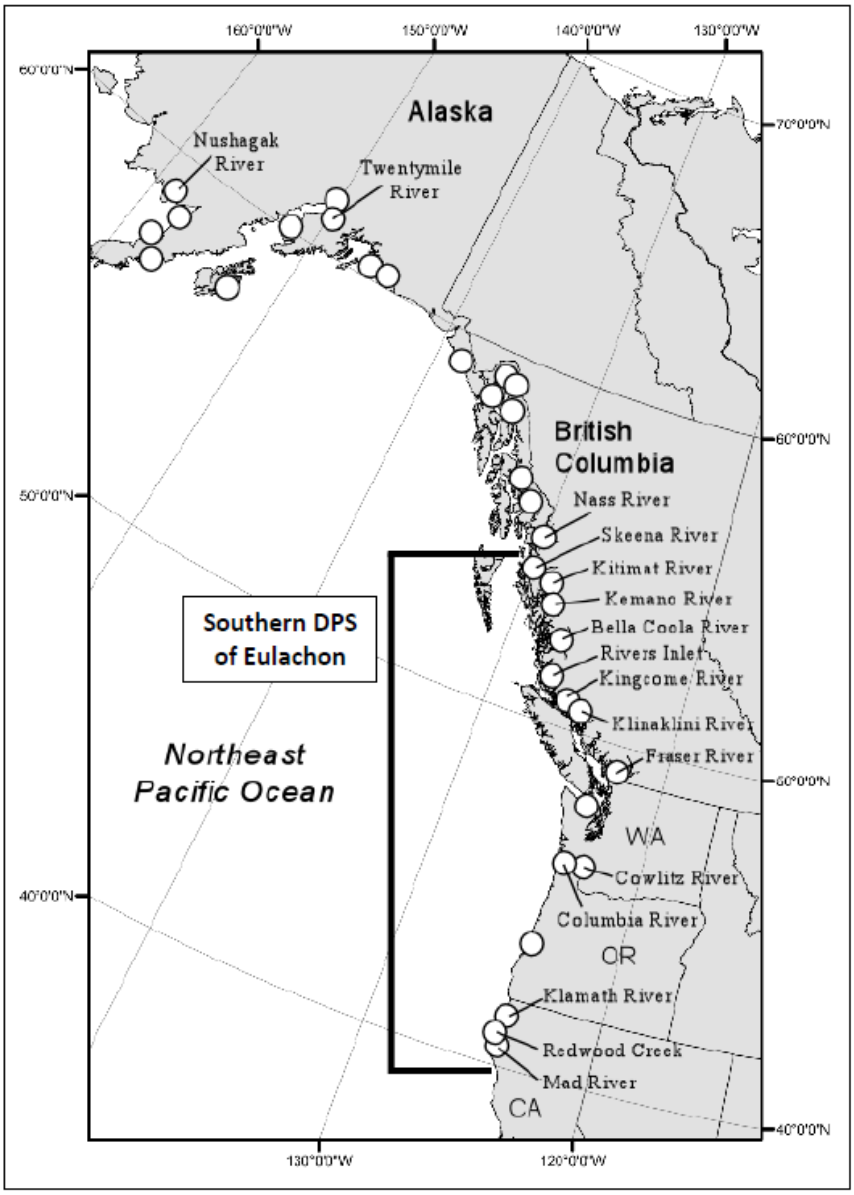


Figure 35. Map identifying the range of the eulachon Southern distinct population segment. From the NMFS 2016 Five-Year Review (NMFS 2016b).

Eulachon are a small (8.5 inches, 21.5 centimeters) anadromous fish, with brown or blue backs, silver on their sides, and white underneath (Figure 36). The Southern DPS was first listed as threatened by NMFS on March 18, 2010 (75 FR 13012).



ska Fisheries Science Center.

We used information available in the status review (Gustafson et al. 2010), the updated status review (Gustafson 2016), the 5-year review (NMFS 2016b), and recent scientific publications to summarize the life history, population dynamics and status of the species, as follows.

Life History

Although primarily marine, eulachon return to freshwater to spawn. For the Southern DPS eulachon, most spawning occurs in the Columbia River and its tributaries. Spawning usually occurs between ages two and five. Spawning is strongly influenced by water temperatures, and the timing of migration typically occurs between December and June, when water temperatures are between 0°C and 10°C (Gustafson 2016). In the Columbia River and further south, spawning occurs from late January to March (Hay and McCarter 2000). Further north, the peak of eulachon runs in Washington State is from February through March (Hay and McCarter 2000). Females lay between 7,000 and 60,000 eggs over sand, course gravel or detritial substrate. Eggs attach to gravel or sand and incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters. In their first year of life, juveniles are found along the continental shelf (Gustafson 2016; Wydoski and Whitney 1979). Adult eulachon are found in coastal and offshore marine habitats. With the exception of some individuals in Alaska, eulachon generally die after spawning (Gustafson 2016). The maximum known lifespan is nine years of age, but 20 to 30 percent of individuals live to four years and most individuals survive to three years of age, although spawning has been noted as early as two years of age. Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). The primary prey of adult eulachon are copepods and euphausiids, malacostracans and cumaceans.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Southern DPS eulachon.

There is no current population abundance estimate for the Southern DPS eulachon. There is a lack of long-term information on Southern DPS eulachon abundance, although the available fisheries landings data indicate a steep decline in the early to mid-1990s (Gustafson 2016). Data from fisheries surveys show that abundance can vary from year to year.

There is no population growth rate available for Southern DPS eulachon, although some indices show an increasing temporal trend. (Gustafson 2016)

Southern DPS eulachon are genetically distinct from eulachon in the northern parts of its range (i.e., Alaska). Recent genetic analysis indicates that the Southern DPS exhibits a regional population structure, with a three-population southern Columbia-Fraser group, coming from the Cowlitz, Columbia, and Fraser rivers (Candy et al. 2015; Gustafson 2016).

Adult and juvenile Southern DPS eulachon can be found in the Pacific Ocean, along the continental shelf, in waters from 50 to 200 meters deep (Gustafson 2016). Adults are most frequently found in the Columbia River and its tributaries (e.g., Cowlitz River, Sandy River), and sometimes in the Klamath River, California.

Status

Eulachon formerly experienced widespread, abundant runs and have been a staple of Native American diets for centuries along the northwest coast. However, such runs that were formerly present in several California rivers as late as the 1960s and 1970s (i.e., Klamath River, Mad River and Redwood Creek) no longer occur (Larson and Belchik 2000). This decline likely began in the 1970s and continued until, in 1988 and 1989, the last reported sizeable run occurred in the Klamath River and no fish were found in 1996, although a moderate run was noted in 1999 (Larson and Belchik 2000; Moyle 2002b). Eulachon have not been identified in the Mad River and Redwood Creek since the mid-1990s (Moyle 2002b). The species is considered to be at moderate risk of extinction throughout its range because of a variety of factors, including predation, commercial and recreational fishing pressure (directed and bycatch), and loss of habitat. Warmer water temperatures associated with climate change could alter the timing of spawning, and the availability of prey for larval and juvenile eulachon (NMFS 2016b). Further population decline is anticipated to continue as a result of climate change and bycatch in commercial fisheries. However, because of their fecundity, eulachon are assumed to have the ability to recover quickly if given the opportunity (Bailey and Houde 1989).

Recovery Goals

See the 2016 Draft Recovery Plan for the Southern DPS eulachon, for complete down listing/delisting criteria for each of their respective recovery goals (NMFS 2016c). The following items were the top recovery actions identified to support in the Draft Recovery Plan:

- Implement outreach and education strategies.
- Conduct strategic research on eulachon.
- Develop biological viability targets.
- Conduct strategic research on eulachon habitats.
- Conduct research on threats, including in marine and freshwater habitat, bycatch, predation, dams and water diversions, water quality, and others.
- Assess regulatory measures, inadequacy of existing regulatory mechanisms.
- Develop a research, monitoring, evaluation, and adaptive management plan.

2.4.11 Chinook Salmon: California Coastal Evolutionarily Significant Unit (ESU)

The California Coastal (CC) Chinook salmon Evolutionarily Significant Unit (ESU) includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River (Humboldt County, CA.) to the Russian River (Sonoma County, CA) (Figure 37).

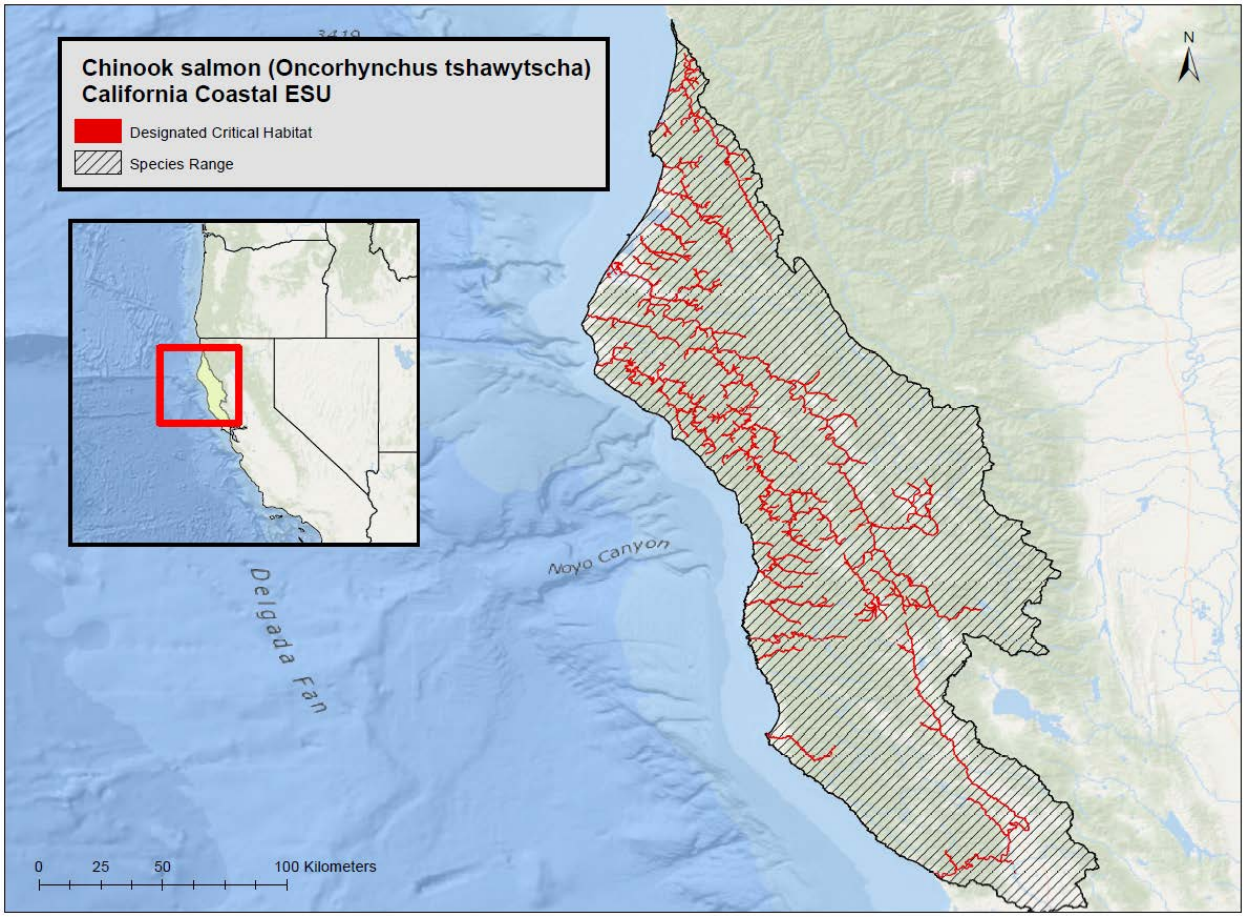


Figure 37. Geographic range and designated critical habitat of Chinook salmon, California coastal ESU.

Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a) (Figure 38). On September 16, 1999, NMFS listed the California coastal ESU of Chinook

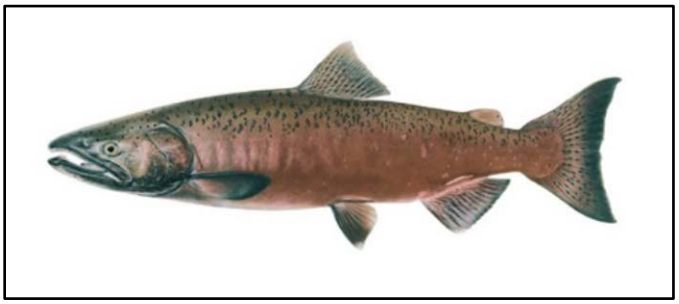


Figure 38. Chinook salmon.

salmon as a "threatened" species (FR 64 50394). On June 28, 2005, NMFS confirmed the listing of CC Chinook salmon as threatened under the ESA and also added seven artificially propagated populations from the following hatcheries or programs to the listing.

Life history

California coastal Chinook salmon are a fall-run, ocean-type fish. Although a spring-run (river-type) component existed historically, it is now considered extinct (Bjorkstedt et al. 2005). The different populations vary in run timing depending on latitude and hydrological differences between watersheds. Entry of California coastal Chinook salmon into the Russian River depends on increased flow from fall storms, usually in November to January. Juveniles of this ESU migrate downstream from April through June and may reside in the estuary for an extended period before entering the ocean.

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability. In general, once Chinook leave their natal rivers, they use the cool, upwelled waters of the continental shelf for migration and feeding (Bellinger et al. 2015).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, California coastal ESU.

Comparison of historical and current abundance information indicates that independent populations of Chinook salmon are depressed in many basins (Bennet 2005; Good et al. 2005b; NMFS 2008a); only the Russian River currently has a run of any significance (Bjorkstedt et al. 2005). The 2000 to 2007 median observed (at Mirabel Dam) Russian River Chinook salmon run size is 2,991 with a maximum of 6,103 (2003) and a minimum of 1,125 (2008) adults (Cook 2008; Sonoma County Water Agency (SCWA) 2008).

The available data, a mixture of short-term (6-year or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/red indexes, provide no

indication that any of the independent populations (likely to persist in isolation) are approaching viability targets. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review (Williams *et al*. 2011).

The loss of the spring-run life history type represents a significant loss of diversity within the ESU, as has been noted in previous status reviews (Good *et al*. 2005; Williams *et al*. 2011). Concern remains about the extremely low numbers of Chinook salmon in most populations of the North-Central Coast and Central Coast strata, which diminishes connectivity across the ESU. However, the fact that Chinook salmon have regularly been reported in the Ten Mile, Noyo, Big, Navarro, and Garcia rivers represents a significant improvement in our understanding of the status of these populations in watersheds where they were thought to have been extirpated. These observations suggest that spatial gaps between extant populations are not as extensive as previously believed.

The California Coastal Chinook ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California (64 FR 50394; September 16, 1999). Seven artificial propagation programs are considered to be part of the ESU.

Status

The lack of long-term population-level estimates of abundance for Chinook salmon populations in this ESU continues to hinder assessment of its status. The available data, a mixture of short-term (6-years or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/redd indexes, show somewhat mixed patterns. Some longer time series associated with index reaches or partial populations show significant negative trends (Prairie Creek, Freshwater Creek, Tomki Creek), one shows a significant positive trend (Van Arsdale Station), and the remainder no significant trends. There remains high uncertainty regarding key populations, including the Upper and Lower Eel River populations and the Mad River population, due to incomplete monitoring across the spawning habitat of Chinook salmon in these basins (O'Farrell *et al.* 2012). The longest time series, video counts in the Russian River, indicates that the population has remained fairly steady over the 14-year period of record (Williams *et al.* 2016). The Russian River probably contains some natural production, but the origin of those fish is not clear because of a number of introductions of hatchery fish over the last century. Williams *et al.* (2016) concluded that there is no indication that any of the independent populations within this ESU are approaching viability targets.

Recovery Goals

Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2016 Recovery Plan. Recovery plan objectives are to: 1) Reduce the present or threatened destruction, modification, or curtailment of habitat or range; 2) Ameliorate utilization for commercial, recreational, scientific, or educational purposes; 3) Abate disease and predation; 4) Establish the adequacy of existing regulatory mechanisms for protecting CC Chinook salmon now and into the future (i.e., post-delisting); 5) Address other natural or manmade factors

affecting the continued existence of CC Chinook salmon; and 6) Ensure the status of CC Chinook salmon is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

2.4.12 Chinook Salmon: Central Valley Spring-Run ESU

The Chinook salmon, Central Valley spring-run ESU includes naturally spawned spring-run Chinook salmon originating from the Sacramento River and its tributaries, and also spring-run Chinook salmon from the Feather River Hatchery Spring-run Chinook Program.

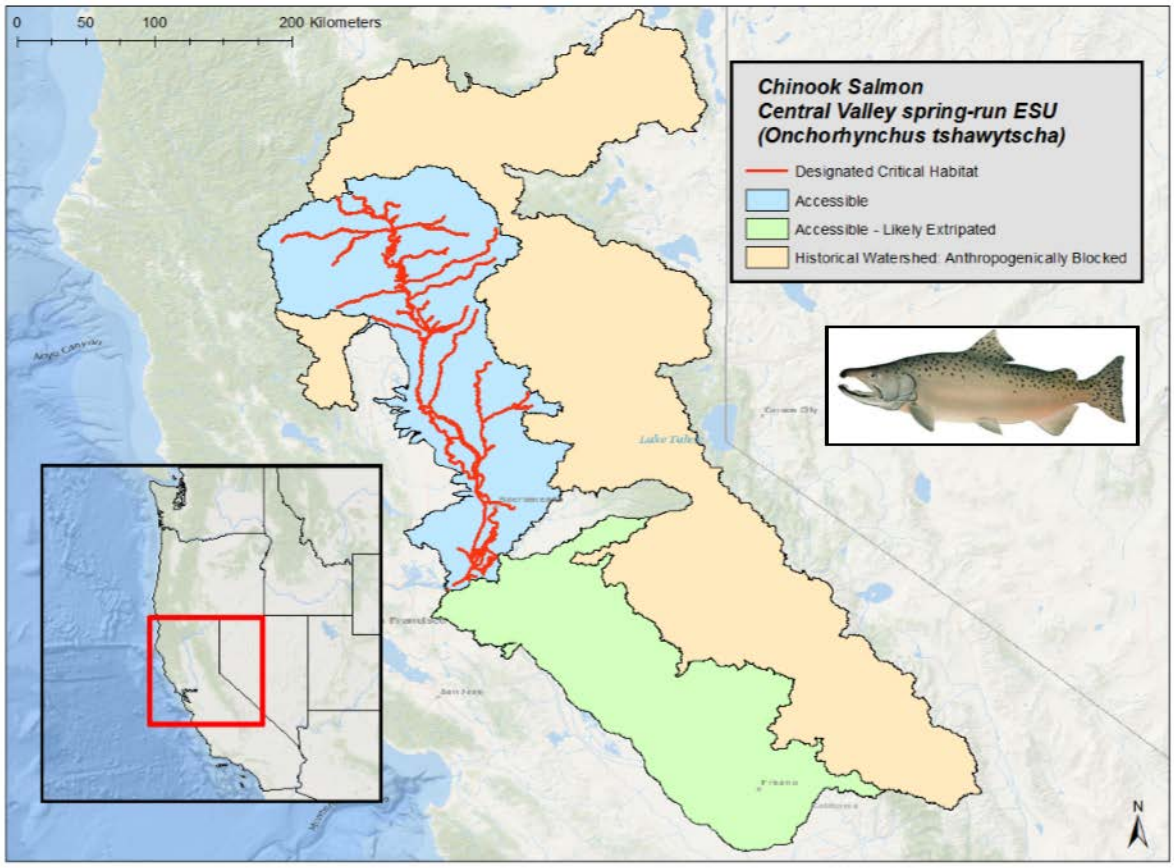


Figure 39. Geographic range and designated critical habitat of Chinook salmon, Central Valley spring-run ESU.

On September 16, 1999, NMFS listed the Central Valley ESU of spring-run Chinook salmon as a "threatened" species (FR 64 50394). Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers to migration were absent. The only known streams that currently support self-sustaining populations of non-hybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Each of these populations is small and isolated (NMFS 2014e).

Life history

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February, and enter the Sacramento River between March and September, primarily in May and June (Moyle 2002a; Yoshiyama et al. 1998). Spring-run Chinook salmon generally enter rivers as sexually immature fish and must hold in freshwater for up to several months before spawning. While maturing, adults hold in deep pools with cold water. Spawning normally occurs between mid- August and early October, peaking in September (Moyle 2002a).

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Spring-run fry emerge from the gravel from November to March (Moyle 2002a). Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, Central Valley spring-run ESU.

The Central Valley as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s. The only known streams that currently support self-sustaining populations of non-hybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Abundance and trend estimates for these streams as well as streams supporting dependent populations are provided in Table 13 (NMFS 2014e).

Table 13. Viability metrics for Central Valley spring-run ESU Chinook salmon populations.

Antelope Creek	8.0	2.7	-0.375 (-0.706, -0.045)	87.8
Battle Creek	1836	612	0.176 (0.033, 0.319)	9.0
Big Chico Creek	0.0	0.0	-0.358 (-0.880, 0.165)	60.7
Butte Creek	20169	6723	0.353 (-0.061, 0.768)	15.7
Clear Creek	822	274	0.010 (-0.311, 0.330)	63.3
Cottonwood Creek	4	1.3	-0.343 (-0.672, -0.013)	87.5
Deer Creek	2272	757.3	-0.089 (-0.337, 0.159)	83.8
Feather River Fish Hatchery	10808	3602.7	0.082 (-0.015, 0.179)	17.1
Mill Creek	2091.0	697.0	-0.049 (-0.183, 0.086)	58.0
Sacramento River[a]	-	-	-	-
Yuba River	6515	2170.7	0.67 (-0.138, 0.272)	9.0

N: Total population size (N) is estimated as the sum of estimated run sizes over the most recent three years for Core 1 populations (Rudd et al.) and Core 2 populations.

$\hat{S}$: The mean population size ($\hat{S}$) is the average of the estimated run sizes for the most recent 3 years (2012 to 2014).

Population growth/decline rate (10 year trend) is estimated from the slope of log-transformed estimated run size.

The catastrophic metric (recent decline) is the largest year-to-year decline in total population size (N) over the most recent 10 such ratios.

[a] Beginning in 2009, estimates of spawning escapement of Upper Sacramento River spring chinook were no longer monitored.

Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation. The majority of CV spring-run Chinook salmon are found to return as three-yearolds, therefore looking at returns every three years is used as an estimate of the CRR. In the past the CRR has fluctuated between just over 1.0 to just under 0.5, and in the recent years with high returns (2012 and 2013), CRR jumped to 3.84 and 8.68 respectively. CRR for 2014 was 1.85, and the CRR for 2015 with very low returns was a record low of 0.14. Low returns in 2015 were further decreased due to high temperatures and most of the CV spring-run Chinook salmon tributaries experienced some pre-spawn mortality. Butte Creek experienced the highest prespawn mortality in 2015, resulting in a carcass survey CRR of only 0.02 (NMFS 2014e).

Threats to the genetic integrity of spring-run Chinook salmon was identified as a serious concern to the species when it was listed in 1999 (FR 64 50394; Myers et al. 1998a). Three main factors compromised the genetic integrity of spring-run Chinook salmon: (1) the lack of reproductive isolation following dam construction throughout the Central Valley resulting in introgression with fall-run Chinook salmon in the wild; (2) within basin and inter-basin mixing between spring and fall broodstock for artificial propagation, resulting in introgression in hatcheries; and (3) releasing hatchery-produced juvenile Chinook salmon in the San Francisco estuary, which contributes to the straying of returning adults throughout the Central Valley (NMFS 2014e).

The Central Valley Technical Recovery Team delineated 18 or 19 historic independent populations of CV spring-run Chinook salmon, and a number of smaller dependent populations,

that are distributed among four diversity groups (southern Cascades, northern Sierra, southern Sierra, and Coast Range) (Lindley et al. 2004). Of these independent populations, only three are extant (Mill, Deer, and Butte creeks) and they represent only the northern Sierra Nevada diversity group. Of the dependent populations, CV spring-run Chinook salmon are found in Battle, Clear, Cottonwood, Antelope, Big Chico, and Yuba creeks, as well as the Sacramento and Feather rivers and a number of tributaries of the San Joaquin River including Mokelumne, Stanislaus, and Tuolumne rivers.

Status

Although spring-run Chinook salmon were probably the most abundant salmonid in the Central Valley, this ESU has suffered the most severe declines of any of the four Chinook salmon runs in the Sacramento River Basin (Fisher 1994). The ESU is currently limited to independent populations in Mill, Deer, and Butte creeks, persistent and presumably dependent populations in the Feather and Yuba rivers and in Big Chico, Antelope, and Battle creeks, and a few ephemeral or dependent populations in the Northwestern California region (e.g., Beegum, Clear, and Thomes creeks). The Central Valley spring-run Chinook salmon ESU is currently faced with three primary threats: (1) loss of most historic spawning habitat; (2) degradation of the remaining habitat; and (3) genetic introgression with the Feather River fish hatchery spring-run Chinook salmon strays. The potential effects of climate change are likely to adversely affect spring-run Chinook salmon and their recovery (NMFS 2014e).

Recovery Goals

Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014e). The ESU delisting criteria for the spring-run Chinook are: 1) One population in the Northwestern California Diversity Group at low risk of extinction; 2) Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction; 3) Four populations in the Northern Sierra Diversity Group at low risk of extinction; 4) Two populations in the Southern Sierra Diversity Group at low risk of extinction; and 5) Maintain multiple populations at moderate risk of extinction.

2.4.13 Chinook Salmon: Lower Columbia River ESU

Chinook salmon, Lower Columbia River ESU includes naturally spawned Chinook salmon originating from the Columbia River and its tributaries downstream of a transitional point east of the Hood and White Salmon Rivers, and any such fish originating from the Willamette River and its tributaries below Willamette Falls.

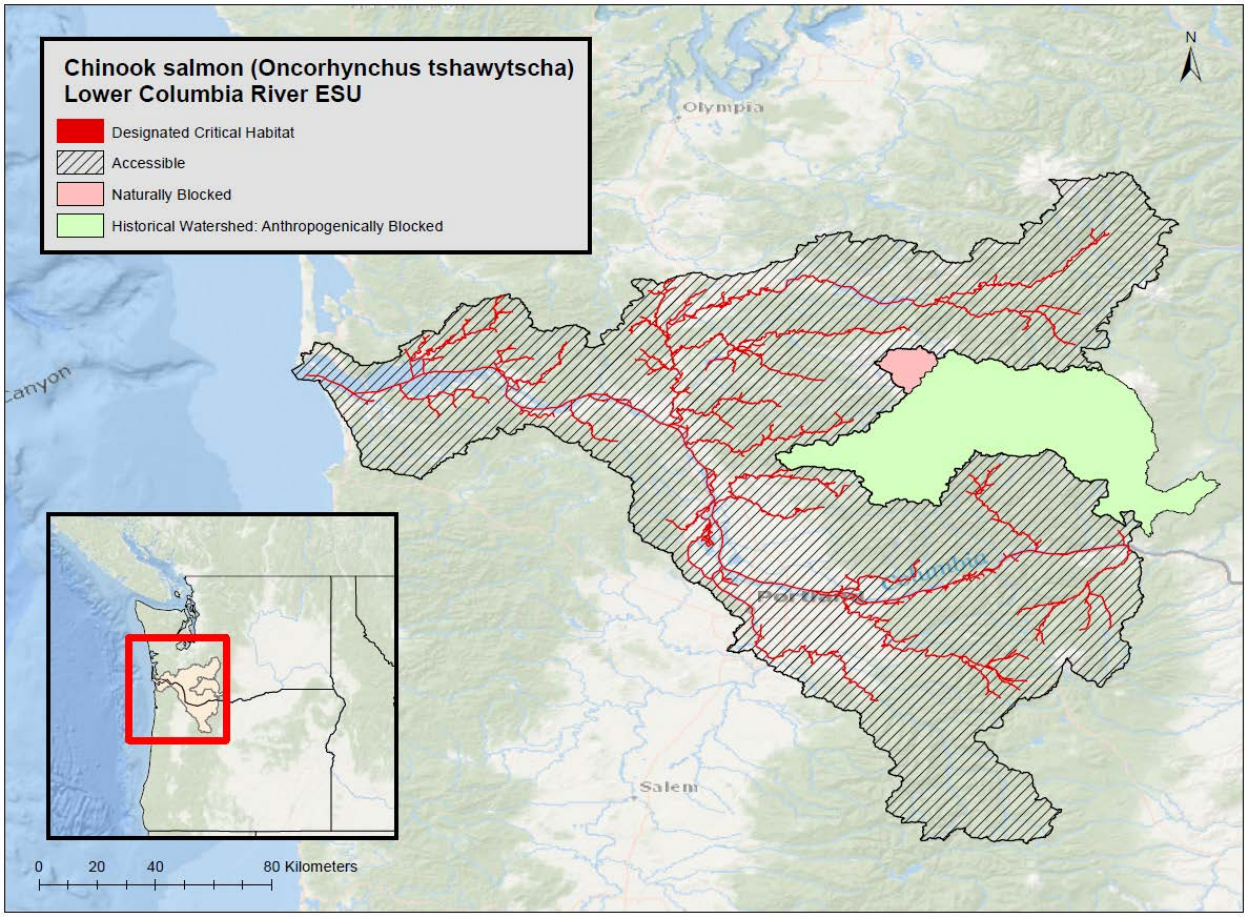


Figure 40. Geographic range and designated critical habitat of Chinook salmon, lower Columbia River ESU.

On March 24, 1999, NMFS listed the Lower Columbia River ESU of Chinook salmon as a "threatened" species (64 FR 14308). The listing was revisited and confirmed as "threatened" in 2005 (70 FR 37160).

Life history

Lower Columbia River Chinook salmon display three run types including early fall-runs, late fall-runs, and spring-runs. Presently, the fall-run is the predominant life history type. Spring-run Chinook salmon were numerous historically. Fall-run Chinook salmon enter fresh water typically in August through October. Early fall-run spawn within a few weeks in large river mainstems. The late fall-run enters in immature conditions, has a delayed entry to spawning grounds, and resides in the river for a longer time between river entry and spawning. Spring-run Chinook salmon enter fresh water in March through June to spawn in upstream tributaries in August and September.

Offspring of fall-run spawning may migrate as fry to the ocean soon after yolk absorption (*i.e.*, ocean-type), at 30–45 mm in length (Healey 1991). In the Lower Columbia River system, however, the majority of fall-run Chinook salmon fry migrate either at 60-150 days post-hatching in the late summer or autumn of their first year. Offspring of fall-run spawning may

also include a third group of yearling juveniles that remain in fresh water for their entire first year before emigrating. The spring-run Chinook salmon migrates to the sea as yearlings (stream-type) typically in spring. However, the natural timing of lower Columbia River spring-run Chinook salmon emigration is obscured by hatchery releases (Myers et al. 2006). Once at sea, the ocean-type lower Columbia River Chinook salmon tend to migrate along the coast, while stream-type lower Columbia River Chinook salmon appear to move far off the coast into the central North Pacific Ocean (Healey 1991; Myers et al. 2006). Adults return to tributaries in the lower Columbia River predominately as three- and four-year-olds for fall-run fish and four- and five-year-olds for spring-run fish.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, lower Columbia River ESU.

Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Many of the ESU's populations are believed to have very low abundance of natural-origin spawners (100 fish or fewer), which increases genetic and demographic risks. Other populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. The Lewis River late-fall population has the largest natural abundance in the ESU and has a strong short-term positive trend and a stable long term trend, suggesting a population near capacity.

Trend indicators for most populations are negative. The majority of populations for which data are available have a long-term trend of <1; indicating the population is in decline (Bennet 2005; Good et al. 2005b). Only the late-fall run population in Lewis River has an abundance and population trend that may be considered viable (McElhany et al. 2007). The Sandy River is the only stream system supporting a natural production of spring-run Chinook salmon of any amount. However, the population has not been directly monitored in a number of years; the most recent estimate was 373 spawners in 2010 (Takata 2011).

The genetic diversity of all populations (except the late fall-run Chinook salmon) has been eroded by large hatchery influences and periodically by low effective population sizes. The near loss of the spring-run life history type remains an important concern for maintaining diversity within the ESU.

The ESU spans three distinct ecological regions: Coastal, Cascade, and Gorge. Distinct life-histories (run and spawn timing) within ecological regions in this ESU were identified as major population groups (MPGs). In total, 32 historical demographically independent populations (DIPs) were identified in this ESU, 9 spring-run, 21 fall-run, and 2 late-fall run, organized in 6 MPGs (based on run timing and ecological region). The basin wide spatial structure has remained generally intact. However, the loss of about 35 percent of historic habitat has affected distribution within several Columbia River subbasins. Currently, only one population appears self-sustaining (Good et al. 2005b).

Status

Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Out of the 32 populations that make up this ESU, only the two late-fall runs (the North Fork Lewis and Sandy) are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years and some are extirpated or nearly so. Five of the six strata fall significantly short of the recovery plan criteria for viability. Low abundance, poor productivity, losses of spatial structure, and reduced diversity all contribute to the very low persistence probability for most Lower Columbia River Chinook salmon populations. Hatchery contribution to naturally-spawning fish remains high for a number of populations, and it is likely that many returning unmarked adults are the progeny of hatchery origin parents, especially where large hatchery programs operate. Continued land development and habitat degradation in combination with the potential effects of climate change will present a continuing strong negative influence into the foreseeable future.

Recovery Goals

Recovery plan targets for this species are tailored for each life history type, and within each type, specific population targets are identified (NMFS 2013c). For spring Chinook salmon, all populations are affected by aspects of habitat loss and degradation. Four of the nine populations require significant reductions in every threat category. Protection and improvement of tributary and estuarine habitat are specifically noted.

For fall Chinook salmon, recovery requires restoration of the Coast and Cascade strata to high probability of persistence, to be achieved primarily by ensuring habitat protection and restoration. Very large improvements are needed for most fall Chinook salmon populations to improve their probability of persistence.

For late fall Chinook salmon, recovery requires maintenance of the North Fork Lewis and Sandy populations which are comparatively healthy, together with improving the probability of persistence of the Sandy population from its current status of “high” to “very high” (NMFS 2013c)[23]. Improving the status of the Sandy population depends largely on harvest and hatchery

[23] According to the 2013 Lower Columbia River Salmon and Steelhead ESA Recovery Plan NMFS. 2013c. ESA recovery plan for lower Columbia River coho salmon, lower Columbia River Chinook salmon, Columbia River chum salmon, and Lower Columbia River steelhead. National Marine Fisheries Service, Northwest Region, editor, Seattle., a population status of “high” means that there is a low/negligible risk of extinction (i.e., between 1 and 5%) and a population status of “very high” means a very low risk of extinction (i.e., <1%).

changes. Habitat improvements to the Columbia River estuary and tributary spawning areas are also necessary. Of the 32 demographically independent populations (DIPs) in this ESU, only the 2 late-fall run populations (Lewis River and Sandy River) could be considered viable or nearly so (NWFSC 2015c).

2.4.14 Chinook Salmon: Puget Sound ESU

The Puget Sound ESU includes naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Twenty-six artificial propagation programs are included as part of the ESU (Figure 41).

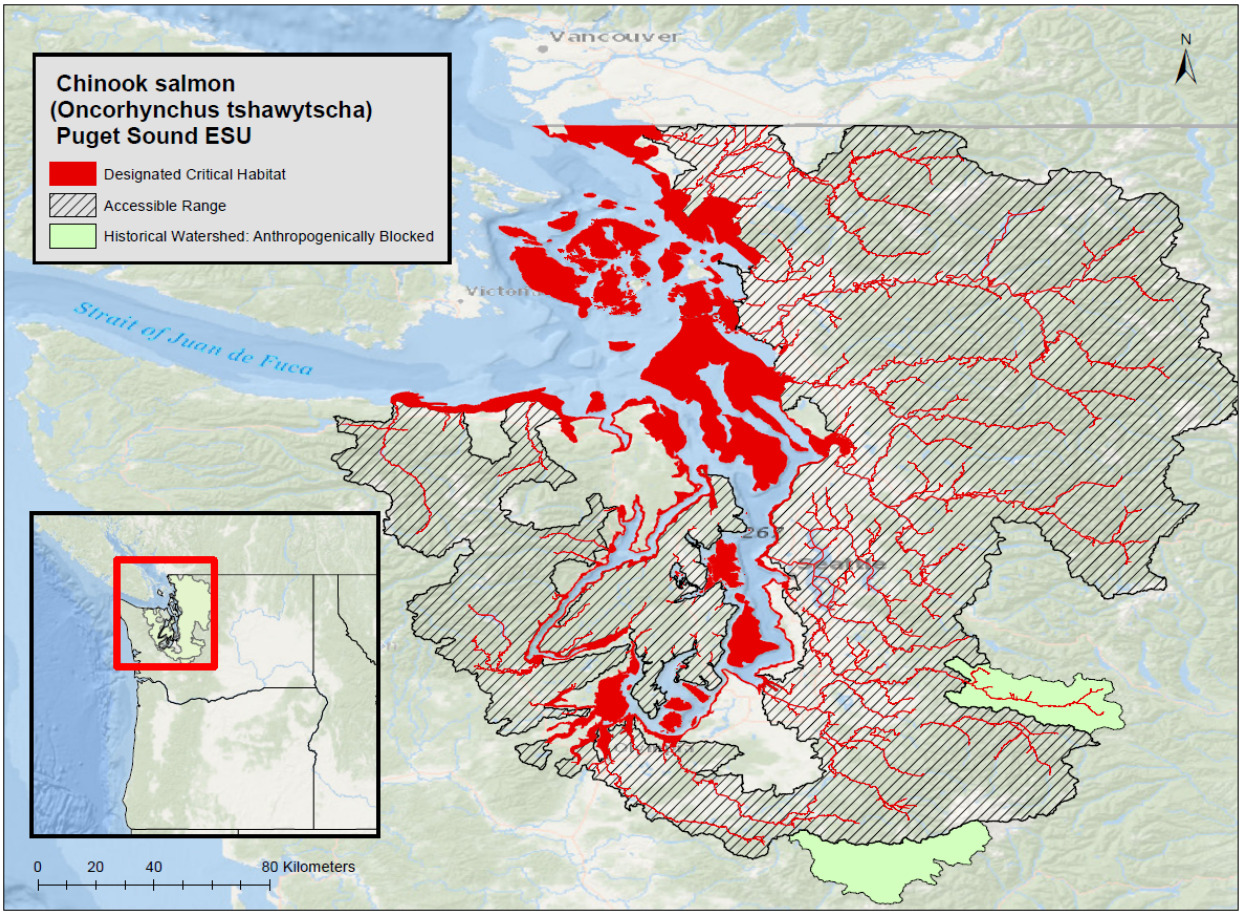


Figure 41. Geographic range and designated critical habitat of Chinook salmon, Puget Sound ESU.

On March 24, 1999, NMFS listed the Puget Sound ESU of Chinook salmon as a "threatened" species (64 FR 14308). The listing was revisited and confirmed as "threatened" in 2005 (70 FR 37160).

Life history

Puget Sound Chinook salmon populations exhibit both early-returning (August) and late-returning (mid-September and October) Chinook salmon spawners (Healey 1991). Juvenile

Chinook salmon within the Puget Sound generally exhibit an "ocean-type" life history. However, substantial variation occurs with regard to juvenile residence time in freshwater and estuarine environments. Hayman (Hayman et al. 1996) described three juvenile life histories for Chinook salmon with varying freshwater and estuarine residency times in the Skagit River system in northern Puget Sound. In this system, 20 percent to 60 percent of sub-yearling migrants rear for several months in freshwater habitats while the remaining fry migrate to rear in the Skagit River estuary and delta (Beamer et al. 2005). Juveniles in tributaries to Lake Washington exhibit both a stream rearing and a lake rearing strategy. Lake rearing fry are found in highest densities in nearshore shallow (<1 m) habitat adjacent to the opening of tributaries or at the mouth of tributaries where they empty into the lake (Tabor et al. 2006). Puget Sound Chinook salmon also has several estuarine rearing juvenile life history types that are highly dependent on estuarine areas for rearing (Beamer et al. 2005). In the estuaries, fry use tidal marshes and connected tidal channels including dikes and ditches developed to protect and drain agricultural land. During their first ocean year, immature Chinook salmon use nearshore areas of Puget Sound during all seasons and can be found long distances from their natal river systems (Brennan et al. 2004).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, Puget Sound ESU.

Estimates of the historic abundance range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. During the period from 1996 to 2001, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Thus, the historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the ESU (Good et al. 2005b).

Available data on total abundance since 1980 indicate that although abundance trends have fluctuated between positive and negative for individual populations, there are widespread negative trends in natural-origin Chinook salmon spawner abundance across the ESU (Ford 2011a). Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now shows that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the technical recovery team planning

ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the technical recovery team as consistent with recovery (Ford 2011a).

Current estimates of diversity show a decline over the past 25 years, indicating a decline of salmon in some areas and increases in others. Salmon returns to the Whidbey Region increased in abundance while returns to other regions declined. In aggregate, the diversity of the ESU as a whole has been declining over the last 25 years.

The Puget Sound technical recovery team identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity.

Status

All Puget Sound Chinook salmon populations are well below escapement abundance levels identified as required for recovery to low extinction risk in the recovery plan. In addition, most populations are consistently below the productivity goals identified in the recovery plan as necessary for recovery. Although trends vary for individual populations across the ESU, most populations have declined in total natural origin recruit abundance since the last status review; and natural origin recruit escapement trends since 1995 are mostly stable. Several of the risk factors identified in the previous status review (Good et al. 2005) are still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat. Although this ESU's total abundance is a greatly reduced from historic levels, recent abundance levels do not indicate that the ESU is at immediate risk of extinction. This ESU remains relatively well distributed over 22 populations in 5 geographic areas across the Puget Sound. Although current trends are concerning, the available information indicates that this ESU remains at moderate risk of extinction (NMFS 2011a).

Recovery Goals

The recovery plan consists of two documents: the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002a). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-

wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and

- Populations that do not meet the viability criteria for all viable salmonid population parameters are sustained to provide ecological functions and preserve options for ESU recovery.

2.4.15 Chinook Salmon: Sacramento River Winter-Run ESU

The Sacramento River winter-run Chinook salmon ESU includes winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries, as well as winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (Figure 42).

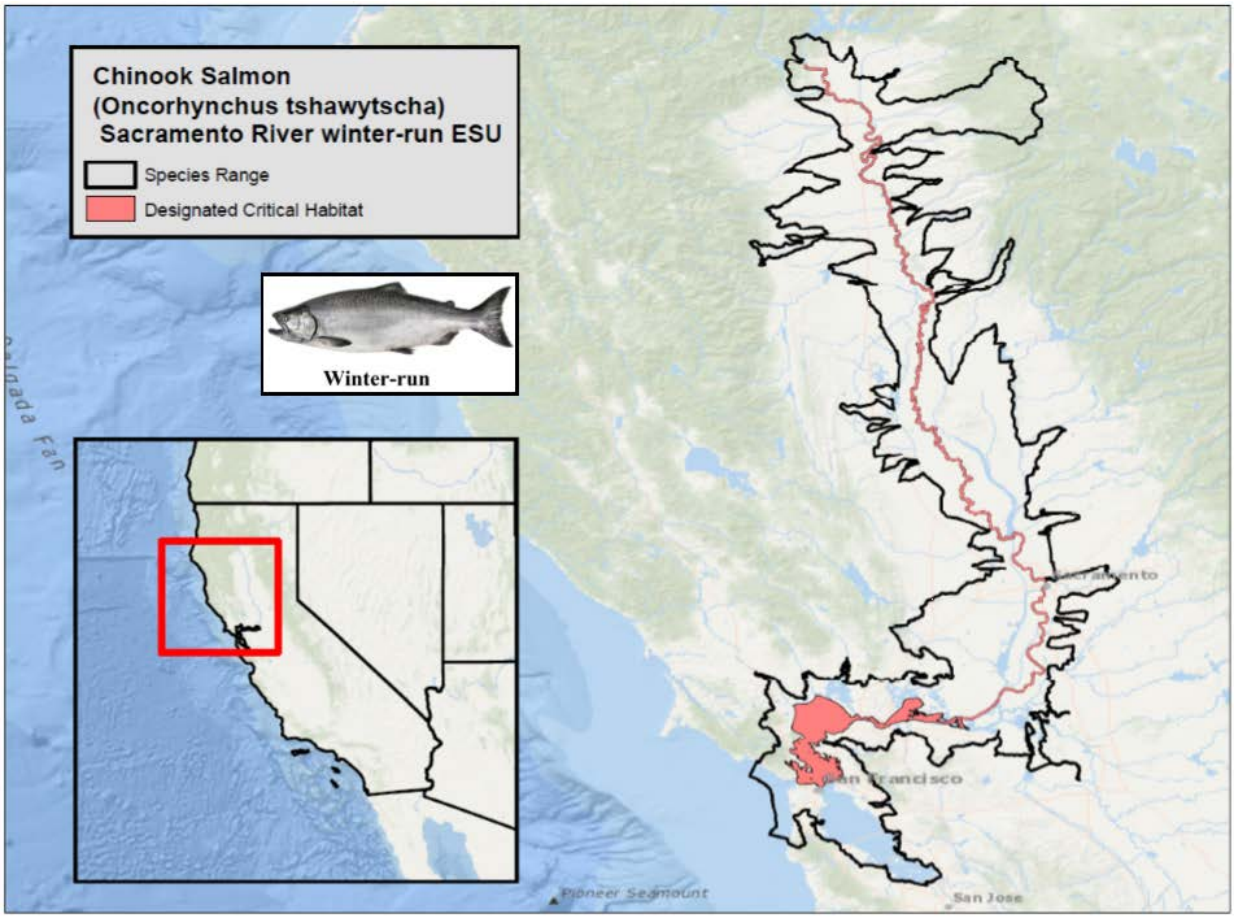


Figure 42. Geographic range and designated critical habitat of Chinook salmon, Sacramento River winter-run ESU.

On January 4, 1994, NMFS listed the Sacramento River winter-run ESU of Chinook salmon as Endangered (59 FR 440).

Life history

Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. As a result, winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer. Adult winter-run Chinook salmon immigration and holding (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (Fish and Service 1995). Winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in suitable habitat prior to spawning. Spawning occurs between late-April and mid-August, with a peak in June and July as reported by California Department of Fish and Wildlife annual escapement surveys (2000-2006).

Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel et al. 1988). Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam primarily occurring from July through November (Poytress and Carrillo 2010; Poytress and Carrillo 2011; Poytress and Carrillo 2012). Emigration of winter-run Chinook salmon juveniles past Knights Landing, located approximately 155.5 river miles downstream of the Red Bluff Diversion Dam, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years (Snider and Titus 2000).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Chinook salmon, Sacramento winter-run.

Over the last ten years of available data (2003 to 2013), the abundance of spawning winter-run Chinook adults ranged from a low of 738 in 2011 to a high of 17,197 in 2007, with an average of 6,298 (NMFS 2011c).

The population declined from an escapement of near 100,000 in the late 1960s to fewer than 200 in the early 1990s (Good et al. 2005a). More recent population estimates of 8,218 (2004), 15,730 (2005), and 17,153 (2006) show a three-year average of 13,700 returning winter-run Chinook salmon. However, the run size decreased to 2,542 in 2007 and 2,850 in 2008. Monitoring data indicated that approximately 5.6 percent of winter-run Chinook salmon eggs spawned in the Sacramento River in 2014 survived to the fry life stage (three to nearly 10 times lower than in

previous years). The drought in 2015 made this another challenging year for winter-run Chinook salmon (NMFS 2016j).

The rising proportion of hatchery fish among returning adults threatens to increase the risk of extinction. Lindley et al. (2007) recommend that in order to maintain a low risk of genetic introgression with hatchery fish, no more than five percent of the naturally-spawning population should be composed of hatchery fish. Since 2001, hatchery origin winter-run Chinook salmon have made up more than five percent of the run, and in 2005 the contribution of hatchery fish exceeded 18 percent (Lindley et al. 2007).

The range of winter-run Chinook salmon has been greatly reduced by Keswick and Shasta dams on the Sacramento River and by hydroelectric development on Battle Creek. Currently, winter-run Chinook salmon spawning is limited to the main-stem Sacramento River between Keswick Dam (river mile 302) and the Red Bluff Diversion Dam (river mile 243) where the naturally-spawning population is artificially maintained by cool water releases from the dams. Within the Sacramento River, the spatial distribution of spawners is largely governed by water year type and the ability of the California Valley Project to manage water temperatures (NMFS 2014e).

Status

New information available since Williams et al. (2011) indicates an increased extinction risk to this ESU (Williams et al. 2016). Poor early life stage survival during consecutive drought years (2012 to 2015) coupled with potential poor ocean conditions and hatchery production practices may further impact survival-to-adulthood and risk of extinction. Temperature conditions during egg development and fry emergence were suboptimal over the duration of rearing in 2014 and 2015 due to reduced cold water in Shasta Reservoir for this life stage. The egg-to-fry survival estimate for brood year 2014 is 5 percent, which is a significant departure from the average of 26.4 percent for brood years 2002 to 2012 (Poytress et al. 2014). The major risk concerns regarding this ESU remain. There is only one extant population and it is spawning outside of its historical range in artificially maintained habitat that is vulnerable to drought and other catastrophes. This ESU remains in danger of extinction and this risk will likely continue until additional low risk populations are re-established within its historical spawning range.

Recovery Goals

Recovery goals, objectives and criteria for the Sacramento River winter-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014e). In order to achieve the downlisting criteria, the species would need to be composed of two populations – one viable and one at moderate extinction risk. Having a second population would improve the species' viability, particularly through increased spatial structure and abundance, but further improvement would be needed to reach the goal of recovery. To delist winter-run Chinook salmon, three viable populations are needed. Thus, the downlisting criteria represent an initial key step along the path to recovering winter-run Chinook salmon.

2.4.16 Chinook Salmon: Snake River Fall-Run ESU

The listed ESU currently includes all natural-origin fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins. The listed ESU also includes fall-run Chinook salmon from four artificial propagation programs (NMFS 2011b; NMFS 2015b) (Figure 43).

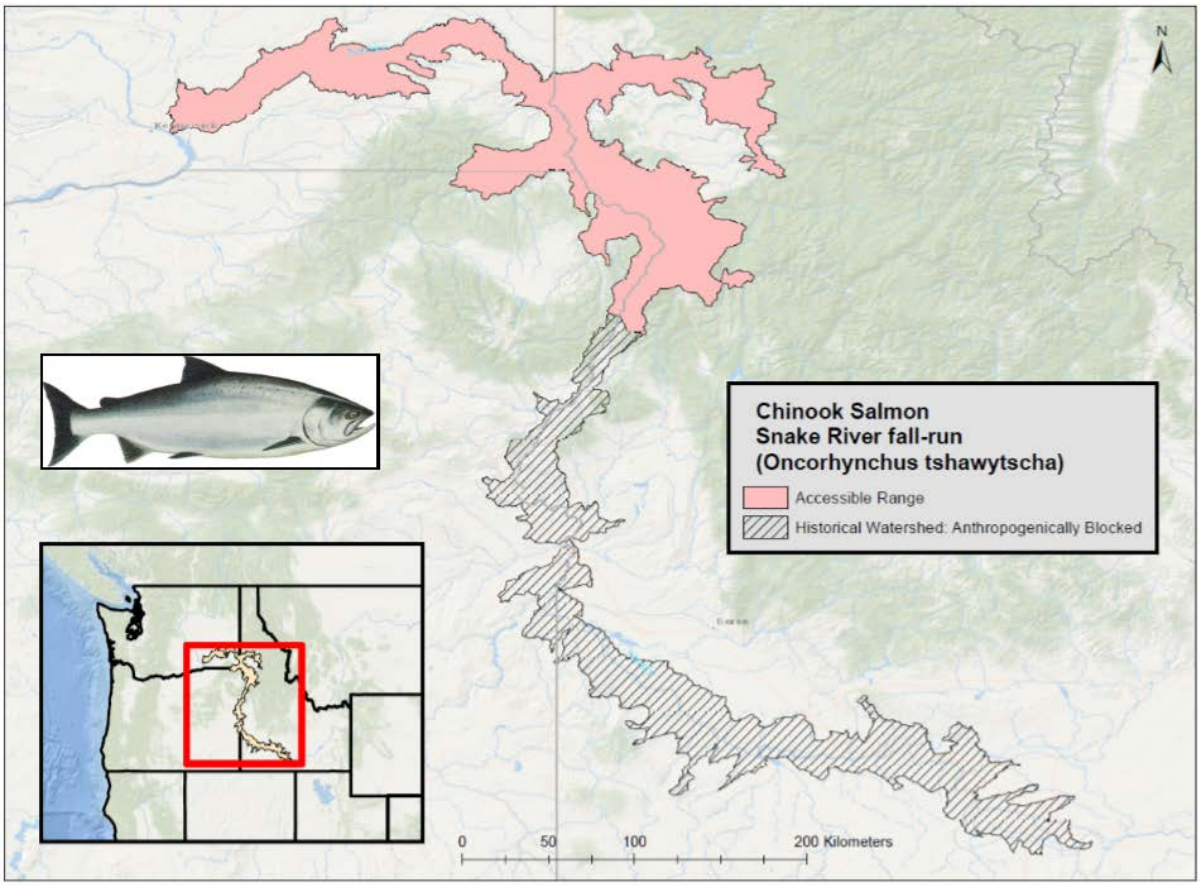


Figure 43. Geographic range of Chinook salmon, Snake River fall-run ESU.

NMFS first listed Snake River fall Chinook salmon as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing status in June 28, 2005 (70 FR 37160), and reaffirmed the status again in its 2014 (79 FR 20802).

Life history

Snake River fall-run Chinook return to the Columbia River in August and September, pass Bonneville Dam from mid-August to the end of September, and enter the Snake River between early September and mid-October (DART 2013). Once they reach the Snake River, fall Chinook salmon generally travel to one of five major spawning areas and spawn from late October through early December (Connor et al. 2014).

Upon emergence from the gravel, most young fall Chinook salmon move to shoreline riverine habitat (NMFS 2015b). Some fall Chinook salmon smolts sustain active migration after passing

Lower Granite Dam and enter the ocean as subyearlings, whereas some delay seaward migration and enter the ocean as yearlings (Connor et al. 2005; McMichael et al. 2008; NMFS 2015b). Snake River fall Chinook salmon can be present in the estuary as juveniles in winter, as fry from March to May, and as fingerlings throughout the summer and fall (Fresh et al. 2005; Roegner et al. 2012; Teel et al. 2014).

Once in the Northern California Current, dispersal patterns differ for yearlings and subyearlings. Subyearlings migrate more slowly, are found closer to shore in shallower water, and do not disperse as far north as yearlings (Fisher et al. 2014; Sharma and Quinn 2012; Trudel et al. 2009; Tucker et al. 2011). Snake River basin fall Chinook salmon spend one to four years in the Pacific Ocean, depending on gender and age at the time of ocean entry (Connor et al. 2005).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, Snake River fall-run ESU.

The naturally spawning fall Chinook salmon in the lower Snake River have included both returns originating from naturally spawning parents and from returning hatchery releases. The geometric mean natural-origin adult abundance for the most recent 10 years of annual spawner escapement estimates (2005-2014) is 6,418, with a standard error of 0.19 (NMFS 2015b).

The current estimate of productivity for this population (1990-2009 brood years) is 1.53 with a standard error of 0.18. This estimate of productivity, however, may be problematic for two reasons: (1) the increasingly small number of years that actually contribute to the productivity estimate means that there is increasing statistical uncertainty surrounding that estimate, and (2) the years contributing to the estimate are now far in the past and may not accurately reflect the true productivity of the current population (NMFS 2015b).

Genetic samples from the aggregate population in recent years indicate that composite genetic diversity is being maintained and that the Snake River Fall Chinook hatchery stock is similar to the natural component of the population, an indication that the actions taken to reduce the potential introgression of out-of-basin hatchery strays has been effective. Overall, the current genetic diversity of the population represents a change from historical conditions and, applying the Interior Columbia Technical Recovery Team (McClure et al.) guidelines, the rating for this metric is moderate risk (NMFS 2015b).

The Interior Columbia Technical Recovery Team identified three populations of this species, although only the lower mainstem population exists at present, and it spawns in the lower main stem of the Clearwater, Imnaha, Grande Ronde, Salmon and Tucannon rivers. The extant population of Snake River fall-run Chinook salmon is the only remaining population from an historical ESU that also included large mainstem populations upstream of the current location of the Hells Canyon Dam complex (IC-TRT 2003; McClure et al. 2005). The population is at moderate risk for diversity and spatial structure (Ford 2011a).

Status

As late as the late 1800s, approximately 408,500 to 536,180 fall Chinook salmon are believed to have returned annually to the Snake River. The run began to decline in the late 1800s and then continued to decline through the early and mid-1900s as a result of overfishing and other human activities, including the construction of major dams. This ESU has one extant population. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the Interior Columbia Technical Recovery Team, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.

Recovery Goals

Recovery goals, objectives and criteria for the Snake River fall-run Chinook are fully outlined in the 2015 Recovery Plan (NMFS 2015b). ESA recovery goals should support conservation of natural fish and the ecosystems upon which they depend. Thus, the ESA recovery goal for Snake River fall Chinook salmon is that: the ecosystems upon which Snake River fall Chinook salmon depend are conserved such that the ESU is self-sustaining in the wild and no longer needs ESA protection.

2.4.17 Chinook Salmon: Snake River Spring/Summer Run ESU

The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016h) (Figure 44).

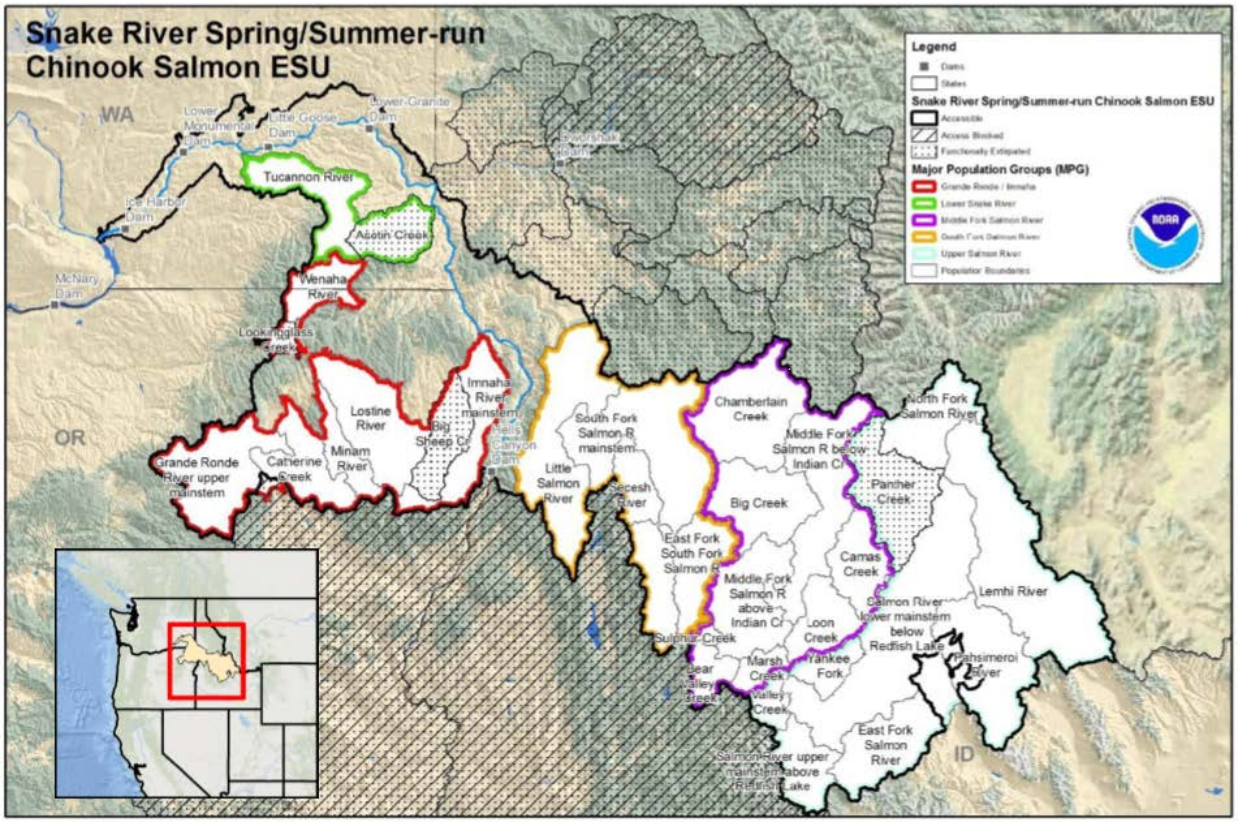


Figure 44. Geographic range and major population groups of Chinook salmon, Snake River spring/summer-run ESU.

The Snake River spring/summer-run Chinook salmon ESU was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160) and made minor technical corrections to the listing on April 14, 2014 (79 FR 20802).

Life history

Adult spring-run Chinook salmon destined for the Snake River return to the Columbia River from the ocean in early spring and pass Bonneville Dam beginning in early March and ending May 31st. Snake River summer-run Chinook salmon return to the Columbia River from June through July. Adults from both runs hold in deep pools in the mainstem Columbia and Snake Rivers and the lower ends of the spawning tributaries until late summer, when they migrate into the higher elevation spawning reaches. Generally, Snake River spring-run Chinook salmon spawn in mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the tributary drainages, although their spawning areas often overlap with those of spring-run spawners.

The eggs that Snake River spring and summer Chinook salmon deposit in late summer and early fall incubate over the following winter, and hatch in late winter and early spring. Juveniles rear through the summer, overwinter, and typically migrate to sea in the spring of their second year of life, although some juveniles may spend an additional year in fresh water. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal

reaches into alternative summer-rearing or overwintering areas. Most yearling fish are thought to spend relatively little time in the estuary compared to sub-yearling ocean-type fish however there is considerable variation in residence times in different habitats and in the timing of estuarine and ocean entry among individual fish (Holsman et al. 2012; McElhany et al. 2000a).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, Snake River spring/summer-run ESU.

Lower Snake River MPG: Abundance and productivity remain the major concern for the Tucannon River population. Natural spawning abundance (10-year geometric mean) has increased but remains well below the minimum abundance threshold for the single extant population in this MPG. Poor natural productivity continues to be a major concern. The integrated spatial structure/diversity risk rating for the Lower Snake River MPG is moderate.

Grande Ronde/Imnaha MPG: The Wenaha River, Lostine/Wallowa River and Minam River populations showed substantial increases in natural abundance relative to the previous Interior Columbia Technical Recovery Team review, although each remains below their respective minimum abundance thresholds. The Catherine Creek and Upper Grande Ronde populations each remain in a critically depressed state. Geometric mean productivity estimates remain relatively low for all populations in the MPG. The Upper Grande Ronde population is rated at high risk for spatial structure and diversity while the remaining populations are rated at moderate.

South Fork Salmon River MPG: Natural spawning abundance (10-year geometric mean) estimates increased for the three populations with available data series. Productivity estimates for these populations are generally higher than estimates for populations in other MPGs within the ESU. Viability ratings based on the combined estimates of abundance and productivity remain at high risk, although the survival/capacity gaps relative to moderate and low risk viability curves are smaller than for other ESU populations. Spatial structure/diversity risks are currently rated moderate for the South Fork Mainstem population (relatively high proportion of hatchery spawners) and low for the Secesh River and East Fork South Fork populations.

Middle Fork Salmon River MPG: Natural-origin abundance and productivity remains extremely low for populations within this MPG. As in the previous Interior Columbia Technical Recovery Team assessment, abundance and productivity estimates for Bear Valley Creek and Chamberlain Creek (limited data series) are the closest to meeting viability minimums among populations in

the MPG. Spatial structure/diversity risk ratings for Middle Fork Salmon River MPG populations are generally moderate. This primarily is driven by moderate ratings for genetic structure assigned by the Interior Columbia Technical Recovery Team because of uncertainty arising from the lack of direct genetic samples from within the component populations.

Upper Salmon River MPG: Abundance and productivity estimates for most populations within this MPG remain at very low levels relative to viability objectives. The Upper Salmon Mainstem has the highest relative abundance and productivity combination of populations within the MPG. Spatial structure/diversity risk ratings vary considerably across the Upper Salmon River MPG. Four of the eight populations are rated at low or moderate risk for overall spatial structure and diversity and could achieve viable status with improvements in average abundance/productivity. The high spatial structure/diversity risk rating for the Lemhi population is driven by a substantial loss of access to tributary spawning/rearing habitats and the associated reduction in life-history diversity. High risk ratings for Pahsimeroi River, East Fork Salmon River, and Yankee Fork Salmon River are driven by a combination of habitat loss and diversity concerns related to low natural abundance combined with chronically high proportions of hatchery spawners in natural areas.

Status

The historical run of Chinook in the Snake River likely exceeded one million fish annually in the late 1800s, by the 1950s the run had declined to near 100,000 adults per year. The adult counts fluctuated throughout the 1980s but then declined further, reaching a low of 2,200 fish in 1995. Currently, the majority of extant spring/summer Chinook salmon populations in the Snake River spring/summer Chinook salmon ESU remain at high overall risk of extinction, with a low probability of persistence within 100 years. Factors cited in the 1991 status review as contributing to the species' decline since the late 1800s include overfishing, irrigation diversions, logging, mining, grazing, obstacles to migration, hydropower development, and questionable management practices and decisions (Matthews and Waples 1991). In addition, new threats ─ such as those posed by toxic contamination, increased predation by non-native species, and effects due to climate change ─ are emerging (NMFS 2016a).

Recovery Goals

Recovery goals, scenarios and criteria for the Snake River spring and summer-run Chinook salmon are fully outlined in the 2016 proposed recovery plan (NMFS 2016h). The status levels targeted for populations within an ESU or DPS are referred to collectively as the "recovery scenario" for the ESU or DPS. NMFS has incorporated the viability criteria into viable recovery scenarios for each Snake River spring/summer Chinook salmon and steelhead MPG. The criteria should be met for an MPG to be considered Viable, or low (5 percent or less) risk of extinction, and thus contribute to the larger objective of ESU or DPS viability.

2.4.18 Chinook Salmon: Upper Columbia River Spring-Run ESU

The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon

River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016h) (Figure 45).

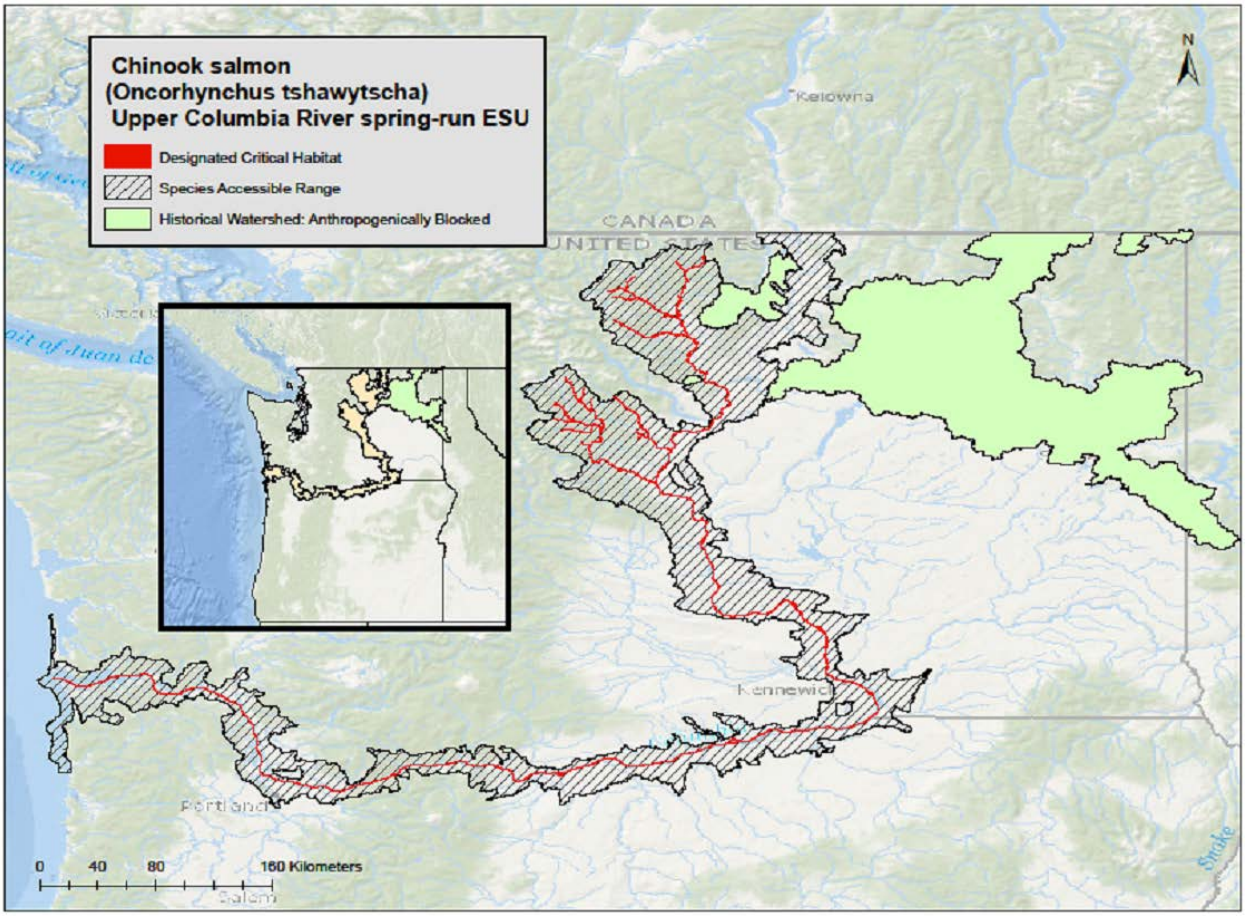


Figure 45. Geographic range and designated critical habitat of Chinook salmon, upper Columbia River ESU.

Upper Columbia River spring-run Chinook salmon ESU, was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160).

Life history

Adult Spring Chinook in the Upper Columbia Basin begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook enter the Upper Columbia tributaries from April through July. After migration, they hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid to late August. Juvenile spring Chinook spend a year in freshwater before migrating to salt water in the spring of their second year of life. Most Upper Columbia spring Chinook return as adults after two or three years in the ocean. Some precocious males, or jacks, return after one winter at sea. A few other males mature sexually in freshwater without migrating to the sea. However, four and five year old fish that have spent two and three years at sea, respectively, dominate the run. Fecundity ranges from 4,200 to 5,900 eggs, depending on the age and size of the female.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, upper Columbia River spring-run ESU.

For all populations, average abundance over the recent 10-year period is below the average abundance thresholds that the Interior Columbia Technical Recovery Team identifies as a minimum for low risk (ICTRT 2008a; ICTRT 2008b; ICTRT 2008c). The geometric mean spawning escapements from 1997 to 2001 were 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population. These numbers represent only 8 percent to 15 percent of the minimum abundance thresholds. The 10-year geometric mean abundance of adult natural-origin spawners has increased for each population relative to the levels reported in the 2011 status review, but natural origin escapements remain below the corresponding Interior Columbia Technical Recovery Team thresholds.

Overall abundance and productivity remains rated at high risk for each of the three extant populations in this MPG/ESU (NWFSC 2015c). The short term lambda estimate for the Wenatchee River is 0.60; the Entiat River is 0.94; and the Methow River is 0.46.

The Interior Columbia Technical Recovery Team characterizes the diversity risk to all upper Columbia River Spring-run Chinook populations as "high." The high risk is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project in 1939-1943.

Spring Chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer Chinook in that area (Peven 1994). The primary spawning areas of spring Chinook in the Wenatchee subbasin include Nason Creek and the Chiwawa, Little Wenatchee, and White rivers. Hamstreet and Carie (2003) described the current spawning distribution for spring Chinook in the Entiat subbasin as the Entiat River (river mile 16.2 to 28.9) and the Mad River (river mile 32 1.5-5.0). Spring Chinook of the Methow population currently spawn in the mainstem Methow River and the Twisp, Chewuch, and Lost drainages (Scribner et al. 1993; Humling and Snow 2004). A few also spawn in Gold, Wolf, and Early Winters creeks.

Status

This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels

observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015c).

Recovery Goals

Recovery goals, objectives and detailed criteria for the Upper Columbia spring-run Chinook are fully outlined in the 2016 Recovery Plan. The general recovery objectives are:

- Increase the abundance of naturally produced spring Chinook spawners within each population in the Upper Columbia ESU to levels considered viable.
- Increase the productivity (spawner:spawner ratios and smolts/redds) of naturally produced spring Chinook within each population to levels that result in low risk of extinction.
- Restore the distribution of naturally produced spring Chinook to previously occupied areas (where practical) and allow natural patterns of genetic and phenotypic diversity to be expressed.

2.4.19 Chinook Salmon: Upper Willamette River ESU

This ESU includes naturally spawned spring-run Chinook salmon originating from the Clackamas River and from the Willamette River and its tributaries above Willamette Falls. Also, spring-run Chinook salmon from six artificial propagation programs (Figure 46).

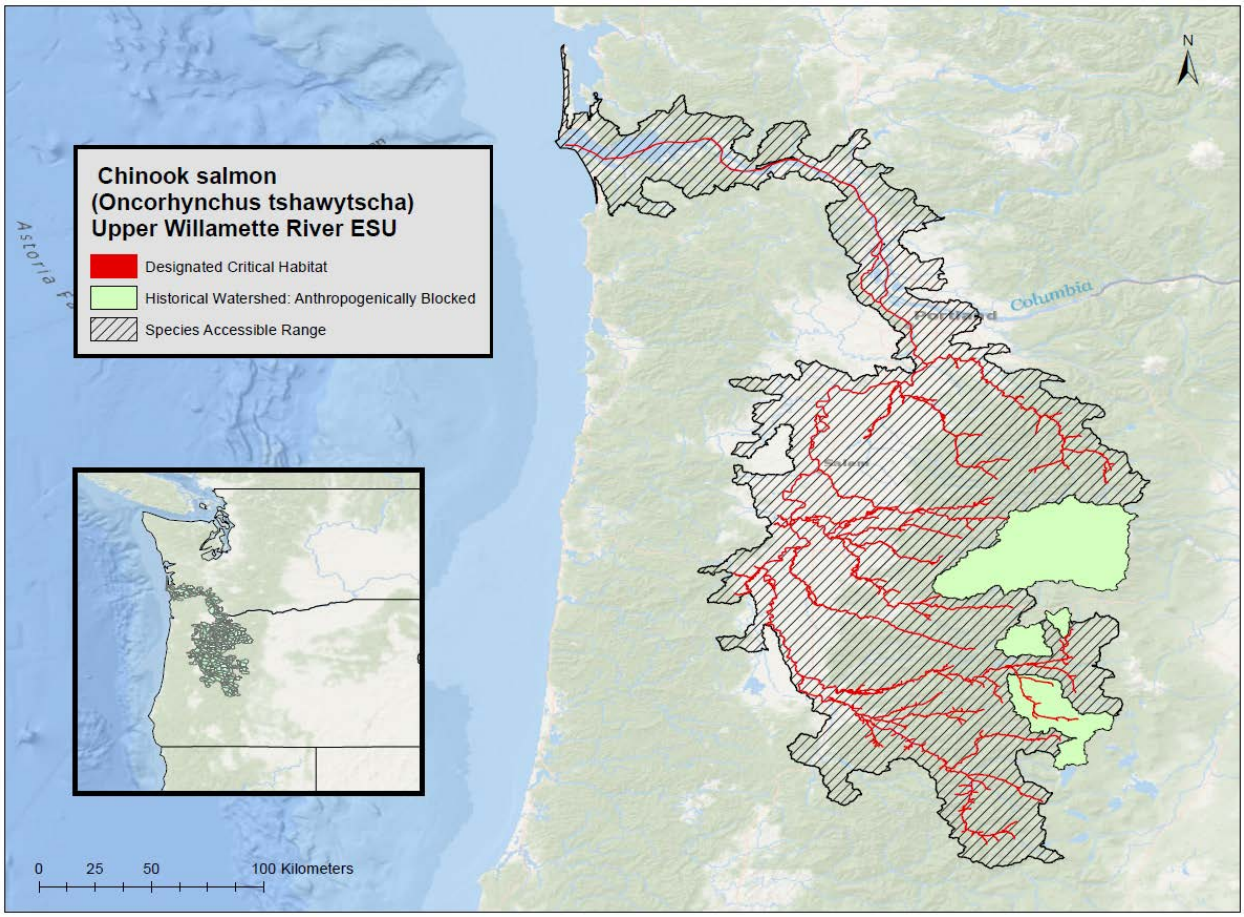


Figure 46. Geographic range and designated critical habitat of Chinook salmon, upper Willamette River ESU.

Upper Willamette River Chinook salmon ESU was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160).

Life history

Upper Willamette River Chinook salmon exhibit an earlier time of entry into the Columbia River than other spring-run Chinook salmon ESUs (Myers et al. 1998b). Adults appear in the lower Willamette River in February, but the majority of the run ascends Willamette Falls in April and May, with a peak in mid- to late May. However, present-day salmon ascend the Willamette Falls via a fish ladder. Consequently, the migration of spring Chinook salmon over Willamette Falls extends into July and August (overlapping with the beginning of the introduced fall-run of Chinook salmon).

The adults hold in deep pools over summer and spawn in late fall or early winter when winter storms augments river flows. Fry may emerge from February to March and sometimes as late as June (Myers et al. 2006). Juvenile migration varies with three distinct juvenile emigration "runs": fry migration in late winter and early spring; sub-yearling (0 yr +) migration in fall to early winter; and yearlings (1 yr +) migrating in late winter to spring. Sub-yearlings and

yearlings rear in the mainstem Willamette River where they also use floodplain wetlands in the lower Willamette River during the winter-spring floodplain inundation period.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Chinook salmon, upper Willamette River ESU.

Abundance levels for five of the seven DIPs in this ESU remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low (although perhaps only marginally better than the zero viable salmonid population score estimated in the Recovery Plan; (ODFW and NFMS 2011). Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The proportion of natural origin spawners improved in the North and South Santiam basins, but was still well below identified recovery goals. Improvement in the status of the Middle Fork Willamette River relates solely to the return of natural adults to Fall Creek, however the capacity of the Fall Creek basin alone is insufficient to achieve the recovery goals for this DIP. The Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat.

Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the viable salmonid population score for the ESU since the last review, so the ESU remains at moderate risk (NWFSC 2015c).

Access of fall-run Chinook salmon to the upper Willamette River and the mixing of hatchery stocks within the ESU have threatened the genetic integrity and diversity of the species. Much of the genetic diversity that existed between populations has been homogenized (Myers et al. 2006).

Radio-tagging results from 2014 suggest that few fish strayed into west-side tributaries (no detections) and relatively fewer fish were unaccounted for between Willamette Falls and the tributaries, 12.9 percent of clipped fish and 5.3 percent of unclipped fish (Jepson et al. 2015). In contrast to most of the other populations in this ESU, McKenzie River Chinook salmon have access to much of their historical spawning habitat, although access to historically high quality habitat above Cougar Dam (South Fork McKenzie River) is still limited by poor downstream juvenile passage. Similarly, natural-origin returns to the Clackamas River have remained flat, despite adults having access to much of their historical spawning habitat.

Status

The Upper Willamette River Chinook ESU is considered to be extremely depressed, likely numbering less than 10,000 fish compared to a historical abundance estimate of 300,000 (Myers et al. 2003). There are seven demographically independent populations of spring-run Chinook salmon in the upper Willamette River Chinook salmon ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette (Myers et al. 2006). The Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Juvenile spring Chinook produced by hatchery programs are released throughout many of the subbasins and adult Chinook returns to the ESU are typically 80-90 percent hatchery origin fish. Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are generally the highest.

Recovery Goals

Recovery goals, objectives and detailed criteria for the Upper Willamette River Chinook are fully outlined in the 2011 Recovery Plan. The 2011 recovery plan outlines five potential scenario options for meeting the viability criteria for recovery. Of the five scenarios, “scenario one” reportedly represented the most balanced approach given limitations in some populations. The approach in this scenario is to recover the McKenzie (core and genetic legacy population) and the Clackamas populations to an extinction risk status of very low risk (beyond minimal viability thresholds), to recover the North Santiam and Middle Fork Willamette populations (core populations) to an extinction risk status of low risk, to recover the South Santiam population to moderate risk, and improve the status of the remaining populations from very high risk to high risk.

2.4.20 Chum Salmon – Columbia River ESU

The Columbia River ESU of chum salmon includes naturally spawned chum salmon originating from the Columbia River and its tributaries in Washington and Oregon (Figure 47), and also chum salmon from two artificial propagation programs.

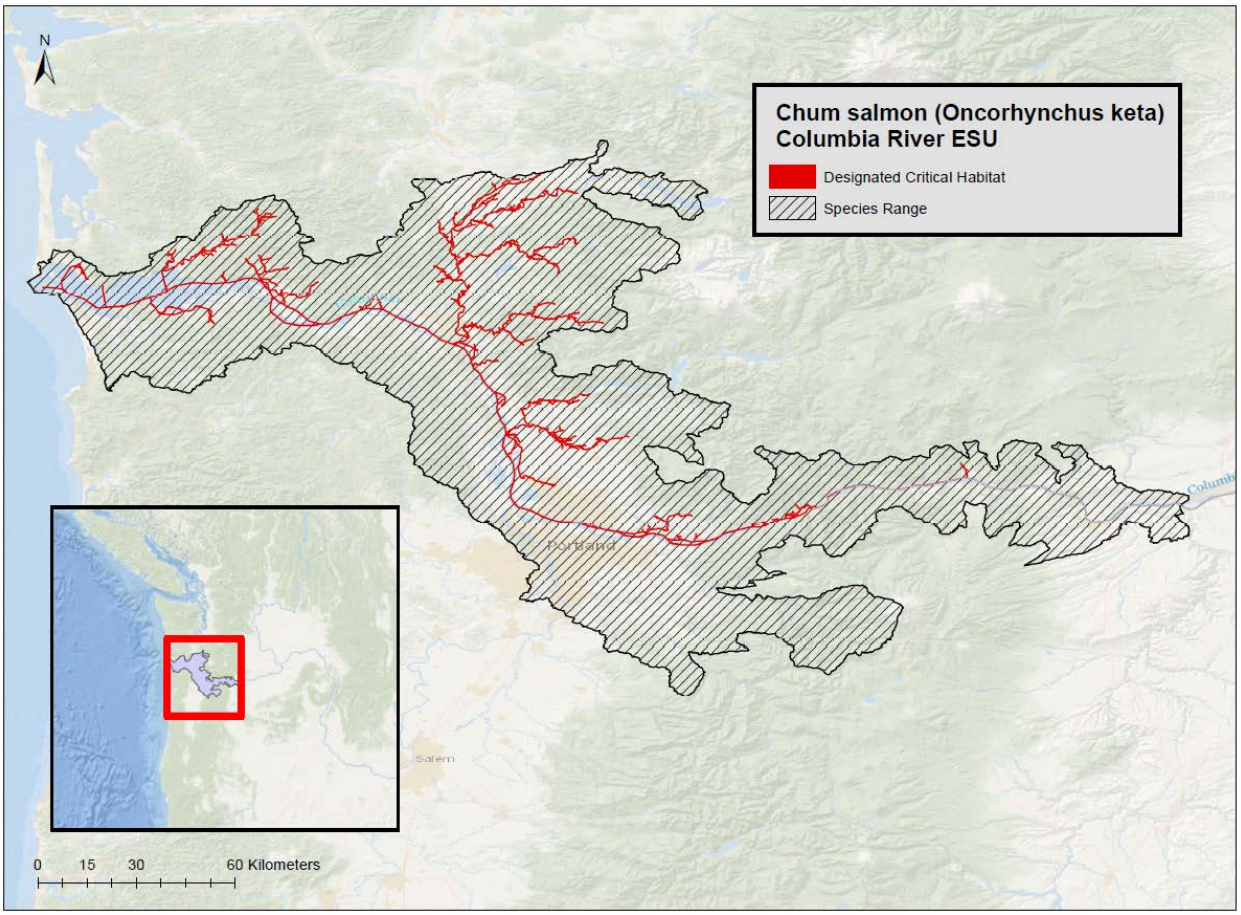


Figure 47. Geographic range and designated critical habitat of chum salmon, Columbia River ESU.

Chum salmon are an anadromous (i.e., adults migrate from marine to freshwater streams and rivers to spawn) and semelparous (i.e., they spawn once and then die) fish species. Adult chum salmon are typically between eight and fifteen pounds, but they can get as large as 45 pounds and 3.6 feet long. Males have enormous canine-like fangs and a striking calico pattern body color (front two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) during spawning (Figure 48). Females are less flamboyantly colored and lack the extreme dentition of the males. Ocean stage chum salmon are metallic greenish-blue along the back with black speckles. Chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

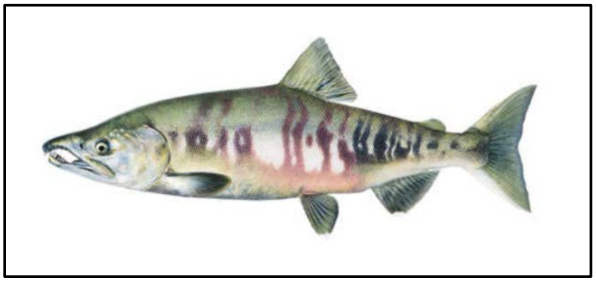


Figure 48. Male coho salmon

Life history

Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 percent of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds ((Salo 1991). The survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude (Johnson et al. 1997b). In general, chum move north and west along the coast upon entering saltwater, and have moved offshore by the end of their first ocean year (Byron and Burke 2014; Quinn 2005).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the chum salmon Columbia River ESU.

Chum populations in the Columbia River historically reached hundreds of thousands to a million adults each year (NMFS 2017b). In the past 50 years, the average has been a few thousand a year. The majority of populations in the Columbia River chum ESU remain at high to very high risk, with very low abundances (NWFSC 2015c). Ford (2011b) concluded that 14 out of 17 of chum populations in this ESU were either extirpated or nearly extirpated.

Only one population (Grays River) is at low risk, with spawner abundances in the thousands, and demonstrating a recent positive trend. Two other populations (Washougal River and Lower Gorge) maintain moderate numbers of spawners and appear to be relatively stable (NWFSC 2015c). The overall trend since 2000 is negative, with the recent peak in abundance (2010-2011) being considerably lower than the previous peak in 2002.

There are currently four hatchery programs in the Lower Columbia River releasing juvenile chum salmon: Grays River Hatchery, Big Creek Hatchery, Lewis River Hatchery, and Washougal Hatchery (NMFS 2017b). Total annual production from these hatcheries has not exceeded 500,000 fish. All of the hatchery programs in this ESU use integrated stocks developed to supplement natural production. Other populations in this ESU persist at very low abundances and the genetic diversity available would be very low (NWFSC 2015c). Diversity has been greatly reduced at the ESU level because of presumed extirpations and low abundance in the

remaining populations (fewer than 100 spawners per year for most populations) (LCFRB 2010a; NMFS 2013b).

The Columbia River chum salmon ESU includes all natural-origin chum salmon in the Columbia River and its tributaries in Washington and Oregon. The ESU consists of three populations: Grays River, Hardy Creek and Hamilton Creek in Washington State. Chum salmon from four artificial propagation programs also contribute to this ESU.

Status

The majority of the populations within the Columbia River chum salmon ESU are at high to very high risk, with very low abundances (NWFSC 2015c). These populations are at risk of extirpation due to demographic stochasticity and Allee effects. One population, Grays River, is at low risk, with spawner abundances in the thousands and demonstrating a recent positive trend. The Washougal River and Lower Gorge populations maintain moderate numbers of spawners and appear to be relatively stable. The life history of chum salmon is such that ocean conditions have a strong influence on the survival of emigrating juveniles. The potential prospect of poor ocean conditions for the near future may put further pressure on the Columbia River chum salmon ESU (NWFSC 2015c). Freshwater habitat conditions may be negatively influencing spawning and early rearing success in some basins, and contributing to the overall low productivity of the ESU. Columbia River chum salmon were historically abundant and subject to substantial harvest until the 1950s (Johnson et al. 1997). There is no directed harvest of this ESU and the incidental harvest rate has been below one percent for the last five years (NWFSC 2015c). Land development, especially in the low gradient reaches that chum salmon prefer, will continue to be a threat to most chum salmon populations due to projected increases in the population of the greater Vancouver-Portland area and the Lower Columbia River overall (Metro 2015). The Columbia River chum salmon ESU remains at a moderate to high risk of extinction (NWFSC 2015c).

Recovery Goals

The ESU recovery strategy for Columbia River chum salmon focuses on improving tributary and estuarine habitat conditions, reducing or mitigating hydropower impacts, and reestablishing chum salmon populations where they may have been extirpated (NMFS 2013b). The goal of the strategy is to increase the abundance, productivity, diversity, and spatial structure of chum salmon populations such that the Coast and Cascade chum salmon strata are restored to a high probability of persistence, and the persistence probability of the two Gorge populations improves. For details on Columbia River chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the NMFS 2013 recovery plan (NMFS 2013b).

2.4.21 Chum Salmon: Hood Canal Summer-Run ESU

The chum salmon, Hood Canal summer-run ESU includes naturally spawned summer-run chum salmon originating from Hood Canal and its tributaries, as well as from Olympic Peninsula rivers between Hood Canal and Dungeness Bay (inclusive; Figure 49) and summer-run chum salmon from four artificial propagation programs.

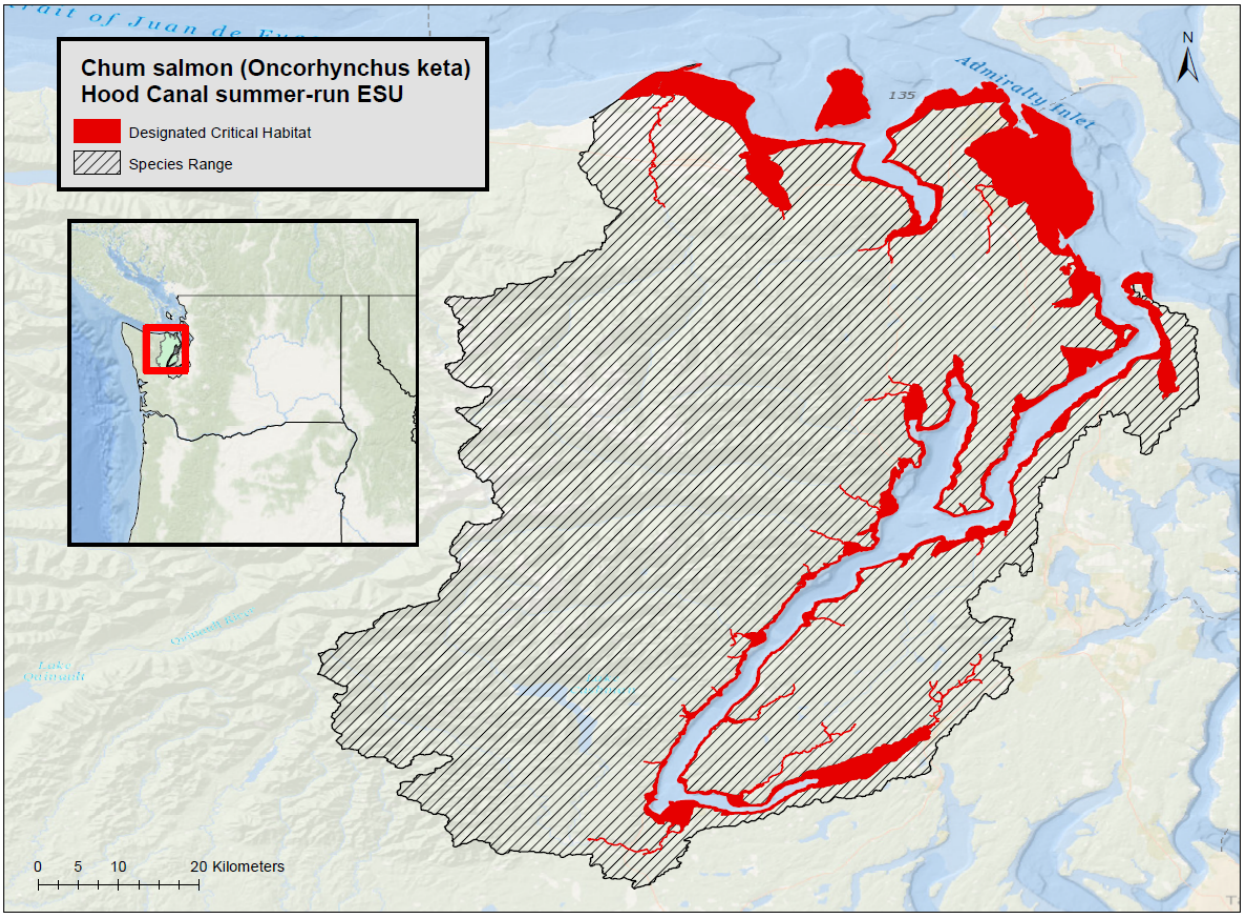


Figure 49. Geographic range and designated critical habitat of chum salmon, Hood Canal ESU.

On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

Life history

Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 percent of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds (Salo 1991). The survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum

salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude (Johnson et al. 1997b). In general, chum move north and west along the coast upon entering saltwater, and have moved offshore by the end of their first ocean year (Byron and Burke 2014; Quinn 2005).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the chum salmon, Hood Canal summer-run ESU.

Of the sixteen populations that comprise the Hood Canal Summer-run chum ESU, seven are considered "functionally extinct" (Skokomish, Finch Creek, Anderson Creek, Dewatto, Tahuya, Big Beef Creek and Chimicum). NMFS examined average escapements (geometric means) for five-year intervals and estimated trends over the intervals for all natural spawners and for natural-origin only spawners. For both populations, abundance was relatively high in the 1970s, lowest for the period 1985-1999, and high again for the most recent 10 years (NWFSC 2015c).

The overall trend in spawning abundance is generally stable for the Hood Canal population (all natural spawners and natural-origin only spawners) and for the Strait of Juan de Fuca population (all natural spawners). Productivity rates, which were quite low during the five-year period from 2005-2009 (Ford 2011b), increased from 2011-2015 and were greater than replacement rates from 2014-2015 for both major population groups (NWFSC 2015c).

There were likely at least two ecological diversity groups within the Strait of Juan de Fuca population and at least four ecological diversity groups within the Hood Canal population. With the possible exception of the Dungeness River aggregation within the Strait of Juan de Fuca population, Hood Canal ESU summer chum spawning groups exist today that represent each of the ecological diversity groups within the two populations (NMFS 2017a). Diversity values (Shannon diversity index) were generally lower in the 1990s for both independent populations within the ESU, indicating that most of the abundance occurred at a few spawning sites (NWFSC 2015c). Although the overall linear trend in diversity appears to be negative, the last five-year interval shows the highest average value for both populations within the Hood Canal ESU.

The Hood Canal summer-run chum salmon ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. The nine populations are well distributed throughout the ESU range except for the eastern side of Hood Canal (Johnson et al. 1997b). Two independent major population groups have been identified for this ESU: (1) spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and (2) spawning aggregations within Hood Canal proper (Sands 2009).

Status

The two most recent status reviews (2011 and 2015) indicate some positive signs for the Hood Canal summer-run chum salmon ESU. Diversity has increased from the low levels seen in the 1990s due to both the reintroduction of spawning aggregates and the more uniform relative

abundance between populations; considered a good sign for viability in terms of spatial structure and diversity (Ford 2011b). Spawning distribution within most streams was also extended further upstream with increased abundance. At present, spatial structure and diversity viability parameters for each population nearly meet the viability criteria (NWFSC 2015c). Spawning abundance has remained relatively high compared to the low levels observed in the early 1990's (Ford 2011b). Natural-origin spawner abundance has shown an increasing trend since 1999, and spawning abundance targets in both populations were met in some years (NWFSC 2015c). Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015c). Overall, the Hood Canal Summer-run chum salmon ESU remains at a moderate risk of extinction.

Recovery Goals

The recovery strategy for Hood Canal Summer-run chum salmon focuses on habitat protection and restoration throughout the geographic range of the ESU, including both freshwater habitat and nearshore marine areas within a one-mile radius of the watersheds' estuaries (NMFS 2007c). The recovery plan includes an ongoing harvest management program to reduce exploitation rates, a hatchery supplementation program, and the reintroduction of naturally spawning summer chum aggregations to several streams where they were historically present. The Hood Canal plan gives first priority to protecting the functioning habitat and major production areas of the ESU's eight extant stocks, keeping in mind the biological and habitat needs of different life-history stages, and second priority to restoration of degraded areas, where recovery of natural processes appears to be feasible (HCCC 2005). For details on Hood Canal Summer-run chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the Hood Canal Coordinating Council 2005 recovery plan (HCCC 2005) and the NMFS 2007 supplement to this recovery plan (NMFS 2007c).

2.4.22 Coho Salmon: Central California Coast ESU

This ESU includes naturally spawned coho salmon originating from rivers south of Punta Gorda, California to and including Aptos Creek, as well as such coho salmon originating from tributaries to San Francisco Bay and coho salmon from three artificial propagation programs (Figure 50).

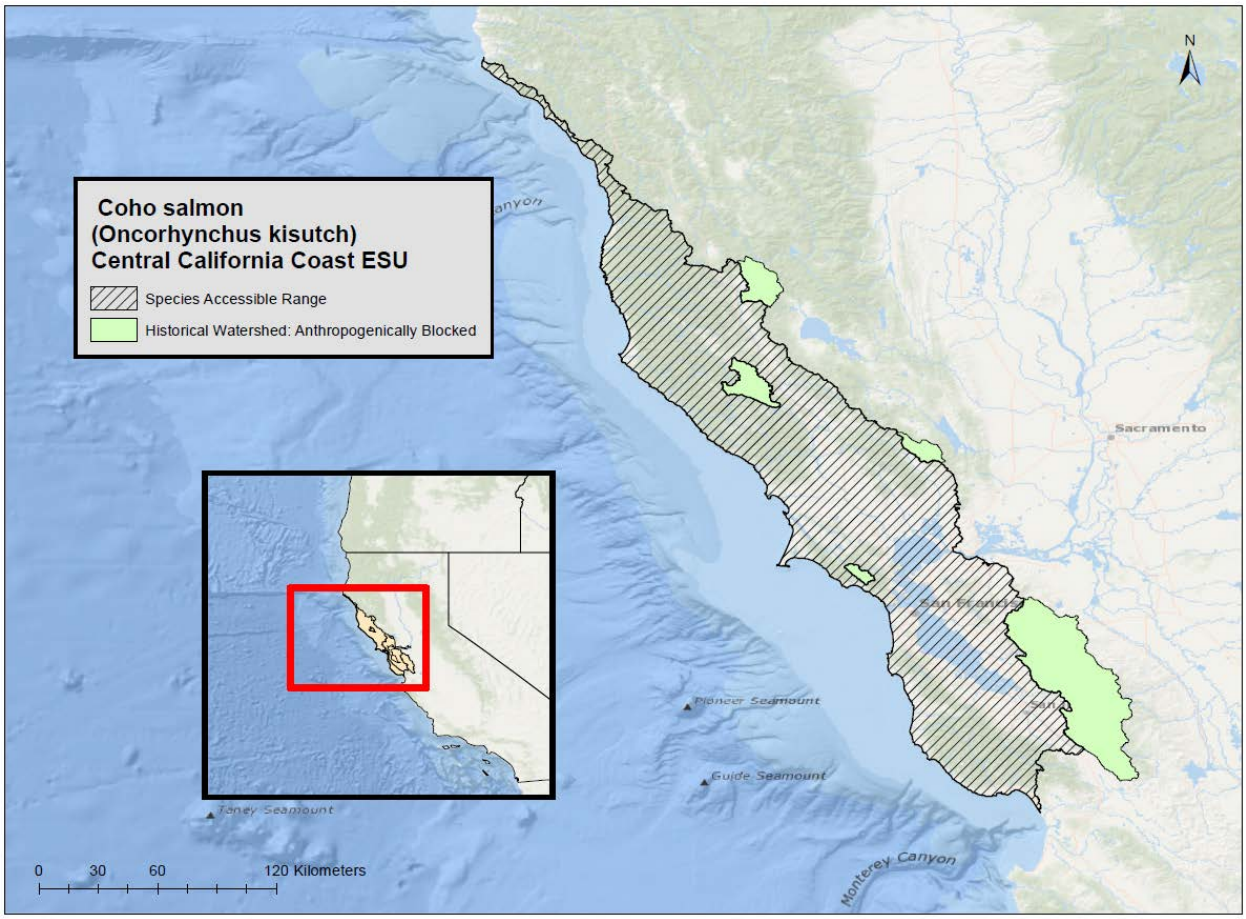


Figure 50. Geographic range of Coho salmon, Central California Coast ESU.



Figure 51. Adult coho salmon.

Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail (Figure 51). Central California coast coho salmon ESU was listed as threatened under the ESA on October 31, 1996 (64 FR 56138). NMFS re-classified the ESU as endangered on June 28, 2005 (70 FR 37160).

Life history

Central California Coast coho salmon typically enter freshwater from November through January, and spawn into February or early March (Moyle 2002a). The upstream migration towards spawning areas coincides with large increases in stream flow (Hassler 1987). Coho salmon often are not able to enter freshwater until heavy rains have caused breaching of sand bars that form at the mouths of many coastal California streams. Spawning occurs in streams

with direct flow to the ocean, or in large river tributaries (Moyle 2002a). Female coho salmon choose a site to spawn at the head of a riffle, just downstream of a pool where water flow changes from slow to turbulent, and where medium to small size gravel is abundant (Moyle 2002a).

Eggs incubate in redds from November through April, and hatch into "alevins" after a period of 35-50 days (Shapovalov and Taft 1954b). The period of incubation is inversely related to water temperature. Alevins remain in the gravel for two to ten weeks then emerge into the water column as young juveniles, known as "fry". Juveniles, or fry, form schools in shallow water along the undercut banks of the stream to avoid predation. The juveniles feed heavily during this time, and as they grow they set up individual territories. Juveniles are voracious feeders, ingesting any organism that moves or drifts over their holding area. The juvenile's diet is mainly aquatic insect larvae and terrestrial insects, but small fish are taken when available (Moyle 2002a).

After one year in freshwater juvenile coho salmon undergo physiological transformation into "smolts" for outmigration to the ocean. Smolts may spend time residing in the estuarine habitat prior to ocean entry, to allow for the transition to the saline environment. After entering the ocean, the immature salmon initially remain in the nearshore waters close to their natal stream. They gradually move northward, generally staying over the continental shelf (Brown et al. 1994). After approximately two years at sea, adult coho salmon move slowly homeward. Adults begin their freshwater migration upstream after heavy fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991) and/or flows are sufficient to reach upstream spawning areas.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to coho salmon, Central California coast ESU.

Limited information exists on abundance of coho salmon within the Central California coast coho salmon ESU. About 200,000 to 500,000 coho salmon were produced statewide in the 1940s (Good et al. 2005b). This escapement declined to about 99,000 by the 1960s with approximately 56,000 (56 percent) originating from streams within the Central California coast coho salmon ESU. The estimated number of coho salmon produced within the ESU in 2011 was between 2,000 and 3,000 wild adults (Gallagher et al. 2010).

Within the Lost Coast – Navarro Point stratum and the Navarro Point – Gualala Point stratum, most independent populations show positive but non-significant population trends. Dependent populations within these stratum have declined significantly since 2011. In the Russian River and Lagunitas Creek watersheds, which are the two largest within the Central Coast strata, recent coho salmon population trends suggest limited improvement, although both populations remain well below recovery targets. Recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins.

Genetic studies show little homogenization of populations, *i.e.*, transfer of stocks between basins have had little effect on the geographic genetic structure of central California coast coho salmon (Sonoma County Water Agency (SCWA) 2002). This ESU likely has considerable diversity in local adaptations given that the ESU spans a large latitudinal diversity in geology and ecoregions, and include both coastal and inland river basins.

The TRT identified 11 "functionally independent", one "potentially independent" and 64 "dependent" populations in the Central California coast coho salmon ESU (Bjorkstedt et al., 2005 with modifications described in Spence et al. 2008). The 75 populations were grouped into five Diversity Strata. The Russian River is of particular importance for preventing the extinction and contributing to the recovery of Central California coast coho salmon (NOAA 2013). The Russian River population, once the largest and most dominant source population in the ESU, is now at high risk of extinction because of low abundance and failed productivity (Spence, Bjorkstedt et al. 2008). The Lost Coast and Navarro Point contain the majority of coho salmon remaining in the ESU.

Status

The low survival of juveniles in freshwater, in combination with poor ocean conditions, has led to the precipitous declines of central California coast coho salmon populations. Most independent populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery.

Recovery Goals

See the 2012 Recovery Plan for complete down listing/delisting criteria for each of the following recovery goals (NMFS 2012b):

1. Prevent extinction by protecting existing populations and their habitats;
2. Maintain current distribution of coho salmon and restore their distribution to previously occupied a`reas essential to their recovery;
3. Increase abundance of coho salmon to viable population levels, including the expression of all life history forms and strategies;
4. Conserve existing genetic diversity and provide opportunities for interchange of genetic material between and within meta populations;
5. Maintain and restore suitable freshwater and estuarine habitat conditions and characteristics for all life history stages so viable populations can be sustained naturally;
6. Ensure all factors that led to the listing of the species have been ameliorated; and
7. Develop and maintain a program of monitoring, research, and evaluation that advances understanding of the complex array of factors associated with coho salmon survival and recovery and which allows for adaptively managing our approach to recovery over time.

2.4.23 Coho Salmon: Lower Columbia River ESU

This ESU includes naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Also, coho salmon from 21 artificial propagation programs (Figure 52).

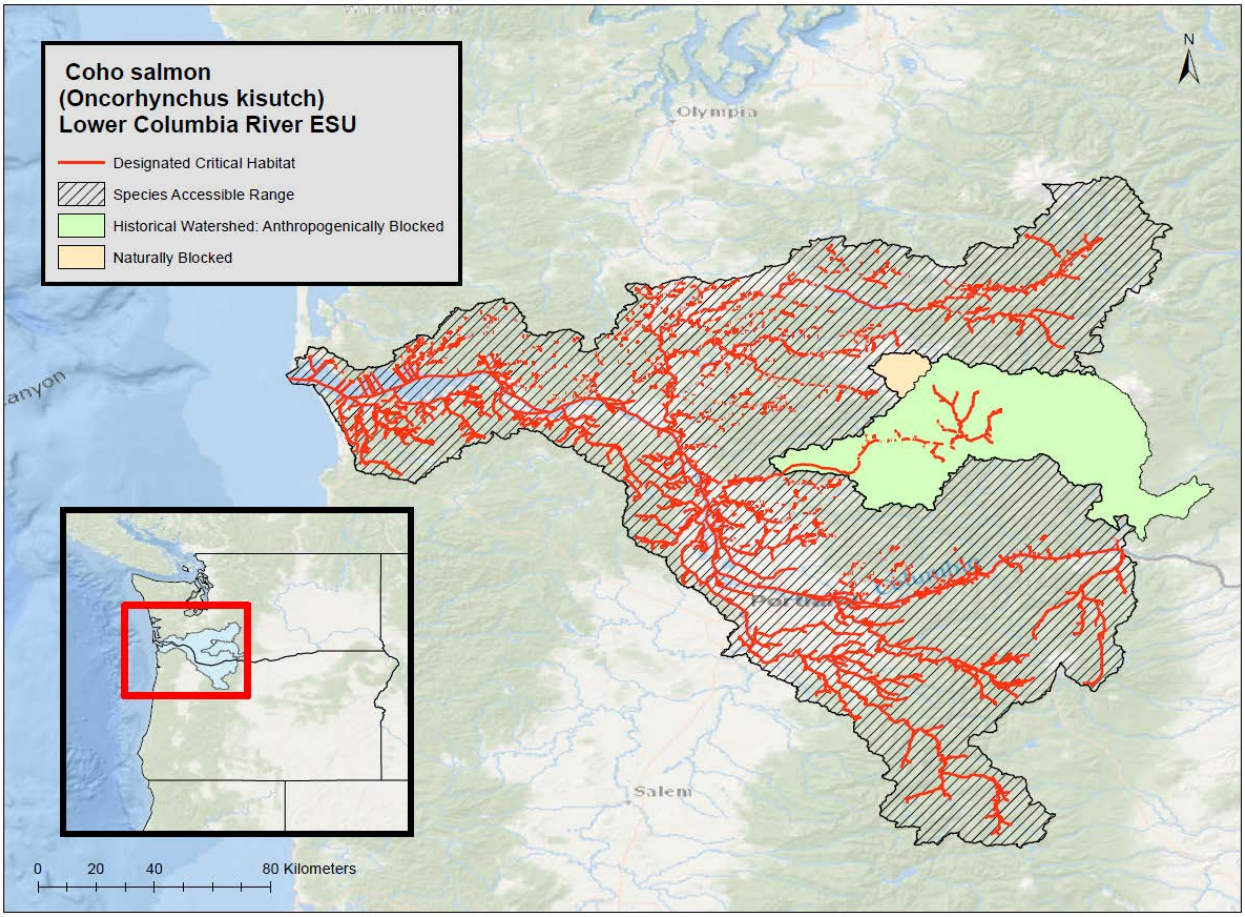


Figure 52. Geographic range and designated critical habitat of Coho salmon, Lower Columbia River ESU.

Lower Columbia River coho salmon ESU was listed as threatened under the ESA on June 28, 2005 .

Life history

Lower Columbia River coho salmon are typically categorized into early- and late-returning stocks. Early-returning (Type S) adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November. Late-returning (Type N) coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January. Most spawning occurs from November to January, but some occurs as late as March (LCFRB 2010b).

Coho salmon typically spawn in small to medium, low- to-moderate elevation streams from valley bottoms to stream headwaters. Coho salmon construct redds in gravel and small cobble substrate in pool tailouts, riffles, and glides, with sufficient flow depth for spawning activity (NMFS 2013d). Eggs incubate over late fall and winter for about 45 to 140 days, depending on water temperature, with longer incubation in colder water. Fry may thus emerge from early spring to early summer (ODFW 2010). Juveniles typically rear in freshwater for more than a year. After emergence, coho salmon fry move to shallow, low-velocity rearing areas, primarily along the stream edges and inside channels. Juvenile coho salmon favor pool habitat and often congregate in quiet backwaters, side channels, and small creeks with riparian cover and woody debris. Side-channel rearing areas are particularly critical for overwinter survival, which is a key regulator of freshwater productivity (LCFRB 2010b).

Most juvenile coho salmon migrate seaward as smolts in April to June, typically during their second year. Salmon that have stream-type life histories, such as coho, typically do not linger for extended periods in the Columbia River estuary, but the estuary is a critical habitat used for feeding during the physiological adjustment to salt water. Juvenile coho salmon are present in the Columbia River estuary from March to August. Columbia River coho salmon typically range throughout the nearshore ocean over the continental shelf off of the Oregon and Washington coasts. Early-returning (Type S) coho salmon are typically found in ocean waters south of the Columbia River mouth. Late-returning (Type N) coho salmon are typically found in ocean waters north of the Columbia River mouth. Most coho salmon sexually mature at age three, except for a small percentage of males (called “jacks”) who return to natal waters at age two, after only 5 to 7 months in the ocean (LCFRB 2010b).

Population dynamics

The following is a discussion of the species’ population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to coho salmon, lower Columbia River ESU.

Washington tributaries indicate the presence of moderate numbers of coho salmon, with total abundances in the hundreds to low thousands of fish. Oregon tributaries have abundances in the hundreds of fish. In the Western Cascade MPG, the Sandy and Clackamas Rivers were the only two populations identified in the original 1996 Status Review that appeared to be self-sustaining natural populations. Natural origin abundances in the Columbia Gorge MPG are low, with hatchery-origin fish contributing a large proportion of the total number of spawners, most notably in the Hood River.

Both the long- and short-term trend, and lambda for the natural origin (late-run) portion of the Clackamas River coho salmon are negative but with large confidence intervals (Good et al. 2005b). The short-term trend for the Sandy River population is close to 1, indicating a relatively stable population during the years 1990 to 2002 (Good et al. 2005b). The long-term trend (1977 to 2002) for this same population shows that the population has been decreasing (trend=0.54); there is a 43 percent probability that the median population growth rate (lambda) was less than one. Long-term abundances in the Coast Range Cascade MPG were generally stable. Scappoose

Creek is exhibiting a positive abundance trend. Clatskanie River coho salmon population maintains moderate numbers of naturally produced spawners.

The spatial structure of some populations is constrained by migration barriers (such as tributary dams) and development in lowland areas. Low abundance, past stock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among coho salmon populations (LCFRB 2010a, ODFW 2010). It is likely that hatchery effects have also decreased population productivity.

This ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon, as well as multiple artificial propagation programs. Most of the populations in the ESU contain a substantial number of hatchery-origin spawners. Myers et al (Myers et al. 2006) identified three MPGs (Coastal, Cascade, and Gorge), containing a total of 24 DIPs in the Lower Columbia River coho salmon ESU (NWFSC 2015c).

Status

Based on the most recent status review (NWFSC 2015c), a few populations with longer term data sets available show stable or slightly positive abundance trends in the last few years. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners. Improvements in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of lower Columbia River coho populations, abundances are still at low levels and the majority of populations remain at moderate or high risk. Land development and increasing human population in this region will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013-2014 and 2014-2015 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years. The 2015 status review concluded that the lower Columbia River coho salmon ESU is still at moderate risk of extinction (NWFSC 2015c).

Recovery Goals

This species is included in the Lower Columbia River recovery plan (NMFS 2013c). Specific recovery goals are to improve all four viability parameters to the point that the Coast, Cascade, and Gorge strata achieve high probability of persistence. Protection of existing high functioning habitat and restoration of tributary habitat are noted needs, along with reduction of hatchery and harvest impacts. Large improvements are needed in the persistence probability of most populations of this ESU.

2.4.24 Coho Salmon: Oregon Coast ESU

This ESU includes naturally spawned coho salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from one artificial propagation program: Cow Creek Hatchery Program (Figure 53).

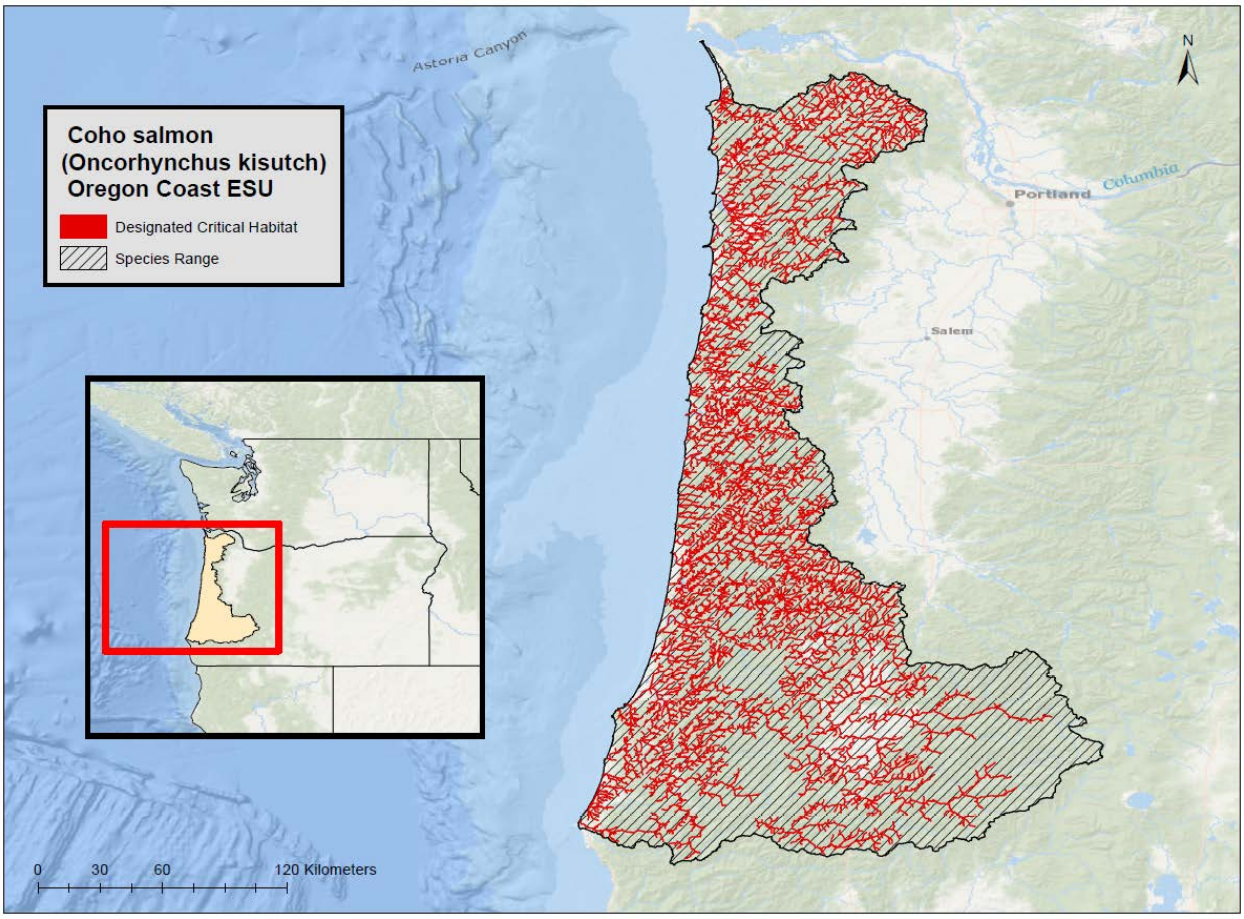


Figure 53. Geographic range and designated critical habitat of coho salmon, Oregon coast ESU.

Oregon coast coho salmon ESU was listed as threatened under the ESA on August 10, 1998 (63 FR 42587). The listing was revisited and confirmed as threatened on June 20, 2011 (76 FR 35755).

Life history

The anadromous life cycle of coho salmon begins in their home stream where they emerge from eggs as 'alevins' (a larval life stage dependent on food stored in a yolk sac). These very small fish require cool, slow moving freshwater streams with quiet areas such as backwater pools, beaver ponds, and side channels (Reeves et al. 1989) to survive and grow through summer and winter seasons. Current production of coho salmon smolts in the Oregon Coast coho salmon ESU is particularly limited by the availability of complex stream habitat that provides the shelter for overwintering juveniles during periods when flows are high, water temperatures are low, and food availability is limited (ODFW 2007).

The Oregon Coast coho salmon follow a yearling-type life history strategy, with most juvenile coho salmon migrating to the ocean as smolts in the spring, typically from as late as March into June . Coho salmon smolts outmigrating from freshwater reaches may feed and grow in lower mainstem and estuarine habitats for a period of days or weeks before entering the nearshore ocean environment. The areas can serve as acclimation areas, allowing coho salmon juveniles to adapt to saltwater. Research shows that substantial numbers of coho fry may also emigrate downstream from natal streams into tidally influenced lower river wetlands and estuarine habitat (Bass 2010; Chapman 1962; Koski 2009).

Oregon Coast coho salmon tend to make relatively short ocean migrations. Coho from this ESU are present in the ocean from northern California to southern British Columbia, and even fish from a given population can be widely dispersed in the coastal ocean, but the bulk of the ocean harvest of coho salmon from this ESU are found off the Oregon coast. The majority of coho salmon adults return to spawn as 3–year-old fish, having spent about 18 months in freshwater and 18 months in salt water (Sandercock 1991). The primary exceptions to this pattern are ‘‘jacks,’’ sexually mature males that return to freshwater to spawn after only 5 to 7 months in the ocean.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to coho salmon, Oregon Coast ESU.

Results from the most recent Northwest Fisheries Science Center review show that while Oregon Coast coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years (NWFSC 2015c).

Most independent populations in the ESU showed an overall increasing trend in abundance with synchronously high abundances in 2002-2003, 2009-2011, and 2014, and low abundances in 2007, 2009, and 2015. This synchrony suggests the overriding importance of marine survival to recruitment and escapement of Oregon Coast coho salmon (NWFSC 2015c). When future conditions are taken into account, the OC coho salmon ESU, as a whole, is at moderate risk of extinction, but the recent risk trend is stable and improving (Stout et al. 2012, NWFSC 2015).

While the 2008 biological review team status review concluded that there was low certainty that ESU-level genetic diversity was sufficient for long-term sustainability in the ESU (Wainwright et al. 2008), the recent Northwest Fisheries Science Center review suggests this is an unlikely outcome. The observed upward trends in abundance and productivity and downward trends in hatchery influence make decreases in genetic or life history diversity or loss of dependent populations in recent years unlikely (NWFSC 2015c).

The geographic setting for the Oregon Coast coho salmon ESU includes the Pacific Ocean and the freshwater habitat (rivers, streams, and lakes) along the Oregon Coast from the Necanicum River near Seaside on the north to the Sixes River near Port Orford on the south. The Oregon/Northern California Coasts Technical Recovery Team identified 56 historical

populations that function collectively to form the Oregon Coast coho salmon ESU. The team classified 21 of the populations as independent because they occur in basins with sufficient historical habitat to have persisted through several hundred years of normal variations in marine and freshwater conditions (NMFS 2016i).

Status

Findings by the Northwest Fisheries Science Center (NWFSC 2015c) and ODFW (2016) show many positive improvements to Oregon Coast coho salmon in recent years, including positive long-term abundance trends and escapement. Results from the Northwest Fisheries Science Center recent review show that while Oregon Coast coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years. Overall, the Northwest Fisheries Science Center found that increases in Oregon Coast coho salmon ESU scores for persistence and sustainability clearly indicate that the biological status of the ESU is improving, due in large part to management decisions (reduced harvest and hatchery releases) (NWFSC 2015c). It determined, however, that Oregon Coast coho salmon abundance remains strongly correlated with marine survival rates.

Recovery Goals

See the 2016 Recovery Plan for detailed descriptions of the recovery goals and delisting criteria (NMFS 2016i). In the simplest terms, NMFS will remove the Oregon Coast coho salmon from federal protection under the ESA when we determine that:

- The species has achieved a biological status consistent with recovery—the best available information indicates it has sufficient abundance, population growth rate, population spatial structure, and diversity to indicate it has met the biological recovery goals.
- Factors that led to ESA listing have been reduced or eliminated to the point where federal protection under the ESA is no longer needed, and there is reasonable certainty that the relevant regulatory mechanisms are adequate to protect Oregon Coast coho salmon sustainability.

2.4.25 Coho Salmon: Southern Oregon and Northern California Coasts ESU

This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California. Also, coho salmon from three artificial propagation programs are included in this ESU (Figure 54).

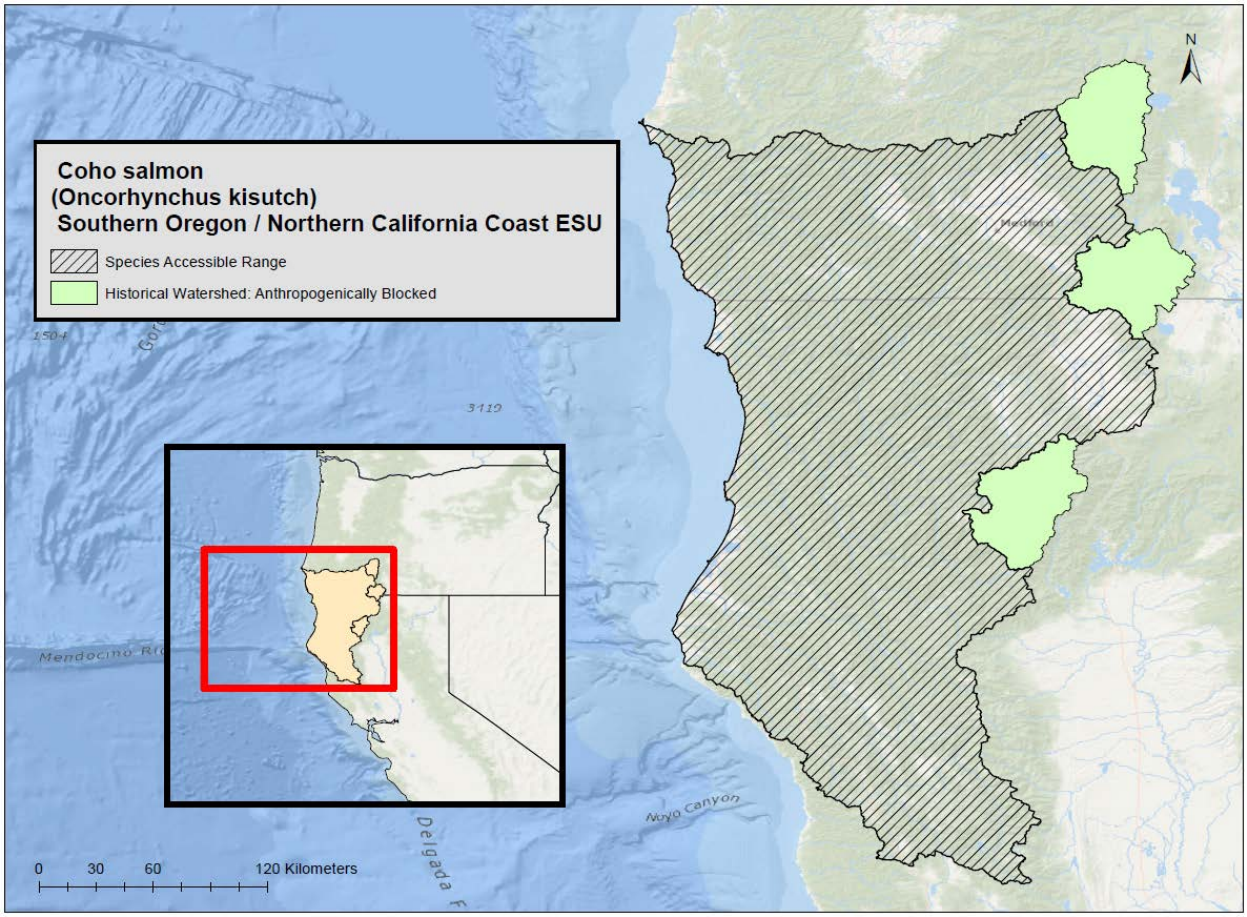


Figure 54. Geographic range of coho salmon, Southern Oregon/Northern California ESU.

Southern Oregon / Northern California Coast coho salmon ESU was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). The listing was revisited and confirmed as threatened on June 28, 2005 .

Life history

Coho salmon is an anadromous fish species that generally exhibits a relatively simple 3-year life cycle. Adults typically begin their freshwater spawning migration in the late summer and fall, spawn by mid-winter, and then die. The run and spawning times vary between and within populations. Depending on river temperatures, eggs incubate in ‘‘redds’’ (gravel nests excavated by spawning females) for 1.5 to 4 months before hatching as ‘‘alevins’’ (a larval life stage dependent on food stored in a yolk sac). Once most of the yolk sac is absorbed, the 30 to 35 millimeter fish (then termed “fry”) begin emerging from the gravel in search of shallow stream margins for foraging and safety (Council 2004). Coho salmon fry typically transition to the juvenile stage by about mid-June when they are about 50 to 60 mm, and both stages are collectively referred to as “young-of-the-year.” Juveniles develop vertical dark bands or “parr marks”, and begin partitioning available instream habitat through aggressive agonistic interactions with other juvenile fish (Quinn 2005). Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as ‘‘smolts’’ in the spring. Coho salmon typically spend 2

growing seasons in the ocean before returning to their natal stream to spawn as 3 year-olds. Some precocious males, called ‘‘jacks,’’ return to spawn after only 6 months at sea (NMFS 2014d).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to coho salmon, Southern Oregon/Northern California coasts ESU.

Although long-term data on abundance of Southern Oregon / Northern California Coast coho salmon are scarce, the best available data indicate that none of the seven diversity strata appear to support a single viable population, although all diversity strata are occupied (NMFS 2014d). Further, 24 out of 31 independent populations are at high risk of extinction and 6 are at moderate risk of extinction.

The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the Southern Oregon / Northern California Coast coho salmon ESU is at high risk of extinction and is not viable (Williams et al. 2011). Estimates from the Rogue River with its four independent populations indicate a small but significant positive trend ($p = 0.01$) over the past 35 years and a non-significant negative trend ($p > 0.05$) over the past 12 years or four generations (NMFS 2016). The decline in abundance from historical levels and the poor status of population viability criteria are the main factors behind the extinction risk of the ESU.

The primary factors affecting the genetic and life-history diversity of Southern Oregon / Northern California Coast coho salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. The ESU's current genetic variability and variation in life-history likely contribute significantly to long-term risk of extinction. Given the recent trends in abundance across the ESU, the genetic and life-history diversity of populations is likely very low and is inadequate to contribute to a viable ESU (NMFS 2014d).

Williams *et al.* (2006) designated 45 populations of coho salmon in the Southern Oregon / Northern California Coast coho salmon ESU as dependent or independent based on their historical population size. Two populations are both small enough and isolated enough that they are only intermittently present (McElhany et al. 2000b; NMFS 2014c; Williams et al. 2006). These populations were further grouped into seven diversity strata based on the geographical arrangement of the populations and basin-scale genetic, environmental, and ecological characteristics.

Status

Though population-level estimates of abundance for most independent populations are lacking, the best available data indicate that none of the seven diversity strata appears to support a single viable population as defined by the Southern Oregon / Northern California Coast coho salmon technical recovery team's viability criteria (low extinction risk; Williams et al. (2008b)). Further, 24 out of 31 independent populations are at high risk of extinction and 6 are at moderate risk of

extinction. Based on the above discussion of the population viability parameters, and qualitative viability criteria presented in Williams et al. (2008b), NMFS concludes that the Southern Oregon / Northern California Coast coho salmon ESU is currently not viable and is at high risk of extinction. The primary causes of the decline are likely long-standing human-caused conditions (e.g., harvest and habitat degradation), which exacerbated the impacts of adverse environmental conditions (e.g., drought and poor ocean conditions) (60 FR 38011; July 25, 1995).

Recovery Goals

A recovery plan is available for this species (NMFS 2014c). In 2016, we completed a 5-year review for this ESU in which we concluded that the ESU should remain listed as threatened; in the last 5 years there has not been improvement in the status of Southern Oregon / Northern California Coast coho salmon or a significant change in risk to persistence of the ESU (NMFS 2016).

2.4.26 Sockeye Salmon: Ozette Lake ESU

This ESU includes naturally spawned sockeye salmon originating from the Ozette River and Ozette Lake and its tributaries. Also, sockeye salmon from two artificial propagation programs are included in this ESU (Figure 55).

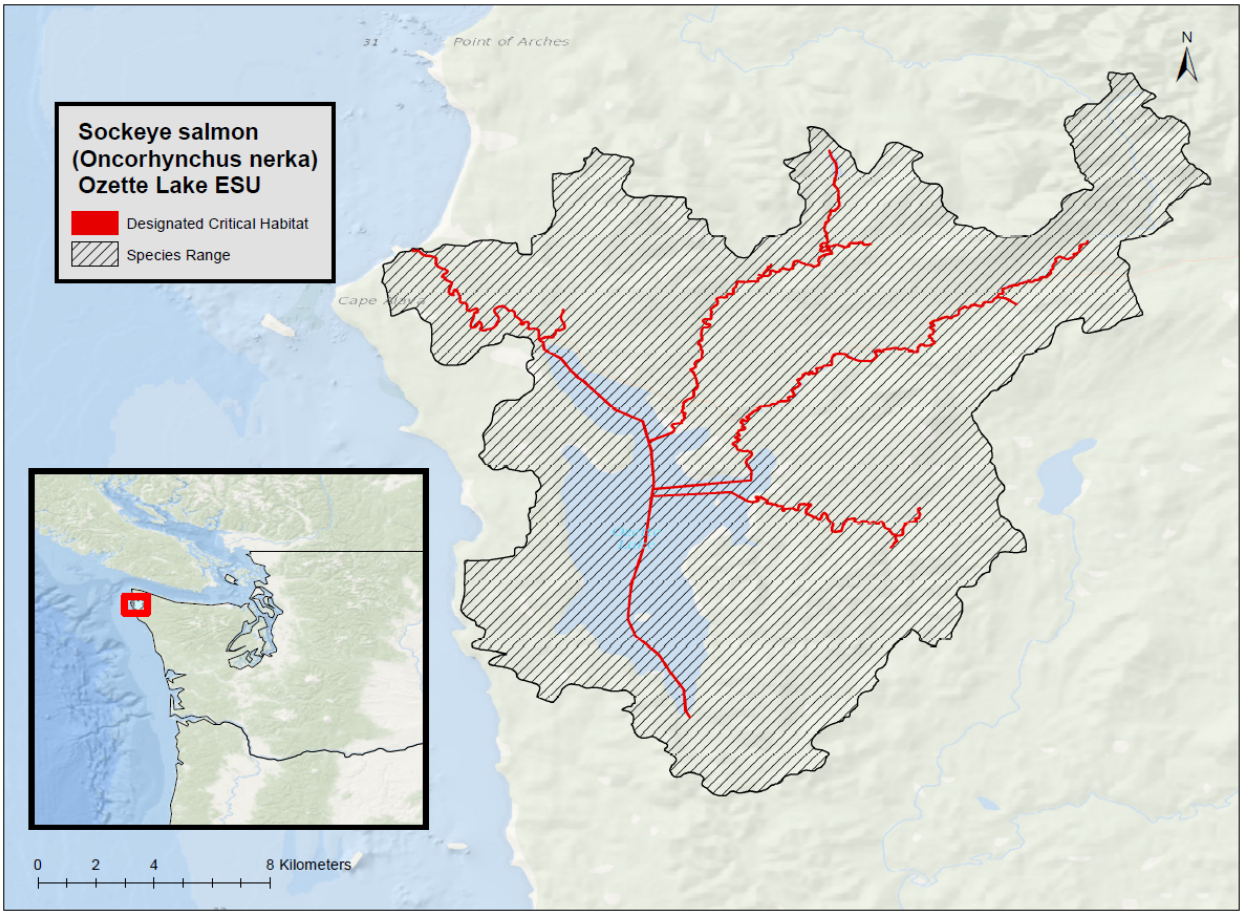


Figure 55. Geographic range and designated critical habitat of Sockeye salmon, Lake Ozette ESU.

The sockeye salmon is an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn), although some sockeye spend their entire lives (about five years) in freshwater. Adult sockeye salmon are about three feet long and eight pounds. Sockeyes are bluish black with silver sides when they are in the ocean, and they turn bright red with a green head when they are spawning (Figure 56). On March 25, 1999, NMFS listed the Ozette Lake sockeye salmon ESU as threatened (64 FR 14528) and reaffirmed the ESU's status as threatened on June 28, 2005.

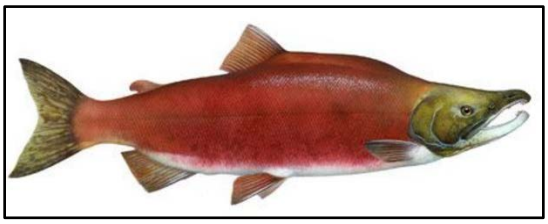


Figure 56. Adult sockeye salmon (spawning).

Life history

Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along "beaches" where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water

temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to sockeye salmon, Lake Ozette ESU.

The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum 1988). The most recent (1996-2006) escapement estimates (run size minus broodstock take) range from a low of 1,404 in 1997 to a high of 6,461 in 2004, with a median of approximately 3,800 sockeye per year (geometric mean: 3,353) (Rawson et al. 2009a).

Productivity has fluctuated up and down over the last few decades, but overall appears to have remained stable (NWFSC 2015c). Given the degree of uncertainty in the abundance estimates, any interpretation of trends of small magnitude or over short time periods is speculative. (NWFSC 2015c).

For the Ozette Lake sockeye salmon ESU, the proportion of beach spawners is likely low; therefore, hatchery-originated fish are not likely to affect greatly the genetics of the naturally-spawned population. However, Ozette Lake sockeye have a relatively low genetic diversity compared to other sockeye salmon populations examined in Washington State (Crewson et al. 2001). Genetic differences do occur among age cohorts. However, because different age groups do not reproduce together, the population may be more vulnerable to significant reductions in population structure due to catastrophic events or unfavorable conditions affecting a single year class.

The Ozette Lake sockeye salmon ESU is composed of one historical population (Currens et al. 2009) with multiple spawning aggregations and two populations from the Umbrella Creek and

Big River sockeye hatchery programs. Historically, at least four lake beaches were used for spawning; today only two beach spawning locations, Allen's and Olsen's Beaches, are used. Additionally, spawning occurs in the two tributaries of the hatchery programs (NWFSC 2015c). The Umbrella creek population is a large component of the total population (averaging over 50 percent for the last decade of data).

Status

NMFS listed the Ozette Lake sockeye salmon ESU because of habitat loss and degradation from the combined effects of logging, road building, predation, invasive plant species, and overharvest. Ozette Lake sockeye salmon have not been commercially harvested since 1982 and only minimally harvested by the Makah Tribe since 1982 (0 to 84 fish per year); there is no known marine fishing of this ESU. Overall abundance is substantially below historical levels, and whether the decrease in abundance is a result of fewer spawning aggregations, lower abundances in each aggregation, or a combination of both factors is unknown. Regardless, this ESU's viability has not improved, and the ESU would likely have a low resilience to additional perturbations. However, recovery potential for the Ozette Lake sockeye salmon ESU is good, particularly because of protections afforded it based on the lake's location within a national park (NMFS 2009; NMFS 2016).

Recovery Goals

We adopted a recovery plan for Lake Ozette sockeye salmon (NMFS 2009c) in May 2009. The criteria of the recovery plan were based upon Rawson *et al.,* (2009b). Recovery criteria include:

- Multiple, spatially distinct and persistent spawning aggregations throughout the historical range of the population (*i.e.,* along the lake beaches and in one or more tributaries).
- One or more persistent spawning aggregations from each major genetic and life history group historically present. Also, genetic distinctness between anadromous sockeye, and kokanee salmon in the lake.
- Abundance between 31,250 and 121,000 adult spawners, over a number of years.

2.4.27 Sockeye Salmon: Snake River ESU

This ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River basin, and also sockeye salmon from one artificial propagation program: Redfish Lake Captive Broodstock Program.

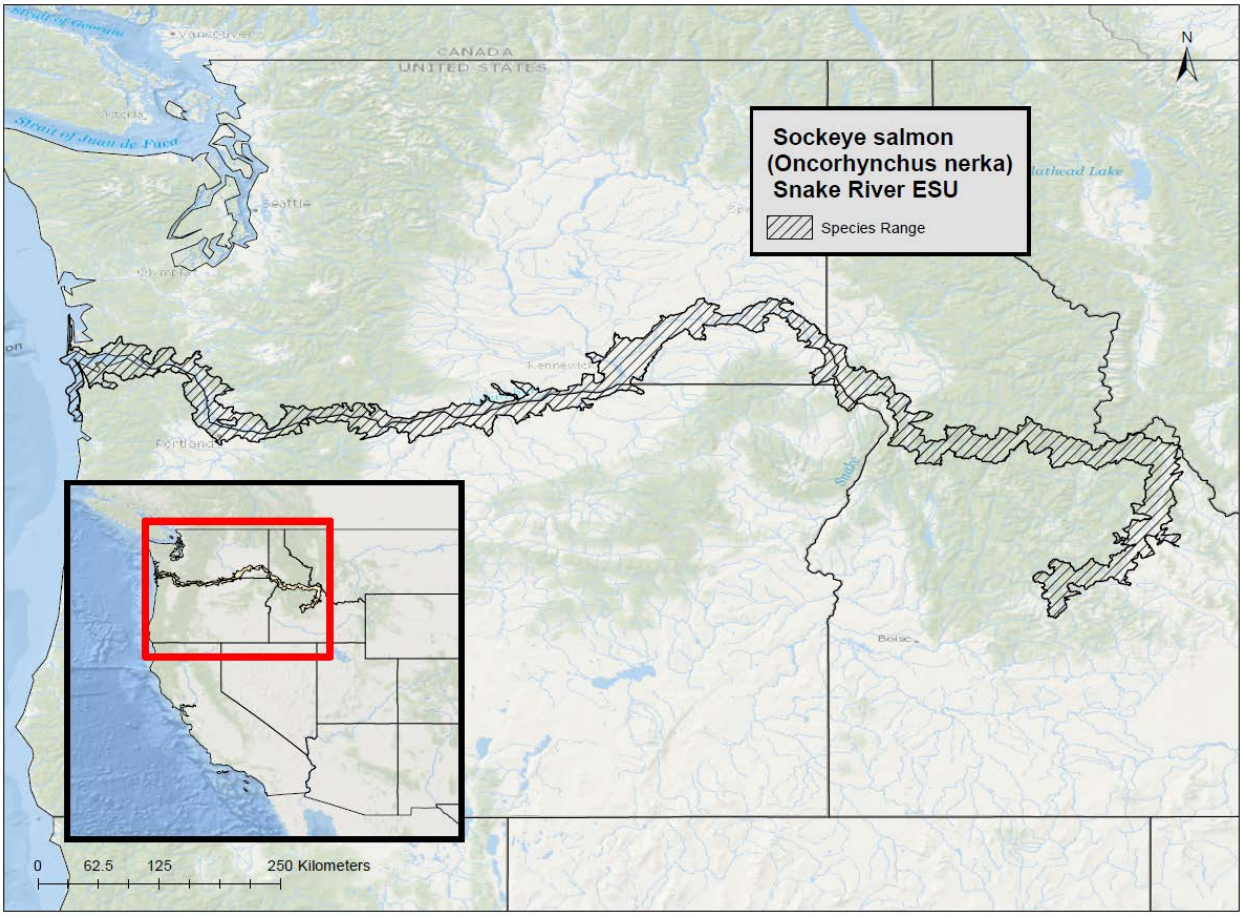


Figure 57. Geographic range of Sockeye salmon, Snake River ESU.

On November 20, 1991 NMFS listed the Ozette Lake sockeye salmon ESU as endangered and reaffirmed the ESU's status as endangered on June 28, 2005 .

Life history

Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along "beaches" where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile

sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to sockeye salmon, Snake River ESU.

Adult returns in the last six years have ranged from a high of 1,579 fish in 2014 (including 453 natural-origin fish) to a low of 257 adults in 2012 (including 52 natural-origin fish). Sockeye salmon returns to Alturas Lake ranged from one fish in 2002 to 14 fish in 2010. No fish returned to Alturas Lake in 2012, 2013, or 2014 (NWFSC 2015c).

The large increases in returning adults in recent years reflect improved downstream and ocean survival as well as increases in juvenile production since the early 1990s. Although total sockeye salmon returns to the Sawtooth Valley in recent years have been high enough to allow for some level of natural spawning in Redfish Lake, the hatchery program remains at its initial phase with a priority on genetic conservation and building sufficient returns to support sustained outplanting and recolonization of the species historic range (NWFSC 2015c).

For the Snake River ESU, the Sawtooth Hatchery is focusing on genetic conservation (NMFS 2016b). An overrepresentation of genes from the anadromous population in Redfish Lake exists, but inbreeding is low, which is a sign of a successful captive broodstock program (Kalinowski et al. 2012).

This species includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, and artificially-propagated sockeye salmon from the Redfish Lake Captive Broodstock Program ((USDC 2014)USDC 2014). The Interior Columbia Technical Recovery Team treats Sawtooth Valley Sockeye salmon as the single MPG within the Snake River Sockeye Salmon ESU. The MPG contains one extant population (Redfish Lake) and two to four historical populations (Alturas, Petit, Stanley, and Yellowbelly Lakes) (NWFSC 2015c). At the time of listing in 1991, the only confirmed extant population included in this ESU was the beach-spawning population of sockeye salmon from Redfish Lake, with about 10 fish returning per year (NMFS 2015a).

Status

The Snake River sockeye salmon ESU includes only one population comprised of all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as

artificially propagated sockeye salmon from the Redfish Lake captive propagation program. Historical evidence indicates that the Snake River sockeye once had a range of life history patterns, with spawning populations present in several of the small lakes in the Sawtooth Basin (NWFSC 2015c). NMFS listed the Snake River sockeye salmon ESU because of habitat loss and degradation from the combined effects of damming and hydropower development, overexploitation, fisheries management practices, and poor ocean conditions. Recent effects of climate change, such as reduced stream flows and increased water temperatures, are limiting Snake River ESU productivity (NMFS 2016b). Adults produced through the captive propagation program currently support the entire ESU. This ESU is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure, and diversity) and would likely have a very low resilience to additional perturbations. Habitat improvement projects have slightly decreased the risk to the species, but habitat concerns and water temperature issues remain (NMFS 2016b). Overall, although the status of the Snake River sockeye salmon ESU appears to be improving, there is no indication that the biological risk category has changed (NWFSC 2015c).

Recovery Goals

We adopted a recovery plan for Lake Ozette sockeye salmon (NMFS 2009c) in May 2009. The criteria of the recovery plan were based upon Rawson et al., (2009b). Recovery criteria include:

- Multiple, spatially distinct and persistent spawning aggregations throughout the historical range of the population (*i.e.,* along the lake beaches and in one or more tributaries).
- One or more persistent spawning aggregations from each major genetic and life history group historically present. Also, genetic distinctness between anadromous sockeye, and kokanee salmon in the lake.
- Abundance between 31,250 and 121,000 adult spawners, over a number of years.

2.4.28 Steelhead Trout: California Central Valley DPS

This distinct population segment, or DPS, includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Sacramento and San Joaquin Rivers and their tributaries; excludes such fish originating from San Francisco and San Pablo Bays and their tributaries. This DPS includes steelhead from two artificial propagation programs.

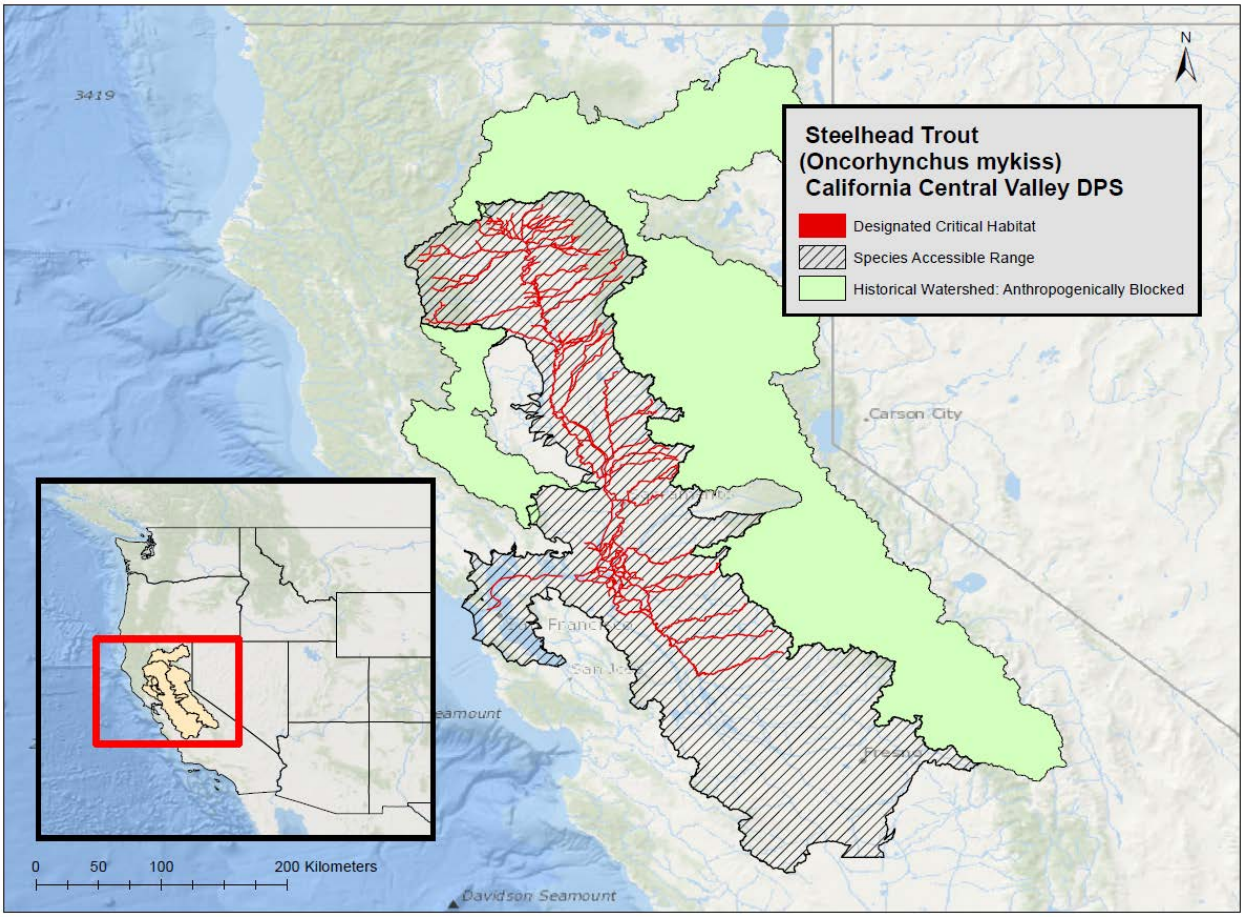


Figure 58. Geographic range and designated critical habitat of California Central Valley Steelhead.

Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides. Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 19, 1998 NMFS listed the California Central Valley DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).



Figure 59. Adult Steelhead Trout

Life history

Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later

(Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-year olds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a). Currently, Central Valley steelhead are considered "ocean-maturing" (also known as winter) steelhead, although summer steelhead may have been present prior to construction of large dams (Moyle 2002a). Ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. Central Valley steelhead enter fresh water from August through April. They hold until flows are high enough in tributaries to enter for spawning (Moyle 2002a). Steelhead adults typically spawn from December through April, with peaks from January through March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock et al. 1961; McEwan 2001).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to California Central Valley Steelhead.

Historic Central Valley steelhead run size may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Based on catch ratios at Chipps Island in the Delta and using some generous assumptions regarding survival, the average number of CV steelhead females spawning naturally in the entire Central Valley during the years 1980 to 2000 was estimated at about 3,600 (Good et al. 2005b).

California Central Valley steelhead lack annual monitoring data for calculating trends. However, the Red Bluff Diversion Dam counts and redd counts up to 1993 and later sporadic data show that the DPS has had a significant long-term downward trend in abundance (NMFS 2009a).

The Central Valley steelhead distribution ranges over a wide variety of environmental conditions and likely contains biologically significant amounts of spatially structured genetic diversity (Lindley et al. 2006). The loss of populations and reduction in abundances have reduced the large diversity that existed within the DPS. The genetic diversity of the majority of steelhead spawning runs within this DPS is also compromised by hatchery-origin fish.

Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems.

Status

Many watersheds in the Central Valley are experiencing decreased abundance of California Central Valley steelhead. Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting steelhead as recent increases in non-clipped (wild) abundance have been observed. Despite the positive trend in Clear Creek, all other concerns raised in the previous status review remain, including low adult abundances, loss and degradation of a large percentage of the historic spawning and rearing habitat, and domination of smolt production by hatchery fish. Many other planned restoration and reintroduction efforts have yet to be implemented or completed, or are focused on Chinook salmon, and have yet to yield demonstrable improvements in habitat, let alone documented increases in naturally produced steelhead. There are indications that natural production of steelhead continues to decline and is now at a very low levels. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. California Central Valley steelhead is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Recovery Goals

See the 2014 recovery plan for the California Central Valley steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. The delisting criteria for this DPS are:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

2.4.29 Steelhead Trout: Central California Coast DPS

This distinct population segment, or DPS, includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays (Figure 60).

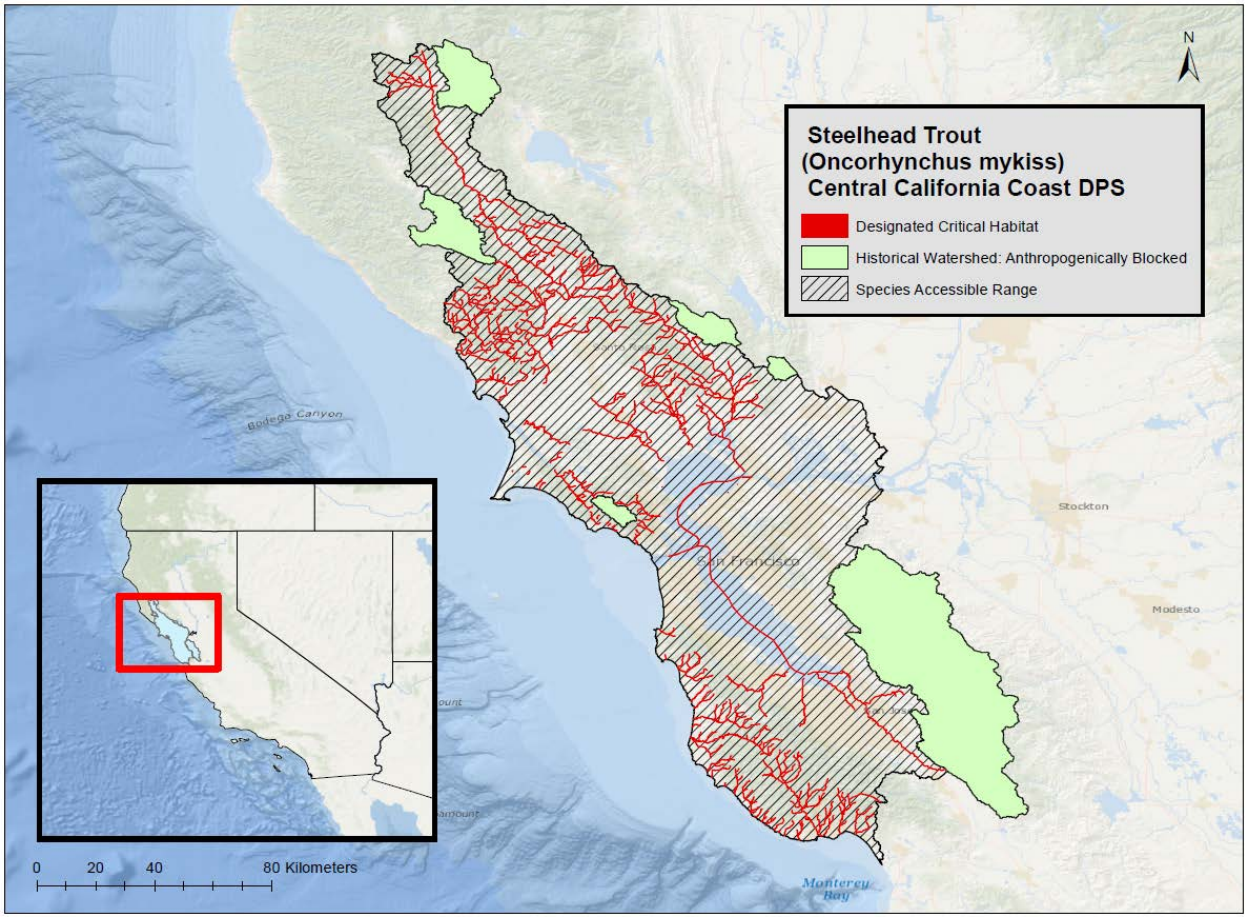


Figure 60. Geographic range and designated critical habitat of Central California Coast Steelhead.

On August 18, 1997 NMFS listed the Central California Coast DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

This DPS is entirely composed of winter-run fish. Adults return to the Russian River and migrate upstream from December to April, and smolts emigrate between March and May (Hayes et al. 2004; Shapovalov and Taft 1954a). Most spawning takes place from January through April. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-year olds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a).While age at smoltification typically ranges for one to four years, recent studies indicate that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age two (Sogard et al. 2009).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Central California Coast Steelhead.

Historically, the entire Central California Coast steelhead DPS may have consisted of an average runs size of 94,000 adults in the early 1960s (Good et al. 2005b). Information on current Central California coast steelhead populations consists of anecdotal, sporadic surveys that are limited to only smaller portions of watersheds. Presence-absence data indicated that most (82 percent) sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss* (Adams 2000; Good et al. 2005b).

Though the information for individual populations is limited, available information strongly suggests that no population is viable. Long-term population sustainability is extremely low for the southern populations in the Santa Cruz mountains and in the San Francisco Bay (NMFS 2008a). Declines in juvenile southern populations are consistent with the more general estimates of declining abundance in the region (Good et al. 2005b). Data on abundance trends do not exist for the DPS as a whole or for individual watersheds. Thus, it is not possible to calculate long-term trends or lambda.

The interior Russian River winter-run steelhead has the largest runs with an estimate of an average of over 1,000 spawners; it may be able to be sustained over the long-term but hatchery management has eroded the population's genetic diversity (Bjorkstedt et al. 2005; NMFS 2008a).

This distinct population segment, or DPS, includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays.

Status

The Central California Coast steelhead consisted of nine historic functionally independent populations and 23 potentially independent populations (Bjorkstedt et al. 2005). Of the historic functionally independent populations, at least two are extirpated while most of the remaining are nearly extirpated. Current runs in the basins that originally contained the two largest steelhead populations for the DPS, the San Lorenzo and the Russian Rivers, both have been estimated at

less than 15 percent of their abundances just 30 years earlier (Good et al. 2005b). The Russian River is of particular importance for preventing the extinction and contributing to the recovery of Central California Coast steelhead (NOAA 2013). Steelhead access to significant portions of the upper Russian River has also been blocked (Busby et al. 1996; NMFS 2008a).

Recovery Goals

See the 2016 recovery plan for the Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. Recovery plan objectives are to:

- Reduce the present or threatened destruction, modification, or curtailment of habitat or range;
- Ameliorate utilization for commercial, recreational, scientific, or educational purposes;
- Abate disease and predation;
- Establish the adequacy of existing regulatory mechanisms for protecting Central California coast steelhead now and into the future (i.e., post-delisting);
- Address other natural or manmade factors affecting the continued existence of Central California coast steelhead;
- Ensure Central California coast steelhead status is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

2.4.30 Steelhead Trout: Lower Columbia River DPS

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls (Figure 61). This DPS includes steelhead from seven artificial propagation programs.

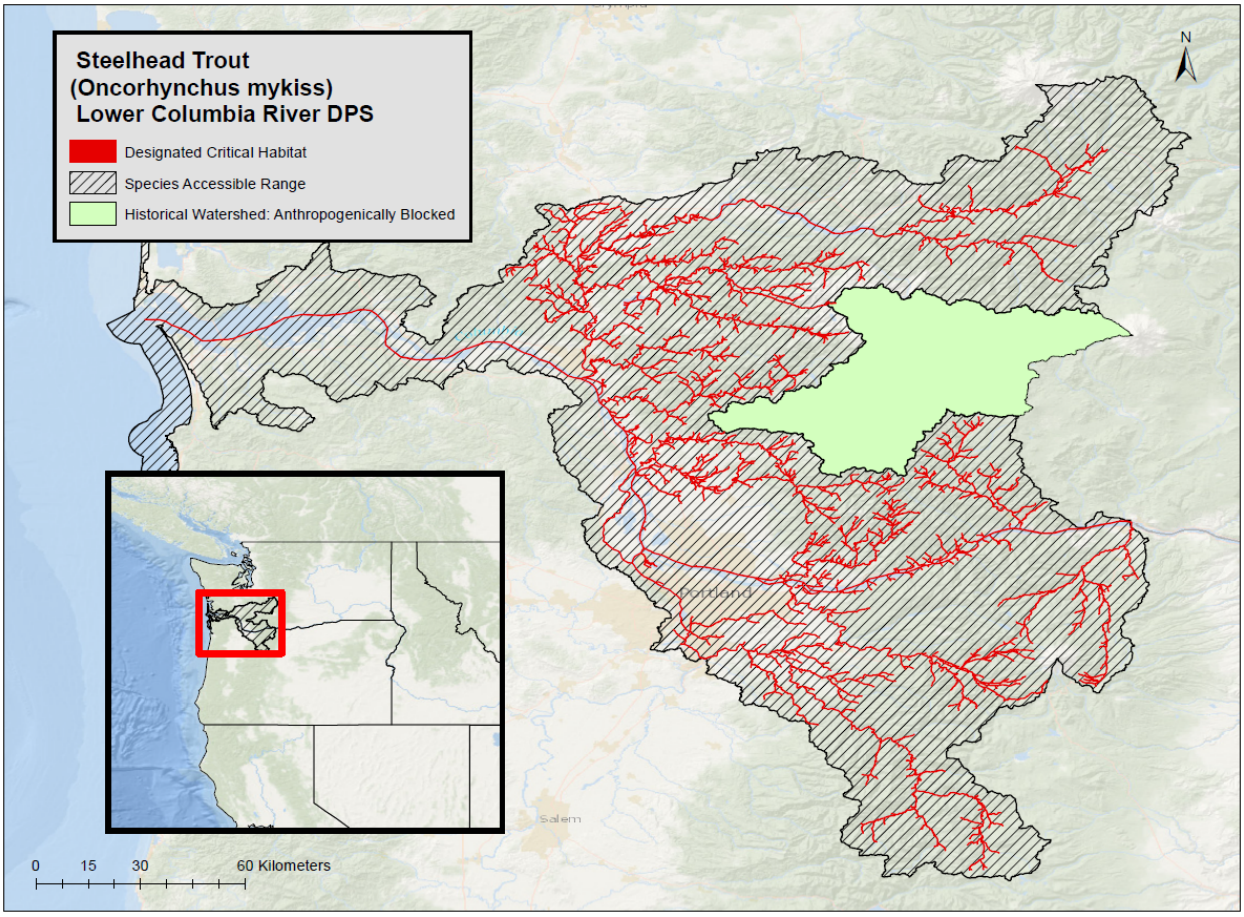


Figure 61. Geographic range and designated critical habitat of lower Columbia River steelhead.

On March 19, 1998 NMFS listed the Lower Columbia River DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

The lower Columbia River steelhead DPS includes both summer- and winter-run stocks. Summer-run steelhead return sexually immature to the Columbia River from May to November, and spend several months in fresh water prior to spawning. Winter-run steelhead enter fresh water from November to April, are close to sexual maturation during freshwater entry, and spawn shortly after arrival in their natal streams. Where both races spawn in the same stream, summer-run steelhead tend to spawn at higher elevations than the winter-run. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The

smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

Steelhead spend approximately 1-3 years in freshwater, then migrate rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). The majority of juvenile lower Columbia River steelhead remain for two years in freshwater environments before ocean entry in spring. Both winter- and summer-run adults normally return after two years in the marine environment. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to lower Columbia River steelhead.

The Winter-run Western Cascade MPG includes native winter-run steelhead in 14 DIPs from the Cowlitz River to the Washougal River. Abundances have remained fairly stable and have remained low, averaging in the hundreds of fish. Notable exceptions to this were the Clackamas and Sandy River winter-run steelhead populations, that are exhibiting recent rises in abundance and maintaining low levels of hatchery-origin steelhead on the spawning grounds (Jacobsen et al. 2014). In the Summer-run Cascade MPG, there are four summer-run steelhead populations. Absolute abundances have been in the hundreds of fish. In the Winter-run Gorge MPG both the Lower and Upper Gorge population surveys for winter steelhead are very limited and abundance levels in the Hood River have been low but relatively stable. In the Summer-run Gorge MPG adult abundance in the Wind River remains stable, but at a low level (hundreds of fish).

Population trends for the Winter-run Western Cascade MPG are fairly stable. Long and short term trends for three independent populations within the Summer-run Cascade MPG are positive; though the 2014 surveys indicate a drop in abundance for all three. Population trends in the Winter-run Gorge MPG is relatively stable. The overall status of the Summer-run Gorge MPG is uncertain.

Total steelhead hatchery releases in the Lower Columbia River Steelhead DPS have decreased since the last status review, declining from n total (summer and winter run) release of approximately 3.5 million to 3 million from 2008 to 2014. Some populations continue to have relatively high fractions of hatchery-origin spawners, whereas others (e.g., Wind River) have relatively few hatchery origin spawners.

There are 4 MPGs comprised of 23 DIPs, including 6 summer-run steelhead populations and 17 winter-run populations, that comprise this DPS (NWFSC 2015c). Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. There have been a number of large-scale efforts to improve

accessibility (one of the primary metrics for spatial structure) in this ESU. Trap and haul operations were begun on the Lewis River in 2012 for winter-run steelhead, reestablishing access to historically-occupied habitat above Swift Dam. In 2014, 1033 adult winter steelhead (integrated program fish) were transported to the upper Lewis River; however, juvenile collection efficiency is still below target levels. In addition, there have been a number of recovery actions throughout the ESU to remove or improve culverts and other small-scale passage barriers.

Status

The lower Columbia River steelhead had 17 historically independent winter steelhead populations and 6 independent summer steelhead populations (McElhany et al. 2003; Myers et al. 2006). All historic lower Columbia River steelhead populations are considered extant. However, spatial structure within the historically independent populations, especially on the Washington side, has been substantially reduced by the loss of access to the upper portions of some basins due to tributary hydropower development. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances (NWFSC 2015c). Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead DIPs were similarly stable, but at low abundance levels. Habitat degradation continues to be a concern for most populations. Even with modest improvements in the status of several winter-run populations, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability. The DPS therefore continues to be at moderate risk (NWFSC 2015c).

Recovery Goals

This species is included in the Lower Columbia River recovery plan (NMFS 2013c). For this species, threats in all categories must be reduced, but the most crucial elements are protecting favorable tributary habitat and restoring habitat in the Upper Cowlitz, Cispus, North Fork Toutle, Kalama and Sandy subbasins (for winter steelhead), and the East Fork Lewis, and Hood, subbasins (for summer steelhead). Protection and improvement is also need among the South Fork Toutle and Clackamas winter steelhead populations.

2.4.31 Steelhead Trout: Middle Columbia River DPS

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; excludes such fish originating from the Snake River basin (Figure 62). This DPS includes steelhead from seven artificial propagation programs.

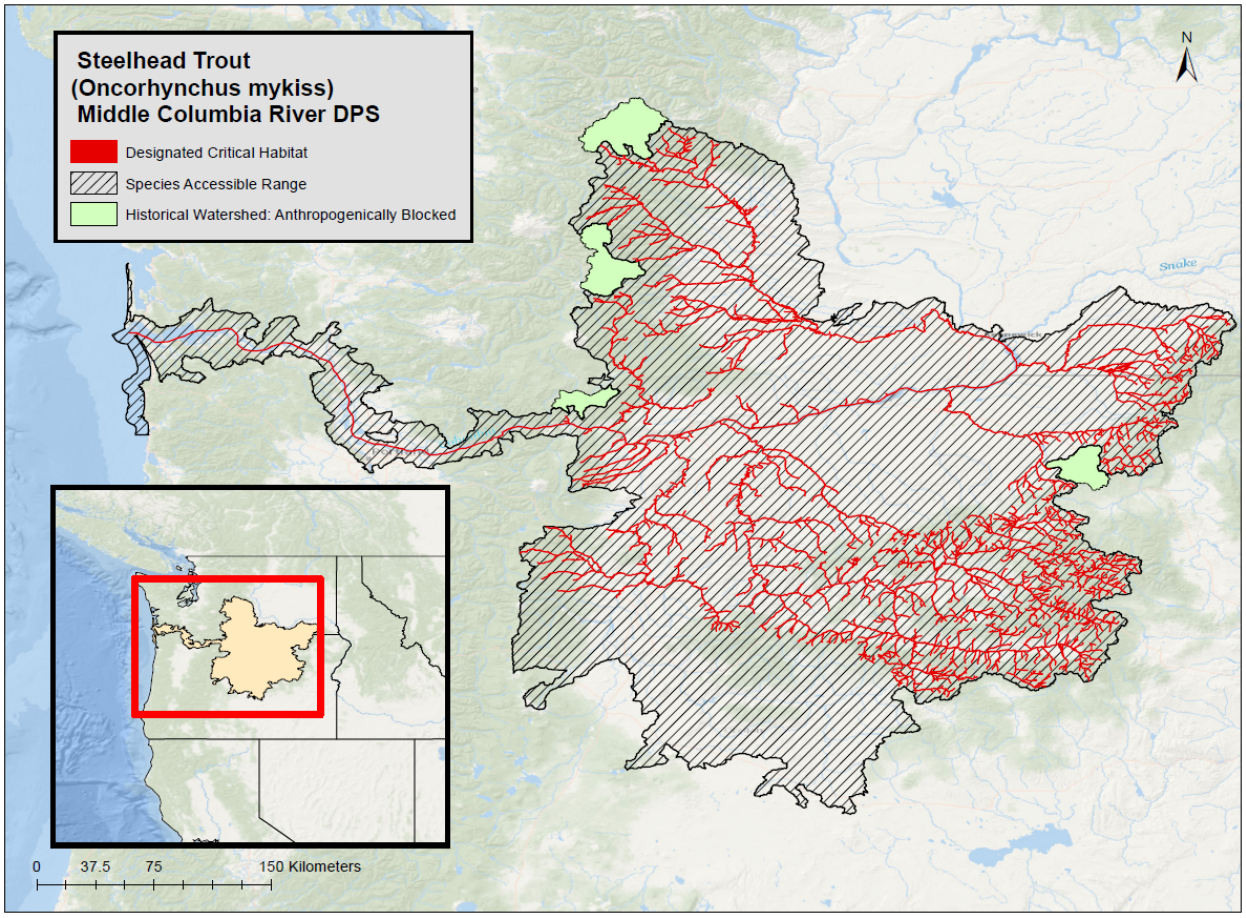


Figure 62. Geographic range and designated critical habitat of middle Columbia River steelhead.

On March 25, 1999 NMFS listed the Middle Columbia River DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

Middle Columbia River steelhead populations are mostly of the summer-run type. Adult steelhead enter fresh water from June through August. The only exceptions are populations of inland winter-run steelhead which occur in the Klickitat River and Fifteenmile Creek (Busby et al. 1996). The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). The majority of juveniles smolt and out-migrate as two-year olds. Most of the rivers in this region produce about equal or higher numbers of adults having spent one year in the ocean as adults having spent two years. However, summer-run steelhead in Klickitat River have a life cycle more like lower Columbia River steelhead whereby the majority of returning adults have spent two years in the ocean (Busby et al. 1996). Adults may hold in the river up to a year before spawning. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to middle Columbia River steelhead.

Historic run estimates for the Yakima River imply that annual species abundance may have exceeded 300,000 returning adults (Busby et al. 1996). The five-year average (geometric mean) return of natural MCR steelhead for 1997 to 2001 was up from previous years' basin estimates. Returns to the Yakima River, the Deschutes River, and sections of the John Day River system were substantially higher compared to 1992 to 1997 (Good et al. 2005b). The five-year average for these basins is 298 and 1,492 fish, respectively (Good et al. 2005b).

There have been improvements in the viability ratings for some of the component populations, but the Middle Columbia River Steelhead DPS is not currently meeting the viability criteria described in the Middle Columbia Steelhead Recovery Plan.

The IC-TRT identified 17 extant populations in this DPS (IC-TRT 2003; McClure et al. 2005). The populations fall into four MPGs: Cascade eastern slope tributaries (five extant and two extirpated populations), the, the John Day River (five extant populations), the Walla Walla and Umatilla rivers (three extant and one extirpated populations), and the Yakima River (four extant populations.

Status

The Interior Columbia Technical Recovery Team identified 16 extant populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one unaffiliated independent population (Rock Creek) (ICTRT 2003). There are two extinct populations in the Cascades Eastern Slope major population group: the White Salmon River and the Deschutes Crooked River above the Pelton/Round Butte Dam complex. Present population structure is delineated largely on geographical proximity, topography, distance, ecological similarities or differences. Using criteria for abundance and productivity, the Interior Columbia Technical Recovery Team modeled a gaps analysis for each of the four MPGs in this DPS under three different ocean conditions and a base hydro condition (most recent 20-year survival rate). The results showed

that none of the MPGs would be able to achieve a 5 percent or less risk of extinction over 100 years without recovery actions. It is important to consider that significant gaps in factors affecting spatial structure and diversity also contribute to the risk of extinction for these fish.

Recovery Goals

See the 2016 recovery plan for the Middle Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2009b).

2.4.32 Steelhead Trout: Northern California DPS

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers in California coastal river basins from Redwood Creek to and including the Gualala River (Figure 63).

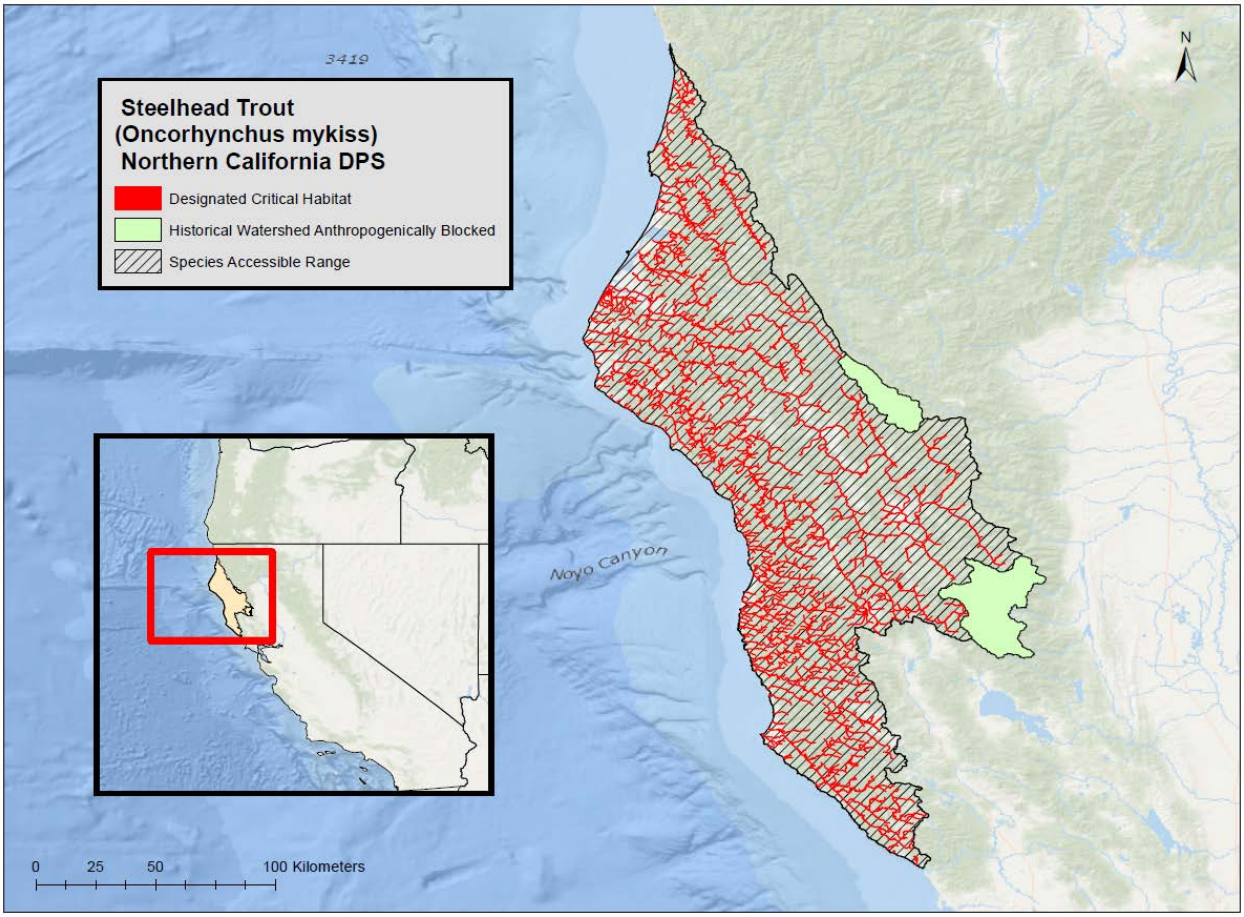


Figure 63. Geographic range and designated critical habitat of northern California steelhead.

On June 7, 2000 NMFS listed the Northern California DPS of steelhead as threatened (65 FR 36074) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

This DPS includes both winter- and summer –run steelhead. In the Mad and Eel Rivers, immature steelhead may return to fresh water as "half-pounders" after spending only two to four

months in the ocean. Generally, a half-pounder will overwinter in fresh water and return to the ocean in the following spring.

Juvenile out-migration appears more closely associated with size than age but generally, throughout their range in California, juveniles spend two years in fresh water (Busby et al 1996). Smolts range from 14-21 cm in length. Juvenile steelhead may migrate to rear in lagoons throughout the year with a peak in the late spring/early summer and in the late fall/early winter period (Shapovalov and Taft 1954a; Zedonis 1992).

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). Steelhead spend anywhere from one to five years in salt water, however, two to three years are most common (Busby et al. 1996).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to northern California steelhead.

Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction.

Overall, the available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5 percent and 13 percent of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Spence 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Spence 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing (Spence 2016). Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the last status review (Williams et al. 2011). Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS (Spence 2016). Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (i.e., Larabee Creek, North Fork Eel, and South Fork Eel).

Artificial propagation was identified as negatively affecting wild stocks of salmonids through interactions with non-native fish, introductions of disease, genetic changes, competition for space and food resources, straying and mating with native populations, loss of local genetic

adaptations, mortality associated with capture for broodstock and palliating the destruction of habitat and concealing problems facing wild stocks.

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers in California coastal river basins from Redwood Creek to and including the Gualala River.

Status

The available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5 percent and 13 percent of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Spence 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Spence 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing (Spence 2016). Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the last status review (Williams et al. 2011). Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS (Spence 2016). Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (i.e., Larabee Creek, North Fork Eel, and South Fork Eel). Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction.

Recovery Goals

See the 2016 recovery plan for the Northern California steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2016f).

2.4.33 Steelhead Trout: Puget Sound DPS

This distinct population segment, or DPS, includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Also, steelhead from six artificial propagation programs.

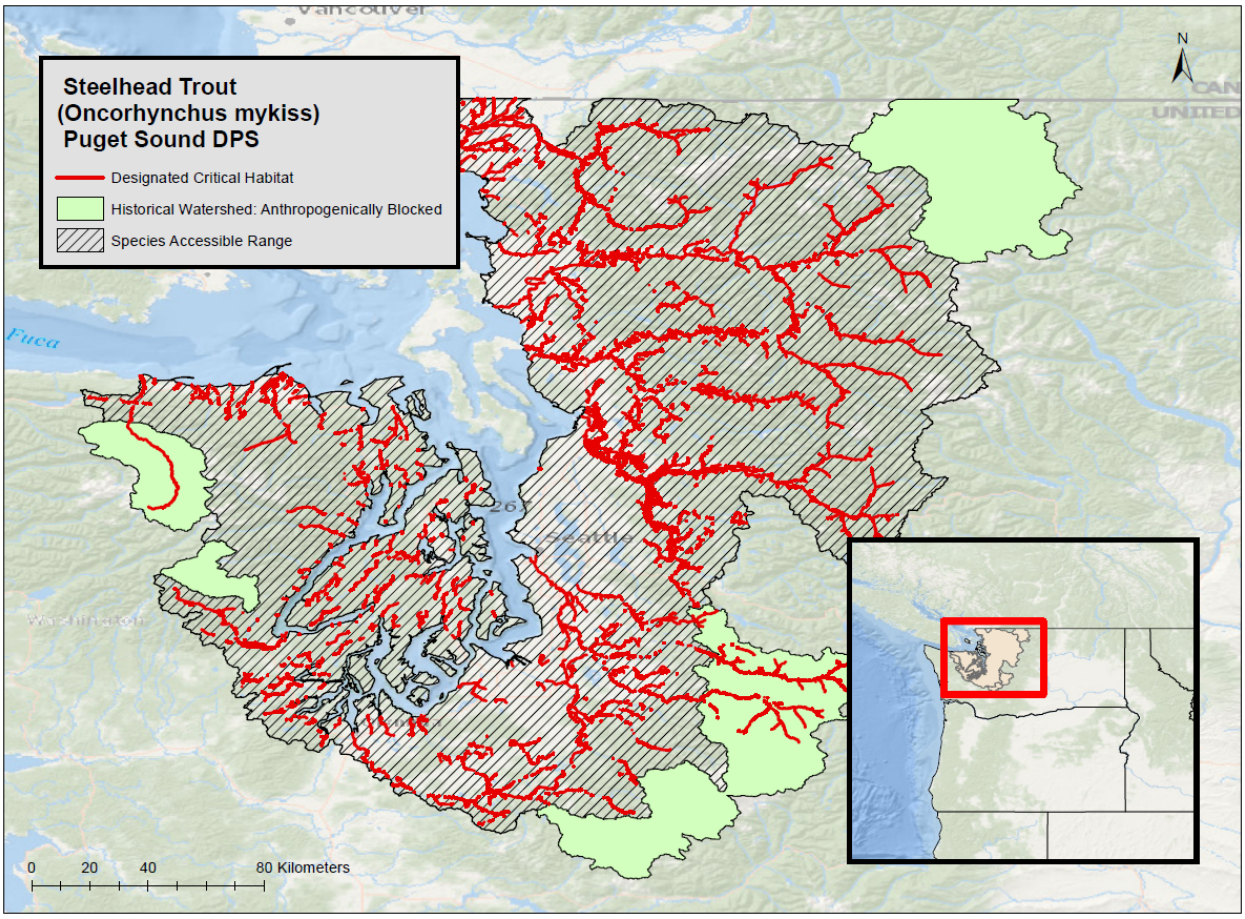


Figure 64. Geographic range and designated critical habitat of Puget Sound steelhead.

On May 11, 2007 NMFS listed the Puget Sound DPS of steelhead as threatened (72 FR 26722).

Life history

The Puget Sound steelhead DPS contains both winter-run and summer-run steelhead. Adult winter-run steelhead generally return to Puget Sound tributaries from December to April (NMFS 2005b). Spawning occurs from January to mid-June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows. Less information exists for summer-run steelhead as their smaller run size and higher altitude headwater holding areas have not been conducive for monitoring. Based on information from four streams, adult run time occur from mid-April to October with a higher concentration from July through September (NMFS 2005b).

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). Smoltification and seaward migration occur from April to mid-May. The ocean growth period for Puget Sound steelhead ranges from one to three years in the ocean (Busby et al. 1996). Juveniles or adults may spend considerable time in the protected marine environment of the fjord-like Puget Sound during migration to the high seas.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Puget Sound steelhead.

Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and early 1980s. Inspection of geometric means of total spawner abundance from 2010 to 2014 indicates that 9 of 20 populations evaluated had geometric mean abundances fewer than 250 adults and 12 of 20 had fewer than 500 adults.

Smoothed trends in abundance indicate modest increases since 2009 for 13 of the 22 DIPs. Between the two most recent five-year periods (2005-2009 and 2010-2014), the geometric mean of estimated abundance increased by an average of 5.4 percent. For seven populations in the Northern Cascades MPG, the increase was 3 percent; for five populations in the Central & South Puget Sound MPG, the increase was 10 percent; and for six populations in the Hood Canal & Strait of Juan de Fuca MPG, the increase was 4.5 percent. However, several of these upward trends are not statistically different from neutral, and most populations remain small. Long-term (15-year) trends in natural spawners are predominantly negative (NWFSC 2015c).

Only two hatchery stocks genetically represent native local populations (Hamma Hamma and Green River natural winter-run). The remaining programs, which account for the vast preponderance of production, are either out-of-DPS derived stocks or were within-DPS stocks that have diverged substantially from local populations. The WDFW estimated that 31 of the 53 stocks were of native origin and predominantly natural production (Washington Department of Fish and Wildlife (WDFW) 1993).

Fifty-three populations of steelhead have been identified in this DPS, of which 37 are winter-run. Summer-run populations are distributed throughout the DPS but are concentrated in northern Puget Sound and Hood Canal; only the Elwha River and Canyon Creek support summer-run steelhead in the rest of the DPS. The Elwha River run, however, is descended from introduced Skamania Hatchery summer-run steelhead. Historical summer-run steelhead in the Green River and Elwha River were likely extirpated in the early 1900s.

Status

Most of the populations in the DPS are small, and recent declines in abundance of natural fish have persisted despite widespread reductions in harvest of natural steelhead in the DPS since the mid-1990s (Ford 2011, NWFSC 2015c). Low population viability is widespread throughout the DPS based on evidence of diminished abundance, productivity, diversity, and spatial structure. The DPS's current status, particularly with respect to abundance and productivity, is considered to be well below the targets needed to achieve delisting and recovery (NWFSC 2015c). Particular aspects of diversity and spatial structure, including limited use of suitable habitat, are still likely to be limiting viability of most Puget Sound steelhead populations.

Recovery Goals

A recovery plan has not yet been developed for the Puget Sound DPS of steelhead.

2.4.34 Steelhead Trout: Snake River Basin DPS

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Snake River basin, and also steelhead from six artificial propagation programs (Figure 65).

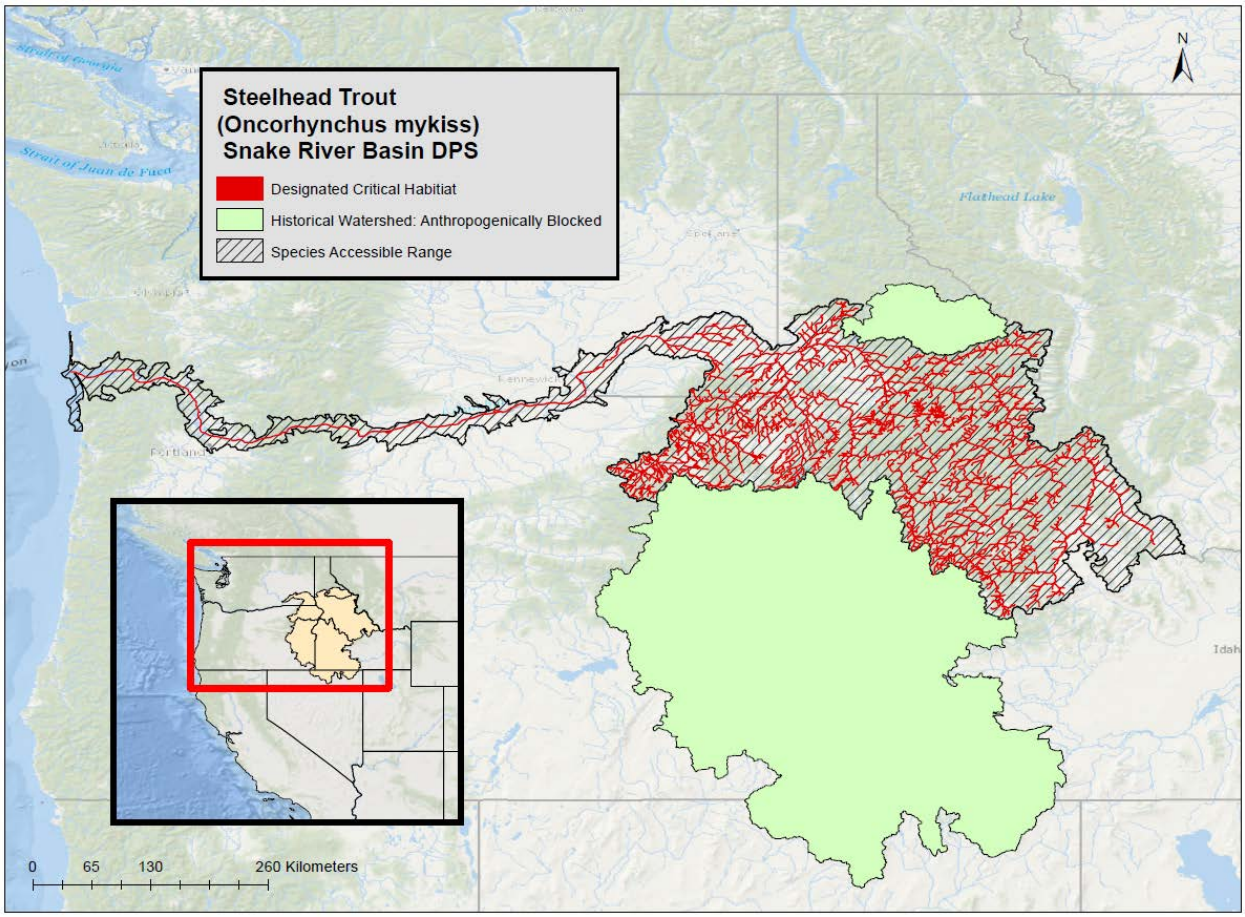


Figure 65. Geographic range and designated critical habitat of Snake River Basin steelhead.

On August 18, 1997 NMFS listed the Snake River Basin DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

Snake River basin steelhead are generally classified as summer-run fish. They enter the Columbia River from late June to October. After remaining in the river through the winter, SR basin steelhead spawn the following spring (March to May). Managers recognize two life history patterns within this DPS primarily based on ocean age and adult size upon return: A-run or B-run. A-run steelhead are typically smaller, have a shorter freshwater and ocean residence (generally one year in the ocean), and begin their up-river migration earlier in the year. B-run steelhead are larger, spend more time in fresh water and the ocean (generally two years in

ocean), and appear to start their upstream migration later in the year. SR basin steelhead usually smolt after two or three years.

The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). The majority of juveniles smolt and out-migrate as two-year olds. Adults may hold in the river up to a year before spawning. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Snake River basin steelhead.

There is uncertainty for wild populations given limited data for adult spawners in individual populations. Regarding population growth rate, there are mixed long- and short-term trends in abundance and productivity. Overall, the abundances remain well below interim recovery criteria.

The most recent five year geometric mean abundance estimates for the two long term data series of direct population estimates (Joseph Creek and Upper Grande Ronde Mainstem populations) both increased compared to the prior review estimates; each of the populations increased an average of 2 percent per year over the past 15 years. Hatchery-origin spawner estimates for both populations continued to be low, and both populations are currently approaching the peak abundance estimates observed since the mid-1980s (NWFSC 2015c).

Genetic diversity is affected by the displacement of natural fish by hatchery fish (declining proportion of natural-origin spawners).

With one exception, spatial structure ratings for all of the Snake River Basin steelhead populations were low or very low risk, given the evidence for distribution of natural production with populations. The exception was the Panther Creek population, which was given a high risk rating for spatial structure based on the lack of spawning in the upper sections.

Status

Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan being written by NMFS based on the updated status information available for this review, and the status of many individual populations remains uncertain (NWFSC 2015c). The Grande Ronde MPG is tentatively rated as viable; more specific data on spawning abundance and the relative contribution of hatchery spawners for the Lower Grande Ronde and Wallowa populations would improve future assessments. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.

Recovery Goals

The Snake River Basin steelhead recovery plan is currently in the process of being developed.

2.4.35 Steelhead Trout: South-Central California Coast DPS

This distinct population segment, or DPS, includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Pajaro River to (but not including) the Santa Maria River.

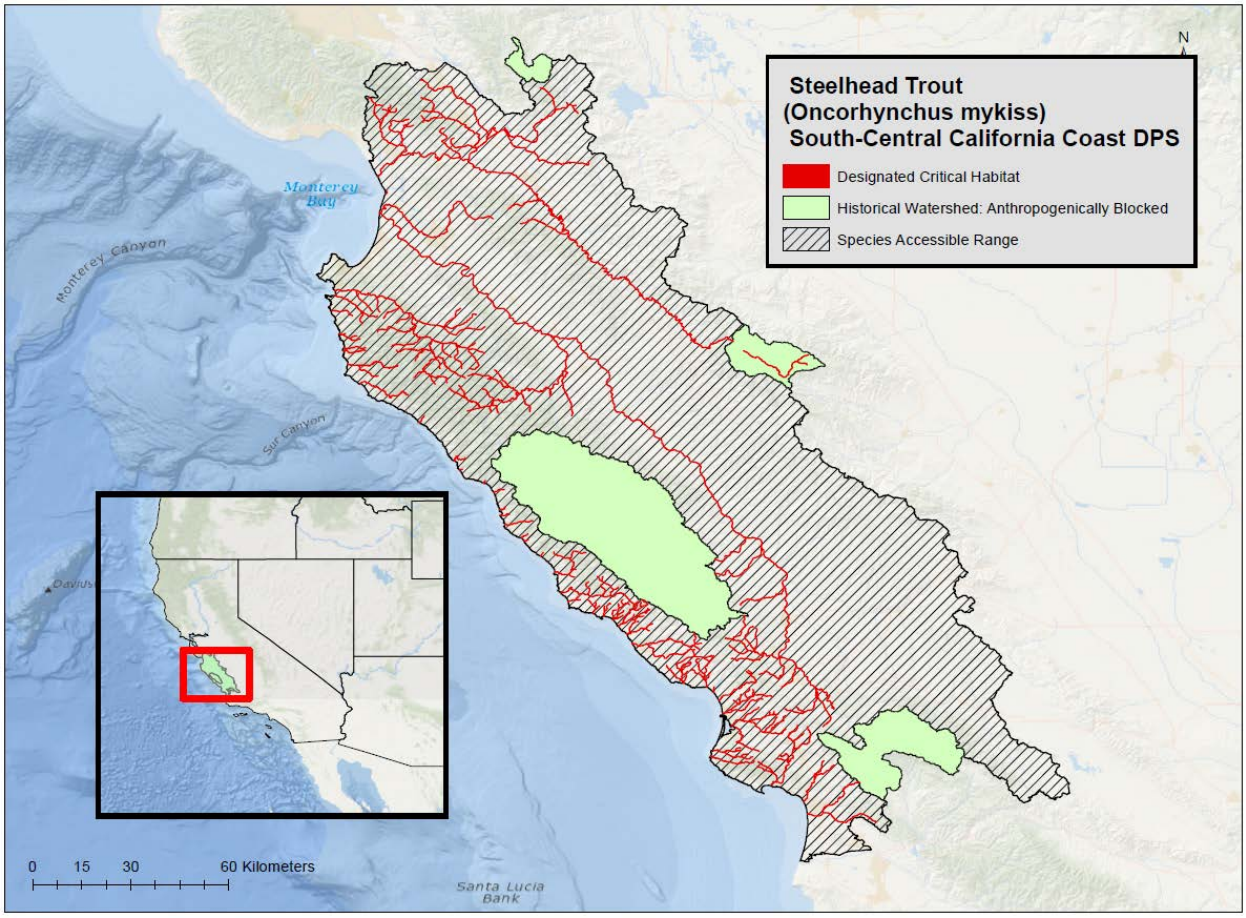


Figure 66. Geographic range and designated critical habitat of South-Central California Coast steelhead.

On August 18, 1997 NMFS listed the South-Central California Coast DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 5248).

Life history

Only winter steelhead are found in this DPS. Most spawning takes place from January through April. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954b). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fast flowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002a). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-year olds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002a). There is limited life history information for steelhead in this DPS.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to South-Central California Coast steelhead.

The data summarized in the most recent status review indicate small (generally <10 fish) but surprisingly persistent annual runs of anadromous *O. mykiss* are currently being monitored across a limited but diverse set of basins within the range of this DPS, but interrupted in years when the mouth of the coastal estuaries fail to open to the ocean due to low flows (Williams et al. 2016, Williams et al. 2011).

There are currently no population trend estimates for this DPS.

South-Central California Coast steelhead include all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California. No artificially propagated steelhead populations that reside within the historical geographic range of this DPS are included in this designation. The two largest basins overlapping within the range of this DPS include the inland basins of the Pajaro River and the Salinas River.

Status

Following the dramatic rise in South-Central California's human population after World War II and the associated land and water development within coastal drainages (particularly major dams and water diversions), steelhead abundance rapidly declined, leading to the extirpation of populations in many watersheds and leaving only sporadic and remnant populations in the remaining, more highly modified watersheds such as the Salinas River and Arroyo Grande Creek watersheds (Boughton et al. 2005, Good et al. 2005, Helmbrecht and Boughton 2005, Busby et al. 1996). A substantial portion of the upper watersheds, which contain the majority of historical spawning and rearing habitats for anadromous *O. mykiss*, remain intact (though inaccessible to anadromous fish) and protected from intensive development as a result of their inclusion in the Los Padres National Forest (Blakley and Barnette 1985, Brown 1945).

Recovery Goals

See the 2013 recovery plan for the South-Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

2.4.36 Steelhead Trout: Southern California DPS

This distinct population segment, or DPS, includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Santa Maria River to the U.S.-Mexico Border.

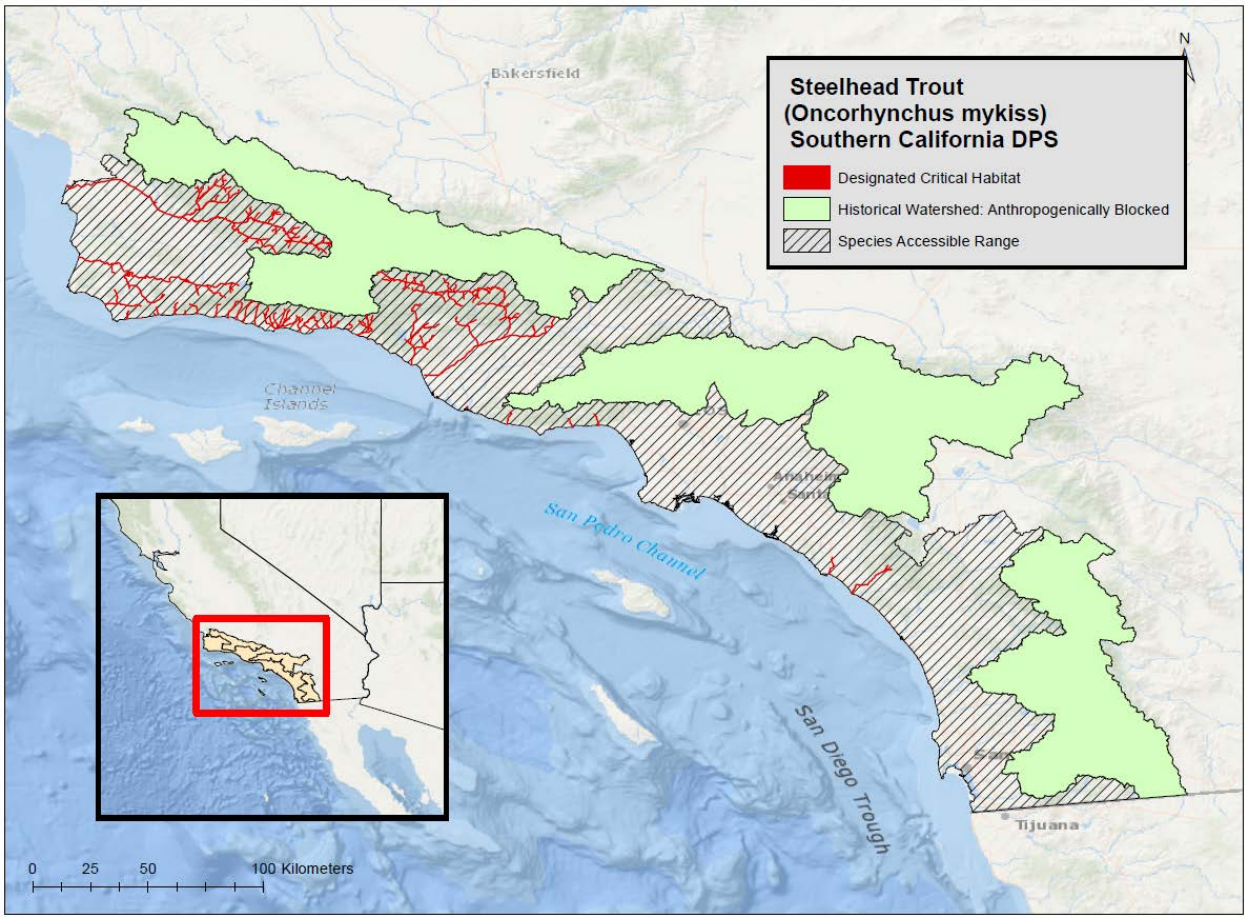


Figure 67. Geographic range and designated critical habitat of Steelhead, Southern California DPS.

On August 18, 1997 NMFS listed the Southern California DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 5248).

Life history

There is limited life history information for Southern California steelhead. In general, migration and life history patterns of Southern California steelhead populations are dependent on rainfall and stream flow (Moore 1980). Steelhead within this DPS can withstand higher temperatures compared to populations to the north. The relatively warm and productive waters of the Ventura River have resulted in more rapid growth of juvenile steelhead compared to the more northerly populations (Moore 1980). In general, this species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to Southern California steelhead.

Limited information exists on Southern California steelhead runs. Based on combined estimates for the Santa Ynez, Ventura, and Santa Clara rivers, and Malibu Creek, an estimated 32,000 to 46,000 adult steelhead occupied this DPS historically. In contrast, less than 500 adults are estimated to occupy the same four waterways presently. The last estimated run size for steelhead in the Ventura River, which has its headwaters in Los Padres National Forest, is 200 adults (Busby et al. 1996).

There are currently no population trend estimates for this DPS. Limited information is available regarding the structural and genetic diversity of the Southern California steelhead.

Status

There is little new evidence to indicate that the status of the Southern California Coast Steelhead DPS has changed appreciably in either direction since the last status review (Williams et al. 2011). The extended drought and the recent genetic data documenting the high level of introgression and extirpation of native *O. mykiss* stocks in the southern portion of the DPS has elevated the threats level to the already endangered populations; the drought, and the lack of comprehensive monitoring, has also limited the ability to fully assess the status of individual populations and the DPS as whole. The systemic anthropogenic threats identified at the time of the initial listing have remained essentially unchanged over the past 5 years, though there has been significant progress in removing fish passage barriers in a number of the smaller and mid-sized watersheds. Threats to the Southern California Steelhead DPS posed by environmental variability resulting from projected climate change are likely to exacerbate the factors affecting the continued existence of the DPS.

Recovery Goals

See the 2012 recovery plan for the Southern California steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

2.4.37 Steelhead Trout: Upper Columbia River DPS

This DPS includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border. Also, steelhead from six artificial propagation programs.

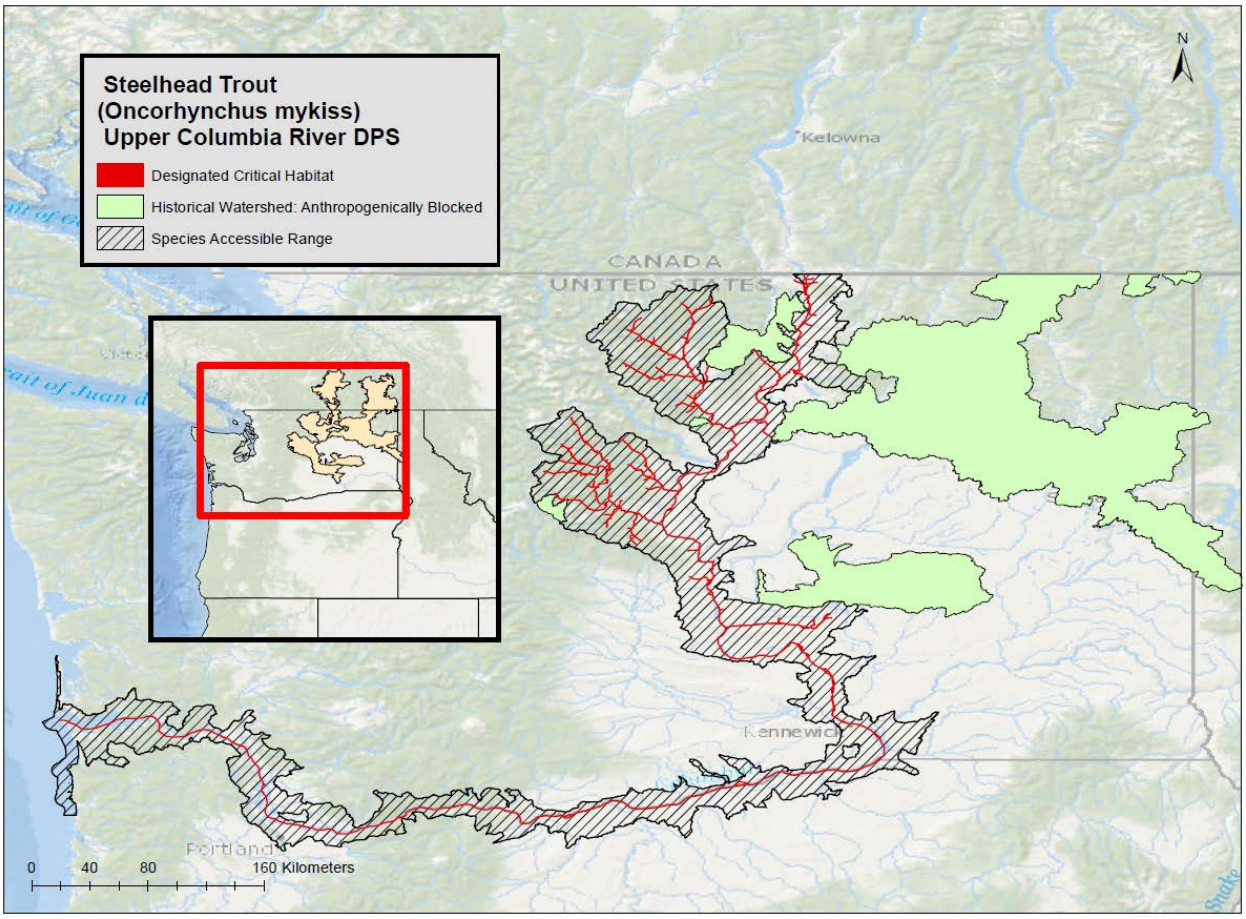


Figure 68. Geographic range and designated critical habitat of upper Columbia River steelhead.

On August 18, 1997 NMFS listed the Upper Columbia River DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 834).

Life history

All upper Columbia River steelhead are summer-run steelhead. Adults return in the late summer and early fall, with most migrating relatively quickly to their natal tributaries. A portion of the returning adult steelhead overwinters in mainstem reservoirs, passing over upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). Most adult steelhead return to fresh water after one or two years at sea.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to upper Columbia River steelhead.

The most recent estimates of natural-origin spawner abundance for each of the four populations in the upper Columbia River Steelhead DPS show fairly consistent patterns throughout the years. None of the populations have reached their recovery goal numbers during any of the years (500 for the Entiat, 2,300 for the Methow, 2,300 for the Okanogan, and 3,000 for Wenatchee).

Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. In spite of recent increases, natural origin abundance and productivity remain well below viability thresholds for three out of the four populations, and the Okanogan River natural-origin spawner abundance estimates specifically are well below the recovery goal for that population. Three of four extant natural populations are considered to be at high risk of extinction and one at moderate risk.

All populations are at high risk for diversity, largely driven by chronic high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations.

The upper Columbia River steelhead DPS is composed of three MPGs, two of which are isolated by dams. With the exception of the Okanogan population, the Upper Columbia River populations were rated as low risk for spatial structure.

Status

Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat and unchanged for the Methow (NWFSC 2015c). However abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations. Short-term patterns in those indicators appear to be largely driven by year-to year fluctuations in survival rates in areas outside of these watersheds. All three populations continued to be rated at low risk for spatial structure but at high risk for diversity criteria. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015c).

Recovery Goals

See the 2007 recovery plan for the Upper Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

2.4.38 Steelhead Trout: Upper Willamette River DPS

This DPS includes naturally spawned anadromous winter-run *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River (Figure 69).

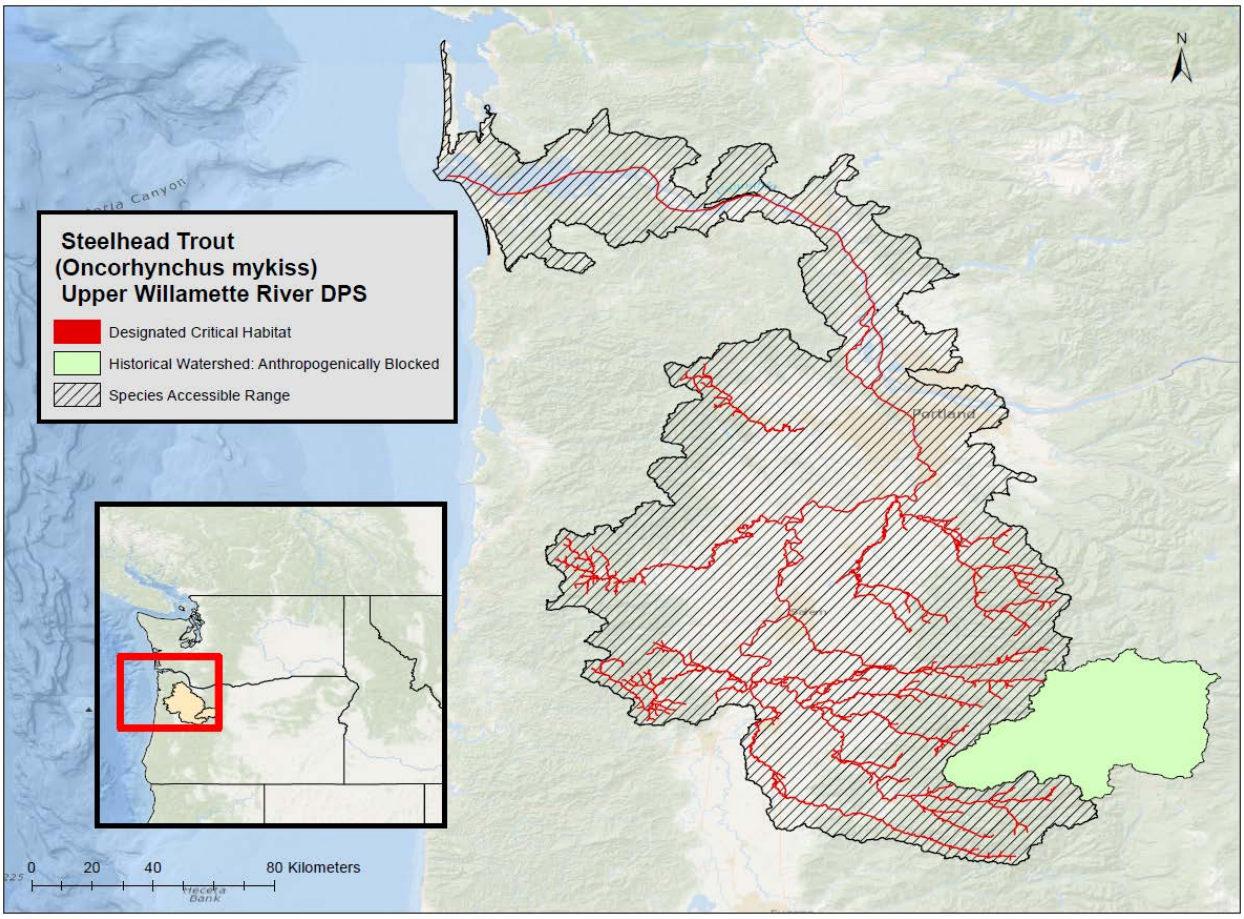


Figure 69. Geographic range and designated critical habitat of upper Willamette River steelhead.

On March 25, 1999 NMFS listed the Upper Willamette River DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834).

Life history

Native steelhead in the Upper Willamette are a late-migrating winter group that enters fresh water in January and February (Howell et al. 1985). UWR steelhead do not ascend to their spawning areas until late March or April, which is late compared to other West Coast winter steelhead. Spawning occurs from April to June 1. The unusual run timing may be an adaptation for ascending the Willamette Falls, which may have facilitated reproductive isolation of the stock. The smolt migration past Willamette Falls also begins in early April and proceeds into early June, peaking in early- to mid-May (Howell et al. 1985). Smolts generally migrate through the Columbia via Multnomah Channel rather than the mouth of the Willamette River. The species spends approximately 1-3 years in freshwater, then migrates rapidly through estuaries, bypassing coastal migration routes of other salmonids, moving into oceanic offshore feeding grounds (Daly et al. 2014; Quinn and Myers 2004). However, as with other coastal steelhead, the majority of juveniles smolt and outmigrate after two years; adults return to their natal rivers to spawn after spending two years in the ocean. Repeat spawners are predominantly female and generally account for less than 10 percent of the total run size (Busby et al. 1996).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to upper Willamette River steelhead.

For the UWR steelhead DPS, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015, and accessibility to historical spawning habitat remains limited, especially in the North Santiam River. Although the recent magnitude of these declines is relatively moderate, the latest status review notes that continued declines would be a cause for concern (NWFSC 2015c).

Recent estimates of escapement in the Molalla River indicate abundance is stable but at a depressed level, and the lack of migration barriers indicates this limitation is likely due to habitat degradation (NWFSC 2015c). In the North Santiam, recent radio-tagging studies and counts at Bennett Dam between 2010 and 2014 estimate the average abundance of returning winter-run adults is following a long-term negative trend (Jepson et al 2013, 2014, and 2015). In the South Santiam live counts at Foster Dam indicate a negative trend in abundance from 2010-2014, and redd survey data indicate consistent low numbers of spawners in tributaries (NWFSC 2015c). Radio-tagging studies in the Calapooia from 2012-2014 suggest that recent abundances have been depressed but fairly stable, however long-term trends in redd counts conducted since 1985 are generally negative (Jepson et al 2013, 2014, and 2015).

Genetic analysis suggests that there is some level introgression among native late-winter steelhead and summer-run steelhead (Van Doornik et al. 2015), and up to approximately 10 percent of the juvenile steelhead at Willamette Falls and in the Santiam Basin may be hybrids (Johnson *et al.* 2013). While winter-run steelhead have largely maintained their genetic distinctiveness over time (Van Doornik et al 2015), there are still concerns that hybridization will decrease the overall productivity of the native population. In addition, releases of large numbers of hatchery-origin summer steelhead may temporarily exceed rearing capacities and displace winter-run juvenile steelhead (NWFSC 2015c).

Four DIPs of UWR steelhead occur within the DPS. Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, and are not part of the DPS, nor are stocked summer steelhead that have become established in the McKenzie River (ODFW and NMFS 2011).

Status

Four basins on the east side of the Willamette River historically supported independent populations for the UWR steelhead, all of which remain extant. Data reported in McElhaney et al. (McElhany et al.) indicate that currently the two largest populations within the DPS are the

Santiam River populations. Mean spawner abundance in both the North and South Santiam River is about 2,100 native winter-run steelhead. However, about 30 percent of all habitat has been lost due to human activities (McElhany et al. 2007). The North Santiam population has been substantially affected by the loss of access to the upper North Santiam basin. The South Santiam subbasin has lost habitat behind non-passable dams in the Quartzville Creek watershed. Notwithstanding the lost spawning habitat, the DPS continues to be spatially well distributed, occupying each of the four major subbasins.

Overall, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015. There is considerable uncertainty in many of the abundance estimates, except for perhaps the tributary dam counts. Radio-tagging studies suggest that a considerable proportion of winter-run steelhead ascending Willamette Falls do not enter the DIPs that constitute this DPS; these fish may be nonnative early winter-run steelhead that appear to have colonized the western tributaries, misidentified summer-run steelhead, or late winter-run steelhead that have colonized tributaries not historically part of the DPS.

Recovery Goals

See the 2011 recovery plan for the Upper Willamette River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

2.4.39 Nassau Grouper

The Nassau grouper is a large, long-lived fish primarily occupying shallow water throughout the Caribbean, south Florida, Bermuda, and the Bahamas (Figure 70).

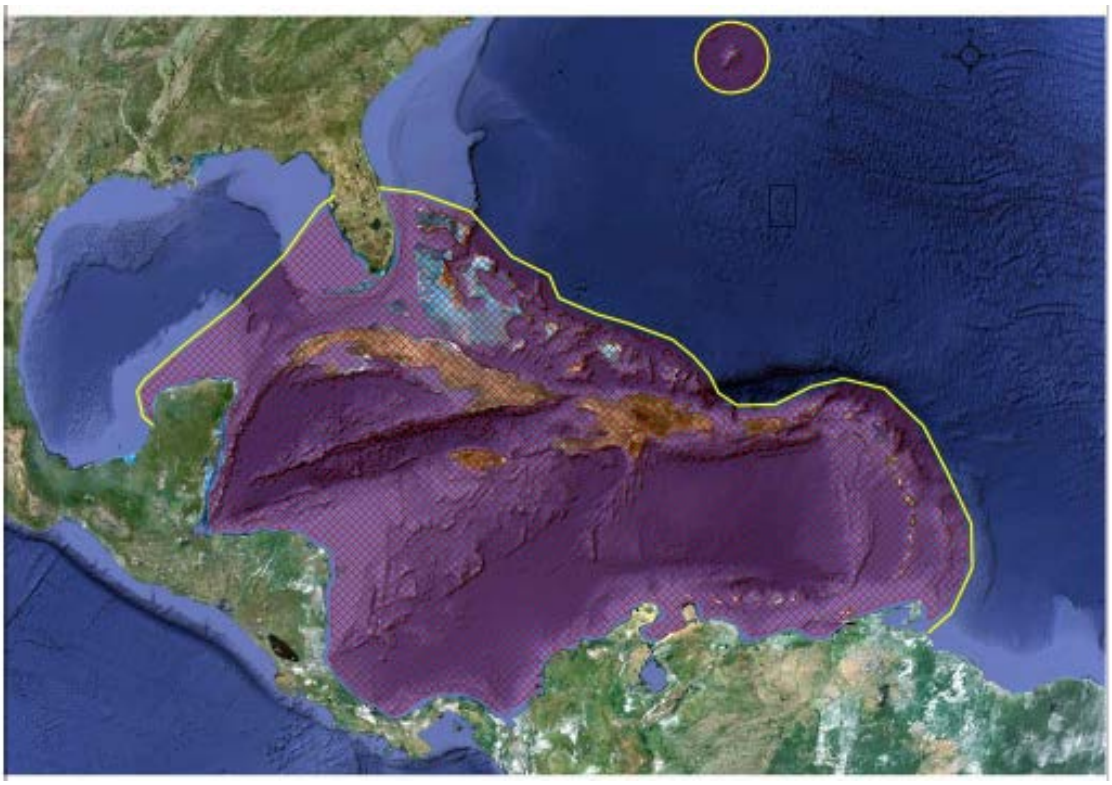


Figure 70. Map identifying the range of the Nassau grouper. From NMFS Biological Report 2013 (NMFS 2013f).

Adult Nassau grouper are large (up to 0.45 meter or 1.5 feet), have distinctive black and white stripes, and are generally found in shallow reef habitat (Figure 20). The Nassau grouper was listed as threatened on June 29, 2016 (81 FR 42268; Figure 71).



Figure 71. Nassau grouper. Photo: NOAA, Stephania Bolden.

We used information available in the status review (NMFS 2013f) and recent scientific publications to summarize the life history, population dynamics and status of the species, as follows.

Life History

Nassau groupers spawn once a year in large aggregations, in groups of a few dozen to thousands spawning at once. Nassau groupers move in groups towards the spawning aggregation sites parallel to the coast or along the shelf edge at depths between 20 and 33 meters. Spawning runs occur in late fall through winter (i.e., a month or two before spawning is likely). Sea surface temperature is thought to be a key factor in the timing of spawning, with spawning occurring at waters temperatures between 25 and 26 degrees Celsius. Spawning aggregation sites are located near significant geomorphological features, such as reef projections (as close as 50 meters to shore) and close to a drop-off into deep water over a wide depth range (six to sixty meters). Sites are usually several hundred meters in diameter, with

soft corals, sponges, stony coral outcrops, and sandy depressions. Nassau groupers stay on the spawning site for up to three months, spawning at the full moon or between the new and full moons. Spawning occurs within twenty minutes of sunset over the course of several days. There have been about fifty known spawning sites in insular areas throughout the Caribbean; many of these aggregations no longer form. Current spawning locations are found in Mexico, Bahamas, Belize, Cayman Islands, the Dominican Republic, Cuba, Puerto Rico and the U.S. Virgin Islands.

Fertilized eggs are transported offshore by ocean currents. Thirty-five to forty days after hatching, larvae recruit from oceanic environment to demersal habitats (at a size of about 32 millimeters total length). Juveniles inhabit macroalgae, coral clumps, and seagrass beds, and are relatively solitary. As they grow, they occupy progressively deeper areas and offshore reefs, and can be found in schools of up to forty individuals. When not spawning, adults are most commonly found in waters less than one hundred meters deep. Nassau grouper diet changes with age. Juveniles eat plankton, pteropods, amphipods, and copepods. Adults are unspecialized piscivores, bottom-dwelling ambush suction predators (NMFS 2013f).

Male and female Nassau groupers reach sexual maturity at lengths between 40 and 45 centimeters standard length, about four to five years old. It is thought that sexual maturity is more determined by size, rather than age. Otolith studies indicate that the minimum age at maturity is between four and eight years; most groupers have spawned by age seven (Bush et al. 2006). Nassau groupers live to a maximum of 29 years.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Nassau grouper.

There is no range-wide abundance estimate available for Nassau grouper. The species is characterized as having patchy abundance due largely to differences in habitat availability or quality, and differences in fishing pressure in different locations (81 FR 42268). Although abundance has been reduced compared to historical levels, spawning still occurs and abundance is increasing in some locations, such as the Cayman Islands and Bermuda.

There is no population growth rate available for Nassau grouper. However, the available information from observations of spawning aggregations has shown steep declines (Aguilar-Perera 2006; Claro and Lindeman 2003; Sala et al. 2001); however, some aggregation sites are comparatively robust and showing signs of increase (Vo et al. 2014; Whaylen et al. 2004).

Recent studies on Nassau grouper genetic variation has found strong genetic differentiation across the Caribbean subpopulations, likely due to barriers created by ocean currents and larval behavior (Jackson et al. 2014a).

Nassau grouper is distributed throughout the Caribbean, south to the northern coast of South America (Figure 19). Current Nassau grouper distribution is considered equivalent to its historical range, although abundance has been severely depleted.

Status

Historically, tens of thousands of Nassau grouper spawned at aggregation sites throughout the Caribbean. Since grouper species were reported collectively in landings data, it is not possible to know how many Nassau grouper were harvested, or estimate historic abundance. That these large spawning aggregations occurred in predictable locations at regular times made the species susceptible to over-fishing, and was a cause of its decline. At some sites (e.g., Belize), spawning aggregations have decreased by over 80 percent in the last 25 years (Sala et al. 2001), or have disappeared entirely (e.g., Mexico) (Aguilar-Perera 2006). Nassau groupers are also targeted for fishing throughout the year during non-spawning months. In some locations, spawning aggregations are increasing. Many Caribbean countries have banned or restricted Nassau grouper harvest, and it is believed that the areas of higher abundance are correlated with effective regulations (81 FR 42268). Since Nassau groupers are dependent upon coral reefs at various points in their life history, loss of coral reef habitat due to climate change. Increasing water temperatures may change the timing and location of spawning. Habitat degradation due to water pollution also poses a threat to the species. Nassau grouper populations have been reduced from historic abundance levels, and remain vulnerable to unregulated harvest, especially the spawning aggregations. NMFS determined that the species warrants listing as threatened.

2.4.40 Scalloped Hammerhead Shark: Eastern Pacific, Central and Southwest Atlantic, and Indo-West Pacific DPSs

All hammerhead sharks belong to the family *Sphyrnidae* and are classified as ground sharks (order: Carcharhiniformes). The hammerhead sharks are recognized by their laterally expanded head that resembles a hammer, hence the common name “hammerhead.” The scalloped hammerhead shark is distinguished from other hammerheads by a noticeable indentation on center and front portion of the head, along with two more indentations on each side of this central indentation, giving the head a “scalloped” appearance. It has a broadly arched mouth and the back of the head is slightly swept backward.

The scalloped hammerhead shark is found throughout the world and lives in coastal warm temperate and tropical seas. It occurs over continental shelves and the shelves surrounding islands, as well as adjacent deep waters, but is seldom found in waters cooler than 22°C (Compagno 1984; Schulze-Haugen and Kohler 2003). It ranges from the intertidal and surface waters to depths of up to approximately 1,475-1,675 ft (450-512 m) (Sanches 1991; Klimley 1993), with occasional dives to even deeper (Jorgensen et al. 2009). It has also been documented entering enclosed bays and estuaries (Compagno 1984).

Life history

The scalloped hammerhead shark gives birth to live young (i.e., “viviparous”), with a gestation period of 9-12 months (Branstetter 1987; Stevens and Lyle 1989), which may be followed by a 1-year resting period (Liu and Chen 1999). Females attain maturity around 6.5-8 feet (2.0-2.5 meters) total length, while males reach maturity at smaller sizes (range 4-6.5 feet (1.3-2.0 meters)). The age at maturity differs by region. For example, in the Gulf of Mexico, Branstetter (1987) estimated that females mature at about 15 years of age and males at around 9 to10 years

of age. In northeastern Taiwan, Chen et al. (1990) calculated age at maturity to be 4 years for females and 3.8 years for males. On the east coast of South Africa, age at sexual maturity for females was estimated at 11 years (Dudley and Simpfendorfer 2006). Parturition, however, does not appear to vary by region and may be partially seasonal (Harry et al. 2011), with neonates present year round but with abundance peaking during the spring and summer months (Duncan and Holland 2006; Adams and Paperno 2007; Bejarano-Álvarez et al. 2011; Harry et al. 2011; Noriega et al. 2011). Females move inshore to birth, with litter sizes anywhere between 1 and 41 live pups. Off the coast of northeastern Australia, Noriega et al. (2011) found a positive correlation between litter size and female shark length for scalloped hammerheads, as did White et al. (2008) in Indonesian waters. However, off the northeastern coast of Brazil, Hazin et al. (2001) found no such relationship. Size at birth is estimated between 1 and 2 feet.

Population Dynamics

Eastern Pacific DPS

Historical estimates of effective population size (or the number of breeding individuals in the population) in the eastern Pacific range from 34,995 to 43,551 individuals (Nance et al. 2011). Using 15 microsatellite loci and mitochondrial DNA from eastern Pacific tissue samples, Nance et al. (2011) discovered that the current effective population size is significantly smaller (1-3 orders of magnitude) than the historical effective population size, indicating that scalloped hammerheads in the eastern Pacific experienced a bottleneck and suffered significant declines. While current abundance data for this DPS are sparse, local and regional population declines have been indicated from recent fishery dependent data. Using fishing mortality estimates calculated from 1997 and 1998 catches, Instituto Nacional de la Pesca (2006) estimated that the scalloped hammerhead shark population in the Gulf of Tehuantepac (Mexico) is decreasing by six percent per year. In Michoacán, Mexico, hammerheads represent 70 percent of the catch, with fishing effort concentrated in breeding areas and directed towards juveniles and pregnant females (CITES 2012). In Costa Rica, shark catches reported by artisanal and longline fisheries have shown a dramatic decline (~50 percent) after reaching a maximum of 5,000 tonnes in 2000 (SINAC 2012). Available data on relative abundance of pelagic sharks in general in the Costa Rica EEZ suggest sharp declines (approximately 58 percent) between 1991 and 2002 (Arauz et al. 2004).

Central and Southwest Atlantic DPS

While scalloped hammerhead sharks in the northwest Atlantic may currently be in a rebuilding phase, populations found further south in the Atlantic could still be in danger of decline (Miller et al. 2014). Historical landings data indicate that large numbers of hammerhead sharks were removed by longliners off the coast of Brazil in the late 20th century (Amroim et al. 1998).

Indo-west Pacific DPS

The Indo-West Pacific DPS range covers a very large area and abundance estimates for this entire DPS are unavailable. However, documented trends in abundance in particular areas suggest significant depletions of local populations. Data collected from East Lombok, Indonesia, suggest potential population declines as the proportion of scalloped hammerheads in the Tanjung

Luar artisanal longline fishery catch decreased from 15 percent to 2 percent from 2001 to 2011 (FAO 2013). Scalloped hammerhead sharks off the coast of South Africa are also thought to be experiencing similar decreases in population size. Analyses of fishery-independent data from beach protection programs have revealed drastic declines in catch rates since the early 1950s. From 1952-1972 Ferretti et al. (2010) estimated a decline of 99.3 percent in scalloped hammerhead catch rates off Main Beach in South Africa, and a decline of 86 percent from 1961-1972 off Brighton Beach, South Africa. Estimates of the decline in hammerhead abundance in Australia's northwest marine region, based on analysis of catch per unit effort data from 1996-2005, range from 58-76 percent (Heupel and McAuley 2007). Data from protective shark meshing programs off beaches in New South Wales and Queensland also suggest significant declines in hammerhead populations off the east coast of Australia. Over a 35 year period, the number of hammerheads caught per year in beach protection nets has decreased by more than 90 percent, from over 300 individuals in 1973 to less than 30 in 2008 (Reid and Krogh 1992, Williamson 2011). Similarly, data from the Queensland shark control program indicates a 63 percent decline in scalloped hammerhead shark abundance between 2005 and 2010 (QLD DEEDI 2011).

Status

Eastern Pacific DPS

Evidence of heavy fishing pressure by artisanal fisherman, limited regulatory mechanisms and poor enforcement indicate that the Eastern Pacific DPS is currently at or near a level of abundance and productivity that places its current and future persistence in question (Miller et al. 2014).

Central and Southwest Atlantic DPS

Although abundance estimates and quality catch data are unavailable for this DPS, the evidence of heavy fishing pressure on this species off the coast of Brazil, Central America, and the Caribbean, with documented large numbers of juvenile and neonate landings, suggests this DPS is likely approaching a level of abundance and productivity that places its current and future persistence in question (Miller et al. 2014).

Indo-west Pacific DPS

Evidence of heavy fishing pressure by industrial, commercial and artisanal fisheries, and reports of significant illegal, unreported and unregulated fishing, especially off the coast of Australia, have likely led to overutilization of the Indo-West Pacific DPS. Coupled with inadequate regulatory measures, especially in the Western Indian Ocean and Indonesian waters, the present and future threats facing this DPS indicate it is approaching a level of abundance and productivity that places its current and future persistence in question (Miller et al. 2014).

2.4.41 Smalltooth Sawfish

Within the United States, smalltooth sawfish have been captured in estuarine and coastal waters from New York southward through Texas, although peninsular Florida has historically been the region of the United States with the largest number of recorded captures (NMFS 2010d).

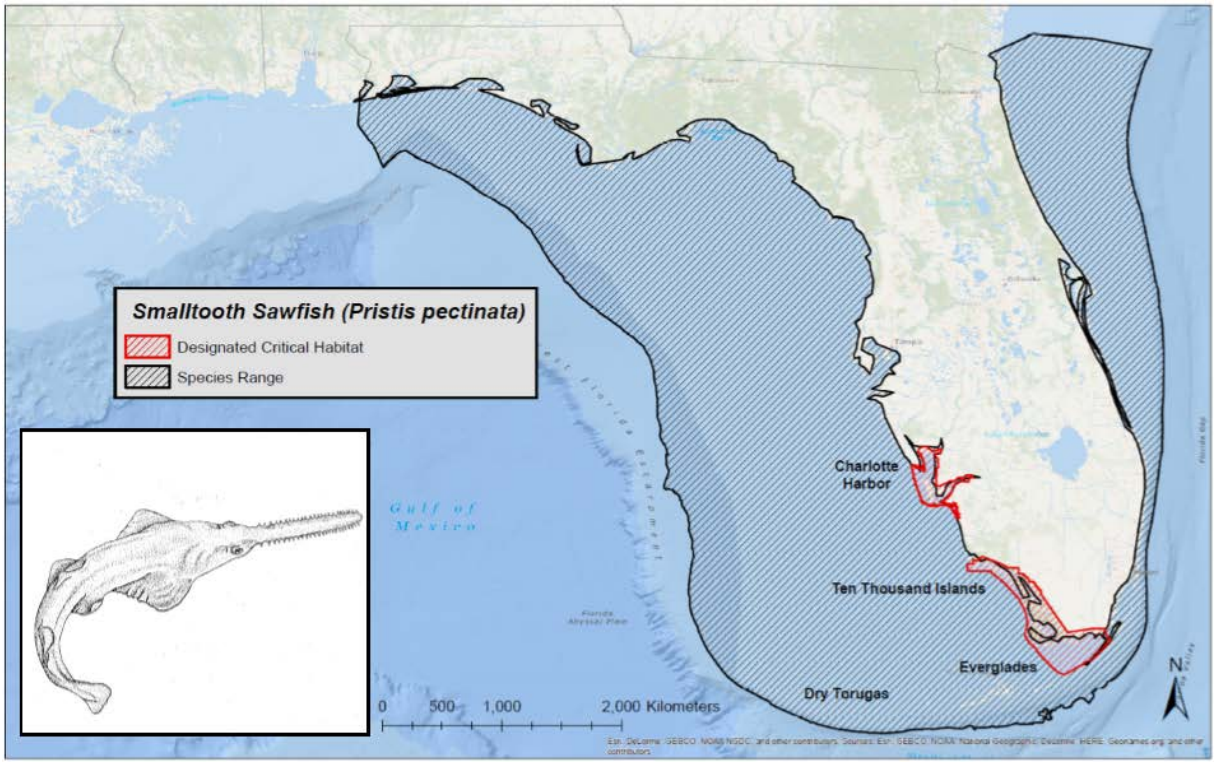


Figure 72. Geographic range and designated critical habitat of smalltooth sawfish, U.S. DPS.

The smalltooth sawfish (*Pristis pectinata*) is a tropical marine and estuarine elasmobranch. Although they are rays, sawfish physically resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their "saw," a long, narrow, flattened rostral blade with a series of transverse teeth along either edge (NMFS 2009d). The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674). Although this species is reported to have a circumtropical distribution, NMFS identified smalltooth sawfish from the Southeast United States as a DPS.

Life history

Smalltooth sawfish size at sexual maturity has been reported as 360 centimeters total length by Simpfendorfer (2005). Carlson and Simpfendorfer (2015) estimated that sexual maturity for females occurs between 7 and 11 years of age. As in all elasmobranchs, smalltooth sawfish are viviparous; fertilization is internal. The gestation period for smalltooth sawfish is estimated at 5 months based on data from the largetooth sawfish (Thorson 1976). Females move into shallow estuarine and nearshore nursery areas to give birth to live young between November and July, with peak parturition occurring between April and May (Poulakis et al. 2011). Litter sizes range between 10 and 20 individuals (Bigalow and Schroeder 1953; Carlson and Simpfendorfer 2015; Simpfendorfer 2005).

Neonate smalltooth sawfish are born measuring 67 to 81 centimeters total length and spend the majority of their time in the shallow nearshore edges of sand and mud banks (Poulakis et al. 2011; Simpfendorfer et al. 2010). Once individuals reach 100 to 140 centimeters total length they begin to expand their foraging range. Capture data suggests smalltooth sawfish in this size class

may move throughout rivers and estuaries within a salinity range of 18 and 30 (practical salinity units). Individuals in this size class also appear to have the highest affinity to mangrove habitat (Simpfendorfer et al. 2011). Juvenile sawfish spend the first 2-3 years of their lives in the shallow waters provided in the lower reaches of rivers, estuaries, and coastal bays (Simpfendorfer et al. 2008; Simpfendorfer et al. 2011). As smalltooth sawfish approach 250 centimeters total length they become less sensitive to salinity changes and begin to move out of the protected shallow-water embayments and into the shorelines of barrier islands (Poulakis et al. 2011). Adult sawfish typically occur in more open-water, marine habitats (Poulakis and Seitz 2004).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to smalltooth sawfish, U.S. DPS.

The abundance of smalltooth sawfish in U.S. waters has decreased dramatically over the past century. Efforts are currently underway to provide better estimates of smalltooth sawfish abundance (NMFS 2014b). Current abundance estimates are based on encounter data, genetic sampling, and geographic extent. Carlson and Simpfendorfer (2015) used encounter densities to estimate the female population size to be 600. Chapman et al. (2011) analyzed genetic data from tissue samples (fin clips) to estimate the effective genetic population size as 250-350 adults (95 percent confidence interval 142-955). Simpfendorfer (2002) estimated that the U.S. population may number less than 5 percent of historic levels based on the contraction of the species' range.

The abundance of juveniles encountered in recent studies (Poulakis et al. 2014; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004) suggests that the smalltooth sawfish population remains reproductively viable. The overall abundance appears to be stable (Wiley and Simpfendorfer 2010). Data analyzed from the Everglades portion of the smalltooth sawfish range suggests that the population growth rate for that region may be around 5 percent per year (Carlson and Osborne 2012; Carlson et al. 2007). Intrinsic rates of growth (λ) for smalltooth sawfish have been estimated at 1.08-1.14 per year and 1.237-1.150 per year by Simpfendorfer (2000) and Carlson and Simpfendorfer (2015) respectively. However, these intrinsic rates are uncertain due to the lack of long-term abundance data.

Chapman et al. (2011) investigated the genetic diversity within the smalltooth sawfish population. The study reported that the remnant population exhibits high genetic diversity (allelic richness, alleles per locus, heterozygosity) and that inbreeding is rare. The study also suggested that the protected population will likely retain >90 percent of its current genetic diversity over the next century.

Recent capture and encounter data suggests that the current distribution is focused primarily to south and southwest Florida from Charlotte Harbor through the Dry Tortugas (Poulakis and Seitz 2004; Seitz and Poulakis 2002). Water temperatures (no lower than 16-18°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major

environmental constraints limiting the distribution of smalltooth sawfish (Bigalow and Schroeder 1953).

Status

The decline in the abundance of smalltooth sawfish has been attributed to fishing (primarily commercial and recreational bycatch), habitat modification (including changes to freshwater flow regimes as a result of climate change), and life history characteristics (i.e. slow-growing, relatively late-maturing, and long-lived species) (NMFS 2009d; Simpfendorfer et al. 2011). These factors continue to threaten the smalltooth sawfish population. Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas, which is also the last U.S. stronghold for the species (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004). While the overall abundance appears to be stable, low intrinsic rates of population increase suggest that the species is particularly vulnerable to rapid population declines (NMFS 2010d).

Recovery Goals

The 2009 Smalltooth Sawfish Recovery Plan (NMFS 2009d) contains complete downlisting/delisting criteria for each of the three following recovery goals.

- Minimize human interactions and associated injury and mortality.
- Protect and/or restore smalltooth sawfish habitats.
- Ensure smalltooth sawfish abundance increases substantially and the species reoccupies areas from which it had been previously extirpated.

2.4.42 *Acropora globiceps* Coral

Acropora globiceps is distributed from the oceanic west Pacific to the central Pacific as far east as the Pitcairn Islands. In the US *A. globiceps* occurs in American Samoa, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and the Pacific Remote Island Areas (PRIAs) (Figure 73). The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

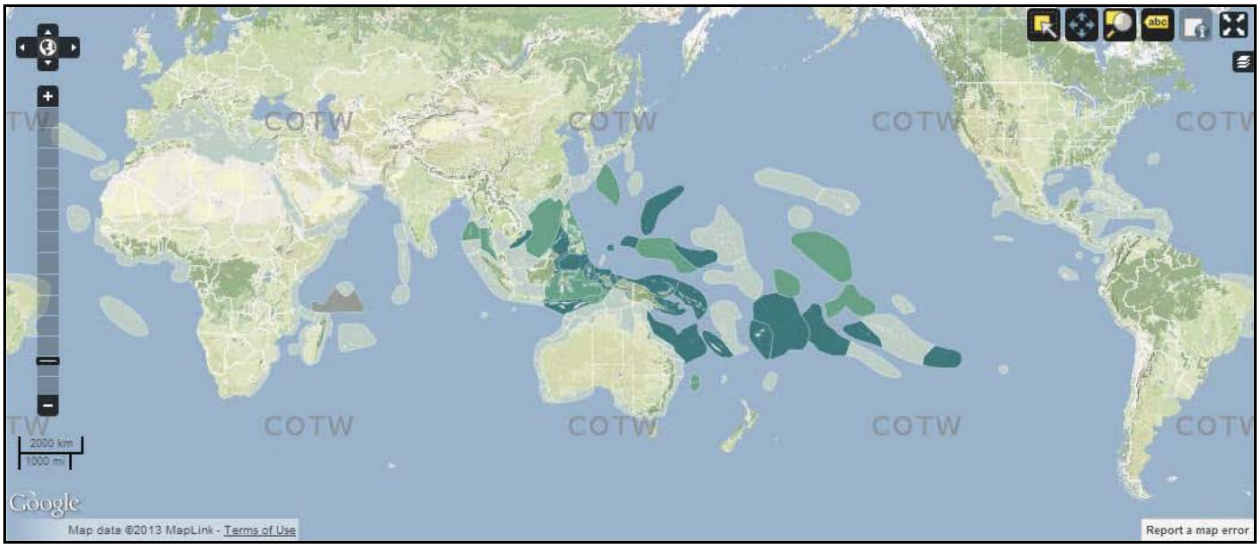


Figure 73. *Acropora globiceps* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

A. globiceps forms digitate colonies with finger shaped vertical or radiating branches. The axial corallite is a small short raised tube. Radial corallites are tubular, may have upward facing openings, are nearly uniform in size, and are often in rows. Colonies are brown or fluorescent green in American Samoa and yellow-brown in the Northern Marianas (at least on Tinian and Rota), and ranging from brown to yellow- brown and green-brown to light tan to gray-green in Guam (Fenner and Burdick 2016). *A. globiceps* was listed as threatened on September 10, 2014 (79 FR 53852).

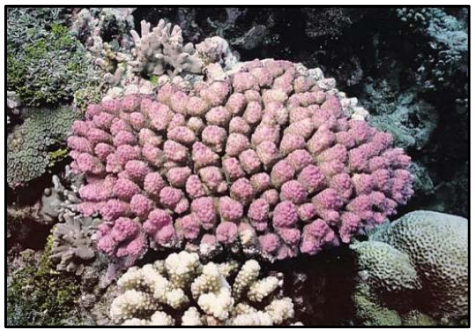


Figure 74. *A. globiceps* colony.

We used information available in the 2014 Review (Veron 2014a) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Acropora are sessile colonies that spawn their gametes into the water column; the larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many *Acropora* species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). All species of the genus *Acropora* studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in *Acropora* colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of *Acropora* are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five *Acropora* species examined by Wallace

(1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization.

Many *Acropora* have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *A. globiceps*.

Veron (2014) reports that *A. globiceps* occupied 3.2 percent of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.95 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as "uncommon." Overall abundance was described as "sometimes common." Veron did not infer trends in abundance from these data. As described in the Indo-Pacific Species Determinations introduction above, based on results from Richards et al. (2008) and Veron (2014), the absolute abundance of this species is likely at least tens of millions of colonies.

The overall decline in abundance ("Percent Population Reduction") was estimated at 35 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 percent (Carpenter et al., 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *A. globiceps* occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited species-specific information.

Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for *Acropora*, the year-by-year replenishment of populations

requires local source populations. For example, Vollmer and Palumbi (2007), using DNA sequence data, determined that *A. cervicornis* in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

A. globiceps has been reported from intertidal, upper reef slopes and reef flats. Although it most commonly occurs at depths of 0 to 8 m (Veron 2000), it has been recorded as deep as 20 m in the Mariana Islands (Fenner and Burdick 2016).

Status

A. globiceps is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, nutrients, and predation. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. *A. globiceps* occurs primarily in depths of zero to eight meters which can be considered a shallow depth range compared to the overall depth of occurrence for reef building corals in general. Shallow reef areas are often subjected to highly variable environmental conditions, extremes, high irradiance, and simultaneous effects from multiple stressors, both local and global in nature. A limited depth range reduces the absolute area in which the species may occur throughout its geographic range and indicates that a large proportion of the population is likely to be exposed to threats that are worse in shallow habitats, such as simultaneously elevated irradiance and seawater temperatures, as well as localized impacts. The combination of these characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.43 *Acropora jacquelineae* Coral

Acropora jacquelineae is distributed within the Coral Triangle including Papua New Guinea, and is reported from American Samoa. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

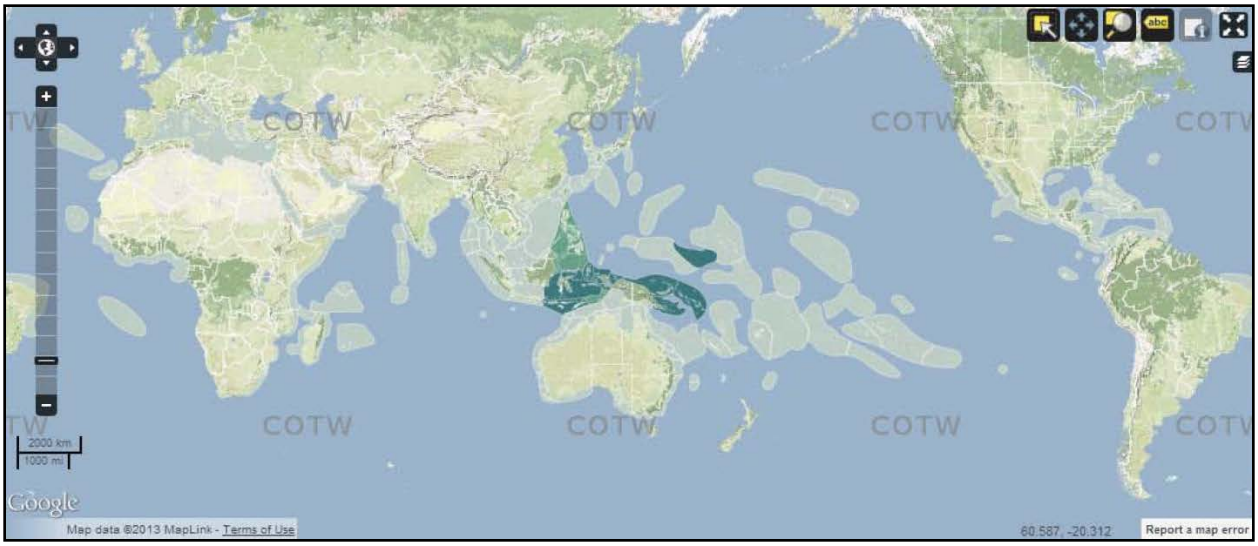


Figure 75. *Acropora jacquelineae* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

Colonies of *A. jacquelineae* are flat plates up to 1 m in diameter. Viewed from above, plates are covered with a mass of fine delicately-curved axial corallites giving an almost moss-like appearance. There is almost no development of radial corallites. Colonies are uniform grey-brown or pinkish in color (Veron, 2000). Axial corallites have thin walls and are only about 1 mm thick (Fenner and Burdick 2016). *A. jacquelineae* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 76. *A. jacquelineae* colony.

We used information available in the 2014 Review (Veron 2014a) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Acropora are sessile colonies that spawn their gametes into the water column; the larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many *Acropora* species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). All species of the genus *Acropora* studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in *Acropora* colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of *Acropora* are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five *Acropora* species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization.

Many *Acropora* have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *A. jacquelineae*.

The total world population of this species is estimated at 31,599,000 colonies, with an effective population size of 3,476,000 colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance ("Percent Population Reduction") was estimated at 37 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 percent. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *A. jacquelineae* occurs in many areas affected by these broad changes, and has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for *Acropora*, the year-by-year replenishment of populations requires local source populations. For example, Vollmer and Palumbi (2007), using DNA sequence data, determined that *A. cervicornis* in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

A. jacquelineae has been reported to occupy subtidal, walls, ledges on walls, and shallow reef slopes protected from wave action (Veron, 2000; Wallace, 1999). *A. jacquelineae* has been reported in water depths ranging from 10 m to 35 m (Carpenter et al., 2008; Wallace, 1999).

Status

A. jacquelineae is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrient enrichment. These threats are expected to continue and increase into the future. In addition existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. *A. jacquelineae' s* distribution is constrained mostly to the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century, as described in the Threats Evaluation. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. Considering the limited range of this species in an area where severe and increasing impacts are predicted, this level of abundance leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.44 *Acropora retusa* Coral

Acropora retusa is distributed from the Red Sea and the Indian Ocean to the central Pacific. It occurs in Guam, CNMI, American Samoa, and PRIAs. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

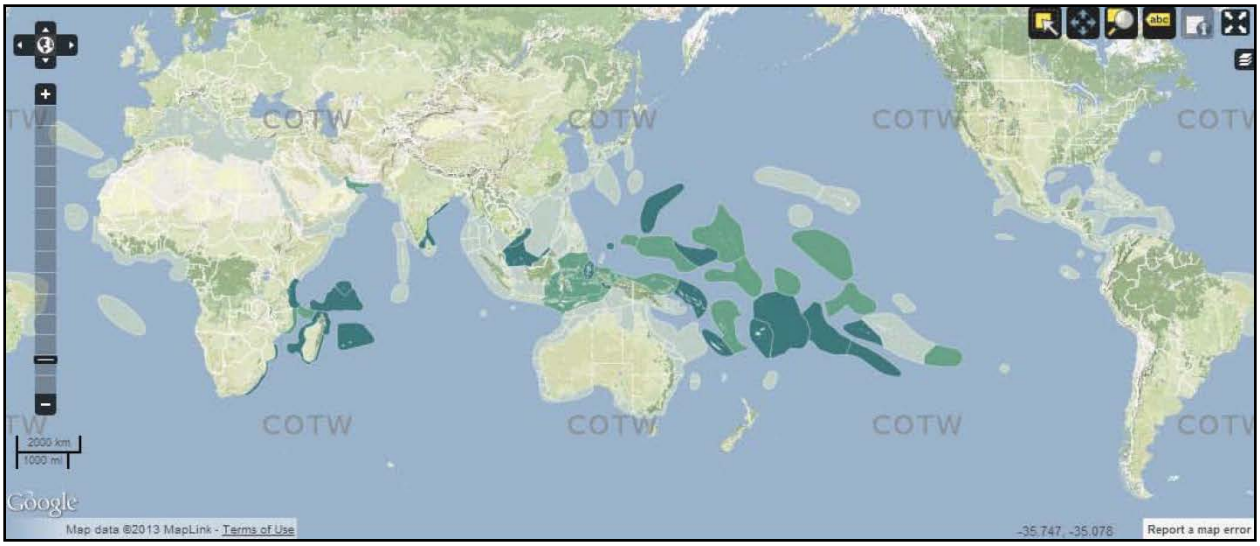


Figure 77. *Acropora retusa* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

A. retusa forms colonies consisting of "digitate" (finger-like) branches. Both the axial corallite and radial corallites are cylindrical in shape, and the axial corallite is about the size of one of the largest radial corrallites. Radial corallites vary in size, giving the branches a "spiny" or "prickly" look. This species has not been distinguished among living colonies until recently, and so it is particularly poorly known. It is on reef slopes and may be in other reef zones as well (Fenner and Burdick 2016). *A. retusa* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 78. *A. retusa* colony.

We used information available in the 2014 Review (Veron 2014a) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Acropora are sessile colonies that spawn their gametes into the water column; the larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many *Acropora* species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). All species of the genus *Acropora* studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in *Acropora* colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of *Acropora* are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five *Acropora* species examined by Wallace

(1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization.

Many *Acropora* have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *A. retusa*.

Veron (2014) reports that *A. retusa* occupied 0.5 percent of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.21 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as "rare." Overall abundance was described as "common in South Africa, rare elsewhere." The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance ("Percent Population Reduction") was estimated at 49 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 18 percent. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *A. retusa* occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited amount of species-specific information.

Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for *Acropora*, the year-by-year replenishment of populations requires local source populations. For example, Vollmer and Palumbi (2007), using DNA

sequence data, determined that *A. cervicornis* in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

A. retusa has been reported to occupy upper reef slopes and tidal pools (Veron, 2000; Veron and Wallace, 1984). *A. retusa* has been reported in water depths ranging from 1 m to 5 m (Carpenter et al., 2008).

Status

A. retusa is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrients. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms addressing global threats that contribute to extinction risk for this species are inadequate. *A. retusa* is restricted to shallow habitat (zero to five meters), where many global and local threats may be more severe, especially near populated areas. Shallow reef areas are often subjected to highly variable environmental conditions, extremes, high irradiance, and simultaneous effects from multiple stressors, both local and global in nature. A limited depth range also reduces the absolute area in which the species may occur throughout its geographic range, and indicates that a large proportion of the population is likely to be exposed to threats that are worse in shallow habitats, such as simultaneously elevated irradiance and seawater temperatures, as well as localized impacts. *A. retusa'* s abundance is considered rare overall. This level of abundance, combined with its restricted depth distribution where impacts are more severe, leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.45 *Acropora speciosa* Coral

Acropora speciosa is distributed from Indonesia to French Polynesia. Within the U.S., the species occurs in American Samoa and the PRIAs. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

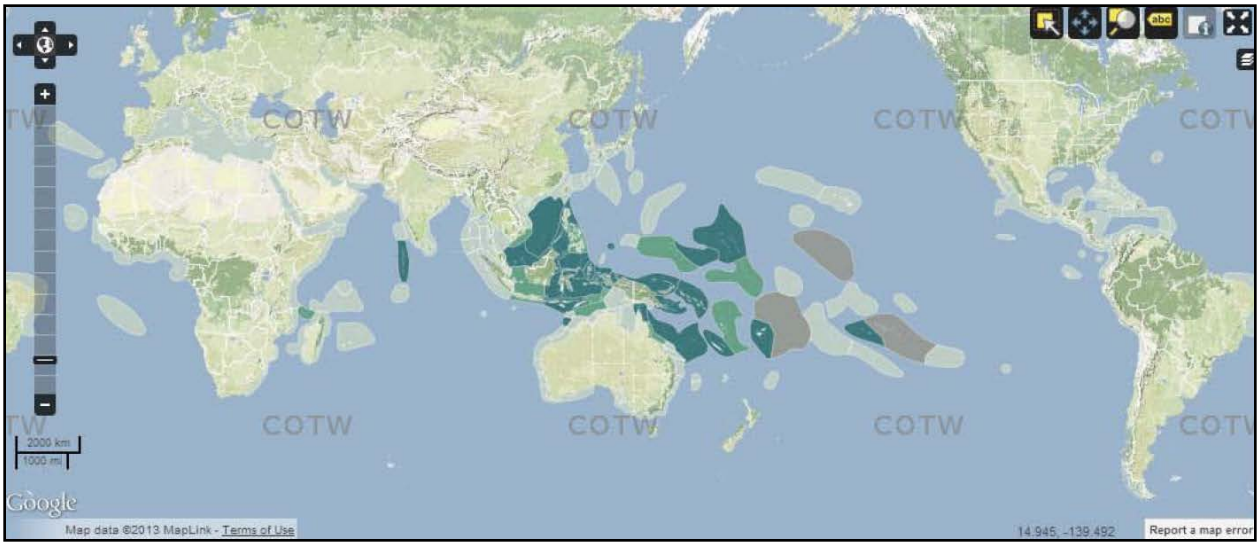


Figure 79. *Acropora speciosa* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

A. speciosa forms small flat-topped colonies with thin scraggly branchlets and many thin, long, smooth axial corallites. Many radials are similar to the axials, and all have blunt ends with thick walls. Colonies are usually rust colored (Fenner and Burdick 2016). *A. speciosa* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 80. *A. speciosa* colony.

We used information available in the 2014 Review (Veron 2014) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Acropora are sessile colonies that spawn their gametes into the water column; the larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many *Acropora* species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). All species of the genus *Acropora* studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in *Acropora* colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of *Acropora* are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five *Acropora* species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization.

Many *Acropora* have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *A. speciosa*.

The total world population of this species has been estimated at 10,942,000 colonies, with an effective population size of 1,204,000 colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance ("Percent Population Reduction") was estimated at 35 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 percent (Carpenter et al. 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *A. speciosa* occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

A. speciosa has been reported to occupy protected environments with clear water and high diversity of *Acropora* (Veron, 2000) and steep slopes or deep, shaded waters (IUCN, 2010). *A. speciosa* has been reported in water depths ranging from 12 m to 30 m (Carpenter et al., 2008) and 15 m to 40 m (Richards, 2009). It is found in mesophotic assemblages in American Samoa (Bare et al., 2010), suggesting the potential for deep refugia.

Status

A. speciosa is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrient enrichment. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms to address global threats that

contribute to extinction risk for this species are inadequate. Although *A. speciosa' s* habitat includes mesophotic depths which may provide some buffering capacity against threats that are more severe in shallower reef environments such as warming, its habitat is quite specialized, which may limit buffering capacity if threats are more pronounced within the type of habitat where the species occurs within. *A. speciosa's* effective population size of 1.2 million genetically distinct colonies could increase vulnerability to extinction if a high proportion of the effective population occurs within the parts of its range most affected by threats, potentially causing the species to decline to such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.46 *Seriatopora aculeata* Coral

Seriatopora aculeata is distributed from Australia, Fiji, Indonesia, Japan, Papua New Guinea, and Madagascar to the Marshall Islands. Within the U.S., the species occurs in Guam and CNMI. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

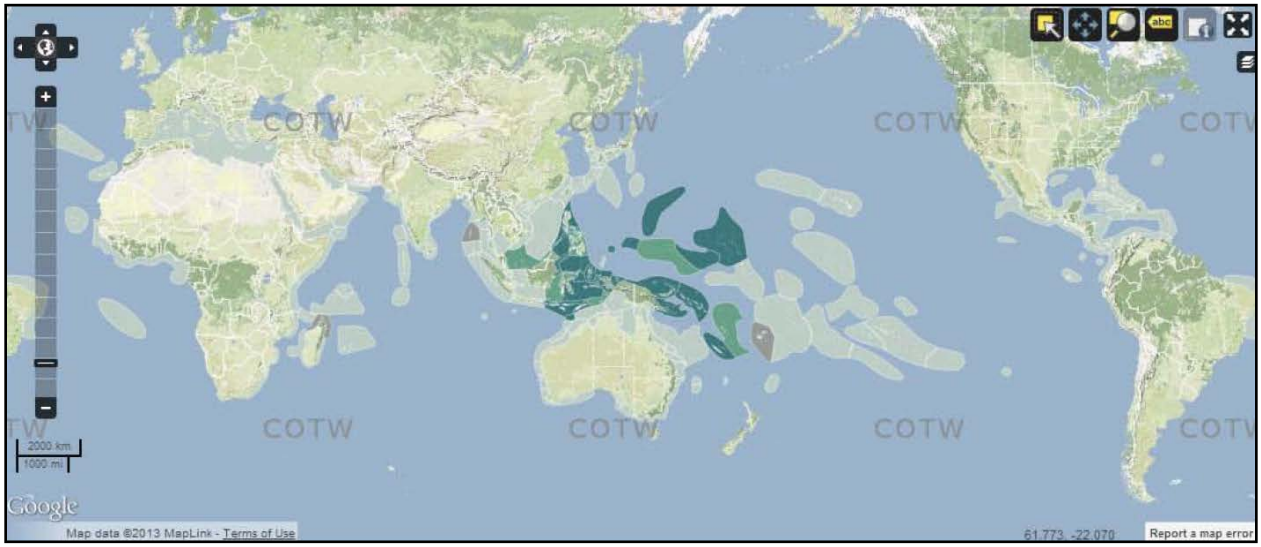


Figure 81. *Seriatopora aculeata* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

S. aculeata makes colonies of pencil-diameter branches, which are usually short and always taper sharply at the end to a relatively sharp tip. The corallites on the branch sides are neither in rows nor raised (Fenner and Burdick 2016). Colonies are pink or cream in color (Veron, 2000). *S. aculeata* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 82. *S. aculeata* colony.

We used information available in the 2014 Review (Veron 2014) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

The reproductive characteristics of *S. aculeata* have not been determined, but its congeners are hermaphroditic brooders (Rinkevich and Loya, 1979a; Shlesinger and Loya, 1985; Yamazato et al., 1991). The larvae of the other *Seriatopora* species studied contain zooxanthellae, leading to the development of autotrophic larvae that can supplement maternal provisioning with energy sources provided by their photosynthetic symbionts (Baird et al., 2009). The minimum size and estimated age at first reproduction have not been determined for *S. aculeata*. However, for the congener *S. hystrix*, the minimum diameter is 8 cm and the estimated age at first reproduction is 1–2 years (Stimson, 1978). Larval longevity has not been determined in this genus. *S. hystrix* can undergo polyp bailout during environmentally stressful conditions and successfully reattach (though at low rates) to the substrate (Sammarco, 1982); however, this potential mode of asexual reproduction has not been documented for *S. aculeata*.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *S. aculeata*.

Veron (2014) reports that *S. aculeata* occupied 10.3 percent of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.70 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as "common," and overall abundance was described as "uncommon." The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance was estimated at 37 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 percent (Carpenter et a. 2014). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years

(Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *S. aculeata* occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but quantification is not possible based on the limited species-specific information.

There is little information available regarding the genetic diversity of this species.

S. aculeata has been reported to occupy shallow reef environments (Veron, 2000). *S. aculeata* has been reported in water depths ranging from 3 m to 40 m (Carpenter et al., 2008).

Status

S. aculeata is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, nutrients, and collection and trade. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. *S. aculeata's* distribution is constrained to the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century, as described in the Threats Evaluation. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.47 *Euphyllia paradivisa* Coral

Euphyllia paradivisa occurs in the Coral Triangle Region and in parts of Oceania. Within U.S. waters, *E. paradivisa* occurs in American Samoa. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

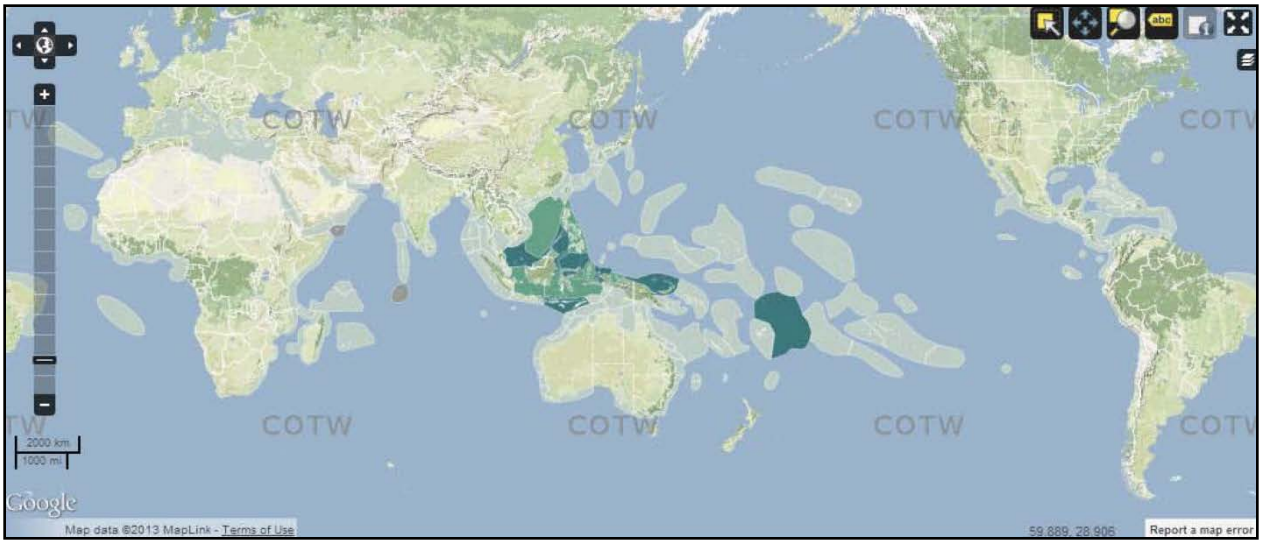


Figure 83. *Euphyllia pardivisa* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

E. paradivisa makes branching colonies, with branches about an inch in diameter. Polyps are only on the ends of branches, and branches are close enough together that they may be hard to distinguish. If the tentacles are in rounded circles, then they are on the ends of branches, instead of on long meandering valleys. The polyps on the ends of branches are fairly large, with only one polyp on the end of each branch, usually. The tentacles have round knobs on the ends. The tentacles also branch, and side branches usually have smaller knobs on the ends.(NMFS 2016). *E. paradivisa* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 84. *E. paradivisa* colony.

We used information available in the 2014 Review (Veron 2014) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

Reproductive mode is not known. One congener (*E. ancora*) is a gonochoric spawner (Guest et al., 2005a; Willis et al., 1985) while another congener (*E. glabrescens*) is reported to be a hermaphroditic brooder in southern Taiwan (Fan et al., 2006). No other information regarding its ecology or life history is available.

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *E. paradivisa*.

Veron (2014) reports that *E. paradivisa* occupied 0.2 percent of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.5 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as “rare,” and overall abundance was described as “uncommon.” Veron did not infer trends in abundance from these data. The absolute abundance of this species is likely at least tens of millions of colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance was estimated at 38 percent, and the decline in abundance before the 1998 bleaching event (“Back-cast Percent Population Reduction”) was estimated at 15 percent (Carpenter et al. 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context. Thus, quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *E. paradivisa* occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited species-specific information.

There is little information available regarding the genetic diversity of this species.

E. paradivisa has been reported from shallow or mid-slope reef environments protected from wave action (Veron, 2000). It typically occupies a depth range of 2 to 25 meters, but has also been recorded in American Samoa at 48 m (Fenner and Burdick 2016).

Status

E. paradivisa is susceptible to warming-induced bleaching, disease, ocean acidification, trophic effects of fishing, nutrients, predation, and collection and trade. These threats are expected to continue and worsen into the future. In addition, the species has inadequate existing regulatory mechanisms for global threats. *E. paradivisa' s* distribution is limited mostly to the Coral Triangle, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century. Multiple ocean warming events have already occurred within the Coral Triangle that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. *E. paradivisa'* s semi-quantitative abundance is rare. Considering the limited range of this species in an area where severe and increasing impacts are predicted, this level of abundance leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats

indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.48 *Isopora crateriformis* Coral

Isopora crateriformis' distribution is from Sumatra (Indonesia) to American Samoa, and there are reports from the western and central Indian Ocean that need confirmation. In U.S. waters, it occurs in American Samoa. The U.S. distribution is described in more detail in the Species Report available at http://www.fpir.noaa.gov/PRD/prd_listed_coral.html.

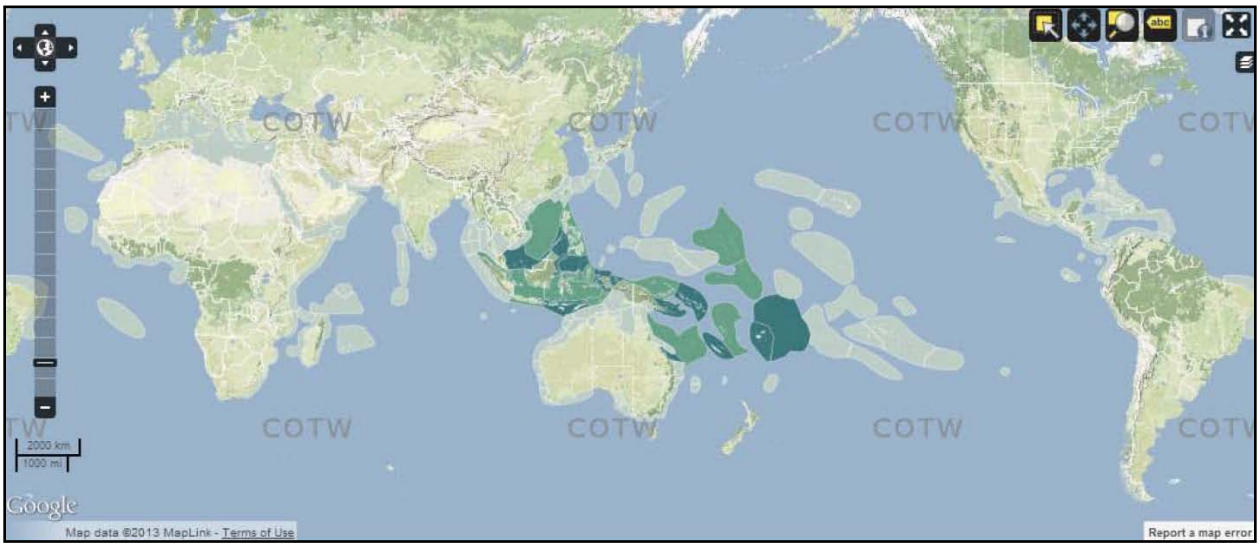


Figure 85. *Isopora crateriformis* distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014a).

I. crateriformis forms colonies that are encrusting or plates. Colonies on slopes usually form plates on their lower edge. The colonies commonly have some low irregular ridges on the surface of the plate, but no branches are formed. Colonies are usually about 1-2 feet diameter. The surface is covered with small round cylindrical corallites close together. Colonies usually are a light rusty color, and some colonies have green centers in their corallites. Colonies are most common on upper reef slopes but can be in other reef zones. This species is rare most places within its range, but is common in parts of American Samoa, especially the southwest coast of Tutuila. Where it is most common, it is most abundant at about 5 m depths, and less common with decreasing or increasing depth from there (NMFS 2016). *I. crateriformis* was listed as threatened on September 10, 2014 (79 FR 53852).



Figure 86. *I. crateriformis* colony.

We used information available in the 2014 Review (Veron 2014) and the 2014 listing document (79 FR 53852) to summarize the life history, population dynamics and status of the species, as follows.

Life history

I. crateriformis is most likely a simultaneous hermaphroditic brooder as is the closely related *Isopora cuneata* (Bothwell, 1981). *Isopora cuneata* can undergo several seasonal cycles of larval production (Kojis, 1986). Its brooding life history allows *Isopora* spp. to locally dominate recruitment at Lord Howe Island, Australia; colonies of this genus also dominate the adult population there, suggesting brooding may drive community structure in remote areas (Harriott, 1992; 1995). *I. cuneata* is not prone to asexual reproduction via fragmentation, based on its semi-encrusting morphology (Bothwell, 1981). The species shows moderate gene flow (Mackenzie et al., 2004) but little potential for large-scale dispersal (Ayre and Hughes, 2004).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to *I. crateriformis*.

Veron (2014) reports that *I. crateriformis* occupied 0.3 percent of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.4 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as "rare." Overall abundance was described as "occasionally common on reef flats." The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

The overall decline in abundance was estimated at 38 percent, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 percent. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences of species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that *I. crateriformis* occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

The species shows moderate gene flow (Mackenzie et al., 2004) but little potential for large-scale dispersal (Ayre and Hughes, 2004).

I. crateriformis is found most commonly in shallow, high-wave energy environments. *I. craterformis* has been reported in water depths ranging from low tide commonly to at least 12 m (Birkeland, 1987). The species was reported (as *A. crateriformis*) on mesophotic reefs (< 50 m depth) in American Samoa (Bare et al., 2010).

Status

I. crateriformis is highly susceptible to ocean warming, disease, acidification, trophic effects of fishing, and nutrients, and predation. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. The majority of *I. crateriformis'* distribution is within the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. *I. crateriformis'* qualitative abundance is rare overall. Considering that much of the range of this species includes areas where severe and increasing impacts are predicted, this level of abundance combined with its restricted depth distribution, leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these biological and environmental characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

2.4.49 Elkhorn Coral

The elkhorn coral is a cnidarian belonging to the taxonomic order of scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Elkhorn coral occurs throughout coastal areas in the Caribbean, Gulf of Mexico, and southwestern Atlantic (Figure 87).

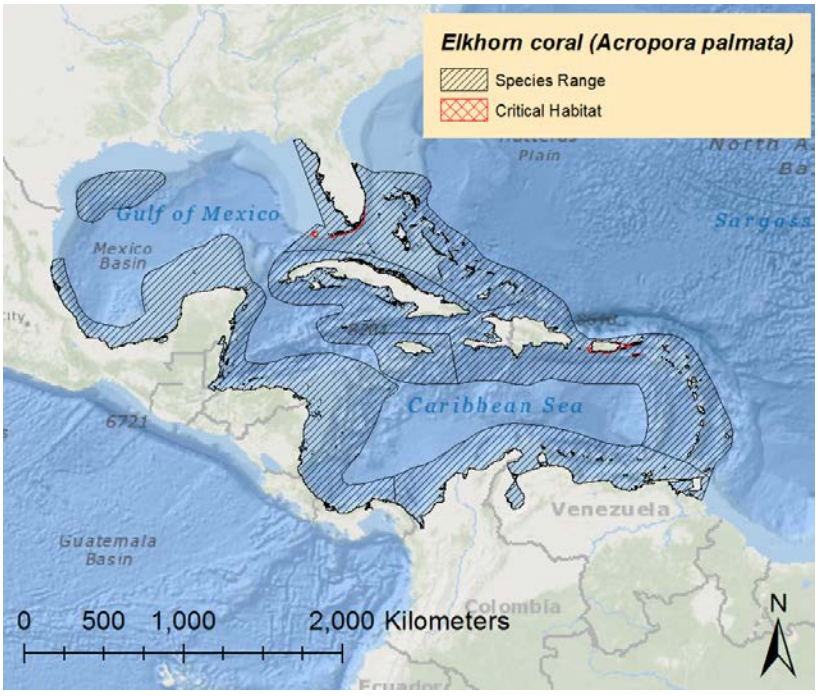


Figure 87. The distribution of elkhorn coral throughout the Caribbean including ESA listed critical habitat.

The Elkhorn coral *A. palmata* is a cnidarian belonging to the taxonomic order of scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Elkhorn corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems.

In addition to being able to catch and eat their own food, Elkhorn coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005a).

A. palmata was listed as threatened under the ESA in 2006. In 2012, a proposal to change the listing to endangered was made, but in 2014 its threatened status was upheld. In 2008, critical habitat for Elkhorn coral was designated in areas surrounding the Florida Keys, Puerto Rico, and portions of the Virgin Islands. Along with staghorn coral, elkhorn coral is the only other large, branching species of coral to produce and occupy vast complex environments within the Caribbean Sea's reef system.



Figure 88. Image of an elkhorn coral colony.

Life history

Elkhorn coral, like most stony corals, employ both sexual and asexual reproductive strategies to propagate. Sexual reproduction in corals includes gametogenesis, the process in which cells undergo meiosis to form gametes within the polyps near the base of the mesenteries (See Figure 4). Since *A. palmata* is hermaphroditic, each polyp contains both sperm and egg cells that are released together in a 'bundle', causing the coral gametes to develop externally from the parental colony. Elkhorn coral reproduces sexually after the full moon of July, August, and/or September, depending on location and timing of the full moon (*Acropora* Biological Review Team 2005). Split spawning (spawning over a 2 month period) has been reported from the Florida Keys (Fogarty et al. 2012). The estimated size at sexual maturity is approximately 250 in^2 (1,600 cm^2), and growing edges and encrusting base areas are not fertile (Soong and Lang 1992). Larger colonies have higher fecundity per unit area, as do the upper branch surfaces (Soong and Lang 1992). Although self-fertilization is possible, elkhorn coral is largely self-incompatible (Baums et al. 2005a; Fogarty et al. 2012). Sexual recruitment rates are low, and this species is generally not observed in coral settlement studies in the field. Rates of post-settlement mortality after nine months are high based on settlement experiments (Szmant and Miller 2005).

Reproduction occurs primarily through asexual reproduction, generating multiple colonies that are genetically identical. Elkhorn coral can quickly monopolize large spaces of shallow ocean floor through fragment dissemination. A branch of *A. palmata* can be carried by waves and currents away from the mother colony to distances that range from 0.1 – 100 meters, but fragments usually travel less than 30 meters (NMFS 2005a).

Because large colonies of *A. palmata* contain several thousand partially autonomous polyps, growth rates for the species are conveyed through the measurement of linear extensions of the organisms' skeletal branches. Depending on the size and location of the colony, physical growth rates for elkhorn corals range from approximately four to eleven centimeters per year. Branches are up to approximately 50 centimeters wide and range in thickness of about four to five

centimeters. Individual colonies can grow to at least two meters in height and four meters in diameter (NMFS 2005a). Total lifespan for the species is unknown (NMFS 2014a).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the elkhorn coral.

Genetic samples from 11 locations throughout the Caribbean indicate that elkhorn coral populations in the eastern Caribbean (St. Vincent and the Grenadines, U.S. Virgin Islands, Curaçao, and Bonaire) have had little or no genetic exchange with populations in the western Atlantic and western Caribbean (Bahamas, Florida, Mexico, Panama, Navassa, and Puerto Rico) (Baums et al. 2005b). While Puerto Rico is more closely connected with the western Caribbean, it is an area of mixing with contributions from both regions (Baums et al. 2005b). Models suggest that the Mona Passage between the Dominican Republic and Puerto Rico promotes dispersion of larval and gene flow between the eastern Caribbean and western Caribbean (Baums et al. 2006b).

Colonial species present a special challenge in determining the appropriate unit to evaluate for abundance. However, the present population of Elkhorn coral is continuing at a very low abundance due to large declines in the past several decades (NMFS 2005a). The western Caribbean is characterized by genetically depauperate populations with lower densities (0.13 ± 0.08 colonies per m^2). The eastern Caribbean populations are characterized by denser (0.30 ± 0.21 colonies per m^2), genotypically richer stands(Baums et al. 2006a).

Baums et al. (2006a) concluded that the western Caribbean had higher rates of asexual recruitment and that the eastern Caribbean had higher rates of sexual recruitment. The research team claims that the postulated geographic differences in the contribution of reproductive modes to population structure may be related to habitat characteristics, possibly the amount of shelf area available.

Genotypic diversity is highly variable for elkhorn coral. From the survey data it can be inferred that genetic variability is more present in colonies within eastern populations as opposed to western. At two sites in the Florida Keys, only one genotype per site was detected out of 20 colonies sampled at each site (Baums et al. 2005b). In contrast, sites within the eastern Caribbean displayed high variability. All 15 colonies sampled in Navassa had unique genotypes (Baums et al. 2006a). Some sites have relatively high genotypic diversity such as in Los Roques, Venezuela (118 unique genotpyes out of 120 samples; Zubillaga et al. 2008) and in Bonaire and Curaçao (18 genotypes of 22 samples and 19 genotypes of 20 samples, respectively; Baums et al. 2006a). In the Bahamas, about one third of the sampled colonies were unique genotypes, and in Panama between 24 and 65 percent of the sampled colonies had unique genotypes, depending on the site (Baums et al. 2006a). A more-recent survey conducted along the coast of Puerto Rico found unique genotypes in 75 percent of the samples with high genetic diversity (Mège et al. 2014).

Elkhorn coral occurs in turbulent water on the back reef, fore reef, reef crest, and spur and groove zone in water ranging from one to thirty meters in depth. Historically, *A. palmata*

inhabited most waters of the Caribbean between one to five meters depth. This included a diverse set of areas comprising of zones along Puerto Rico, Hispaniola, the Yucatan peninsula, the Bahamas, the southwestern Gulf of Mexico, the Florida Keys, the Southeastern Caribbean islands, and the northern coast of South America (Dustan and Halas 1987; Goreau 1959a; Jaap 1984a; Kornicker and Boyd 1962; Scatterday 1974; Storr 1964). While the present-day spatial distribution of elkhorn coral is similar to its historic spatial distribution, its presence within its range has become increasingly sparse due to declines in the latter half of the 20th century from a variety of abiotic and biotic threats.

Based on population estimates from both the Florida Keys and St. Croix, U.S. Virgin Islands, there are at least hundreds of thousands of elkhorn coral colonies. Absolute abundance is higher than estimates from these two locations given the presence of this species in many other locations throughout its range. The effective population size is smaller than indicated by abundance estimates due to the tendency for asexual reproduction. Across the Caribbean, percent cover appears to have remained relatively stable, albeit it at extremely low levels, since the population crash in the 1980s. Frequency of occurrence has decreased since the 1980s, indicating potential decreases in the extent of occurrence and effects on the species' range. However, the proportions of Caribbean sites where elkhorn coral is present and dominant have recently stabilized since the mid-2000s. There are locations such as the U.S. Virgin Islands where populations of elkhorn coral appear stable or possibly increasing in abundance and some such as the Florida Keys where population number appears to be decreasing.

Status

The decline in the total abundance of elkhorn coral has been attributed to a series of stressors consisting of disease, temperature-induced bleaching, excessive sedimentation, nitrification, pollution (i.e. oxybenzone from sunscreen) ,and large hurricanes/tropical storms (Brainard et al. 2011a; Downs et al. 2016; Hernandez-Delgado et al. 2011; Mayor et al. 2006; Rogers and Muller 2012). It is believed that these effects act synergistically with one another thereby increasing the overall damage to already-stressed *A. palmata* colonies that have undergone disturbance by another threat. The current population trend appears to be steady, although there are places where populations continue to decrease and others where there appears to be modest or contained recovery (Miller et al. 2013a). However, even if growth and recruitment end up surpassing mortality, this species requires prompt analysis and monitoring on a regional scale. Reasoning for this includes the current presence of areas with low genetic diversity and density within western Caribbean populations along with localized high rates of disease and bleaching (Miller et al. 2013a).

Recovery Goals

The 2015 Elkhorn Coral (*A. palmata*) and Staghorn Coral (*A. cervicornis*) Recovery Plan contains complete downlisting/delisting criteria for each of the two following recovery goals.

Ensure Population Viability – Specific criteria include: 1) Preserving Abundance; 2) Maintaining Genotypic Diversity; and 3) Properly Observing and Recording Recruitment Rates.

Eliminate or sufficiently abate global, regional, and local threats – Specific criteria include: 1) Developing quantitative recovery criterion through research to identify, treat, and reduce outbreaks of coral disease; 2) Controlling the Local and Global Impacts of Rising Ocean Temperature and Acidification; 3) Reducing the Loss of Recruitment Habitat (if criterion 1, preserving abundance, is met then this objective is complete; 4) Reducing sources of nutrients, sediments, and contaminants; 5) Developing and adopting appropriate and effective regulatory mechanisms to abate threats; 6) Reducing impacts of natural and anthropogenic abrasion and breakage; and 7) Reducing impacts of predation.

2.4.50 Staghorn Coral

The staghorn coral is a cnidarian belonging to the taxonomic order of Scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Staghorn coral occurs throughout coastal areas in the Caribbean, Gulf of Mexico, and southwestern Atlantic (Figure 89).

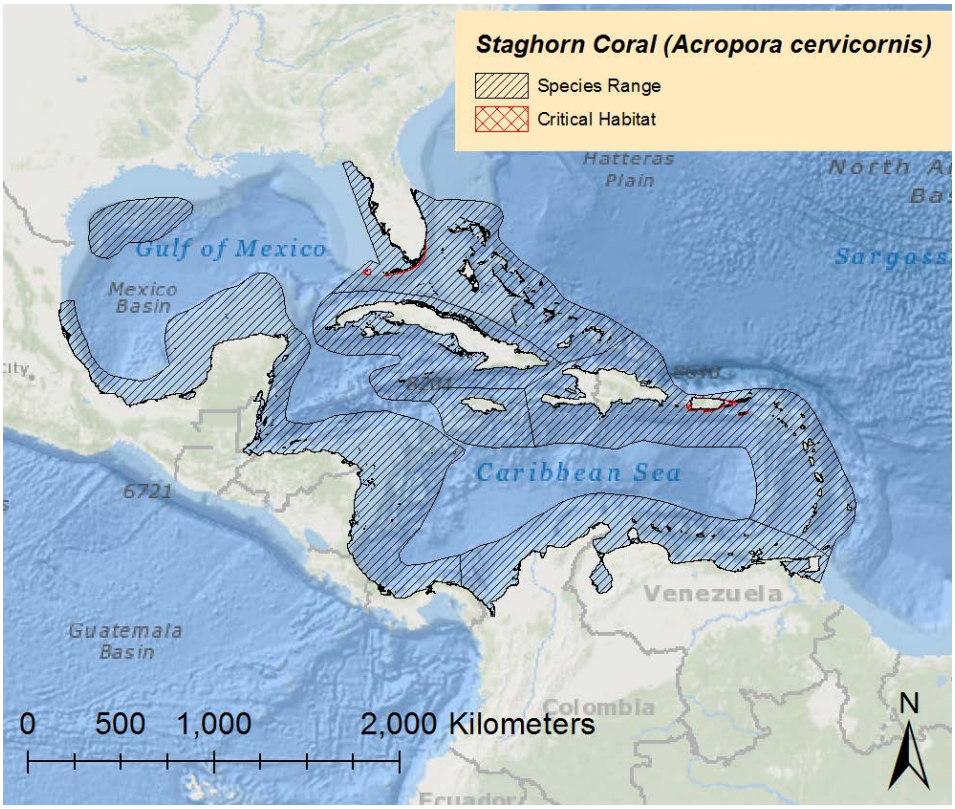


Figure 89. The distribution of the staghorn coral throughout the Caribbean.

Staghorn coral is characterized by antler-like colonies with straight or slightly curved, cylindrical branches. The diameter of branches ranges from 0.25-5 centimeters in Lirman et al. (2010a), and linear branch growth rates have been reported to range between 3-11.5 centimeters per year (*Acropora* Biological Review Team 2005). The species can exist as isolated branches, individual colonies up to about 1.5 meters diameter, and thickets comprised of multiple colonies that are difficult to distinguish from one another (*Acropora* Biological Review Team 2005).



Figure 90. Image of a staghorn coral.

Staghorn coral naturally occurs on spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hard bottom habitats (Cairns 1982; Davis 1982; Gilmore and Hall 1976; Goldberg 1973; Jaap 1984b; Miller et al. 2008; Wheaton and Jaap 1988). Historically it grew in thickets in water ranging from approximately five to twenty meters in depth; though it has rarely been found to approximately 60 meters (Davis 1982; Jaap 1984b; Jaap et al. 1989; Schuhmacher and Zibrowius 1985; Wheaton and Jaap 1988). At the northern extent of its range, it grows in deeper water 16-30 meters (Goldberg 1973). Historically, staghorn coral was one of the primary constructors of mid-depth 10-15 meter reef terraces in the western Caribbean, including Jamaica, the Cayman Islands, Belize, and some reefs along the eastern Yucatan peninsula (Adey 1978). In the Florida Keys, staghorn coral occurs in various habitats but is most prevalent on patch reefs as opposed to their former abundance in deeper fore-reef habitats (i.e., 5 to 22 meters) (Miller et al. 2008). There is no evidence of range constriction, though loss of staghorn coral at the reef level has occurred (*Acropora* Biological Review Team 2005).

Precht and Aronson (2004) suggest that coincident with climate warming, staghorn coral only recently re-occupied its historic range after contracting to south of Miami, Florida, during the late Holocene. They based this idea on the presence of large thickets off Ft. Lauderdale, Florida, which were discovered in 1998 and had not been reported in the 1970s or 1980s (Precht and Aronson 2004). However, because the presence of sparse staghorn coral colonies in Palm Beach County, north of Ft. Lauderdale, was reported in the early 1970s(though no thicket formation was reported) (Goldberg 1973), there is uncertainty associated with whether these thickets were present prior to their discovery or if they recently appeared coincident with warming. The proportion of reefs with staghorn coral present decreased dramatically after the Caribbean-wide mass mortality in the 1970s and 1980s, indicating the spatial structure of the species has been affected by extirpation from many localized areas throughout its range (Jackson et al. 2014b).

Staghorn coral was observed in 21 out of 301 stations between 2011 and 2013 in stratified random surveys designed to detect *Acropora* colonies along the south, southeast, southwest, and west coasts of Puerto Rico (García Sais et al.2013). Staghorn coral was also observed at 16 sites outside of the surveyed area. The largest colony was 60 centimeters and density ranged from one to ten colonies per fifteen square meters (García Sais et al.2013).

Life history

Relative to other corals, staghorn coral has a high growth rate that has allowed acroporid reef growth to keep pace with past changes in sea level (Fairbanks 1989). Growth rates, measured as skeletal extension of the end of branches, range from approximately four to eleven centimeters per year (*Acropora* Biological Review Team 2005). Annual linear extension has been found to be dependent on the size of the colony. New recruits and juveniles typically grow at slower rates. Stressed colonies and fragments may also exhibit slower growth.

Staghorn coral is a hermaphroditic broadcast spawning species. The spawning season occurs several nights after the full moon in July, August, or September depending on location and timing of the full moon and may be split over the course of more than one lunar cycle (Szmant 1986; Vargas-Angel et al. 2006). The estimated size at sexual maturity is approximately seventeen centimeters branch length, and large colonies produce proportionally more gametes than small colonies (Soong and Lang 1992). Basal and branch tip tissue is not fertile (Soong and Lang 1992). Sexual recruitment rates are low, and this species is generally not observed in coral settlement studies. Laboratory studies have found that certain species of crustose-coralline algae produce exudates which facilitate larval settlement and post-settlement survival (Ritson-Williams et al. 2010a).

Reproduction occurs primarily through asexual fragmentation that produces multiple colonies that are genetically identical (Tunnicliffe 1981). The combination of branching morphology, asexual fragmentation, and fast growth rates, relative to other corals, can lead to persistence of large areas dominated by staghorn coral. The combination of rapid skeletal growth rates and frequent asexual reproduction by fragmentation can enable effective competition and can facilitate potential recovery from disturbances when environmental conditions permit. However, low sexual reproduction can lead to reduced genetic diversity and limits the capacity to repopulate spatially dispersed sites.

Population Dynamics

The following is a discussion of the species' population and its variance over time. Staghorn coral historically was one of the dominant species on most Caribbean reefs, forming large, single-species thickets and giving rise to the nominal distinct zone in classical descriptions of Caribbean reef morphology (Goreau 1959b). Massive, Caribbean-wide mortality, apparently primarily from white band disease (Aronson and Precht 2001), spread throughout the Caribbean in the mid-1970s to mid-1980s and precipitated widespread and radical changes in reef community structure (Brainard et al. 2011a). In addition, continuing coral mortality from periodic acute events such as hurricanes, disease outbreaks, and mass bleaching events has added to the decline of staghorn coral (Brainard et al. 2011a). In locations where quantitative data are available (Florida, Jamaica, U.S.Virgin Islands, Belize), there was a reduction of approximately 92 to greater than 97 percent between the 1970s and early 2000s (*Acropora* Biological Review Team 2005).

A report on the status and trends of Caribbean corals over the last century indicates that cover of staghorn coral has remained relatively stable (though much reduced) throughout the region since

the large mortality events of the 1970s and 1980s. The frequency of reefs at which staghorn coral was described as the dominant coral has remained stable. The number of reefs with staghorn coral present declined during the 1980s (from approximately 50 to 30 percent of reefs), remained relatively stable at 30 percent through the 1990s, and decreased to approximately 20 percent of the reefs in 2000-2004 and approximately 10 percent in 2005-2011 (Jackson et al. 2014b).

Since the 2006 listing of staghorn coral as threatened, continued population declines have occurred in some locations with certain populations of both listed *Acropora* species (Staghorn and Elkhorn) decreasing up to an additional 50 percent or more (Colella et al. 2012; Lundgren and Hillis-Starr 2008; Muller et al. 2008; Rogers and Muller 2012; Williams et al. 2008a). There are some small pockets of remnant robust populations such as in southeast Florida (Vargas-Angel et al. 2003), Honduras (Keck et al. 2005; Riegl et al. 2009), and Dominican Republic (Lirman et al. 2010a). Additionally, Lidz and Zawada (2013) observed 400 colonies of staghorn coral along 44 miles (70.2 km) of transects near Pulaski Shoal in the Dry Tortugas where the species had not been seen since the cold-water die-off of the 1970s.

Vollmer and Palumbi (2007) examined 22 populations of staghorn coral from 9 regions in the Caribbean (Panama, Belize, Mexico, Florida, Bahamas, Turks and Caicos, Jamaica, Puerto Rico, and Curaçao) and concluded that populations greater than approximately 500 kilometers apart are genetically different from each other with low gene flow across the greater Caribbean. Fine-scale genetic differences have been detected at reefs separated by as little as two kilometers, suggesting that gene flow in staghorn coral may not occur at much smaller spatial scales (Garcia Reyes and Schizas 2010; Vollmer and Palumbi 2007). This fine-scale population structure was greater when considering genes of elkhorn coral were found in staghorn coral due to back-crossing of the hybrid *A. prolifera* with staghorn coral (Garcia Reyes and Schizas 2010; Vollmer and Palumbi 2007). Populations in Florida and Honduras are genetically distinct from each other and other populations in the U.S.Virgin Islands, Puerto Rico, Bahamas, and Navassa (Baums et al. 2010), indicating little to no larval connectivity overall. However, some potential connectivity between the U.S.Virgin Islands and Puerto Rico was detected and also between Navassa and the Bahamas (Baums et al. 2010).

Staghorn coral is distributed throughout the Caribbean Sea, in the southwestern Gulf of Mexico, and in the western Atlantic Ocean. Based on population estimates, there are at least tens of millions of colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. The effective population size is smaller than indicated by abundance estimates due to the tendency for asexual reproduction. There is no evidence of range constriction or extirpation at the island level. However the species is absent at the reef level. Populations appear to consist mostly of isolated colonies or small groups of colonies compared to the vast thickets once prominent throughout its range. Thickets are a prominent feature at only a few known locations. Across the Caribbean, percent cover appears to have remained relatively stable since the population crash in the 1980s. Frequency of occurrence has decreased since the 1980s. There are examples of increasing trends in some locations (Dry Tortugas and southeast Florida), but not over larger spatial scales or longer periods. Population

model projections from Honduras at one of the only known remaining thickets indicate the retention of this dense stand under undisturbed conditions. If refuge populations are able to persist, it is unclear whether they would be able to repopulate nearby reefs as observed sexual recruitment is low. Thus, we conclude that the species has undergone substantial population decline and decreases in the extent of occurrence throughout its range. Percent benthic cover and proportion of reefs where staghorn coral is dominant have remained stable since the mid-1980s and since the listing of the species as threatened in 2006. We also conclude that population abundance is at least tens of millions of colonies, but likely to decrease in the future with increasing threats.

Status

The species has undergone substantial population decline and decreases in the extent of occurrence throughout its range due mostly to disease. Although localized mortality events have continued to occur, percent benthic cover and proportion of reefs where staghorn coral is dominant have remained stable over its range since the mid-1980s. There is evidence of synergistic effects of threats for this species where the effects of increased nutrients are combined with acidification and sedimentation. Staghorn coral is highly susceptible to a number of threats, and cumulative effects of multiple threats are likely to exacerbate vulnerability to extinction. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because staghorn coral is limited to areas with high, localized human impacts and predicted increasing threats.

Staghorn coral commonly occurs in water ranging from five to twenty meters in depth, though it occurs in depths of 16-30 meters at the northern extent of its range, and has been rarely found to 60 meters in depth. It occurs in spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hard bottom habitats. This habitat heterogeneity moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef and hard bottom environments that are predicted, on local and regional scales, to experience highly variable thermal regimes and ocean chemistry at any given point in time. Its absolute population abundance has been estimated as at least tens of millions of colonies in the Florida Keys and Dry Tortugas combined and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range.

Staghorn coral has low sexual recruitment rates, which exacerbates vulnerability to extinction due to decreased ability to recover from mortality events when all colonies at a site are extirpated. In contrast, its fast growth rates and propensity for formation of clones through asexual fragmentation enables it to expand between rare events of sexual recruitment and increases its potential for local recovery from mortality events, thus moderating vulnerability to extinction. Its abundance and life history characteristics, combined with spatial variability in ocean warming and acidification across the species' range, moderate the species' vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point

in time. However, we also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Recovery Goals

The recovery goals for staghorn coral are the same as those described above for elkhorn coral.

2.4.51 Lobed Star Coral

The lobed star coral is a cnidarian belonging to the taxonomic genus of *Orbicella*, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Lobed Star coral occurs in the western Atlantic and greater Caribbean as well as the Flower Garden Banks, but may be absent from Bermuda (Figure 92).

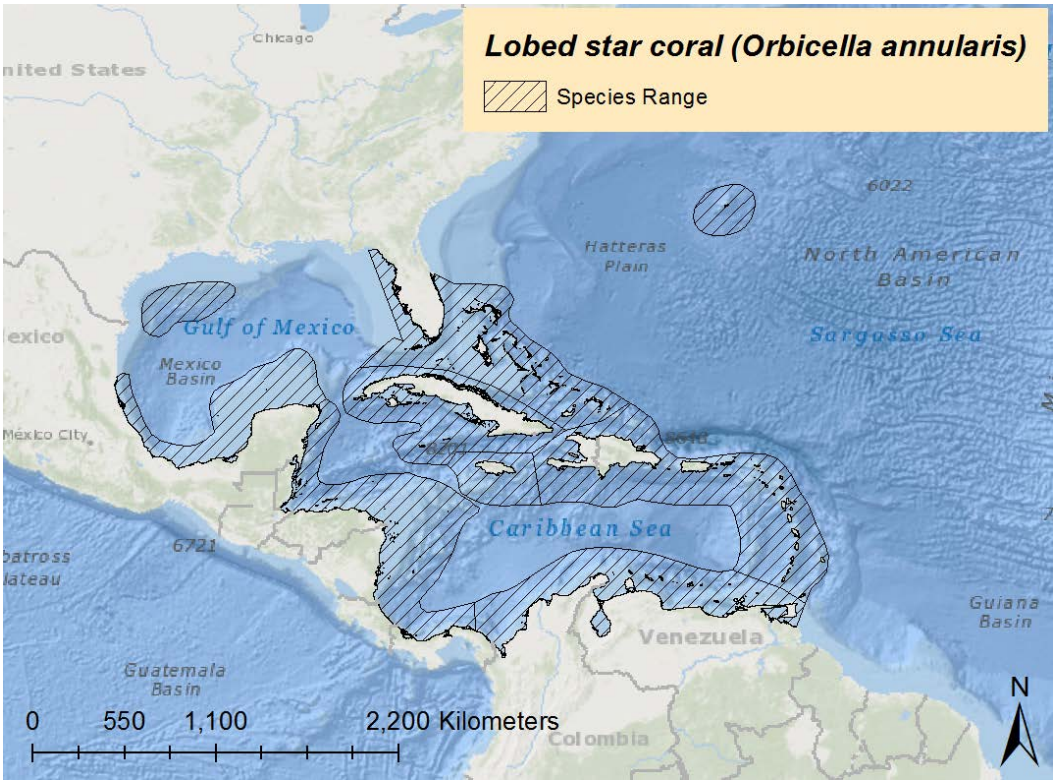


Figure 91. The distribution of the lobed star coral throughout the Caribbean.

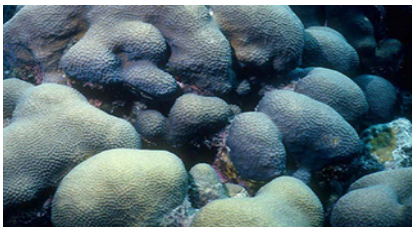


Figure 92. Image of a lobed star coral colony.

On September 10, 2014, NMFS listed lobed star coral as threatened (79 FR 53851). Lobed star coral (*O. annularis*), mountainous star coral (*O. faveolata*), and boulder star coral (*O. franksi*) are the three species in the *Orbicella* spp. complex. These three species were formerly in the genus *Montastraea*; however, recent work has reclassified the three species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The star coral species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a

single species –*Montastraea annularis*– with varying growth forms ranging from columns, to massive boulders, to plates. In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata*, and *Montastraea* (now *Orbicella*) *franksi.* The three species were differentiated on the basis of morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have supported the partitioning of the *annularis* complex into three species.

Lobed star corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Lobed star coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005a) (See Figure 3). Lobed star coral colonies grow in columns that exhibit rapid and regular upward growth. In contrast to the other two star coral species, margins on the sides of columns are typically dead. Live colony surfaces usually lack ridges or bumps.

Lobed star coral is reported from most reef environments within the Caribbean (except for Bermuda) in depths of approximately 0.5-20 meters. The star coral species complex is a common, often dominant component of Caribbean mesophotic (e.g., >30 meters) reefs, suggesting the potential for deep refuge across a broader depth range, but lobed star coral is generally described with a shallower distribution.

Life history

The star coral species complex has growth rates ranging from 0.06-1.2 centimeters per year and averaging approximately one centimeter in linear growth per year. The reported growth rate of lobed star coral is 0.4 to 1.2 centimeters per year (Cruz-Piñón et al. 2003; Tomascik 1990). They grow slower in deep and murky waters.

All three species of the star coral complex are hermaphroditic broadcast spawners[24], with spawning concentrated on six to eight nights following the full moon in late August, September, or early October depending on location and timing of the full moon. All three species are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Further, mountainous star coral is largely reproductively incompatible with boulder star coral and lobed star coral, and it spawns about one to two hours earlier. Fertilization success measured in the field was generally below 15 percent for all three species, as it is closely linked to the number of colonies concurrently spawning. Lobed star coral is reported to have slightly smaller egg size and potentially smaller size/age at first reproduction that the other two species of the *Orbicella* genus. In Puerto Rico, minimum size at reproduction for the star coral species complex was 83 square centimeters.

[24] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

Successful recruitment by the star coral complex species has seemingly always been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of twelve square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex.

In addition to low recruitment rates, lobed star corals have late reproductive maturity. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the lobed star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain abundant, the buffering capacity of this life history strategy has likely been reduced by recent population declines and partial mortality, particularly in large colonies.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the lobed star coral.

Lobed star corals are the third most abundant coral species by percent cover in permanent monitoring stations in the U.S.Virgin Islands. A decline of 60 percent was observed between 2001 and 2012 primarily due to bleaching in 2005. However, most of the mortality was partial mortality and colony density in monitoring stations did not change (Smith 2013).

Lobed star coral was historically considered to be one of the most abundant species in the Caribbean (Weil and Knowton 1994). Percent cover has declined to between 37 percent and 90 percent over the past several decades at reefs at Jamaica, Belize, Florida Keys, The Bahamas, Bonaire, Cayman Islands, Curaçao, Puerto Rico, U.S.Virgin Islands, and St.Kitts and Nevis. Based on population estimates, there are at least tens of millions of lobed star coral colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. Lobed star coral remains common in occurrence. Abundance has decreased in some areas to between 19 percent and 57 percent, and shifts to smaller size classes have occurred in locations such as Jamaica, Colombia, The Bahamas, Bonaire, Cayman Islands, Puerto Rico, U.S. Virgin Islands, and St. Kitts and Nevis. At some reefs, a large proportion of the population is comprised of non-fertile or less-reproductive size classes. Several population projections indicate population decline in the future is likely at specific sites, and local extirpation is possible within 25-50 years at conditions of high mortality, low recruitment, and slow growth rates. We conclude that while substantial population decline has occurred in lobed star coral, it is still common throughout the Caribbean and remains one of the dominant species numbering at least in the tens of millions of colonies. We conclude that the buffering capacity of

lobed star coral's life history strategy that has allowed it to remain abundant has been reduced by the recent population declines and amounts of partial mortality, particularly in large colonies. We also conclude that the population abundance is likely to decrease in the future with increasing threats.

In the Florida Keys, abundance of lobed star coral ranked 30 out of 47 coral species in 2005, 13 out of 43 in 2009, and 12 out of 40 in 2012. Extrapolated population estimates from stratified random samples were 5.6 million ± 2.7 million (standard error [SE]) in 2005, 11.5 million ± 4.5 million (SE) in 2009, and 24.3 million ± 12.4 million (SE) in 2012. Size class distribution was somewhat variable between survey years, with a larger proportion of colonies in the smaller size classes in 2005 compared to 2009 and 2012 and a greater proportion of colonies in the greater than 90 centimeters size class in 2012 compared to 2005 and 2009. Partial colony mortality was lowest at less than ten centimeters (as low as approximately five percent) and up to approximately 70 percent in the larger size classes. In the Dry Tortugas, Florida, abundance of lobed star coral ranked 41 out of 43 in 2006 and 31 out of 40 in 2008. The extrapolated population estimate was 0.5 million ± 0.3 million (SE) colonies in 2008. Differences in population estimates between years may be attributed to sampling effort rather than population trends (Miller et al. 2013a).

Colony density varies by habitat and location, and ranges from less than 0.1 to greater than one colony per approximately ten square meters. In surveys of 1,176 sites in southeast Florida, the Dry Tortugas, and the Florida Keys between 2005 and 2010, density of lobed star coral ranged between 0.09 and 0.84 colonies per approximately ten square meters and was highest on mid-channel reefs followed by inshore reefs, offshore patch reefs, and fore-reefs (Burman et al. 2012). Along the east coast of Florida, density was highest in areas south of Miami (0.34 colonies per approximately ten square meters) compared to Palm Beach and Broward Counties (ten square meters; Burman et al. 2012). In surveys between 2005 and 2007 along the Florida reef tract from Martin County to the lower Florida Keys, density of lobed star coral was approximately 1.3 colonies per approximately ten square meters (Wagner et al. 2010). Off southwest Cuba on remote reefs, lobed star coral density was 0.31 ± 0.46 (SD) per approximately ten meters transect on 38 reef-crest sites and 1.58 ± 1.29 colonies per approximately ten meters transect on 30 reef-front sites. Colonies with partial mortality were far more frequent than those with no partial mortality which only occurred in the size class less than 100 centimeters) (Alcolado et al. 2010).

Lobed star coral has been described as common overall. Demographic data collected in Puerto Rico over nine years before and after the 2005 bleaching event showed that population growth rates were stable in the pre-bleaching period (2001–2005) but declined one year after the bleaching event. Population growth rates declined even further two years after the bleaching event, but they returned and then stabilized at the lower rate the following year.

Population trends are available from a number of studies. In a study of sites inside and outside a marine protected area in Belize, lobed star coral cover declined significantly over a ten year period (1998/99 to 2008/09) (Huntington et al. 2011). In a study of ten sites inside and outside of a marine reserve in the Exuma Cays, Bahamas, cover of lobed star coral increased between 2004

and 2007 inside the protected area and decreased outside the protected area (Mumby and Harborne 2010). Between 1996 and 2006, lobed star coral declined in cover by 37 percent in permanent monitoring stations in the Florida Keys (Waddell and Clarke 2008a). Cover of lobed star coral declined 71 percent in permanent monitoring stations between 1996 and 1998 on a reef in the upper Florida Keys (Porter et al. 2001).

Cover of lobed star coral at Yawzi Point, St. John, U.S.Virgin Islands declined from 41 percent in 1988 to approximately 12 percent by 2003 as a rapid decline began with the aftermath of Hurricane Hugo in 1989 (Edmunds and Elahi 2007). This decline continued between 1994 and 1999 during a time of two hurricanes (1995) and a year of unusually high sea temperature (1998) but percent cover remained statistically unchanged between 1999 and 2003. Colony abundances declined from 47 to 20 colonies per approximately one square meter between 1988 and 2003, due mostly to the death and fission of medium-to-large colonies ($\geq$ 151 square centimeters). Meanwhile, the population size class structure shifted between 1988 and 2003 to a higher proportion of smaller colonies in 2003 (60 percent less than 50 square centimeters in 1988 versus 70 percent in 2003) and lower proportion of large colonies (six percent greater than 250 square centimeters in 1988 versus three percent in 2003. The changes in population size structure indicated a population decline coincident with the period of apparent stable coral cover. Population modeling forecasted the 1988 size structure would not be reestablished by recruitment and a strong likelihood of extirpation of lobed star coral at this site within 50 years (Edmunds and Elahi 2007).

Asexual fission and partial mortality can lead to multiple clones of the same colony. The percentage of unique individuals is variable by location and is reported to range between 18 percent and 86 percent (thus, 14-82 percent are clones). Colonies in areas with higher disturbance from hurricanes tend to have more clonality. Genetic data indicate that there is some population structure in the eastern, central, and western Caribbean with population connectivity within but not across areas. Although lobed star coral is still abundant, it may exhibit high clonality in some locations, meaning that there may be low genetic diversity.

Status

Lobed star coral has undergone major declines mostly due to warming-induced bleaching and disease. Several population projections indicate population decline in the future is likely at specific sites and that local extirpation is possible within 25-50 years at conditions of high mortality, low recruitment, and slow growth rates. There is evidence of synergistic effects of threats for this species including disease outbreaks following bleaching events and increased disease severity with nutrient enrichment. Lobed star coral is highly susceptible to a number of threats, and aggregate effects of multiple threats have likely contributed to its decline and exacerbate vulnerability to extinction. Despite high declines, the species is still common and remains one of the most abundant species on Caribbean reefs. Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. However, the buffering capacity of these life history characteristics is expected to decrease as colonies shift to smaller size classes, as has been observed in locations in the species' range. Its absolute

population abundance has been estimated as at least tens of millions of colonies in the Florida Keys and Dry Tortugas combined and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because lobed star coral is limited to an area with high localized human impacts and predicted increasing threats. Star coral occurs in most reef habitats 0.5-20 meters in depth which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience high temperature variation and ocean chemistry at any given point in time. Its abundance and life history characteristics, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Recovery Goals

No final recovery plan currently exists for lobed star coral; however a recovery outline was published in 2014. The following contains the recovery goals listed in the document:

Short Term Goals

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *Dendrogyra cylindrus*, *Mycetophyllia ferox*, and *Orbicella* spp.

Long Term Goals

- Cultivate and implement U.S.and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

2.4.52 Mountainous Star Coral

Mountainous Star coral belongs to the taxonomic family of Merulinidae, a group of stony corals whose hard exoskeletons are highly fused and lack paliform lobes.Mountainous Star coral occurs

in the western Atlantic and throughout the Caribbean, including the Bahamas, Flower Garden Banks, and the entire Caribbean coastline (Figure 93).

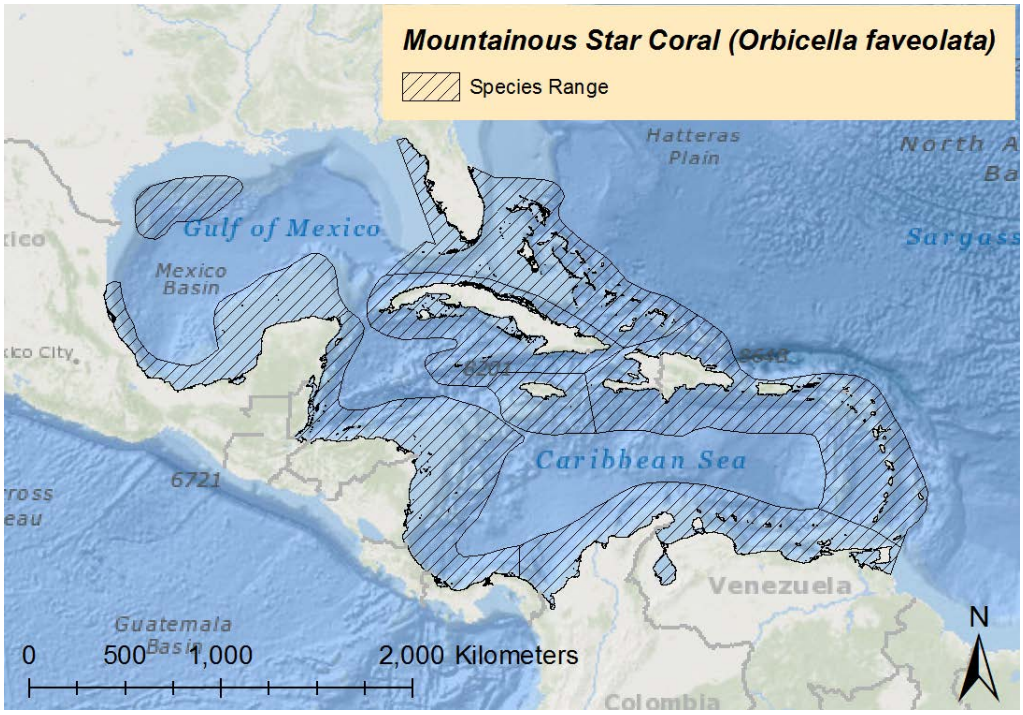


Figure 93.The distribution of mountainous star coral throughout the Caribbean.

Mountainous star coral grows in heads or sheets, the surface of which may be smooth or have keels or bumps. The skeleton is much less dense than in the other two star coral species. Colony diameters can reach up to ten meters with heights of four to five meters.

As stated, mountainous star coral is found in the western Atlantic and throughout the Caribbean. There is conflicting information on whether or not it occurs in Bermuda. Mountainous star coral has been reported in most reef habitats and is often the most abundant coral at ten to twenty meters in fore-reef environments. The depth range of mountainous star coral has been reported as approximately 0.5-40 meters, though the species complex has been reported to depths of 90 meters.Star coral species are a common, often dominant component of Caribbean mesophotic reefs (e.g., > 30 meters), suggesting the potential for deep refugia for mountainous star coral.

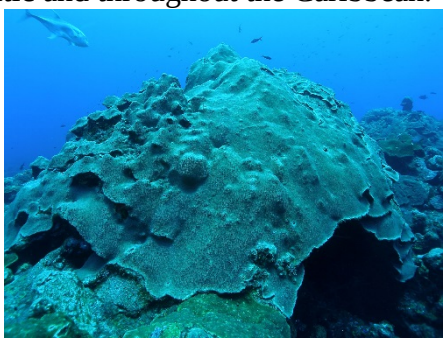


Figure 94. Image of a mountainous star coral colony.

Life history

The star coral species complex has growth rates ranging from 0.06 - 1.2 centimeters per year and averaging approximately one-centimeter linear growth per year. Mountainous star coral's growth rate is intermediate between the other star coral complex species (Szmant et al., 1997).

The star coral complex species are hermaphroditic broadcast spawners[25].Spawning is concentrated on six to eight nights following the full moon in late August, September, or early October. All three species of star coral are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Fertilization success measured in the field was generally below 15 percent for all three species. In Puerto Rico, the minimum size at reproduction for a star coral species complex was 83 square centimeters.

Successful recruitment by star corals has seemingly always been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of 12 square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex.

Life history characteristics of mountainous star coral is considered intermediate between lobed star coral and boulder star coral especially regarding growth rates, tissue regeneration, and egg size. Spatial distribution may affect fecundity on the reef, with deeper colonies of mountainous star coral being less fecund due to greater polyp spacing. Reported growth rates of mountainous star coral range between 0.3 and 1.6 centimeters per year (Cruz-Piñón et al. 2003; Tomascik 1990; Villinski 2003; Waddell 2005). Graham and van Woesik (2013) report that 44 percent of small colony mountainous star coral in Puerto Morelos, Mexico that resulted from partial colony mortality produced eggs at sizes smaller than those typically characterized as being mature. The number of eggs produced per unit area of smaller fragments was significantly less than in larger size classes. Szmant and Miller (2005) reported low post-settlement survivorship for mountainous star coral transplanted to the field with only three to fifteen percent remaining alive after 30 days. Post-settlement survivorship was much lower than the 29 percent observed for elkhorn coral after seven months (Szmant and Miller 2005).

Mountainous star coral has slow growth rates, late reproductive maturity, and low recruitment rates. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain abundant, we conclude that the buffering capacity of this life history strategy has been reduced by recent population declines and partial mortality, particularly in large colonies.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the mountainous star coral.

[25] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

Population trend data exists for several locations. At nine sites off Mona and Desecheo Islands, Puerto Rico, no species extirpations were noted at any site over ten years of monitoring between 1998 and 2008 (Bruckner and Hill 2009). Both mountainous star coral and lobed star coral sustained large losses during the period. The number of colonies of mountainous star coral decreased by 36 percent and 48 percent at Mona and Desecheo Islands, respectively (Bruckner and Hill 2009). In 1998, 27 percent of all corals at six sites surveyed off Mona Island were mountainous star coral colonies, but this statistic decreased to approximately 11 percent in 2008 (Bruckner and Hill 2009). At Desecheo Island, 12 percent of all coral colonies were mountainous star coral in 2000, compared to seven percent in 2008.

Extrapolated population estimates from stratified random samples in the Florida Keys were 39.7 ± eight million (standard error [SE]) colonies in 2005, 21.9 ± 7 million (SE) colonies in 2009, and 47.3 ± 14.5 million (SE) colonies in 2012. The greatest proportion of colonies tended to fall in the 10-20 centimeter and 20-30 centimeter size classes in all survey years, but there was a fairly large proportion of colonies in the greater than 90 centimeter-size class. Partial mortality of the colonies was between ten percent and 60 percent of the surface across all size classes. In the Dry Tortugas, Florida, mountainous star coral ranked seventh most abundant out of 43 coral species in 2006 and fifth most abundant out of 40 in 2008. Extrapolated population estimates were 36.1 ± 4.8 million (SE) colonies in 2006 and 30 ± 3.3 million (SE) colonies in 2008. The size classes with the largest proportion of colonies were 10-20 centimeter and 20-30 centimeter, but there was a fairly large proportion of colonies in the greater-than-90 centimeter size class. Partial mortality of the colonies ranged between approximately two percent and 50 percent. Because these population abundance estimates are based on random surveys, differences between years may be attributed to sampling effort rather than population trends (Miller et al. 2013a).

In the U.S. Virgin Islands, the reproductive performance of *O. faveolata* was assessed over a five-week period at three depth ranges five ten meters, 15–22 meters and 35–40 meters. The results showed that corals at the upper edge of the mesophotic zone 35–40 meters were more fecund and produced more eggs than those at shallower depths (Holstein et al. 2016).

Information regarding population structure is limited. Observations of mountainous star coral from 182 sample sites in the upper and lower Florida Keys and Mexico showed three well-defined populations based on five genetic markers, but the populations were not stratified by geography, indicating they were shared among the three regions (Baums et al. 2010). Of ten mountainous star coral colonies observed to spawn at a site off Bocas del Toro, Panama, there were only three genotypes (Levitan et al. 2011) potentially indicating 30 percent clonality.

In a survey of 31 sites in Dominica between 1999 and 2002, mountainous star coral was present at 80 percent of the sites at one to ten percent cover (Steiner 2003a). In a 1995 survey of 16 reefs in the Florida Keys, mountainous star coral ranked as the coral species with the second highest percent cover (Murdoch and Aronson 1999). On 84 patch reefs three meters to five meters depth spanning 149 miles (240 kilometers) in the Florida Keys, mountainous star coral was the third most abundant coral species comprising seven percent of the 17,568 colonies encountered. It was present at 95 percent of surveyed reefs between 2001 and 2003 (Lirman and Fong 2007). In

surveys of 280 sites in the upper Florida Keys in 2011, mountainous star coral was present at 87 percent of sites visited (Miller et al. 2011). In 2003 on the East Flower Garden Bank, mountainous star coral comprised ten percent of the 76.5 percent coral cover on reefs 32-40 meters, and partial mortality due to bleaching, disease, and predation were rare at monitoring stations (Precht et al. 2005).

Colony density ranges from approximately 0.1-1.8 colonies per ten square meters and varies by habitat and location. In surveys along the Florida reef tract from Martin County to the lower Florida Keys, density of mountainous star coral was approximately 1.6 colonies per ten square meters (Wagner et al. 2010). On remote reefs off southwest Cuba, density of mountainous star coral was 0.12 ± 0.20 (SE) colonies per ten meters transect on 38 reef-crest sites and 1.26 ± 1.06 (SE) colonies per ten meters transect on 30 reef-front sites (Alcolado et al. 2010). In surveys of 1,176 sites in southeast Florida, the Dry Tortugas, and the Florida Keys between 2005 and 2010, density of mountainous star coral ranged between 0.17 and 1.75 colonies per ten square meters and was highest on mid-channel reefs followed by offshore patch reefs and fore-reefs (Burman et al. 2012). Along the east coast of Florida, density was highest in areas south of Miami at 0.94 colonies per ten square meters compared to 0.11 colonies per ten square meters in Palm Beach and Broward Counties (Burman et al. 2012).

Status

Mountainous star coral has undergone major declines mostly due to warming-induced bleaching and disease (Manzello et al. 2015). There is evidence of synergistic effects of threats for this species including disease outbreaks following bleaching events and reduced thermal tolerance due to chronic local stressors stemming from land-based sources of pollution (Grottoli et al. 2014). Mountainous star coral is highly susceptible to a number of threats, and cumulative effects of multiple threats have likely contributed to its decline and exacerbate its vulnerability to extinction(Grottoli et al. 2014). Despite high declines, the species is still common and remains one of the most abundant species on Caribbean reefs (Smith 2013). Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. The buffering capacity of these life history characteristics, however, is expected to decrease as colonies shift to smaller size classes as has been observed in locations in its range. Its absolute population abundance has been estimated as at least tens of millions of colonies in each of several locations including the Florida Keys, Dry Tortugas, and the U.S. Virgin Islands and is higher than the estimate from these three locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because mountainous star coral is limited to an area with high, localized human impacts and predicted increasing threats. Its depth range of 0.5 meters to at least 40 meters, moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters, and acidification is generally predicted to accelerate most in waters that are deeper and cooler than those in which the species occurs. Mountainous star coral occurs in most reef habitats, including

both shallow and mesophotic reefs, which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable temperatures and ocean chemistry at any given point in time. Its abundance, life history characteristics, and depth distribution, combined with spatial variability in ocean warming and acidification across the species' range, decreases its vulnerability to extinction because the threats are non-uniform (Smith 2013). Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Recovery Goals

No final recovery plans currently exists for mountainous star coral; however a recovery outline for the species was published in 2014. The following contains recovery goals listed in the document:

Short Term Goals

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally-manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *Dendrogyra cylindrus*, *Mycetophyllia ferox*, and *Orbicella* spp.

Long Term Goals

- Cultivate and implement U.S.and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

2.4.53 Boulder Star Coral

The boulder star coral is a cnidarian belonging to the taxonomic genus of *Orbicella*, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Boulder Star coral occurs in the western Atlantic and throughout the Caribbean, including the Bahamas, Flower Garden Banks, and the entire Caribbean coastline (Figure 95).

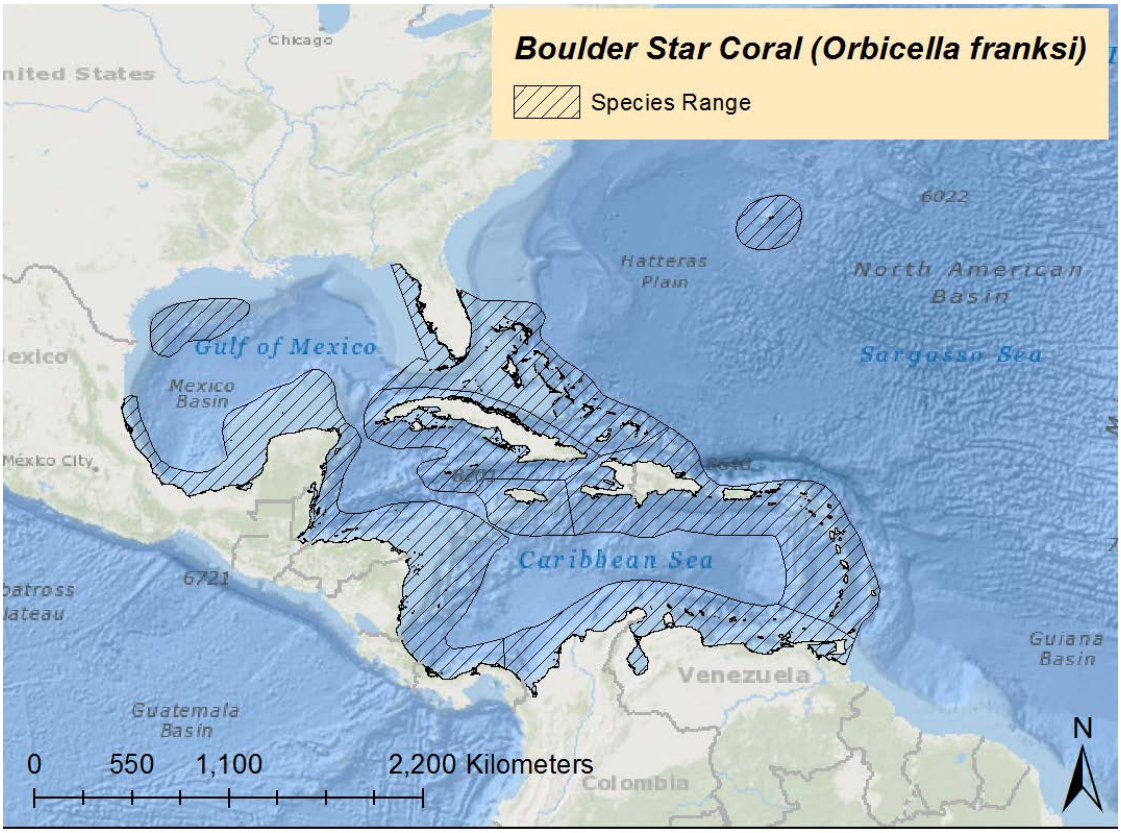


Figure 95. The distribution of boulder star coral throughout the Caribbean.

Some studies report on the star coral species complex rather than individual species because visual distinction can be difficult where colony structure cannot be discerned (e.g., small colonies or photographic methods). Information from these studies is reported for the species complex. Where species-specific information is available, it is reported. Information about boulder star coral published prior to 1994 will be attributed to the species complex, since it is dated prior to the split of *O. annularis* into three separate species.

Boulder star coral is distinguished by large, unevenly arrayed polyps that give the colony its characteristic irregular surface. Colony form is variable, and the skeleton is dense with poorly developed annual bands. Colony diameter can reach up to five meters with a height of up to two meters.

Life history

All three species of the star coral complex are hermaphroditic broadcast spawners[26], with spawning concentrated on six to eight nights following the full moon in late August, September, or early October, depending on timing of the full moon and location. Boulder star coral spawning is reported to be about one to two hours earlier than lobed star coral and mountainous star coral.

[26] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

All three species are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Fertilization success measured in the field was generally below 15 percent for all three species, as it was closely linked to the number of colonies concurrently spawning. In Puerto Rico, minimum size at reproduction for the star coral species complex was 83 square centimeters.

Successful recruitment by the star coral species complex appears to always have been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of approximately 12 square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex. Of 351 colonies of boulder star coral tagged in Bocas del Toro, Panama, larger colonies were noted to spawn more frequently than smaller colonies between 2002 and 2009 (Levitan et al. 2011).

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the boulder star coral.

Boulder star coral is reported as common. In a 1995 survey of 16 reefs in the Florida Keys, boulder star coral had the highest percent cover of all species (Murdoch and Aronson 1999). In surveys throughout the Florida Keys, boulder star coral in 2005 ranked 26th most abundant out of 47 coral species, 32nd out of 43 in 2009, and 33rd out of 40 in 2012. Extrapolated population estimates from stratified random surveys were 8.0 ± 3.5 million (standard error [SE]) colonies in 2005, 0.3 ± 0.2 million (SE) colonies in 2009, and 0.4 ± 0.4 million (SE) colonies in 2012. The authors note that differences in extrapolated abundance between years were more likely a function of sampling design rather than an indication of population trends. In 2005, the greatest proportions of colonies were in the smaller size classes of approximately 10-20 centimeters and approximately 20-30 centimeter. Partial colony mortality ranged from zero percent to approximately 73 percent and was generally higher in larger colonies (Miller et al. 2013a).

In the Dry Tortugas, Florida, boulder star coral ranked fourth highest in abundance out of 43 coral species in 2006 and 8th out of 40 in 2008. Extrapolated population estimates were 79 ± 19 million (SE) colonies in 2006 and 18.2 ± 4.1 million (SE) colonies in 2008. Miller et al. (2013a) notes the difference in estimates between years was more likely a function of sampling design rather than population decline. In the first year of the study (2006), the greatest proportion of colonies were in the size class approximately 20-30 centimeters with twice as many colonies as the next most numerous size class and a fair number of colonies in the largest size class of greater than 90 centimeters. Partial colony mortality ranged from approximately 10-55 percent. Two years later (2008), no size class was found to dominate, and proportion of colonies in the medium-to-large size classes (approximately 60-90 centimeters) appeared to be less than in 2006. The number of colonies in the largest size class of greater than 90 centimeters remained consistent. Partial colony mortality ranged from approximately 15-75 percent (Miller et al. 2013a).

Abundance in Curaçao and Puerto Rico appears to be stable over an eight to ten year period. In Curaçao, abundance was stable between 1997 and 2005, with partial mortality similar or less in

2005 compared to 1998 (Bruckner and Bruckner 2006). Abundance was also stable between 1998-2008 at nine sites off Mona and Desecheo Islands, Puerto Rico. In 1998, four percent of all corals at six sites surveyed off Mona Island were boulder star coral colonies and approximately five percent in 2008; at Desecheo Island, about two percent of all coral colonies were boulder star coral in both 2000 and 2008 (Bruckner and Hill 2009).

Based on population estimates, there are at least tens of millions of colonies present in both the Dry Tortugas and U. S. Virgin Islands. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. The frequency and extent of partial mortality, especially in larger colonies of boulder star coral, appear to be high in some locations such as Florida and Cuba, though other locations like the Flower Garden Banks appear to have lower amounts of partial mortality. A decrease in boulder star coral percent cover by 38 percent and a shift to smaller colony size across five countries suggest that population decline has occurred in some areas; colony abundance appears to be stable in other areas. We anticipate that while population decline has occurred, boulder star coral is still common with the number of colonies at least in the tens of millions. Additionally, we conclude that the buffering capacity of boulder star coral's life history strategy that has allowed it to remain abundant has been reduced by the recent population declines and amounts of partial mortality, particularly in large colonies. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

The star coral species complex has growth rates ranging from 0.06-1.2 centimeters per year and averaging approximately one-centimeter linear growth per year. Boulder star coral is reported to be the slowest of the three species in the complex (Brainard et al. 2011b). They grow slower in deep or murky waters.

Of 351 boulder star coral colonies observed to spawn at a site off Bocas del Toro, Panama, 324 were unique genotypes. Over 90 percent of boulder star coral colonies on this reef were the product of sexual reproduction, and 19 genetic individuals had asexually propagated colonies made up of two to four spatially adjacent clones of each. Individuals within a genotype spawned more synchronously than individuals of different genotypes. Additionally, within five meters, colonies nearby spawned more synchronously than farther spaced colonies, regardless of genotype. At distances greater than five meters, spawning was random between colonies (Levitan et al. 2011).

In addition to low recruitment rates, lobed star corals have late reproductive maturity. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the lobed star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain

abundant, the buffering capacity of this life history strategy has likely been reduced by recent population declines and partial mortality, particularly in large colonies.

Boulder star coral is found in the western Atlantic Ocean and throughout the Caribbean Sea including in the Bahamas, Bermuda, and the Flower Garden Banks. Boulder star coral tends to have a deeper distribution than the other two species in the *Orbicella* species complex. It occupies most reef environments and has been reported from water depths ranging from approximately five to fifty meters, with the species complex reported to 90 meters. *Orbicella* species are a common, often dominant, component of Caribbean mesophotic reefs (e. g. , > 30 meters), suggesting the potential for deep refugia for boulder star coral.

Status

Boulder star coral has undergone declines most likely from disease and warming-induced bleaching. There is evidence of synergistic effects of threats for this species including increased disease severity with nutrient enrichment. Boulder star coral is highly susceptible to a number of threats, and cumulative effects of multiple threats have likely contributed to its decline and exacerbate vulnerability to extinction. Despite declines, the species is still common and remains one of the most abundant species on Caribbean reefs. Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. However, the buffering capacity of these life history characteristics is expected to decrease as colonies shift to smaller size classes as has been observed in locations in its range. Its absolute population abundance has been estimated as at least tens of millions of colonies in both a portion of the U. S. Virgin Islands and the Dry Tortugas and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because boulder star coral is limited to a areas with high localized human impacts and predicted increasing threats. Its depth range of approximately five to fifty meters, possibly up to 90 meters, moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters, and acidification is generally predicted to accelerate most in waters that are deeper and cooler than those in which the species occurs. Boulder star coral occurs in most reef habitats, including both shallow and mesophotic reefs, which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable temperatures and ocean chemistry at any given point in time. Its abundance, life history characteristics, and depth distribution, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. However, we anticipate that the population abundance is likely to decrease in the future with increasing threats.

Recovery Goals

No final recovery plan currently exists for boulder star coral; however, a recovery outline was developed in 2014 to serve as interim guidance to direct recovery efforts, including recovery planning, until a final recovery plan is developed and approved. The following contains the recovery goals listed in the document:

Short Term Goals

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally-manageable stress and mortality sources (e. g. , acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *Dendrogyra cylindrus*, *Mycetophyllia ferox,* and *Orbicella* spp.

Long Term Goals

- Cultivate and implement U. S. and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

2.4.54 Rough Cactus Coral

The rough cactus coral is a cnidarian belonging to the taxonomic genus of *Mycetophyllia*, a group of ridged corals that form colonies with a flat disc shape. Rough cactus coral occurs in the western Atlantic Ocean and throughout the wider Caribbean Sea (Figure 96).

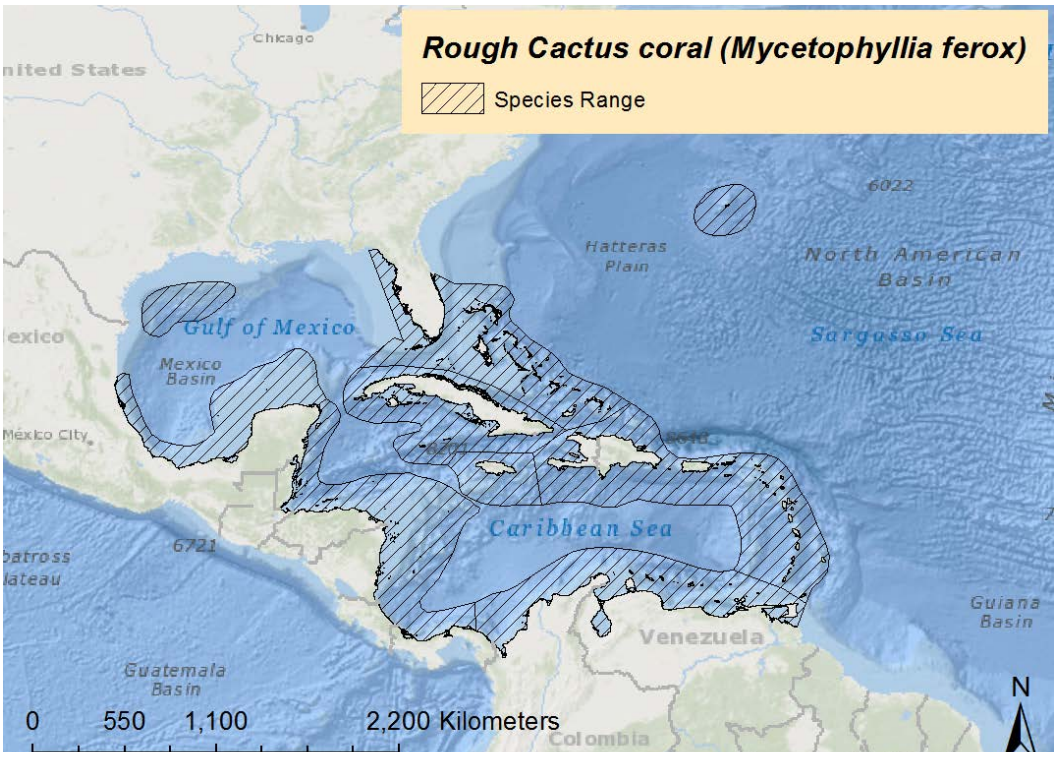


Figure 96. The distribution of rough cactus coral throughout the Caribbean.

Rough cactus coral forms a thin, encrusting plate that is weakly attached to substrate. Rough cactus coral is taxonomically distinct (i.e., separate species), though difficult to distinguish in the field from other *Mycetophyllia* species. The maximum colony size of the species is 50 centimeters in diameter.



Figure 97. Image of rough cactus coral colony.

While rough cactus coral occurs in the western Atlantic Ocean and throughout the wider Caribbean Sea, it has not been reported in the Flower Garden Banks (Gulf of Mexico) or in Bermuda. It inhabits reef environments in water depths of five to ninety meters, including shallow and mesophotic habitats (e.g., > 30 meters).

Life history

Rough cactus coral is a hermaphroditic brooding[27] species. Colony size at first reproduction is greater than 100 square centimeters. Recruitment of rough cactus coral appears to be very low, even in studies from the 1970s. Rough cactus coral has a lower fecundity compared to other

[27] Simultaneously containing both sperm and eggs, which are fertilized within the parent colony and grows for a period of time before release.

species in its genus (Morales Tirado 2006). Over a ten year period, no colonies of rough cactus coral were observed to recruit to an anchor-damaged site in the U.S. Virgin Islands, although adults were observed on the adjacent reef (Rogers and Garrison 2001). No other life history information appears to exist for rough cactus coral.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the rough cactus coral.

Rough cactus coral is usually uncommon or rare according to published and unpublished records, indicating that it constitutes < 0.1 percent species contribution (percent of all colonies counted) and occurs at densities < 0.8 colonies per ten square meters in Florida and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (Veron 2002, Wagner el al., 2010, and AGRRA database as cited in Brainard et al. 2011c). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera Puerto Rico, and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show *M. ferox* cover to be consistently less occasional observations up to two percent and no apparent temporal trend (Brainard et al. 2011c).

Dustan (1977) proposes that rough cactus coral was much more abundant in the upper Florida Keys in the early mid- 1970s (the methods are not well described for that study) than current observations, but that it was highly affected by disease. This could be interpreted as a substantial decline. Long-term Coral Reef Evaluation and Monitoring Program monitoring data in Florida on species presence/absence from fixed sites (stations) show a dramatic decline; for 97 stations in the main Florida Keys, occurrence had declined from 20 stations in 1996 to four stations in 2009; in Dry Tortugas occurrence had declined from eight out of twenty-one stations in 2004 to three stations in 2009 (R. Ruzicka and M. Colella, Florida Marine Research Institute, St. Petersburg, FL. pers. comm., Oct 2010 cited in Brainard et al. 2011c).

According to the IUCN Species Account and the Convention on International Trade in Endangered Species species database, rough cactus coral occurs throughout the U.S. waters of the western Atlantic but has not been reported from Flower Garden Banks (Hickerson et al. 2008). The following areas include locations within federally protected waters where rough cactus coral has been observed and recorded(cited in Brainard et al. 2011c):Dry Tortugas National Park;Virgin Island National Park/Monument; Florida Keys; National Marine Sanctuary; Navassa Island National Wildlife Refuge; Biscayne National Park; Buck Island Reef National Monument.

On reefs where rough cactus coral is found, it generally occurs at abundances of less than one colony per approximately ten square meters and percent cover of less than 0.1 (Burman et al. 2012).Based on population estimates, there are at least hundreds of thousands of rough cactus coral colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many

other locations throughout its range. Low encounter rate and percent cover coupled with the tendency to include *Mycetophyllia* spp. at the genus level make it difficult to discern population trends of rough cactus coral from monitoring data. However, reported losses of rough cactus coral from monitoring stations in the Florida Keys and Dry Tortugas (63-80 percent loss) indicate population decline in these locations. Based on declines in Florida, we conclude rough cactus coral has likely declined throughout its range, and will continue to decline based on increasing threats. As a result it is presumed that genetic diversity for the species is low.

Status

Rough cactus coral has declined due to disease in at least a portion of its range and has low recruitment, which limits its capacity for recovery from mortality events and exacerbates vulnerability to extinction. Its depth range of 5 to 90 meters moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters. Acidification is predicted to accelerate most in deeper and cooler waters than those in which the species occurs. Its habitat includes shallow and mesophotic reefs which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable thermal regimes and ocean chemistry at any given point in time. Rough cactus coral is usually uncommon to rare throughout its range. Its abundance, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time.

Recovery Goals

No final recovery plan currently exists for rough cactus coral, however a recovery outline was developed in 2014 to serve as interim guidance to direct recovery efforts, including recovery planning, until a final recovery plan is developed and approved. The following contains the recovery goals listed in the document:

Short Term Goals

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally-manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *Dendrogyra cylindrus*, *M. ferox*, and *Orbicella* spp.

Long Term Goals

- Cultivate and implement U.S. and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

2.4.55 Pillar Coral

The pillar coral is a cnidarian belonging to the taxonomic order of Scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Pillar coral is present in the western Atlantic Ocean and throughout the greater Caribbean Sea, though absent from the southwest Gulf of Mexico (Tunnell 1988) (Figure 98).

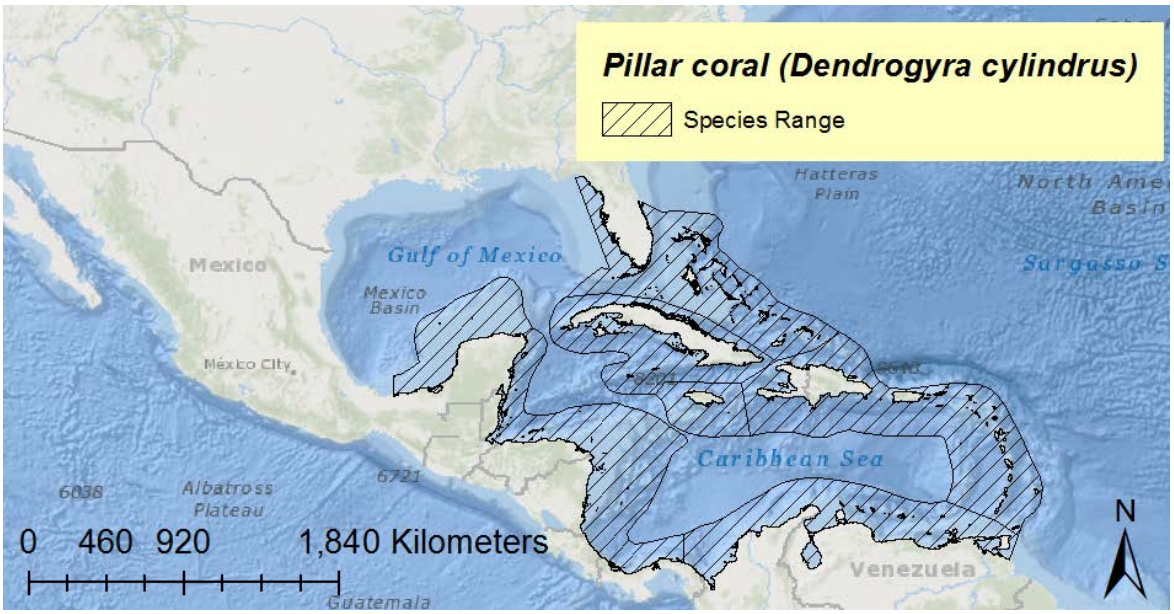


Figure 98. The distribution of the pillar coral throughout the Caribbean.

On September 10, 2014, NMFS listed pillar star coral as threatened (79 FR 53851). Pillar corals form tubular columns on top of encrusted foundations. Colonies are generally grey-brown in color and may reach approximately three meters in height. Polyps' tentacles remain extended during the day, giving columns a furry appearance.

Brainard et al. (2011a) identified a single known colony in Bermuda that is in poor condition. There is fossil evidence of the presence of the species off Panama less than 1,000 years ago, but

it has been reported as absent today (Florida Fish and Wildlife Conservation Commission 2013). Pillar coral inhabits most reef environments in water depths ranging from approximately one to twenty-five meters, but it is most common in water between approximately five to fifteen meters deep (Acosta and Acevedo 2006; Cairns 1982; Goreau and Wells 1967).



Figure 99. Image of a pillar coral.

Life history

Reported average growth rates for pillar coral have been documented to be approximately 1.8-2.0 centimeters per year in linear extension within the Florida Keys, compared to 0.8 centimeters per year as reported in Colombia and Curaçao. Partial mortality rates are size-specific with larger colonies having greater rates. Frequency of partial mortality can be high (e.g., 65 percent of 185 colonies surveyed in Colombia), while the amount of partial mortality per colony is generally low (average of three percent of tissue area affected per colony).

Pillar coral is a gonochoric broadcast spawning[28] species with relatively low annual egg production for its size. The combination of gonochoric spawning with persistently low population densities is expected to yield low rates of successful fertilization and low larval supply. Sexual recruitment of this species is low, and reports indicate juvenile colonies are lacking in the Caribbean. Spawning has been observed to occur several nights after the full moon of August in the Florida Keys (Neely et al. 2013; Waddell and Clarke 2008b) and in La Parguera, Puerto Rico (Szmant 1986). Pillar coral can also reproduce asexually by fragmentation following storms or other physical disturbance, but it is uncertain how much storm-generated fragmentation contributes to asexually produced offspring.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section consists of abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the pillar coral.

Pillar coral is uncommon but conspicuous with scattered, isolated colonies and is rarely found in aggregations. Benthic cover is generally less than one percent in monitoring studies. Mean density of pillar coral was approximately 0.5 colonies per ten square meters in the Florida Keys between 2005 and 2007. In a study of pillar coral demographics at Providencia Island, Colombia, 283 pillar coral colonies were detected in a survey of 1.66 square kilometers for an overall density of approximately 450 colonies per square mile.

Pillar coral ranked least common out of 47 coral species in 2005 and 41 out of 43 species in 2009 in stratified random samples of the Florida Keys. Based on random surveys stratified by habitat type, extrapolated abundance for the Florida Keys was 23,000 ± 23,000 (standard error [SE]) colonies in 2005 and 25,000 ± 25,000 (SE) colonies in 2009 (Miller et al. 2013b). Because these

[28] Parents only contain one gamete (egg or sperm), which are released into the water column for fertilization by another parent's gamete.

population estimates were based on random sampling, differences between years is more likely a function of sampling effort rather than an indication of population trends. All pillar coral colonies reported in 2005 were in the 70-80 centimeter size class with less than two percent partial mortality. Four years later in 2009, all reported colonies were greater than 90 centimeters. In 2012, no pillar coral colonies were encountered in 600 surveys from Key Biscayne to Key West, Florida, although the sampling design was not optimized for this species. This species was not reported in the Dry Tortugas in 2006 and 2008, rarely encountered during pilot studies conducted over several years (1999 to 2002), and was the least abundant of 49 coral species encountered (Miller et al. 2013b).

There are at least tens of thousands of pillar coral colonies present in the Florida Keys based on population estimates. Absolute population abundance is higher than the estimate from this location given the presence of this species in many other locations throughout its range. Although there is evidence of potentially higher population levels in some areas of the Caribbean during the Pleistocene, pillar coral is currently uncommon to rare. Few studies report pillar coral population trends, and the low abundance and infrequent encounter rate in monitoring programs result in small samples sizes. The low coral cover of this species renders monitoring data difficult to extrapolate to realize trends. Therefore, we conclude that pillar coral is naturally uncommon to rare and that trends are unknown.

Out of 283 pillar coral colonies at Providencia Island, Colombia, 70 colonies resulted from asexual fragmentation and no sexual recruits were observed. Size class distribution was skewed to smaller size classes less than 60 centimeters in height, and average colony height was approximately 0.73 meters (Acosta and Acevedo 2006). During surveys of Utila, Honduras, between 1999 and 2000, pillar coral was sighted in 19.6 percent of 784 surveys and ranked 26th most common in abundance out of 48 coral species (Afzal et al. 2001).

Pillar coral's average percent cover was 0.002 on patch reefs and 0.303 in shallow offshore reefs in annual surveys of 37 sites in the Florida Keys between 1996 and 2003 (Somerfield et al. 2008). At permanent monitoring stations in the U.S. Virgin Islands, pillar coral has been observed in low abundance at 10 of 33 sites and ranged in cover from less than 0.05-0.22 percent where present (Smith 2013). In Dominica, pillar coral comprised less than 0.9 percent cover and was present at 13.3 percent of 31 surveyed sites (Steiner 2003b). Of seven fringing reefs surveyed off Barbados, pillar coral was observed on one of them, and cover was 2.7 ± 1.4 percent (Tomascik and Sander 1987). In monitored photo-stations in Roatan, Honduras, cover of pillar coral increased slightly from 1.35 percent in 1996 to 1.67 percent in 1999 and then declined to 0.44 percent in 2003 and to 0.43 percent in 2005 (Riegl et al. 2009). In the U.S. Virgin Islands, seven percent of 26 monitored colonies experienced total colony mortality between 2005 and 2007, though the very low cover of pillar coral (0.04 percent) remained relatively stable during this time period (Smith et al. 2013).

In stratified random surveys from Palm Beach County to the Dry Tortugas, Florida, between 2005 and 2010, pillar coral was seen only on the ridge complex and mid-channel reefs at densities of approximately one and 0.1 colonies per approximately ten square meters, respectively (Burman et al. 2012). Average number of pillar coral colonies in remote reefs off

southwest Cuba was 0.013 ± 0.045 colonies per approximately ten meter transect, and the species ranked sixth rarest out of 38 coral species (Alcolado et al. 2010). In surveys of the upper Florida Keys in 2011, pillar coral was the second rarest out of 37 coral species and encountered at one percent of sites (Miller et al. 2011).

Status

Pillar coral survival is susceptible to a number of threats, but there is little evidence of population declines thus far. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because pillar coral is limited to an area with high, localized human impacts and predicted increasing threats. *D. cylindrus* inhabits most reef environments in water depths ranging from one to twenty-five meters, but is naturally rare. Estimates of absolute abundance are at least tens of thousands of colonies in the Florida Keys, and absolute abundance is higher than estimates from this location due to the occurrence of the species in many other areas throughout its range. It is a gonochoric broadcast spawner with observed low sexual recruitment. Its low abundance, combined with its geographic location, exacerbates vulnerability to extinction. This is because increasingly severe conditions within the species' range are likely to affect a high proportion of its population at any given point in time. Also, low sexual recruitment is likely to inhibit recovery potential from mortality events, further exacerbating its vulnerability to extinction. We anticipate that pillar coral is likely to decrease in abundance in the future with increasing threats.

Recovery Goals

No final recovery plans currently exists for pillar coral, however a recovery outline was published in 2015. The following contains the recovery goals listed in the document:

Short Term Goals

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *D. cylindrus*, *M. ferox*, and *Orbicella* spp.

Long Term Goals

- Cultivate and implement U.S. and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

2.4.56 Johnson's Seagrass

NMFS listed Johnson's seagrass as threatened under the ESA on September 14, 1998.

Life history

Based on the current knowledge of the species, Johnson's seagrass reproduction is believed to be entirely asexual, and dispersal is by vegetative fragmentation. Sexual reproduction in Johnson's seagrass has not been documented. Female flowers have been found; however, dedicated surveys in the Indian River Lagoon have not discovered male flowers, fertilized ovaries, fruits, or seeds, either in the field or under laboratory conditions (Hammerstrom and Kenworthy 2002; Jewett-Smith et al. 1997; NMFS 2007a). Searches throughout the range of Johnson's seagrass have produced the same results, suggesting either that the species does not reproduce sexually or that the male flowers are difficult to observe or describe, as noted for other *Halophila* species (Kenworthy 1997). Surveys to date indicate that the incidence of female flowers appears to be much higher near the inlets leading to the Atlantic Ocean.

Throughout its range, Johnson's seagrass occurs in dynamic and disjunctive patches. It spreads rapidly, growing horizontally from dense apical meristems with leaf pairs having short life spans (Kenworthy 1997). Kenworthy suggested that the observed horizontal spreading, rapid growth patterns, and high biomass turnover could explain the dynamic patches observed in distribution studies of this species. While patches may colonize quickly, they may also disappear rapidly. Sometimes they will disappear for several years and then re-establish, a process referred to as "pulsating patches" (Heidelbaugh et al. 2000; Virnstein and Hall 2009; Virnstein and Morris 2007). Mortality, or the disappearance of patches, can be caused by a number of processes, including burial from bioturbation and sediment deposition (Heidelbaugh et al. 2000), erosion, herbivory, desiccation, and turbidity. In the absence of sexual reproduction, one possible explanation for the pulsating patches is dispersal and re-establishment of vegetative fragments, a process that commonly occurs in aquatic plants and has been demonstrated in other seagrasses (Di Carlo et al. 2005; Philbrick and Les 1996), and was also confirmed by experimental mesocosm[29] studies with Johnson's seagrass (Hall et al. 2006).

Johnson's seagrass is a shallow-rooted species and vulnerable to uprooting by wind, waves, storm events, tidal currents, bioturbation, and motor vessels. It is also vulnerable to burial by sand movement and siltation (Heidelbaugh et al. 2000). Having a canopy of only 2 cm -5 cm, it may be easily covered by sediments transported during storms or redistributed by macrofaunal bioturbation during the feeding activities of benthic organisms. Mesocosm experiments indicate that clonal fragments can only survive burial for up to a period of 12 days (W.J. Kenworthy, CCFHR, NOAA, Beaufort, North Carolina, 1997 unpublished). Mechanisms capable of disturbing patches may create clonal fragments that become dispersed. Hall et al. (2006) showed that drifting fragments of Johnson's seagrass can remain viable for 4 to 8 days, during which time they can settle, root, and grow. The process of asexual fragmentation can occur year-round.

[29] A mesocosm is an experimental tool that brings a small part of the natural environment under controlled conditions.

Fragments could drift several kilometers under the influence of wind and tidally-driven circulation, providing potential recruits for dispersal and new patch formation. In the absence of sexual reproduction, these are likely to be the most common forms of dispersal and patch maintenance.

Population dynamics

Johnson's seagrass occurs in a variety of habitat types, including on intertidal wave-washed sandy shoals, on flood deltas near inlets, in deep water, in soft mud, and near the mouths of canals and rivers, where presumably water quality is sometimes poor and where salinity fluctuates widely. It is an opportunistic plant that occurs in a patchy, disjunctive distribution from the intertidal zone to depths of approximately 2 to 3 meters in a wide range of sediment types, salinities, and in variable water quality conditions (NMFS 2007a).

Johnson's seagrass exhibits a narrow geographical range of distribution and has only been found growing along approximately 200 km of coastline in southeastern Florida north of Sebastian Inlet, Indian River County, south to Virginia Key in northern Biscayne Bay, Miami-Dade County. This apparent endemism suggests that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world. Kenworthy (Kenworthy 1997; Kenworthy 1999) confirmed its limited geographic distribution in patchy and vertically disjunctive areas throughout its range. Two survey programs have monitored the presence and abundance of Johnson's seagrass within this range. One program, conducted by the St. Johns River Water Management District since 1994, continues to survey the northern section of the species' geographic range between Sebastian Inlet and Jupiter Inlet (Virnstein and Hall 2009; Virnstein and Morris 2007). The second survey, initiated in 2006, monitored the southern range of the species between Jupiter Inlet and Virginia Key in Biscayne Bay (Kunzelman 2007). This survey is no longer conducted. Since the last status review (NMFS 2007a), there have not been any reported reductions in the geographic range of the species. In fact, the St. Johns River Water Management District observed Johnson's seagrass approximately 21 km north of the Sebastian Inlet mouth on the western shore of the Indian River Lagoon-a discovery that slightly extends the species' known northern range (Virnstein and Hall 2009).

Johnson's seagrass is a perennial species (meaning it lasts for greater than 2 growing seasons), showing no consistent seasonal or year-to-year pattern based on the northern transect surveys, but has exhibited some winter decline (NMFS 2007a). However, during exceptionally mild winters, Johnson's seagrass can maintain or even increase in abundance from summer to winter. In the surveys conducted between 1994 and 2007, it occurred in 7.1 percent of the l m^2 quadrats in the northern range. Depth of occurrence within these surveys ranged from 0.03 to 2.5 m. Where it does occur, its distribution is patchy, both spatially and temporally. It frequently disappeared from transects only to reappear several months or several years later (NMFS 2007a).

Information on the species' distribution and results of limited experimental work suggest that Johnson's seagrass has a wider tolerance range for salinity, temperature, and optical water quality conditions than other species such as paddle grass, *Halophila decipiens* (Dawes et al. 1989) (Kenworthy and Haunert 1991); (Gallegos and Kenworthy 1996); (Durako et al. 2003;

Kenworthy and Fonseca 1996; Torquemada et al. 2005). Johnson's seagrass has been observed near the mouths of freshwater discharge canals (Gallegos and Kenworthy 1996), in deeper turbid waters of the interior portion of the Indian River Lagoon (Kenworthy 2000; Virnstein and Morris 2007), and in clear water associated with the high energy environments and flood deltas inside ocean inlets (Heidelbaugh et al. 2000; Kenworthy 1993; Kenworthy 1997; Virnstein and Morris 2007; Virnstein et al. 1997). It can colonize and persist in high-tidal energy environments and has been observed where tidal velocities approach the threshold of motion for unconsolidated sediments (35-40 cm s^{-1}). The persistent presence of high-density, elevated patches of Johnson's seagrass on flood tidal deltas near inlets suggests that it is capable of sediment stabilization. Intertidal populations of Johnson's seagrass may be completely exposed at low tides, suggesting high tolerance to desiccation and wide temperature tolerance.

Observations by researchers have suggested that Johnson's seagrass exploits unstable environments or newly-created unvegetated patches by exhibiting fast growth and support for all local ramets in order to exploit areas in which it could not otherwise compete. It may quickly recruit to locally uninhabited patches through prolific lateral branching and fast horizontal growth. While these attributes may allow it to compete effectively in periodically disturbed areas, if the distribution of this species becomes limited to stable areas it may eventually be outcompeted by more stable-selected plants represented by the larger-bodied seagrasses (Durako et al. 2003). In addition, the physiological attributes of Johnson's seagrass may limit growth (i.e., spreading) over large areas of substrate if the substrate is somehow altered (e.g., dredged to a depth that would preclude future recruitment of Johnson's seagrass); therefore, its ability to recover from widespread habitat loss may be limited. The clonal and reproductive growth characteristics of Johnson's sea grass result in its distribution being patchy, non-contiguous, and temporally fluctuating. These attributes suggest that colonization between broadly disjunctive areas is likely difficult and that the species is vulnerable to becoming endangered if it is removed from large areas within its range by natural or anthropogenic means.

Status

Kenworthy (1993; 1997; 2000) and NMFS (2002a; 2007a) discuss the results of numerous field studies and summarize an extensive literature review regarding the status of Johnson's seagrass. Based on the results of 14 years of monitoring in the species' northern range (1994-2007) and three years of monitoring in the species' southern range (2006-2009), there has been no significant change in the northern or southern range limits of Johnson's seagrass (NMFS 2007a). It appears that the populations in the northern range are stable and capable of sustaining themselves despite stochastic events related to severe storms (Steward et al. 2006) and fluctuating climatology. Longer-term monitoring data are needed to confirm the stability of the southern distribution of the species (NMFS 2007a). However, based on the results of the southern transect sampling, it appears there is a relatively continuous, although patchy, distribution of Johnson's seagrass from Jupiter Inlet to Virginia Key, at least during periods of relatively good environmental conditions and no significant large-scale disturbances. Larger seagrasses, predominantly turtle grass *(Thalassia testudinum)*, begin to out-compete Johnson's seagrass in the southern range. While there has been a slight extension in the known northern

range (Virnstein and Hall 2009), the limit of the southern range in the vicinity of Virginia Key (latitude 25.75°N) appears to be stable. There have been no reports of this species further south of the currently known southern distribution.

The possibility of mortality due to reduced salinity over long periods of time is a potential significant threat to the species. Other potential threats include dredging/filling, construction and shading from in and over-water structures, propeller scarring and anchor mooring, trampling, storms, and siltation, but these threats are local and small-scale and are not considered threats to the persistence and recovery of the species. It is uncertain how Johnson's seagrass will be affected by the synergistic effects of rising temperatures and sea levels associated with climate change (in conjunction with other stressors such as reduced salinity from freshwater runoff). However, evolutionary change in a species can occur within a few generations (Rice and Emery 2003), thus making it possible for seagrasses to cope if the changes occur at a rate slow enough to allow for adaptation.

Recovery goals

See the 2002 recovery plan for Johnson's seagrass for complete down-listing/delisting criteria for recovery goals for the species.

2.5 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Since this consultation is national in scope, covering an action area that includes all waters of the United States marked by federal navigation aids (i.e., territorial sea, bays, harbors, ports, and rivers), it is not practical to describe the impacts of all Federal, state, and private actions and other human activities at every individual ATON site. The following analysis discusses the principal natural and human-caused phenomena believed to have led to the current status of ESA-listed species, habitat, and the ecosystem within the action area. The activities that shape the environmental baseline in the action area of this consultation include, but are not limited to, vessel traffic, fisheries, habitat and water quality degration, and climate change. Increased shoreline and coastal development is expected to exacerbate and increase the magnitude and effect of some of these factors (e.g., habitat and water quality degradation).

2.5.1 Operation and Maintenance of Coast Guard's ATON System

The existence of all federal ATON is included in the Environmental Baseline, as well as ATON operation and maintenance activities that occurred prior to the issuance of this opinion. As described further in section 1.3, ATON operation refers to the physical presence of ATON in the environment, as well as any light or sound signals emitted from an ATON. Coast Guard maintenance of federal ATON includes, but is not limited to, the following activities: inspecting

and replacing ATON chain, sinkers, buoys, dayboards, ladders, platforms, and pilings; repairing lighting equipment, power systems (batteries and solar panels), and sound signals; responding to and repairing ATON discrepancies; and conducting repairs to structures. The operation and maintenance of federal ATON has been ongoing for decades. Table 2 lists the number and type of federal ATON in each Coast Guard District that are currently in operation, as well as their average servicing (maintenance) interval.

2.5.2 Vessel Traffic

A wide variety of vessels operate in the action area including, but not limited to, large commercial shipping vessels, fishing boats, recreational vessels, construction tenders, and military vessels. Vessel traffic in the action area is generally concentrated around established ports that are marked with ATON. Vessels may pose a number of threats to ESA-listed resources in the action area including elevated underwater noise (as described below in section 2.5.3), direct physical impacts to species or habitats, and marine pollution.

Ship groundings can result in significant impacts to ESA-listed resources and, more generally, the marine environment where the grounding occurred. In coral reef ecosystems, such collisions kill corals (potentially ESA-listed corals) and other benthic invertebrates, decrease habitat complexity, and open space for colonization by algae (Precht et al. 2001; Schroeder et al. 2008). Ship groundings can also result in large scale oil and contaminant spills, potentially impacting species and habitats far away from where the ship grounding occurred. For example, in 1989 the Exxon Valdez ran aground in Prince William Sound, Alaska, spilling 42 million liters of crude oil (Matkin et al. 2008). The Sound was the most affected area, but the oil spread more than 750 km to the southwest along the Kenai Peninsula, Kodiak archipelago, and the Alaska Peninsula (Peterson et al. 2002). Mass mortalities of marine species were observed in unprecedented numbers immediately following the incident. Additionally, in the years following the grounding, more long-term effects were documented from continued exposures to persistent oil, delayed impacts to growth and reproduction, and indirect effects of trophic cascades. These effects were observed at individual organism, population, and ecosystem levels (Peterson et al. 2002).

Another example occurred in 1993 when a longline fishing vessel ran aground off Rose Atoll in American Samoa. Direct physical damage to the reef was documented including broad scarring and a large scattering of debris on the reef slope around the vessel (Green et al. 1997; Schroeder et al. 2008). Damage assessment crews also documented the release of 100,000 gallons of diesel fuel, 500 gallons of lube oil, and 2,500 pounds of ammonia (Schroeder et al. 2008). The chemical release spread to other areas around the atoll by waves and currents. Schroeder et al. (2008) assessed the long term effects of this ship grounding event and found that more than 13 years after the incident, the fish community and benthic species assemblage were both still being affected by the ship grounding. Even in more minor, but much more common, incidents such as may occur when operating a recreational dive boat, poor boating and anchoring practices (e.g., dropping anchor on live corals) can impact ESA-listed corals causing abrasion and breakage.

Propeller scarring and improper anchoring are known to impact seagrasses (Kenworthy et al. 2002; Sargent et al. 1995) and eelgrass (Mumford 2007). These activities can severely disrupt the benthic habitat by uprooting plants, severing rhizomes, destabilizing sediments, and significantly reducing the viability of the seagrass community. Propeller dredging and improper anchoring in shallow areas are a major disturbance to even the most robust seagrasses. Damage to seagrasses from propeller scarring and improper anchoring by motor vessels is recognized as a significant resource management problem in Florida (Sargent et al. 1995). In Florida, a number of local, state, and federal statutes prohibit damaging seagrasses through vessel impacts, and a number of conservation measures, including the designation of vessel control zones, signage, mooring fields, and public awareness campaigns, are directed at minimizing vessel damage to seagrasses. Despite these efforts, vessel damage can have significant local and small-scale (1 m^2 to 100 m^2) impacts on seagrasses (Kirsch et al. 2005), but there is no direct evidence that these small-scale local effects are so widespread that they are a threat to the survival of Johnson's seagrass. Similarly, damage from propellers and high energy boat wakes have been identified as a stressor for eelgrass in Puget Sound, Washington (Mumford 2007).

Vessel strike of some more mobile ESA-listed species may also be of concern in the action area. For example, Brown and Murphy (2010) documented a total of 28 Atlantic sturgeon mortalities in the Delaware Estuary from 2005 to 2008. The majority of those mortalities were likely from vessel strike. Additionally, though not a concern for larger juveniles or adults, juvenile ESA-listed salmonids may be subject to mortality from ship wakes. This was identified as a threat to these species in the Columbia River estuary, primarily for juvenile fry that are less than 60 mm long and that rear inches from the shore (NMFS 2011d).

2.5.3 Underwater Noise

A wide variety of anthropogenic and natural sources contribute to underwater noise in the action area and throughout the world's oceans (Hatch and Wright 2007). Increases in underwater noise should be considered relative to ambient noise levels, when assessing potential effects to marine species. Ambient noise is background noise and it has no single source or point. Sources of ambient underwater noise are typically naturally caused and include wind, waves, precipitation, and biological sources such as shrimp, fish, and cetaceans. Precipitation can contribute up to 35 decibel (dB) to the existing sound level, and increases in wind speed of 5 to 10 knots can cause a 5 dB increase in ambient ocean noise across most frequencies (Urick 1983). The highest noise levels occur in nearshore areas, such as portions of the action area, where the sound of surf can increase underwater noise levels by 20 dB or more within 600 feet from the surf zone in the 200 hertz (Hz) to 2 kilohertz (kHz) regime (Wilson et al. 1985).

Anthropogenic sources of noise that are most likely to contribute to increases in underwater noise in the action area are noise from commercial shipping and general vessel traffic, dredging, underwater construction, and military activities. Large commercial vessels or barges can generate high noise levels. Sounds emitted by these vessels can be characterized as low-frequency, continuous, or tonal, and sound pressure levels at a source will vary according to

speed, burden, capacity and length (Kipple and Gabriele 2007; McKenna et al. 2012b; Richardson et al. 1995b). Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139 to 463 km away (Polefka 2004). Many factors, including ship size, speed, load, condition, age, and engine type, determine the noise range generated. In general, sources levels from vessels can range from less than 150 dB re: 1 µPa to over 190 dB for the largest vessels. Much of the increase in noise in the action area and other ocean environments is due to increased shipping as ships become more numerous and of larger tonnage (Hildebrand 2009; McKenna et al. 2012a; NRC 2003). Pile driving is a common source of construction noise in the action area used to build a number of different structures including bridges, piers, harbor facilities (Popper et al. 2014b). The predominant energy in pile driving impulses is at frequencies below 500 Hz (Laughlin 2006; Reyff 2008; Reyff 2012).

The ESA-listed species that occur in the action area are regularly exposed to many of these anthropogenic sound sources, with a range of potential effects possible. Many researchers have described behavioral responses of marine mammals to the sounds produced by vessels, as well as dredging and construction (Richardson et al. 1995a). Most observations have been limited to short term behavioral responses, which included temporary cessation of feeding, resting, or social interactions. Masking may also occur, in which an animal may not be able to detect, interpret, and/or respond to biologically relevant sounds. Recent scientific evidence suggests that marine mammals compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (McDonald et al. 2006) (Parks 2003) (Parks 2009).

Noise may also result in changes in fish behavior (Popper et al. 2014a). For example, Simpson et al. (2016a) used laboratory and field experiments to study the potential effects of vessel noise on anti-predator behavior for the settlement life stage of the Ambon damselfish (*Pomacentrus amboinensis*), a demersal, site-attached, coral reef fish. The authors found that motorboat noise can have detrimental effects on anti-predator behavior of Ambon damselfish, potentially as a result of increased stress. These results are not broadly applicable though, as the winners and losers in other predator-prey interactions will depend on the hearing sensitivities and noise tolerance levels of the species being considered, and the noise source (Simpson et al. 2016a).

Physical injury could also occur if an animal is exposed to high intensity sound of relatively short duration (e.g., exposure to airguns, explosions, or pile driving). For example, sound from pile driving activities have been shown to injure or kill fish (e.g., Popper et al. 2014b).

Impacts to ESA-listed resources in the action area may result from increased levels of anthropogenic-induced background noise or high intensity, short-term anthropogenic sounds. The majority of impacts will likely be short-term behavioral responses, although more serious impacts are possible. Information is not currently available to determine the potential population level effect of anthropogenic sound levels in the action area or the larger marine environment (MMC 2007) on ESA-listed species. More information would be required including, but not limited to, empirical data on how sound impacts an individual’s growth and vital rates, how these

changes impact that individual's ability to reproduce successfully, and then the relative influence of that individual's reproductive success on the population being considered. As a result, the consequences of anthropogenic sound on ESA-listed species in the action area at the population or species scale remain uncertain.

2.5.4 Habitat Degradation, Pollution, and Development

Coastal, estuarine, and riverine habitat of the United States where ATON occur has been degraded by a number of human activities conducted both within or in close proximity to the water body and by activities conducted more remotely in the upland portion of watersheds that may be outside of the action area. The mosaic of land uses associated with urban and suburban centers has been cited as the primary cause of declining environmental conditions in the United States (Flather C.H. et al. 1998) and other areas of the world (Houghton 1994). Habitat degradation impacts the ecosystem and the biological organisms (e.g. ESA-listed species) within.

Most land areas covered by natural vegetation are highly porous and have very little sheet flow; precipitation falling on these landscapes infiltrates the soil, is transpired by the vegetative cover or evaporates. The increased transformation of the landscapes of the United States into a mosaic of urban and suburban land uses has increased the area of impervious surfaces such as roads, rooftops, parking lots, driveways, sidewalks, etc., in those landscapes. Precipitation that would normally infiltrate soils in forests, grasslands and wetlands falls on and flows over impervious surfaces. That runoff is then channeled into storm sewers and released directly into surface waters (rivers and streams), which changes the magnitude and variability of water velocity and volume in those receiving waters. Inputs of sediments into aquatic ecosystems can result from erosion resulting from high velocity flows (Beechie et al. 2010; Gosselink and Lee 1989). As water moves through a watershed it carries sediments and pollutants to streams (e.g., (Allan 2004; Dudgeon 2005; Paul and Meyer 2001), wetlands (e.g., (Wright et al. 2006; Zedler and Kercher 2005), and coastal environments in the action area.

While provisions of the Clean Water Act have helped significantly improve the quality of aquatic ecosystems, nonpoint sources of water pollution, which are believed to be responsible for the majority of modern water quality problems in the United States, are not subject to Clean Water Act permitting and regulatory requirements. Instead, nonpoint sources of pollution are regulated by programs overseen by the States. As discussed in EPA's latest National Coastal Condition Report nonpoint sources have been identified as one of the stressors contributing to coastal water pollution (USEPA 2012). Since 2001, EPA has periodically released these reports detailing condition of the nation's coastal bays and estuaries and assessing trends in water quality in coastal areas. The latest National Coastal Condition Report indicates that coastal water conditions have remained "fair" and the trend assessment demonstrates no significant change in the water quality of U.S. coastal waters since the publication of the second National Coastal Condition Report in 2004 (USEPA 2012).

In 2008, the Heinz Center for Science, Economics and the Environment (Heinz Center 2008) published a comprehensive report on the condition of our nation's ecosystems. Contaminants were detected in approximately 80 percent of sampled freshwater fish and most of these detected contaminants exceeded wildlife benchmarks (1992–2001 data) (Gilliom et al. 2006). Additionally, nearly all saltwater fish tested had at least five contaminants at detectable levels, and concentrations exceeded benchmarks for the protection of human health in one-third of fish tissue samples—most commonly Dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons, and mercury (USEPA 2007). Increases in polluted runoff have been linked to a loss of aquatic species diversity and abundance, including many important commercial and recreational fish species. Nonpoint source pollution has also contributed to coral reef degradation, fish kills, seagrass bed declines and algal blooms, including blooms of toxic algae. In addition, many shellfish bed and swimming beach closures can be attributed to polluted runoff.

Salmonids are exposed to a number of contaminants throughout their range and life history cycle. Exposure to pollution is of significant concern for all life stages, but is likely particularly significant for freshwater life stages. Organic pollutants, particularly PCBs, DDT, and its congeners, pesticides, and endocrine disruptors are of particular concern. These chemicals can inhibit smell, disrupt reproductive behavior and physiology, impair immune function, and lead to mortality through impairment of water balance when traveling between fresh and salt water systems (Varanasi et al. 1993). Diffuse and extensive population centers contribute increased contaminant volumes and variety from such sources as wastewater treatment plants and sprawling development. Urban runoff from impervious surfaces and roadways often contains oil, copper, pesticides, PAHs, and other chemical pollutants and flow into surface waters. Point and nonpoint pollution sources entering rivers and their tributaries affect water quality in available spawning and rearing habitat for salmon. Juvenile salmonids that inhabit urban watersheds often carry high contaminant burdens, which is partly attributable to the biological transfer of contaminants through the food web (Varanasi et al. 1993).

Degraded water quality can also harm listed sturgeon in the action area (ASSRT 2007b; NMFS 2010a; SSRT 2010; USFWS and GSMFC 1995). Specific optimal water quality ranges vary between sturgeon species, but must be within an appropriate range for successful spawning and juvenile survival (Collins et al. 2000a). Low dissolved oxygen (DO) levels and high water temperatures are of particular concern, because these factors may limit available habitat and survival of juveniles and early life stage sturgeon. Temperature stresses were shown to cause notochord abnormalities in larval green sturgeon, with significant decreases in larval survival at temperatures between 26-28°C and temperatures above 28°C being lethal (Linares-Casenave et al. 2013). Secor and Gunderson (1998) and Collins et al. (2001) hypothesized survival of juvenile sturgeon in estuaries may be compromised due to combined effects of increased hypoxia and temperature in nursery areas. Hypoxia affects sturgeon species more than other fish species due to their limited ability to oxyregulate at low DO (Secor and Gunderson 1998; Secor and

Niklitschek 2002). Sturgeon species during the first year of life are particularly susceptible to low DO because of their limited locomotive means to escape from hypoxic waters (Secor and Niklitschek 2002).

The life history of sturgeon (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose them to long-term, repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979b). These contaminants settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web (i.e., to sturgeon). Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and changing other physical properties of the water.

Contaminants like dioxin, heavy metals, mercury, and other by-products of agricultural, municipal and industrial waste have been documented in tissue samples collected from shortnose sturgeon throughout their range, as well as in Gulf and Atlantic sturgeon (SSRT 2010). Levels of contaminants in wild green sturgeon are not known, but heavy contaminant loads have been found in white sturgeon, which co-occur with green sturgeon (NMFS 2010a). Studies have implicated contaminants in inhibiting growth and reproductive development, and lower reproductive success in white sturgeon (Feist et al. 2005; Foster et al. 2001a; Foster et al. 2001b; Kruse and Scarnecchia 2002). Heavy metals and contaminants have been found in white sturgeon tissue (Fairey et al. 1997; Greenfield et al. 2005). Green sturgeon are susceptible to negative effects from contaminant exposure. In a lab study, juvenile green sturgeon exposed to methyl mercury had significantly higher mortality than white sturgeon exposed to the same or higher levels (Lee et al. 2011).

The long-term effects of heavy metal and organochlorine accumulation in sturgeon tissue are not known (Ruelle and Henry 1992; Ruelle and Keenlyne 1993). High levels of pesticides and contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Hammerschmidt et al. 2002; Moore and Waring 2001), reduced survival of larval fish (Jezierska et al. 2009), delayed maturity (Jorgensen et al. 2004) and skeletal deformities (Villeneuve et al. 2005). Pesticide and contaminant exposure in fish may affect anti-predator and homing behavior, reproductive function, physiological maturity, and swimming ability (Beauvais et al. 2000; Moore and Lower 2001; Scholz et al. 2000; Scott and Sloman 2004).

Development intensifies use of coastal and other resources, resulting in impacts on water quality, habitat, and air quality. Development impacts coastal resources in the action area through point and nonpoint source pollution (as described further above), increased sedimentation, concentrated recreational use, and intensive ship traffic using major port facilities. Riverine habitat throughout the action area been greatly influenced by the construction of dams and shipping channels.

Construction of dams and dredging activities in the action area affects anadromous fish species. Dams, without adequate fish passage systems, have extirpated anadromous fish from some of their pre-development spawning and rearing habitats (NMFS 2008b). Additionally, water impoundments resulting from dam operations affect downstream water quality characteristics, vital components to anadromous fish survival (NMFS 2008b). For example, construction of the Federal Columbia River Power System (FCRPS) has blocked salmon and steelhead access from thousands of miles of habitat in the Columbia River basin. The FCRPS also resulted in the inundation of many Columbia River mainstem spawning and shallow-water rearing areas (loss of spawning gravel and access to spawning and rearing areas); altered water quality, quantity (due to seasonal changes in flows and consumptive losses from human use), temperature, and velocity; food (alteration of food webs); and safe passage (increased mortality rates of migrating juveniles) (NMFS 2008b).

Similar effects have been observed in other watersheds in the action area. The construction of dams has blocked upriver passage for the majority of sturgeon populations. Dams can have profound effects on sturgeon species by eliminating or impeding access to historic habitat, modifying free-flowing rivers to reservoirs and altering downstream flows and water temperatures. For example, the Essex Dam on the Merrimac River in Massachussetts blocks access to 58 percent of the historically available habitat for Atlantic sturgeon. Dams also pose a threat to green sturgeon Southern DPS, in particular on the Sacramento River, with dams blocking access to putative spawning habitat (Thomas et al. 2014). Dams also can fragment sturgeon populations. This has been the case for shortnose and Atlantic sturgeon populations on the Connecticut River and the Santee-Cooper River system (SSRT 2010).

Many rivers and estuaries are periodically dredged for flood control or to support commercial and recreational boating. Dredging also aids in construction of infrastructure and in marine mining. Dredging may have adverse impacts on aquatic ecosystems including direct removal/burial of organisms, turbidity, contaminant resuspension, noise/disturbance, alterations due to hydrodynamic regime and physical habitat, and actual loss of riparian (Chytalo 1996; Winger et al. 2000). Dredges are generally either mechanical or hydraulic. Mechanical dredges are used to scoop or grab bottom substrate and are capable of removing hard-packed materials and debris. Mechanical dredge types are clamshell buckets, endless bucket conveyor, or single backhoe or scoop bucket types. However, these dredge types often have difficulty retaining fine materials in the buckets and do not dredge continuously. Material excavated from mechanical dredging is often loaded onto barges for transport to a designated placement site (Palermo et al. 2008). Hydraulic dredges are used principally to dredge silt, sand, and small gravel. Hydraulic dredges include cutterhead pipeline dredges and self-propelled hopper dredges. These machines remove material from the bottom by suction, producing slurry of dredged material and water, either pumped directly to a placement site, or in the case of a hopper dredge, into a hopper and later transported to a dredge spoil site. Cutterhead pipeline dredges can excavate most materials including some rock without blasting and can dredge almost continuously (Palermo et al. 2008).

The impacts of dredging operations on ESA-listed species in the action area are often difficult to assess. Hydraulic dredges can lethally take ESA-listed species (e.g., sturgeon) by entraining them in dredge drag arms and impeller pumps (NMFS 1998a). Mechanical dredges have also been documented to lethally take ESA-listed species (Dickerson 2006). In addition to direct effects, indirect effects from either mechanical or hydraulic dredging include destruction of benthic feeding areas, disruption of spawning migrations, and deposition of resuspended fine sediments in spawning habitat (NMFS 1998a). Another critical impact of dredging is the encroachment of low dissolved oxygen and high salinities upriver after channelization (Collins et al. 2001). For example, adult shortnose sturgeon can tolerate at least short periods of low dissolved oxygen and high salinities, but juveniles are less tolerant of these conditions in laboratory studies. Collins et al. (2001) concluded harbor modifications in the lower Savannah River have altered hydrographic conditions for juvenile sturgeon by extending high salinities and low dissolved oxygen upriver.

The responses of coral populations to coastal development and pollution are relatively well understood (ISRS 2004). For example, increases in water turbidity in coral habitat reduces light penetration, photosynthesis and growth, and increases metabolic costs (ISRS 2004; Rogers 1979a; Rogers 1983b; Telesnicki and Goldberg 1995). Increased nutrients can also impact corals by negatively affecting fertilization rates and rates of coral calcification (Harrison and Ward 2001; ISRS 2004; Marubini and Davies 1996). Increases in soil erosion from coastal development can lead to sediment loading in coastal waters which directly impact reef building corals.The most common direct effect of sedimentation is deposition of sediment on coral surfaces as it settles out from the water column. Corals with certain morphologies (e.g., mounding) can passively reject settling sediments or corals can actively displace sediment by ciliary action or mucous production, both of which require energetic expenditures (Bak and Elgershuizen 1976; Dallmeyer et al. 1982; Lasker 1980; Stafford-Smith 1993; Stafford-Smith and Ormond 1992). Corals that are unsuccessful in removing sediment will be smothered and die (Golbuu et al. 2003; Riegl and Branch 1995; Rogers 1983a). Sediment can also induce sublethal effects, such as reductions in tissue thickness (Flynn et al. 2006) and excess mucus production (Marszalek 1981). In addition, suspended sediment can reduce the amount of light in the water column, making less energy available for coral photosynthesis and growth (Anthony and Hoegh Guldberg 2003; Bak 1978; Rogers 1979b). While some corals may be more tolerant of short-term elevated levels of sedimentation, sediment stress and turbidity can induce bleaching (Philipp and Fabricius 2003; Rogers 1979b). Finally, sediment impedes fertilization of spawned gametes (Gilmour 2002; Humphrey et al. 2008) and reduces larval settlement, as well as the survival of recruits and juveniles (Birrell et al. 2005; Fabricius et al. 2003).

Dock construction on the east coast of Florida portion of the action area impacts Johnson's seagrass. Impacts can occur from construction activities, prop scarring or pollution from boat activity, and reduced photosynthesis due to the presence of an overwater structure blocking incident radiation and creating a shadow under the dock (Burdick and Short 1999; Landry et al.

2008). Further, Kelty and Bliven (2003) found that the number of dock and dock construction permit application are increasing steadily with coastal population growth.

2.5.5 Fisheries

Several types of fishing gear used in the action area are known to have adverse effects on ESA-listed resources. For example, hook-and-line gear as well as traps have all been documented as interacting with corals. Available information suggests hooks and lines can become entangled in reefs, resulting in breakage and abrasion of corals. Net fishing can also affect corals due to the practice by some fishers in Puerto Rico and the United States Virgin Islands of encircling patch reef areas with nets and then using divers to scare fish into the net, as well as the practice by some net fishers in Puerto Rico of dragging nets along the marine bottom in shallow nearshore areas. A study by Sheridan et al. (2005) showed that most trap fishers do not target high-relief bottoms to set their traps due to potential damage to the traps. Lost traps and illegal traps can affect corals and their habitat if they are moved onto reefs or colonized hardbottoms during storms, or placed on coral habitat, because the movement of the traps leads to breakage and abrasion of corals.

Directed harvest in commercial fisheries of ESA-listed sturgeon is prohibited. However, green sturgeon are frequently caught incidentally in tribal gill-net salmon fisheries and in white sturgeon commercial and sport fisheries (NMFS 2010a). Commercial fishing trawls also represent a source of bycatch for green sturgeon during their oceanic phase (Lindley et al. 2008). Estimates of green sturgeon bycatch in West coast groundfish trawl fisheries were generated based on observer data collected from 2002-2008, and ranged from 782 to 51 individuals annually; post capture survival rates were not calculated and remain uncertain (Bellman et al. 2010). Despite the harvest bans, adult sturgeon on the U.S. east coast are believed to be especially vulnerable to fishing gears for other anadromous species (such as shad, striped bass and herring) during times of extensive migration – particularly the spawning migration upstream, followed by movement back downstream (Litwiler 2001). Listed salmonids are also caught as bycatch in the action area.

Fisheries may impact Steller sea lions in the action area through entanglement or competition for prey fish species resulting in nutritional stress. Angliss and Outlaw (2005) reported that since the mid-1990s, western DPS Steller sea lion mortality incidental to commercial fishing was approximately 30 animals per year. Significant concern also exists regarding competition between commercial fisheries and Steller sea lions for the same resource: stocks of pollock, Pacific cod, and Atka mackerel. Significant evidence exists showing that the western DPS is declining as a result of change in diet and resulting declines in growth, birth rates, and survival (Atkinson et al. 2008; Calkins et al. 1998; Calkins and Goodwin 1988; Pitcher et al. 1998; Trites and Donnelly 2003). As a result, limitations on fishing grounds, duration of fishing season, and monitoring have been established to prevent Steller sea lion nutritional deficiencies as a result of inadequate prey availability.

2.5.6 Hatcheries

Each year hatcheries along the west coast of the United States release millions of juvenile salmon into the action area, with 200 million salmon released annually into the Columbia River alone. These hatchery programs are intended to support tribal, recreational, and commercial fisheries (NMFS 2008b). Hatcheries can also be used as a tool for conservation, helping to prevent salmon and steelhead extinction (e.g., Kline and Flagg 2014). However, hatchery programs do have the potential to increase the extinction risk and threaten the long-term viability of natural salmonid populations (NMFS 2008b). Hatchery programs can have unintended consequences including outbreeding depression when hatchery fish spawn with natural-origin fish, disease transmission, and competition between hatchery and natural-origin fish for limited resources (e.g., food, habitat) (NMFS 2008b). Efforts have been made to reduce these risks including the implementation of Hatchery Genetic Management Plans (NMFS 2008b).

2.5.7 Invasive Species

Aquatic nuisance species (ANS) are aquatic and terrestrial organisms, introduced into new habitats throughout the action area and other areas of the world, that produce harmful impacts on aquatic ecosystems and native species (http://www.anstaskforce.gov). They are also referred to as invasive, alien, or nonindigenous species. Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). Invasive species have been implicated in the endangerment of 48 percent of the species listed under ESA (Czech and Krausman 1997).

In general, species located higher within a food web (including most ESA-listed species under NMFS' jurisdiction) are more likely to become extinct as a result of an invasion; conversely, species that are more centrally or bottom-oriented within a food web are more likely to establish (Byrnes et al. 2007; Harvey and May 1997). Propagule pressure is generally the reason for this trend, as individuals lower in the food web tend to have higher fecundity and lower survival rates (r-selection). This unbalancing of food webs makes subsequent introductions more likely as resource utilization shifts, increasing resource availability, and exploitation success by non-native species (Barko and Smart 1981; Byrnes et al. 2007). Such shifts in the base of food webs fundamentally alters predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002).

The most commonly reported impact of non-native species in the coastal environment (i.e., a large portion of the action area) is competition for limited resources (Nyberg 2007). Molluscs, decapods, and aquatic plants tend to be especially capable invaders and have proven to be disruptive to food webs. The most common impacts are alteration of habitat and nutrient availability as well as altering species composition and diversity within an ecosystem (Strayer 2010). Crabs, polychaetes, and mussels can increase bioturbation and aerate the sediment (Nyberg 2007). Gastropods can alter the biogeochemical cycle through excretion of biogenic silicate in the faeces and pseudofaeces (Ragueneau et al. 2005). Molluscan invasions can also

provide substrate for epibionts, shelter for benthic species, remove nutrients from the water, decrease turbidity and increase light penetration, remove sediments, and promote phytoplankton blooms by releasing nutrients from sediments (Bertness 1984; Gutierrez et al. 2003; Hecky et al. 2004). Invasives species may also prey upon ESA-listed species. For example, the crown-of-thorns sea star *Acanthaster planci* can significantly disrupt localized coral reef ecosystems by feeding on live coral (e.g., (Timmers et al. 2012)), including the ESA-listed coral considered in this opinion. At the Tanguisson Reef, Guam, a population explosion of the sea star reduced coral cover to <1 percent of pre-disturbance levels in 1968-1969. However, the effect of the sea star can be relatively temporary. For example, at the Tanguisson Reef, coral species richness, cover, and composition reached or exceeded measurements of comparable reefs before the disturbance within 12 years (Colgan 1987).

Red tide dinoflagellates have been introduced via ballast water discharges and have the potential to undergo extreme seasonal population fluctuations. During bloom conditions, high levels of neurotoxins are released into local and regional surface water and air that can cause illness and death in fishes, sea turtles, marine mammals, and invertebrates (as well as their larvae) (Hallegraeff and Bolch 1992; Hallegraeff 1998; Hamer et al. 2001; Hamer et al. 2000; Lilly et al. 2002; McMinn et al. 1997). The brown alga, *Aureococcus anophagefferens*, causes brown tide when it blooms, causing diebacks of eelgrass habitat due to blooms decreasing light availability and failure of scallops and mussels to recruit (Doblin et al. 2004).

Invasive plants can cause widespread habitat alteration, including native plant displacement, changes in benthic and pelagic animal communities, altered sediment deposition, altered sediment characteristics, and shifts in chemical processes such as nutrient cycling (Grout et al. 1997; Ruiz et al. 1999; Wigand et al. 1997). Introduced seaweeds alter habitat by colonizing previously unvegetated areas, while algae form extensive mats that exclude most native taxa, dramatically reducing habitat complexity and the ecosystem services provided by it (Wallentinus and Nyberg 2007). Invasive algae can alter native habitats through a variety of impacts, including trapping sediment, reducing the number of suspended particles that reach the benthos for benthic suspension and deposit feeders, reduce light availability, and adversely impact foraging for a variety of animals (Britton-Simmons 2004; Gribsholt and Kristensen 2002; Levi and Francour 2004; Sanchez et al. 2005).

ANS adversely affect listed salmon species through several mechanisms, including: predation, competition, trophic structure alteration, introgression, and transfer of pathogens (Sanderson et al. 2009). Channel catfish, small and largemouth bass, and walleye prey on juvenile salmon (Sanderson et al. 2009). Juvenile shad prey heavily on zooplankton, which are also the primary prey for juvenile Chinook salmon (Haskell et al. 2006). The presence of brook trout in the Columbia River Basin is associated with a 12 percent reduction in the survival of juvenile salmon (Levin et al. 2002). Non-native crustaceans, mollusks, and plants pose significant risks to salmonids and the function of their ecosystems. For example, the invasive New Zealand mud snail has been detected in the diet of juvenile Columbia River Chinook salmon, indicating the

potential for a shift in estuarine food web structure (Bersine et al. 2008). Non-native quagga and zebra mussel invasions in the eastern U.S. have resulted in competition with native mussels, disruption of food webs, and bioaccumulation of toxins; similar threats are expected if these species invade western waterways (Sanderson et al. 2009). Aquatic plants, such as purple loosestrife and Eurasian water milfoil, have been introduced to the Pacific Northwest through ballast water. These rapidly decomposing plants have the potential to alter ecosystem function through changes in seasonal nutrient availability and depressed dissolved oxygen concentrations (Blossey et al. 2001; Cronin et al. 2006; Unmuth et al. 2000). Climate change is likely to facilitate the establishment and expansion of ANS. In summary, non-native species have adversely affected salmonid species, primarily through predation and competition; however, they also have the potential, through the mechanisms listed above, to equal or exceed the impacts caused by overharvest, habitat loss, hatcheries, and threats to the hydrosystem (Ruckelshaus et al. 2002b; Sanderson et al. 2009).

2.5.8 Marine Debris

Debris can be introduced into the action area by its improper disposal, accidental loss, or natural disasters (Watters et al. 2010), and can include plastics, glass, derelict fishing gear, derelict vessels, or military expendable materials. Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (Academies 2008) and continues to accumulate in the ocean and along shorelines within the action area. Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it. Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for all listed species in the action area. Entanglement can also result in drowning for air breathing marine species including pinnipeds. Marine debris ingestion can lead to intestinal blockage which can impact feeding ability and lead to death. NOAA (2014) reported that entanglement rates for Steller sea lions in Alaska may be increasing. Raum-Suryan et al. (2009) reported an entanglement rate of 0.26 percent whereas a prior study had reported an entanglement rate of only 0.07 percent. Marine debris may also impact coral reef ecosystems. For example, Chiappone et al. (2002) conducted surveys of the Florida Keys and documented marine debris entanglement in reef areas. The authors documented damage from marine debris on coral reef habitat, including damage to scleractinian corals (likely inclusive of ESA-listed corals such as elkhorn and staghorn coral).

2.5.9 Scientific Research Permits

Regulations developed under Section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research within the action area. Prior to the issuance of these permits, the proposal must be reviewed for compliance with section 7 of the ESA.

2.5.10 Climate Change

The Fifth Assessment Synthesis Reports from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) conclude that climate change is unequivocal (IPCC 2014). The Report concludes oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m have warmed by 0.11^{o}C per decade over the period 1971 to 2010) (IPCC 2014). Global mean sea level rose by 0.19 m between 1901 and 2010, and the rate of sea level rise since the mid-nineteenth century has been greater than the mean rate during the previous 2 millennia (IPCC 2014). The IPCC projects a rise of the world's oceans from 0.26 to 0.98 meters by the end of the century, depending on the level of greenhouse gas emissions. Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, hurricanes, heat waves, and droughts (IPCC 2014).

Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered in this opinion, is difficult (Simmonds and Isaac 2007). Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. He predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. Previous warming events (e.g., El Niño, the 1977 through 1998 warm phase of the Pacific Decadal Oscillation) may illustrate the potential consequences of climate change. Off the U.S. west coast, past warming events have reduced nutrient input and primary productivity in the California Current, which also reduced productivity of zooplankton through upper-trophic level consumers (Doney et al. 2012; Sydeman et al. 2009; Veit et al. 1996).

Climate-mediated changes in important prey species populations are likely to affect predator populations. For example, past warming events have resulted in reduced food supplies for marine mammals along the U.S. west coast (Feldkamp et al. 1991; Hayward 2000; Le Boeuf and Crocker 2005). Some marine mammal distributions may have shifted northward in response to persistent prey occurrence in more northerly waters during El Niño events (Benson et al. 2002; Danil and Chivers 2005; Lusseau et al. 2004; Norman et al. 2004; Shane 1994; Shane 1995). For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or

negatively impact population sustainability (Simmonds and Eliott. 2009). Foraging is not the only aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Eliott. 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott. 2009).

Climate change is expected to impact anadromous fish species in the action area. For example, in the Columbia River basin, alterations in precipitation and and temperature levels may result in shifts to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season. With lower snowpack, watersheds will see their runoff dimished and exhausted earlier in the season, resulting in lower streamflows and warmer water temperatures in the June through September period (ISAB 2007). This would be expected to reduce the areal extent of suitable inland salmon habitat in the Columbia River basin and to impact the quality and quantity of rearing habitat, greatly affecting spring and summer salmon and steelhead runs (NMFS 2008b). As a result of water temperature and hydrologic effects of climate change, Crozier et al. (2008)showed that abundance of four Snake River Chinook salmon populations would be reduced by 20-40 percent by the year 2040. In the Delaware River, Collier (Collier 2011) predicted that sea level rise, combined with more frequent droughts and increased human demand for water, may result in expansion of the salt wedge further upstream. This may restrict the availability of spawning and rearing habitat, and may affect the development of sub-adult life stages.

In the NMFS's final rule to list 20 coral species as threatened (79 FR 53851), ocean warming and acidification, associated wtih climate change, were identified as two of the most important threats to the current or expected future extinction risk of reef building corals. Reef building organisms are predicted to decrease the rate at which they deposit $CaCO_3$ in response to increased ocean acidity and warmer water temperatures (Raymundo et al. 2008). Further, the most severe coral bleaching events observed to date have typically been accompanied by ocean warming events such as the El Niño-Southern Oscillation (Glynn 2001). Bleaching episodes result in substantial loss of coral cover, and result in the loss of important habitat for associated reef fishes and other biota. Corals can typically withstand mild to moderate bleaching, but severe or prolonged bleaching events can lead to coral colony death (79 FR 53851). While the susceptibility to ocean warming and acidication associated with climate change is expected to vary by species and specific coral colony (based on latitude, depth, bathymetry, etc) (79 FR 53851), climate change is expected to have major impacts on the coral species considered in this opinion.

As stated previously, climate change has also been associated with an increase in extreme weather events such as hurricanes (IPCC 2014). In 2017, the southeastern portion of the United

States and the Caribbean were impacted by several hurricanes (e.g., Harvey, Irma, Maria). Though damage has not yet been fully assessed, based on impacts observed from previous storms, impacts are expected to sea turtle nests, coral reefs, and seagrass habitats throughout the region (e.g., Carlson et al. 2010; Gardner et al. 2005; Milton et al. 1994).

This is not an exhaustive review of all available literature regarding the potential impacts of climate change to the species considered in this opinion. However, this review provides some examples of impacts that may occur. While it is difficult to accurately predict the consequences of climate change to the species considered in this opinion, a range of consequences are expected, ranging from beneficial to catastrophic.

2.5.11 The Impact of the Baseline on ESA-listed Species

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed resources considered in this opinion. Some of these stressors result in mortality or serious injury to individual animals (e.g., fisheries), whereas others result in more indirect (e.g., a fishery that impacts prey availability) or non-lethal (e.g., anthropogenic noise) impacts. The ongoing operation and maintenance of the Coast Guard's ATON system may negatively impact ESA-listed resources in some ways (e.g., impacts to benthic habitat around the ATON, introduction of underwater noise during maintenance), but also provide some benefit to ESA-listed resources by preventing direct harm associated with large vessel groundings, and the secondary effects of pollution resulting from vessel accidents. Assessing the aggregate impacts of these stressors on the species considered in this opinion is difficult and, to our knowledge, no such analysis exists. This becomes even more difficult considering that some of the species in this opinion are wide ranging and subject to stressors in locations outside of the action area.

We consider the best indicator of the aggregate impact of the Environmental Baseline on ESA-listed resources to be the status and trends of those species. As noted in section 2.4, some of the species considered in this opinion are seeing increases in population abundance, some are declining, and for some, the status remains unknown. Taken together, this indicates that the Environmental Baseline is impacting species in different ways.

2.6 Effects of the Action

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or designated critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. §402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses is organized following the stressor, exposure, response, risk assessment framework, with the risk assessment for each species presented in Section 2.8 of this opinion.

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed

species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

2.6.1 Stressors Associated with the Proposed Action

Depending on the particular species, the potential stressors we expect to result from the proposed action are turbidity, vessel strike, vessel noise, aircraft noise, pile driving, displacement from habitat, and contact with ATON components. Details on how each of these potential stressors may affect ESA-listed species is presented in section 2.6.2 for ATON maintenance and section 2.6.3 for ATON establishment and discontinuance.

2.6.2 Species Exposure and Response Analysis: ATON Maintenance

The ESA-listed species that are likely to be adversely affected by ATON maintenance are listed in Table 10. Below we present our exposure and response analysis for the effects of ATON maintenance on these species. For each species or species group, we discuss each stressor mentioned above and then determine whether each of these stressors is likely to have adverse effects on that particular species or species group. The exposure and response analysis also provides discussion on how specific project design critieria help to minimize or avoid adverse effects to ESA-listed resources.

2.6.2.1 Steller Sea Lions: Western DPS

With the exception of the analysis presented below regarding harassment of Western DPS Steller sea lions resting on buoys and hauled out at Sea Lion Rocks during ATON maintenance, the conclusions on Coast Guard ATON stressors for other marine mammals in Section 2.3.1 apply to Western DPS Steller sea lions.

Western DPS Steller sea lions occupy both terrestrial and marine habitats. During the breeding season (mid-May to mid-July), most adult Steller sea lions occupy rookeries, typically on islands or offshore reefs. Pups stay on land for about two weeks after which they spend increasing time in nearshore waters until they begin to disperse from rookeries to haul-outs with females at about 2.5 months of age (Maniscalco et al. 2002; Maniscalco et al. 2006; Raum-Suryan et al. 2004). While some juveniles and non-breeding adults occur at or near the rookeries during the breeding season, most are on haulouts (i.e., terrestrial areas used by adult sea lions during times other than the breeding season and by non-breeding adults and subadults throughout the year) or are at sea foraging. When not on land, Steller sea lions are seen near shore and out to the edge of the continental shelf and beyond (Boor and Small 2012; NMFS 2008d).

Approaching aircraft or vessels can disturb pinnipeds, including Steller sea lions, while they are hauled out of the water. The response of pinnipeds to aircraft or vessels potentially includes no discernible reaction, temporarily leaving the haulout site, permanently abandoning the haulout site, and mortality (Calambokidis and Jeffries 1991; NOAA 2007; Suryan and Harvey 1999; Wilson et al. 2012). In general, vessels that approach rookeries and haulouts at slow speed, in a manner that allows sea lions to observe the approach have less effect than fast approaches and a

sudden appearance (Kucey 2005; NMFS 2008d). In Coast Guard District 17, Western DPS Steller sea lions will be affected by vessel and aircraft approach during ATON maintenance activities. According to the Coast Guard, approximately 200 sea lions are flushed annually from haulout sites (Dave Seris, Coast Guard District 17, email communication to Sadie Wright, NMFS, on November 3, 2016).

The most frequent interaction between Coast Guard assets and Western DPS Steller sea lions occurs during buoy tending operations. ATON crews often encounter Steller sea lions resting on a buoy (usually one or two animals on each buoy in District 17). Sometimes the animals leap from the ATON as the Coast Guard vessel or helicopter approaches the buoy, but other times the crew encourages the animals to leap from the ATON into the water by making noises, approaching the ATON, or spraying the animals with a fire hose. Once animals are flushed from buoys, they will not be able to return until the ATON maintenance activities are complete (typically about an hour). Sea lions that are flushed may remain in close proximity to the ATON or may leave the area to seek alternative resting or foraging habitat. We do not expect individual animals to be exposed to this type of disturbance more than one to three times per year since floating ATON are not serviced frequently (i.e., servicing interval is once every 4 to 36 months).

The Coast Guard also interacts with Western DPS Steller sea lions at Sea Lion Rocks, the location of a navigational light in the Eastern Aleutian Islands (Dave Seris, Coast Guard District 17, personal communication to Sadie Wright, NMFS, on November 3, 2016). This ATON is typically serviced by helicopter, but is sometimes also serviced via small boat. Sea Lion Rocks is a Western DPS Steller sea lion rookery and when the helicopter approaches the lighthouse, some sea lions flush into the water. Though the actual number of Steller sea lions present on Sea Lion Rocks when the aid is serviced varies (depending on whether or not the animals are hauled out or out foraging), approximately 250 individuals are typically present in close proximity when the aid is serviced (Dave Seris, Coast Guard District 17, email communication to Sadie Wright, NMFS, on August 8, 2017). The Coast Guard estimates that of the 200 Steller sea lions that are flushed annually from haulout sites due to ATON maintenance, about 80 percent are flushed from Sea Lion Rocks (Dave Seris, Coast Guard District 17, email communication to Sadie Wright, NMFS, on November 3, 2016). As described in the PDC in Section 1.3.5 of this opinion, the Coast Guard takes measures to minimize the effects of servicing this ATON on Steller sea lions. First, the sea lion rookery is located along the south and southeastern shores of Sea Lion Rocks and the Coast Guard avoids flying over the rookery to the extent practicable by approaching the island from the northwest and departing in the same direction. This minimizes the number of Steller sea lions exposed to stressors (e.g., noise, visual) associated with the approaching helicopter. Additionally, the Coast Guard avoids servicing the aid from May through the end of July during the peak reproductive season when sea lions are most densely concentrated at the rookery.

If animals are flushed from Sea Lion Rocks, this has the potential to cause a stampede, which could lead to trampling of some individuals, particularly juveniles. However, injury or mortality

from trampling is not anticipated because maintenance activities will occur after the breeding season when the density of sea lions at haulouts on Sea Lion Rocks is expected to be lower. Because animals are expected to be more spaced apart when ATON servicing occurs, it is not likely that they would trample one another. Similar to instances of Stellers being flushed from buoys, animals may not return to Sea Lion Rocks until the ATON maintenance activities are complete (typically about an hour). Sea lions that are flushed may remain in close proximity to the site or may leave the area to seek alternative resting or foraging habitat. Additionally, if any animals remain at the haulout site during the servicing event, they would likely experience short-term vigilance behavior.

There is a possibility that predators (e.g., killer whales) could be in the area when Steller sea lions are flushed from buoys or other haulouts. If this occurred, sea lions would be more susceptible to predation because their preferred sheltering habitat (e.g., the buoy) is unavailable. However, the likelihood of a killer whale or other predator being in the immediate vicinity of a haulout during the short time period the ATON is being serviced is low and even if a predator was nearby, Steller sea lions are mobile animals and would most likely be able to seek alternative haulouts or shelter. Because the likelihood of predators being in the immediate vicinity at the same time the ATON is being serviced is so remote, we do not expect a predation event is reasonably certain to occur.

NMFS' interim guidance on the ESA term "Harass" defines harassment as an action which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. A significant disruption in normal behavior patterns is defined as a change in the animal's behavior that could increase the risk of injury. An injury in the context of analyzing behavioral responses could be a physical injury or a physiological or other impact that would reasonably be expected to negatively affect the animal's growth, health, reproductive success or ability to survive. Based on this definition and the information presented above, only instances where Steller sea lions are flushed from Sea Lion Rocks, resulting in an increased risk of trampling, would Coast Guard ATON maintenance activities change the animal's behavior to a degree that could increase the risk of injury. As stated above, flushing sea lions from buoys is not expected to increase the risk of injury and therefore, would not rise to the level of take under the ESA. With the exception of the increased risk of injury at Sea Lion Rocks, we believe the effects of infrequently flushing Steller sea lions temporarily from their haulouts is insignificant.

In summary, infrequently flushing Steller sea lions temporarily from most haulouts (e.g., buoys) is not likely to adversely affect Steller sea lions. Only flushing of Steller sea lions from Sea Lion Rocks is expected to adversely affect individuals of the species.

2.6.2.2 Fishes

The potential stressors that we expect to result from the proposed action that may affect ESA-listed fish species are increased turbidity, vessel strike, vessel noise, displacement from habitat, and pile driving.

Turbidity

During detachment or placement of ATON sinkers and chains, during removal and driving of piles, and while Coast Guard ATON vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in temporary increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). Increases in turbidity have the potential to affect foraging success of fishes (Gregory and Levings 1998; Utne-Palm 2002) and if chronic, could impact fish growth rates (e.g., Sigler et al. 1984). Newcombe and Macdonald (1991) determined that the effects of suspended sediments on aquatic organisms was dependent on the duration of the increase in suspended sediments, with longer durations leading to a higher likelihood of a negative affect. Increases in turbidity caused by resuspension of sediment from installation of structures on the seafloor, spudding, and/or vessel propellers would be expected to quickly subside (i.e., within hours) following completion of the ATON activity. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels. Additionally, per the PDC, the Coast Guard will implement measures to minimize the resuspension of sediment including, when operationally feasible, lowering all objects to the bottom in a controlled manner, operating at minimum safe speeds while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom, operating vessels in marked channels whenever possible, and avoiding spudding down when conducting ATON operations in coral habitats. For these reasons, water quality impacts resulting from increases in turbidity associated with sediment resuspension during ATON operations are insignificant and are not likely to adversely affect ESA-listed fish species.

Vessel strike

Sturgeon and smalltooth sawfish could also be susceptible to vessel strike (e.g., Brown and Murphy 2010). However, the Coast Guard's biological evaluation limits the proposed action to vessel operations in the immediate vicinity of an ATON and transit between adjacent ATON.[30] Therefore, only vessel operations occurring at the ATON site or between adjacent ATON sites are considered in this opinion. Generally, vessel speed at the ATON site or between adjacent ATON sites is relatively slow due to the precision with which vessels must operate during these activities. There has never been a documented instance where a vessel associated with ATON operations (i.e., vessel operations in the immediate vicinity of the ATON and transit between adjacent ATON) has struck an ESA-listed fish species. Further, per the PDC described in section 1.3.5, the Coast Guard will implement a number of measures to minimize the likelihood that a vessel will strike sturgeon or sawfish. These measures include having topside crew members on

[30]According to the Coast Guard's biological evaluation, transit from homeports to the ATON site are not part of the proposed action considered in this consultation because the Coast Guard categorizes this transit time as law enforcement or other activities as opposed to ATON activities.

the lookout for ESA-listed species, and remaining 50 yards from all observed sturgeon and sawfish while vessels are underway.

While it is possible for a vessel to strike a sturgeon or sawfish during the course of ATON operations, we do not believe that an ATON vessel strike is likely to occur. As stated previously, the Coast Guard has been conducting ATON operations in the action area for years and no such incident has occurred. Additionally, the Coast Guard employs minimization measures to reduce the likelihood for a strike. Consequently, NMFS has determined that the likelihood of vessel strike of an ESA-listed fish species during Coast Guard ATON operations is so low as to be discountable. For this reason, vessel strike is not likely to adversely affect ESA-listed fish species and vessel strike of fish will not be considered further in this opinion.

Vessel noise

According to Popper et al. (2014a), there is no direct evidence of mortality or injury to fish from vessel noise. Popper et al. (2014a) suggest that low frequency vessel noise (primarily from shipping traffic) may mask sounds of biological importance. However, any potential masking would be temporary as both the fish and vessel would be transiting the action area (likely at different speeds and in different directions) or lasting the duration of a particular ATON operation (if an individual fish were to remain in close proximity to the ATON during operations). For these reasons, we do not expect any short-term instances of masking to have any fitness consequences for any individual fish. Vessel activity may result in changes in fish behavior (Popper et al. 2014a). Simpson et al. (2016b) used laboratory and field experiments to study the potential effects of vessel noise on anti-predator behavior for the settlement life stage of the Ambon damselfish (*Pomacentrus amboinensis*), a demersal, site-attached, coral reef fish. The authors found that motorboat noise can have detrimental effects on anti-predator behavior of Ambon damselfish, potentially as a result of increased stress. These results are not broadly applicable though, as the winners and losers in other predator-prey interactions will depend on the hearing sensitivities and noise tolerance levels of the species being considered, and the noise source (Simpson et al. 2016a). Additionally, any potential effects of Coast Guard ATON vessel noise on predator-prey dynamics would be brief as both the fish and vessel would be transiting the action area (likely at different speeds and in different directions). Any behavioral responses to vessel noise are expected to be temporary (e.g., a startle response, brief avoidance behavior) and we do not expect these reactions to have any measurable effects on any individual's fitness. We expect individuals that exhibit a temporary behavioral response will return to baseline behavior immediately following exposure to the vessel noise. We do not expect these short term behavioral reactions to rise to the level of take. For these reasons, the effect of vessel noise that may result in behavioral reactions is insignificant and is not likely to adversely affect the ESA-listed fish species considered in this opinion.

Habitat exclusion

Potential effects to ESA-listed fish within the action area also include being temporarily unable to use a site for forage and refuge habitat due to potential avoidance of construction activities and

related noise.[31] These effects are insignificant due to the small size of ATON action areas and the limited time it will take to complete each action (i.e., typically a few hours). Because the effects of temporary habitat exclusion during ATON operations are insignificant to ESA-listed fish species, temporary habitat exclusion is not likely to adversely effect ESA-listed fish species.

Pile driving – Exposure and Response

Pile driving activities in Coast Guard Districts 1, 5, 7, 8, 11, 13, and 14 are expected to adversely affect ESA-listed fish species. Fish may be injured or killed when exposed to high levels of underwater sound, such as those generated by impulsive sound sources such as impact pile driving (e.g., Fahlman et al. 2012; Halvorsen et al. 2011; Halvorsen et al. 2012a; Popper et al. 2014a). Pathologies of fishes associated with very high sound level exposure and drastic changes in pressure are collectively known as barotraumas. Barotraumas range from non-lethal to lethal depending on explosion characteristics. Lethal injuries include hemorrhage and rupture of blood vessels and internal organs, including the swim bladder and kidneys. Death can be instantaneous, occur within minutes after exposure, or occur several days later. Non-lethal barotrauma may result in altered physiological states, including changes in scale loss, hormone levels, sensory detection, tissue damage, embolisms, and possible changes in behaviors that increase the fish's risk of exposure to predation (Fahlman et al. 2012; Popper et al. 2014b; Popper et al. 2004) or other decreased fitness consequence. The severity of the injury depends on a number of factors, including the size of the fish and the exposed individual's degree of sensitivity to sound. Yelverton et al. (1975) found there was a relationship between fish size and the exposed individual's susceptibility to mortality from underwater blasts. The authors found that smaller fish were more susceptible to mortality at lower sound impulses than larger fish. Differences in fish sensitivity to acoustic pressure may be the result of the presence and type of swim bladder, and more importantly, the proximity and linkage of the swim bladder to the ear (Halvorsen et al. 2012a; Halvorsen et al. 2012b; Popper et al. 2003; Popper et al. 2014b). Fishes with swim bladders may be more sensitive to sound, and therefore more susceptible to injury from underwater sound exposure, than are fishes that lack swim bladders. The air within the swim bladder is a much lower density than that of water and the fish's body. Thus the air (and swim bladder), can easily be compressed by sound pressure waves traveling through the fish's body.

Exposure to high noise levels can also cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift or TTS), decreasing sensory capability for periods lasting from hours to days (Popper et al. 2014b). Fish suffering damage to hearing organs may suffer equilibrium problems, and may have a reduced ability to detect predators and prey.

Underwater sounds have also been shown to alter the behavior of fishes (see review by Hastings and Popper 2005). Exposure to human-made sound may result in agitation, alarm, or startle responses. The startle response in fishes is a quick burst of swimming that may be involved in avoidance of predators. Other potential changes include reduced predator awareness and reduced

[31] Note that this discussion does not apply to the potential effects of pile driving which are discussed further below.

feeding. A study in Puget Sound, Washington suggests that pile driving operations disrupt juvenile salmon schooling behavior and habitat use (Feist et al. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results are not conclusive but there is a suggestion that pile-driving operations may result in a disruption in the normal migratory behavior of the salmon in that study, though the mechanisms salmon may use for avoiding the area are not understood at this time. Other research suggests that fish would move away from a sound source such as impact pile driving that is so loud that it could cause physiological damage (e.g., Anderson 1990; Dahl et al. 2015; Popper et al. 2014b). On the other hand, fish may respond to the first few strikes of an impact hammer with a startle response, but then the startle response wanes and some fish may remain within the potentially harmful area (Dolat 1997). The potential for adverse behavioral effects will depend on a number of factors, including the sensitivity to sound, the type and duration of the sound, as well as life stages of fish that are present in the areas affected by underwater sound.

The ESA-listed species that may be affected by pile driving in each district are listed in Table 14 below, along with the average annual number of steel and wood piles driven by the Coast Guard in each district for ATON maintenance.

Table 14. ESA-listed fish species that may be affected by pile driving activities associated with navigation aid maintenance in each Coast Guard district and the average number of wood or steel piles driven in each district annually.

Coast Guard District	Species	Average number of piles driven in Coast Guard District (wood/steel)
District 1	Atlantic salmon: Gulf of Maine DPS; Shortnose sturgeon; Atlantic sturgeon: Gulf of Maine, New York Bight DPSs	0 / 8
District 5	Shortnose sturgeon; Atlantic sturgeon –New York Bight, Chesapeake Bay, and Carolina DPSs	105 / 85
District 7	Shortnose sturgeon; Atlantic sturgeon –Carolina, and South Atlantic DPSs; Smalltooth sawfish; Gulf sturgeon; Nassau grouper; Scalloped hammerhead shark: Central and Southwest Atlantic DPS	420 / 100
District 8	Gulf sturgeon	1,447 / 0
District 11	Chinook salmon: California Coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Sacramento River winter-run, Snake River fall-run, Snake River spring/summer run, Upper Columbia River spring-run, Upper Willamette River ESUs; Chum salmon: Columbia River, Hood Canal summer-run ESUs; Coho salmon: Central California Coast, Lower Columbia River, Oregon Coast, Southern Oregon Northern California coast ESUs; Sockeye salmon: Ozette Lake, Snake River ESUs; Steelhead trout: Puget Sound, Middle Columbia River, Upper Willamette River, Lower Columbia River, Snake River Basin, Upper Columbia River DPSs; Scalloped hammerhead shark: Eastern Pacific DPS; Green sturgeon: Southern DPS; Pacific eulachon: Southern DPS	0 / 20
District 13	Chinook salmon: California Coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Sacramento River winter-run, Snake River fall-run, Snake River spring/summer run, Upper Columbia River spring-run, Upper Willamette River ESUs; Chum salmon: Columbia River, Hood Canal summer-run ESUs; Coho salmon: Central California Coast, Lower Columbia River, Oregon Coast, Southern Oregon Northern California coast ESUs; Sockeye salmon: Ozette Lake, Snake River ESUs; Steelhead trout: Northern California, California Central Valley, Central California, South-Central California DPSs; Bocaccio: Puget Sound/Georgia Basin DPS; Yelloweye rockfish: Puget Sound/Georgia Basis DPS; Green sturgeon: Southern DPS; Pacific eulachon: Southern DPS	0 / 30
District 14	Scalloped hammerhead shark: Indo-West Pacific DPS; Giant Manta Ray (proposed)*	1 / 3

*While the Giant Manta Ray has a circumglobal distribution, in US waters, it is only commonly observed around Hawaii in District 14. Because sightings are sporadic in other portions of the action area and because a large majority of their lives are spent in offshore waters where they would not be affected by pile driving, the likelihood of this species being affected by Coast Guard pile driving outside of District 14 is discountable.

The type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer all influence the sounds produced during pile driving. Other factors (e.g., species of fish, size of fish, physical condition of the fish, maximum sustained sound pressure and frequency, shape of the sound wave (rise time, depth of the fish in the water column, amount of air in the water, size and number of waves on the water surface, tidal currents, and presence of predators) can also influence the degree to which an individual fish exposed to underwater sound will be affected.

Three metrics are commonly used to evaluate noise impacts on fish:[32]

- *Peak Sound Pressure level* (PK; re: 1µPa) – The greatest absolute instantaneous sound pressure within a specific time interval and frequency band.
- *Root Mean Square* (RMS SPL; re: 1µPa) – The square root of the average of the square of the pressure of the sound signal over a given duration.
- *Sound Exposure Level* (SEL_{cum}; re: $1\mu Pa^2s$) – A measure of sound level that takes into account the duration of the signal. Ten times the logarithm to the base 10 of the ration of a given time integral of squared instantaneous frequency-weighted sound pressure over a stated time interval or event to the product of the squared reference sound pressure and reference duration of one second.

For impact pile driving, a multi-agency work group determined that to protect listed species, sound pressure waves should be within a single strike threshold of 206 decibels (dB), and for cumulative strikes either 187 dB SEL where fish are larger than two grams or 183 dB SEL where fish are smaller than two grams (Stadler and Woodbury 2009). The decision to include the SEL metric along with peak dB SPL metric was based upon the primary rationale that this SEL metric provided a way to sum the energy over multiple impulses, which cannot be accomplished with peak pressure. Using SEL, the exposure of fish to a total amount of energy (i.e., dose) can be used to determine if a physical injury occurs. Since the cumulative SEL formula takes into account all impact pile strikes within a 24-hour period (to be reset only after a break of 12 hours or longer), the size of the injury zone is designated at its maximum extent through the course of a pile-driving day. During the early portion of the construction day, the injury zone (based on the cumulative SEL metric) will be smaller and will only gradually increase out to the final distance after all strikes have been completed.

There is uncertainty as to the behavioral response of fishes to high levels of underwater sound. Based on the information currently available, and until new data indicate otherwise, NMFS believes a 150 dB root-mean-square pressure (RMS) threshold for behavioral responses for

[32] Noise metric definitions from NOAA. 2016b. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold for Onset of Permanent and Temporary Threshold Shifts..

fishes with swim bladders (e.g., salmonids) is appropriate for impact pile driving (NMFS 2011e; NMFS 2011f).

ESA-listed fish species may occur year-round in waters considered in this consultation. However, the likelihood of take resulting from pile driving and removal will be minimized by following the PDC described in Section 1.3.5 of this opinion, including completing the work during preferred in-water work windows and using a vibratory hammer when possible. The choice of hammer type depends on pile material, substrate type, and other factors. Impact hammers can drive piles into most substrates, including hardpan and glacial till, while vibratory hammers are limited to softer, unconsolidated substrates.

The vast majority of fixed structures built each year by the Coast Guard that involve pile driving (98 percent) consist of four or fewer piles. Most structures (85 percent) consist of a single pile. The standard Coast Guard pile structure consists of either 12 or 18 inch wood or hollow steel piles. Per the PDC described in section 1.3.5 of this opinion, pile driving using piles larger than 18 inches in diameter or with more than four steel piles will require a separate consultation under section 7 of the ESA.

NMFS has developed a spreadsheet to assess the potential effect to fishes exposed to elevated levels of underwater sound (peak and RMS pressure as well as SEL) resulting from pile driving. The distance to the thresholds of behavioral impacts and onset of physical injury can be calculated with the following information:

- Type of hammer – impact or vibratory
- Number of impact hammer strikes per pile
- Diameter of pile
- Pile type (e.g., steel, concrete or wood)
- Hydroacoustic assumptions (e.g., source level)
- Number of piles

We used a protective approach to select source levels for analyzing impacts to ESA-listed fish species. We reviewed available information from various pile driving studies and selected the most relevant data to the proposed action in terms of pile type and size, water depth, and substrate. Table 15 identifies sources chosen and the peak, root mean square (rms), and SEL values used to model the injury and disturbance thresholds for fish.

Table 15. Summary of information used in pile driving analysis including underwater source levels used.

Pile characteristics (size; material)	Installation method	Strikes per pile	Source level		
			dB peak[1]	dB RMS[1]	Single Strike SEL[2]
12 inch; wood	Impact	200	180	170	155
	Vibratory[3]	--	165	150	150
18 inch; hollow steel	Impact	500	198	185	169
	Vibratory[4]	--	175	160	160

[1]Measured at 10 m; referenced to 1 µPa.

[2]Measured at 10 m; referenced to 1 µPa2*sec.

[3]Underwater sound levels from vibratory driving of 12 inch wood piles is not available. We used noise levels collected during vibratory driving of a 12 inch steel pile as a proxy, though we would expect sound levels from a wood pile to be much lower (CalTrans 2012).

[4]Underwater sound levels from vibratory driving of 18-inch hollow steel piles is not available. We used typical noise levels collected during vibratory driving of a 24-inch steel pile as a proxy, but we would expect sound levels from an 18 inch pile to be lower (CalTrans 2012).

Vibratory pile driving lacks the fast rise times, high peak pressures, and high acoustic impulse associated with some impulsive sounds (e.g., impact pile driving) that have been shown to cause physical injury to fish. NMFS has not established thresholds to protect listed species for vibratory pile driving. However, the peak pressure from vibratory pile driving or pile removal would not exceed 206 dB (Table 15), the criteria for onset of physical injury as defined above for impact pile driving. For these reasons, we do not expect vibratory pile driving to injure or kill ESA-listed fish. Since the sound created during the removal of piles would be similar to driving piles with a vibratory hammer, we also do not expect injury or mortality of fishes to result from pile removal.

Table 16 lists the calculated distance from one or four pile structures where noise levels exceed thresholds described above during impact pile driving.

Table 16. Distance from piles driven by an impact hammer where noise exceeds thresholds.

Structure characteristics (# piles; pile size; material)	206 dB peak (onset injury)	183 dB cumulative SEL for fish <2 grams (onset injury)	187 dB cumulative SEL for fish >2 grams (onset injury)	Range to behavioral threshold (150 dB)
1; 12”; wood	< 1 meter	9 meters	5 meters	215 meters
4; 12”; wood	< 1 meter	22 meters	12 meters	215 meters
12; 12”; wood	< 1 meter	22 meters	22 meters	215 meters
1; 18”; steel	3 meters	73 meters	40 meters	2,154 meters
4; 18”; steel	3 meters	185 meters	100 meters	2,154 meters

Notes: All sound pressure levels expressed in dB re 1 µPa; SEL are expressed in dB re 1 μPa^2*sec. Practical spreading loss model (15 log R) used for calculations. Additionally, the 183 dB cumulative SEL threshold is not

applicable to some species considered in this opinion (i.e., sturgeon, scalloped hammerhead shark, smalltooth sawfish) because during all life stages, these species are larger than 2 grams.

During impact pile driving, even though work will be done during times to minimize potential exposure to ESA-listed fish species (per the PDC in section 1.3.5), individual ESA-listed fish may move through the action area at varying rates and be exposed to sound from pile driving that could cause lethal or sub-lethal injuries or behavioral impacts. Take caused by impact pile driving cannot be accurately quantified as a number of fish because the distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional and operate across far broader temporal and spatial scales than will be affected by the proposed action. Thus, the distribution and abundance of fish within each action area cannot be predicted precisely based on existing habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be harmed or harassed during pile driving activities.

In such circumstances, NMFS uses the causal link established between the activity and the likely changes in habitat conditions affecting the listed species to describe the extent of take as a numerical level of habitat disturbance. For this consultation, take is quantified as the extent of habitat where noise exceeds thresholds that could cause injury or behavioral impacts. Table 14 lists the annual average number of piles driven during ATON maintenance in each Coast Guard district and the ESA-listed fish species that occur in each district. Many ESA-listed species' ranges span multiple Coast Guard districts (e.g., shortnose sturgeon) or occur in only a portion of a Coast Guard district (e.g., smalltooth sawfish). However, we cannot predict exactly which structures will be replaced in a given year or how many structures will be replaced annually within each species' range. For this reason, we total the average number of structures that will be replaced in all Coast Guard districts that overlap with each species' range. In some years, the Coast Guard must replace a higher number of structures in some areas such as following extreme weather events. To conservatively estimate the number of piles that could be replaced in a given year when a higher than normal number of piles must be rebuilt, we double the average number of piles replaced annually.

Table 16 lists the distances around each pile in which fish could experience injury or a behavioral impact. The distance around each pile, multiplied by the number of structures replaced of each type (i.e., wood versus steel) and size (single pile structure vs structures with up to four piles) annually, was our estimate of the extent of take in the form of harm (distance to onset injury) and harassment (distance to behavioral impact) for ATON maintenance. This information is presented in Table 17.

Table 17. Extent of take in the form of harm and harassment to ESA-listed fish species from impact pile driving.

Species		Extent of take (km^2; harm [i.e.,	
Green sturgeon: Southern DPS		0.0132	0.19
Bocaccio: Puget Sound/Georgia Basin DPS		0.0099	0.10
Yelloweye rockfish: Puget Sound/Georgia Basis DPS		0.0099	0.10
Atlantic salmon: Gulf of Maine DPS		0.0031	0.01
Shortnose sturgeon		0.1998	1.16
Atlantic sturgeon	Gulf of Maine DPS	0.0031	0.01
	New York Bight DPS	0.0577	0.39
	Chesapeake Bay DPS	0.0549	0.38
	Carolina DPS	0.1971	1.15
	South Atlantic DPS	0.1462	0.72
Gulf sturgeon		0.4540	0.92
Smalltooth sawfish		0.1462	0.72
Chinook salmon: California Coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Sacramento River winter-run, Snake River fall-run, Snake River spring/summer run, Upper Columbia River spring-run, Upper Willamette River ESUs		0.0132	0.19
Coho salmon: Central California Coast, Lower Columbia River, Oregon Coast, Southern Oregon Northern California coast ESUs		0.0132	0.19
Chum salmon: Columbia River, Hood Canal summer-run ESUs		0.0099	0.10
Sockeye salmon: Ozette Lake, Snake River ESUs		0.0099	0.10
Steelhead	Puget Sound, Middle Columbia River, Upper Willamette River, Lower Columbia River, Snake River Basin, Upper Columbia River DPSs	0.0099	0.10
	Northern California, California Central Valley, Central California, South-Central California DPSs	0.0037	0.08
Nassau grouper		0.1462	0.72
Pacific eulachon: Southern DPS		0.0132	0.19
Scalloped hammerhead shark	Indo-West Pacific DPS	0.0008	0.01
	Eastern Pacific DPS	0.0037	0.08
	Central and Southwest Atlantic DPS	0.1462	0.72
Giant Manta Ray		0.0008	0.01

ESA-listed fishes, particularly mature individuals, are generally able to avoid the adverse conditions created by construction if those conditions are limited to areas that are small or local compared to the total habitat area, and if the system can recover before the next disturbance. Numerous studies have documented that fish may alter their behavior and avoid anthropogenic noise sources including oncoming vessels, airguns, pile driving, and general construction noise (De Robertis and Handegard 2013; Olsen et al. 1983; Ona and Godo 1990; Popper et al. 2014b). This means most ESA-listed fishes will, to the maximum extent possible, readily move out of a construction area (e.g., the area around a pile being driven) to obtain a more favorable position within their range of tolerance along a complex gradient of temperature, turbidity, flow, noise, contaminants, and other environmental features.

In the case of Coast Guard impact pile driving, we estimated that the injury zone around each pile ranged from 5 to 185 meters depending on the size, type, number of piles, and size of the fish. While information on the behavioral responses of fish to pile driving is limited, it is generally assumed that most fish would move away from a sound source that is so loud that it could cause physiological damage (e.g., Dahl et al. 2015). We believe the majority of fish potentially present in the action area will not remain this close to the construction activity during the full duration of the pile driving action and, in most cases, Coast Guard pile driving would not injure or kill ESA-listed fish. However, the degree and effectiveness of the avoidance response varies with life stage, season, the frequency and duration of exposure to the unfavorable condition, and the ability of the individual to balance other behavioral needs for feeding, growth, migration, and territory. Also important is the exposed individual's degree of sensitivity to sound and the individual's ability to detect the sound and location of it.

We cannot be certain that all fish (particularly juveniles) will be able to detect underwater sound from pile driving and avoid injury, but we expect larger, healthy individuals (e.g., adult salmonids) would be more likely to leave the area and avoid physical impacts. If ESA-listed fish do avoid the area around a pile during pile driving, in most cases, we would not expect this to result in negative implications for the individual. In most cases, individuals would simply seek alternative habitat nearby that is not currently being exposed to elevated levels of underwater noise. However, in some circumstances, forcing individuals to seek alternative habitat could result in an increased predation risk as they leave their preferred sheltering habitat.

2.6.2.3 Corals

Navigation aid operations in Coast Guard Districts 7 and 14 are expected to adversely affect ESA-listed corals. Potential effects to corals include smothering, breakage or abrasions from direct contact with Coast Guard equipment and effects due to declines in water quality from

turbidity. The Coast Guard may also remove ESA-listed corals from ATON components (e.g., sinkers, chain, buoy hull, pilings) while they are servicing the ATON[33].

During detachment or placement of ATON sinkers and chains, during removal and driving of piles, and while Coast Guard ATON vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in temporary increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). The lateral extent and duration of increased turbidity would also depend on substrate type and water movement in the area. However, increases in turbidity caused by resuspension of sediment from installation of structures on the seafloor, spudding, and/or vessel propellers would be expected to quickly subside (i.e., within hours) following completion of the ATON operation. Any sediments that do not immediately settle to the seafloor are expected to be swept away in currents and/or tidal flow and diluted to undetectable levels.

Additionally, per the PDC, the Coast Guard will implement measures to minimize the resuspension of sediment including, when operationally feasible, lowering all objects to the bottom in a controlled manner, operating at minimum safe speeds while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom, operating vessels in marked channels whenever possible, and avoiding spudding down when conducting ATON operations in coral habitats. The Coast Guard will not drop anchor on coral habitats. For these reasons, water quality impacts resulting from increases in turbidity associated with sediment resuspension during ATON operations are insignificant and are not likely to adversely affect ESA-listed corals in Districts 7 and 14.

Due to underwater surveys conducted by the Coast Guard in 2012 around navigation aids in District 7, there is more information available on the presence or absence of ESA-listed corals in proximity to navigation aids in District 7 (the Atlantic and Caribbean) than in District 14 (the Indo-Pacific). Because of this difference, our exposure analysis for the effects of ATON maintenance (i.e., due to breakage or abrasions from direct contact with Coast Guard equipment and the removal of ESA-listed corals from ATON components) on ESA-listed corals differs by Coast Guard District.

2.6.2.4 Exposure analysis for ESA-listed corals in District 7

ESA-listed corals in Coast Guard District 7 are likely to be adversely affected by ATON maintenance activities that result in corals coming in direct contact with Coast Guard equipment. These activities include spudding down, pile replacement, and scour (including the area impacted by the placement of the sinker) from floating ATON. In order to evaluate the magnitude of potential effects of the maintenance of ATON on ESA-listed corals, all available information on the presence of ESA-listed coral species around ATON in Coast Guard District 7 was compiled to determine which ATON are, or are likely to be, in close proximity to ESA-listed corals. The

[33] While the potential for ESA-listed corals to grow and settle on ATON components exists, no listed Indo-Pacific coral species has ever been observed to grow on artificial substrates (Lance Smith, NMFS, personal communication to Eric MacMillan, NMFS; July 21, 2017).

ATON evaluated were within Key West, Miami, and San Juan Coast Guard Areas of Responsibility. These ATON were selected because their location overlaps with the known range of ESA-listed corals in District 7.

The information on ESA-listed coral presence/absence near ATON resulted from surveys conducted by the US Coast Guard in 2012 in support of a previous section 7 consultation on ATON maintenance (NMFS 2013a). In some cases, the presence or absence of corals in close proximity to each particular ATON was confirmed by a Coast Guard dive survey. In other cases, the Coast Guard was unable to conduct a dive survey at a particular ATON, but reports from other benthic surveys suggested corals were likely present in close proximity.

The Coast Guard is unable to perform additional underwater coral surveys in support of this current consultation (Tech 2014). In total, 676 navigation aids occur within the known range of ESA-listed corals (458 fixed and 218 floating) in Coast Guard District 7. Out of the 458 fixed aids within the known range of ESA-listed corals, 129 were determined to be in close enough proximity to corals that we might reasonably expect that the maintenance of these ATON could affect ESA-listed corals (e.g., from spudding down, pile replacement). However, dive surveys completed around eleven of the fixed aids determined that no ESA-listed corals were present, leaving a total of 118 fixed aids in District 7 that could have ESA-listed corals in close proximity.

Out of the 218 floating aids within the known range of ESA-listed corals, 73 were determined to be in close enough proximity to corals that we might reasonably expect the presence and maintenance of these ATON could affect ESA-listed corals (e.g., from repair/replacement of tackle, repair/replacement of anchors, chain scour). However, dive surveys completed around 36 of the floating aids determined that no ESA-listed corals were present, leaving a total of 37 floating aids in District 7 that could have ESA-listed corals in close proximity.

Because the Coast Guard is unable to conduct underwater coral surveys at every ATON site at regular intervals (Tech 2014), we do not have enough site-specific information to determine the number of individual coral colonies of each ESA-listed species that may be impacted by the presence and maintenance of existing Coast Guard navigation aids. In addition, coral reef communities are highly dynamic whether humans are present or not, with species density, colony size and morphology, and other factors varying over small spatial and temporal scales (e.g., seasonal and annual cycles of natural disturbance, like storms can drastically alter species distribution and density in a particular area). The spatial and temporal variability in coral habitat and species abundance is described in detail in the final rule's Corals and Coral Reefs section (79 FR 53852). Thus, even if reliable species-level data can be produced for a given action area site, over time, any changes in species abundance and density caused by the proposed action are likely to be confounded by natural variability. For these reasons and in accordance with 80 FR 26832, we will use a habitat surrogate approach to express the extent of anticipated incidental take of ESA-listed corals from the Coast Guard’s ATON maintenance activities in District 7.

To estimate the extent of habitat affected by the proposed action that could contain ESA-listed coral, we first estimated the area of habitat that may be affected by spudding down and pile replacement of fixed aids, as well as the area of habitat that could be continuously affected by scour and the presence of the sinker from each floating aid.

- Pile replacement: Replacement of pile-supported structures is expected to impact ESA-listed corals. When a pile supporting an ATON signal is replaced, the old pile may be left in place or removed, depending on the Coast Guard's evaluation of safety concerns. The new pile is placed close to the old pile, but may impact previously undisturbed benthic habitat. We estimated an impact area based on the number and size of the piles to be installed for ATON located in close proximity to ESA-listed corals in District 7. We cannot predict exactly how many structures will be replaced annually. However, we do know that there are 118 fixed ATON that could be in close proximity to corals, and we know that approximately 8.35 percent of all structures are replaced annually in District 7. Using this proportion, we estimate that an average of ten structures are replaced each year in District 7 in areas where ESA-listed corals could occur. However, in some years, the Coast Guard must replace a higher number of structures in some areas such as following extreme weather events. To conservatively estimate the number of structures that could be replaced in a given year when a higher than normal number of structures must be rebuilt, we double the average number of structures replaced annually. The area of impact will be the area of the installed pile multiplied by the number of piles supporting the structure. Assuming an 18-inch pile is used (the largest pile size used in District 7), this equates to an area of impact of 0.16 m^2 per pile replaced.
- Spudding: Spuds are steel pipes or beams that are attached to and lowered from the bottom of a barge and driven into the marine bottom to create a temporary stable platform. Spuds must be repositioned sometimes when the vessel is not in the most appropriate location to service the ATON. This type of anchor method only occurs during maintenance of fixed aids when pile replacement is required. Many Coast Guard ATON maintenance vessels use dynamic positioning, so no spuds are required to maintain position during a servicing event. Additionally, per the PDC, the Coast Guard minimizes spudding down, and repositioning of spuds, in coral habitat whenever feasible. When spudding down is required, four spuds are sunk into the seafloor, each spud contacting one square foot of substrate. However, even though only one square foot of substrate will be directly impacted, spudding can also cause the collapse of surrounding coral habitat areas (Report 2014). For example, the use of a spud barge in Krum Bay, St. Thomas, U.S. Virgin Islands, in an area containing patch reefs expanded the area of impact for each spud by a factor of four (i.e., for a one square foot spud, four square feet of coral would be impacted) due to substrate collapse. To estimate the area of impact on ESA-listed species from spudding down, we will assume a worst-case scenario (i.e., worst-case scenario in terms of potential impacts to ESA-listed corals) where the Coast Guard is required to spud down and that all four spuds will be required whenever a piling structure needs to be replaced. This results in an area of impact of 1.48 m^2 for each ATON. To

account for the possibility that all four spuds must be repositioned, we double this impact area for each ATON. This result in an impact of 2.96 m^2 for each ATON.

- Scour: Chains and lines[34] from floating navigation aids move in a circle beneath the water and may create a circle of scour on the seafloor because they do not have floats to maintain buoy tackle off the seafloor. The chain portion of a floating ATON may crush and displace organisms that settle in the scour radius surrounding the sinker. Lines may abrade and cut sessile benthic organisms as they move. The Coast Guard's BE did not provide an average chain scour radius for floating aids in District 7. The BE estimated an average chain scour radius of 67 feet for floating aids in District 14, but the installation of ATON in a particular area in Puerto Rico led to a surveyed scour radius of 100 feet (NOAA 2011). To be conservative in our estimate of the impacted area, we assumed a worst-case scenario where the scour radius around aids in District 7 averaged 100 feet. While the Coast Guard makes every effort to return sinkers to their exact original location, adverse weather and strong water currents may cause the sinker to drop a few feet away from the intended target location (no more than ten feet from the assigned position). Therefore, to estimate the area of impact from scour on habitat that may contain ESA-listed corals, we assumed a worst-case scenario where the Coast Guard places the sinker ten feet away from its assigned position each time the sinker is lifted, thus increasing the scour radius by ten feet. We then calculated the total area of scour around the sinker[35].

For estimating impacts from pile replacement, we multiplied the total area of habitat affected per pile by the number of fixed structures that are replaced annually and the average number of piles supporting each structure in District 7. For estimating impacts from spudding, we multiplied the area of habitat affected per spudding event by the number of fixed ATON replaced per year in close proximity to coral (Table 18). This resulted in an average area of impact of 3.12 m^2 per structure replaced.

Table 18. Area of habitat affected by maintenance of fixed navigation aids in areas of District 7 in close proximity to corals.

Habitat affected (m^2) per pile/structure		Max number of fixed ATON replaced per year close to coral	Average number of pilings per structure in District 7	Habitat affected (m^2) annually		**Total habitat area affected annually (m^2)**
Pile replacement	Spudding down			Pile replacement	Spudding down	
0.16 per pile*	2.96 per structure	20	2	6.4	59.2	65.6

*Assumes an 18-inch pile, the largest size pile that is considered in this opinion. Total habitat area impacted per structure depends on the number of piles in a particular structure.

[34] Note that most buoys are attached to the sinker by a chain or wire rope; a synthetic line may be used occasionally.
[35] Note that the scour radius also includes the area of habitat impacted by the placement of the sinker since the chain or line is attached in the middle of the sinker.

Chain scour impacts were not estimated on an annual basis. Instead, we estimated an area of total habitat that could be continuously affected from chain scour (and the presence of the sinker) by multiplying the number of floating navigation aids that could have ESA-listed corals in close proximity by the estimated area of impact from each floating aid (Table 19).

Table 19. Area of habitat continuously affected by chain scour in areas of District 7 in close proximity to corals.

Habitat area (m^2)/aid	Number of floating aids near coral	Total habitat area affected (m^2)
3,267*	37	120,879

*As described above, we assumed a scour radius of 30.5 meters (+ 3 meters distance from previous position) for aids in District 7. Note that calculations for the extent of habitat affected by chain scour are not annual estimates, but the amount of habitat that is continuously affected by the presence of the ATON at a particular location.

Additionally, ESA-listed corals that may have attached to ATON components between servicing events are likely to be adversely affected when the Coast Guard cleans these components by physically removing the organisms or when piles are removed. Corals attached to buoy components would likely be recently settled larva or juvenile coral colonies that settle on buoy components between servicing events (in District 7 the minimum servicing interval for floating aids is 4 months and the maximum servicing interval is 36 months). Corals that settle on piles supporting fixed aids could be older, and potentially sexually mature, as piles are not replaced every time an aid is serviced. The Coast Guard does not always remove old pilings. If the piling is not removed, the corals attached would not be effected. However, when pilings are removed (as is often the case because leaving pilings in place may present a navigational hazard), any organisms attached would be harmed.

We do not have information available to estimate the number of ESA-listed coral colonies of each species that may be attached to the different components (e.g., piles, concrete sinkers, buoys) of ATON and may be removed during maintenance activities. In accordance with 80 FR 26832, we will use a habitat surrogate approach to express the extent of anticipated incidental take of ESA-listed corals from the Coast Guard's ATON maintenance activities. The extent of take of ESA-listed corals will be estimated based on the number of piles removed annually in areas where ESA-listed corals occur (i.e., maximum of 40 piles annually) and the maximum annual number of floating aid servicing events (i.e., 148[36]) in areas where ESA-listed corals could occur.

2.6.2.5 Exposure analysis for ESA-listed corals in District 14

ESA-listed corals in Coast Guard district 14 are also likely to be adversely affected by ATON maintenance activities that result in corals coming in direct contact with Coast Guard equipment. These activities include spudding down, pile replacement, and scour (including the area impacted by the placement of the sinker) from floating ATON. We do not have enough site-specific information available to estimate the number of ESA-listed coral colonies that are likely to be

[36] Maximum number based on number of floating aids in areas where ESA-listed corals could occur and minimum servicing interval of floating navigation aids (37 floating aids in areas where ESA-listed corals could occur; 4 month minimum servicing interval in District 7; 37 aids x 4 months = 148 servicing events per year).

adversely affected by the proposed action from making contact with Coast Guard equipment in District 14. Additionally, the Coast Guard is unable to perform underwater coral surveys in support of this consultation in District 14 (Tech 2014). Furthermore, information on the presence/absence of ESA-listed corals in District 14 is extremely limited. Many areas in the Indo-Pacific, have not been surveyed for the majority of ESA-listed species. For this analysis, we rely on information available from surveys and strong predictions of occurrence for areas that have not been surveyed. The information on species distribution and abundance used in this analysis is presented in Table 20 and is consistent with that presented in the final rule to list 20 species of coral as threatened under the ESA (79 FR 53851). For these reasons and in accordance with 80 FR 26832, we will use a habitat surrogate approach to express the extent of anticipated incidental take of ESA-listed corals from the Coast Guard's ATON maintenance activities.

Table 20. Known geographic distribution and abundance of ESA-listed corals in Coast Guard District 14.

Species	Known distribution within U.S. waters	Minimum abundance estimate (Number of colonies)[4]
A. globiceps	American Samoa[1]; Mariana Islands[2]; PRIA[3] – Palmyra Atoll, Kingman Reef, Wake Atoll	Tens of millions
A. jacquelineae	American Samoa - Tutuila & Offshore Banks	31,599,000
A. retusa	American Samoa; Mariana Islands – Guam and offshore banks; PRIA - Howland Island, Kingman Reef, Johnston Atoll, Wake Atoll, and Jarvis Island	Millions
A. speciosa	American Samoa - Tutuila & Offshore Banks; PRIA – Kingman Reef	10,942,0000
E. paradivisa	American Samoa - Tutuila & Offshore Banks	Tens of millions
I. crateriformis	American Samoa - Tutuila & Offshore Banks, Ofu & Olosega, Ta'u	Millions
S. aculeata	Mariana Islands – Guam and offshore banks, Saipan and Garapan Bank	Millions

[1]American Samoa: Unless otherwise noted, this includes Tutuila & Offshore Banks, Ofu & Olosega, Ta'u, and Rose Atoll.

[2]Mariana Islands (Guam and Commonwealth of the Mariana Islands): Unless otherwise noted, this includes Guam & Offshore Banks, Rota, Aguijian, Tinian and Tatsumi Reef, Saipan and Garapan Bank, Farallon de Medinilla, Anatahan, Pagan, Maug Islands & Supply Reef.

[3]Pacific Remote Island Area (PRIA): Unless otherwise noted, this includes Howland Island, Palmyra Atoll, Kingman Reef, Johnston Atoll, Wake Atoll, and Jarvis Island.

[4]Minimum abundance information comes from the Final Rule to list 20 species of coral under the Endangered Species Act (79 FR 53851). For these species, the Rule lists an abundance estimate for a subset of areas within the range of the species. The Rule then states that the absolute abundance is higher than this estimate given the presence of the species in many other areas throughout its range.

To estimate the extent of habitat affected by the proposed action that could contain ESA-listed coral, we first estimated the area of habitat that may be affected by spudding down and pile replacement of fixed aids, as well as the area of habitat that could be continuously affected by scour and the presence of the sinker from each floating aid. Results of each of these calculations are presented in Table 21.

- Pile replacement: Replacement of piling structures is also expected to impact ESA-listed corals. When a piling supporting an ATON signal is replaced, the old piling may be left in place or removed, depending on the Coast Guard's evaluation of safety concerns. The new piling is placed close to the old piling, but may impact previously undisturbed benthic habitat. We estimated an impact area based on the number and size of the piles to be installed in each species' range on an annual basis. We cannot predict exactly how many structures will be replaced annually. However, we do know the number of fixed ATON within the known range of each ESA-listed coral in District 14 (Table 21), and we know that approximately 6.5 percent of all structures are replaced annually in District 14. Using this proportion, we estimate an average of structures that are replaced each year in District 14 in areas where ESA-listed corals could occur (Table 21). However, in some years, the Coast Guard must replace a higher number of structures in some areas such as following extreme weather events. To conservatively estimate the number of structures that could be replaced in a given year when a higher than normal number of structures must be rebuilt, we double the average number of structures replaced annually. The area of impact will be the area of the installed pile multiplied by the number of piles supporting the structure. Assuming an 18-inch pile is used (the largest pile size used in District 14), this equates to an area of impact of 0.16 m^2 per pile replaced.
- Spudding down: Spuds are steel pipes or beams that are attached to and lowered from the bottom of a barge and driven into the marine bottom to create a temporary stable platform. Spuds must be repositioned sometimes when the vessel is not in the most appropriate location to service the ATON. This type of anchor method only occurs during maintenance of fixed aids when pile replacement is required. Many Coast Guard ATON maintenance vessels use dynamic positioning, so no spuds are required to maintain position during a servicing event. Additionally, per the PDC, the Coast Guard minimizes spudding down, and repositioning of spuds, in coral habitat whenever feasible. When spudding down is required, four spuds are sunk into the seafloor, each spud contacting one square foot of substrate. However, even though only one square foot of substrate will be directly impacted, spudding can also cause the collapse of surrounding coral habitat areas (Report 2014). For example, the use of a spud barge in Krum Bay, St. Thomas, U.S. Virgin Islands, in an area containing patch reefs expanded the area of impact for each spud by a factor of four (i.e., for a one square foot spud, four square feet of coral would

be impacted) due to substrate collapse. To estimate the area of impact on ESA-listed species from spudding down, we will assume a worst-case scenario (i.e., worst-case scenario in terms of potential impacts to ESA-listed corals) where the Coast Guard is required to spud down and that all four spuds will be required whenever a piling structure needs to be replaced. This results in an area of impact of 1.48 m^2 for each ATON. To account for the possibility that all four spuds must be repositioned, we double this impact area for each ATON. This result in an impact of 2.96 m^2 for each ATON.

- Chain scour: Chains and lines[37] from floating navigation aids move in a circle beneath the water and may create a circle of scour on the seafloor because they do not have floats to maintain buoy tackle off the seafloor. The chain portion of a floating ATON may crush and displace organisms that settle in the scour radius surrounding the sinker. Lines may abrade and cut sessile benthic organisms as they move. Additionally, while the Coast Guard makes every effort to return the sinker to its exact original location, adverse weather and strong water currents may cause the sinker to drop a few feet away from the intended target location (typically no more than ten feet from the assigned position). To estimate the area of impact from chain scour on habitat that may contain ESA-listed corals, we assumed a worst-case scenario where the Coast Guard places the sinker ten feet away from its assigned position each time the sinker is lifted, thus increasing the scour radius by ten feet. We then calculated the total area of chain scour around the sinker. This results in a total area of impact of 1,725 m^2 per aid[38].

For estimating impacts from pile replacement, we multiplied the total area of habitat affected per pile (0.16 m^2) by the number of fixed structures that are replaced annually within each species' range and the average number of piles supporting each structure in District 14 (i.e., 2 piles). For estimating impacts from spudding, we multiplied the area of habitat affected per spudding event (i.e., 2.96 m^2) by the number of fixed ATON replaced per year within each species' range (Table 21). This resulted in an average area of impact of 3.12 m^2 per structure replaced. Chain scour impacts were not estimated on an annual basis. Instead, we estimated an area of total habitat that could be continuously affected from chain scour (and the presence of the sinker) by multiplying the number of floating navigation aids within each species' range by the estimated area of impact from each floating aid (Table 21).

[37] Note that most buoys are attached to the sinker by a chain or wire rope; a synthetic line may be used occasionally.
[38] [1]According to the Coast Guard's biological evaluation, the scour radius of the average floating ATON in District 14 is approximately 20.5 meters (+ 3 meters distance from previous position).

Table 21. Area of habitat (m^2) affected annually (with the exception of chain scour calculations) within the geographic range of each species.

Species	A) Number of floating ATON in species range (number serviced per year)	B) Number of fixed ATON in species' range (max number of structures replaced per year)	**D) Total habitat area affected annually (m^2)**	**E) Chain scour – total area affected (m^2)***
A. globiceps	73 (29)	42 (6)	18.7	125,941
A. jacquelineae	6 (3)	13 (2)	6.2	10,351
A. retusa	73 (29)	42 (6)	18.7	125,941
A. speciosa	43 (17)	17 (4)	12.5	74,185
E. paradivisa	6 (3)	13 (2)	6.2	10,351
I. crateriformis	6 (3)	13 (2)	6.2	10,351
S. aculeata	30 (12)	25 (4)	12.5	51,757

*Note that calculations for the extent of habitat affected by chain scour are not annual estimates, but the amount of habitat that is continuously affected by the presence of the ATON at a particular location.

Additionally, ESA-listed corals that may have attached to ATON components between servicing events are likely to be adversely affected when the Coast Guard cleans these components by physically removing the organisms or when pilings are replaced. The majority of corals affected would likely be recently settled larva or juvenile coral colonies that settle on structures between servicing events[39].

We do not have information available to estimate the number of ESA-listed coral colonies of each species that may be attached to the different components of ATON structures and may be removed during maintenance activities. Additionally, it is not practical for the Coast Guard to conduct underwater surveys of all ATON structures prior to conducting maintenance in order to determine ESA-listed coral species presence/absence or abundance. Finally, information on the presence/absence of ESA-listed corals in the Indo-Pacific is extremely limited. In accordance with 80 FR 26832, we will use a habitat surrogate approach to express the extent of anticipated incidental take of ESA-listed corals from the Coast Guard's ATON maintenance activities. The extent of take of ESA-listed corals will be estimated based on the number of pilings removed within the range of each ESA-listed coral species annually (likely resulting in mortality of larger coral colonies) and the number of floating aid servicing events (which could result in injury or mortality of recently settled or juvenile corals) occurring within the range of each ESA-listed coral species annually (Table 22).

Table 22. Annual number of pilings removed or floating aid servicing events occurring within the geographic range of each ESA-listed coral species.

Species	Maximum number of pilings removed annually within species range	Number of floating aid servicing events annually within species range*
A. globiceps	6	29
A. jacquelineae	2	3
A.retusa	6	29
A. speciosa	4	17
E. paradivisa	2	3
I. crateriformis	2	3
S. aculeata	4	12

***** Coast Guard ATON maintenance records indicate that on average, navigation aids are serviced every 31 months in District 14 (service 38.7 percent of D14 aids every year).

[39] As noted above, while the potential for ESA-listed corals to grow and settle on ATON components exists, no listed Indo-Pacific coral species has ever been observed to grow on artificial substrates (Lance Smith, NMFS, personal communication to Eric MacMillan, NMFS; July 21, 2017).

2.6.2.6 Response analysis

ESA-listed corals that occur in the area of habitat impacted by spudding down, pile replacement, and scour will be subject to a range of effects. Even slight physical contact from ATON components with a coral colony can crush and/or scrap off living polyps and interconnecting soft tissues in the area of contact, causing injured or dead tissue in the disturbed area or making the coral more susceptible to disease. Intense contact, such as contact over a large area and/or high velocity impact could injure or kill tissue over large areas, and/or result in breakage of the coral skeleton or dislodgement of the coral from the substrate. Based on the available information, NMFS expects that any ESA-listed coral colonies that come in direct contact with ATON components (from spudding down, pile replacement, or scour) could experience whole or partial tissue death, depending on what proportion of the colony's living tissues are affected.

Fragmentation of the skeleton could result in the development of new, but genetically identical colonies, particularly in the case of branching coral species. Bothwell (1981) reports that several *Acropora* species successfully colonize through fragmentation and translocation of fragments by storm-driven waves. Broken pieces that have not been pulverized and are transported outside of the scour zone may develop into new colonies over time, but re-growth of damaged tissue and skeleton has energetic costs that could slow other physiological processes such as sexual reproduction. Exposed areas of coral skeleton are prone to bioerosion and overgrowth by algae and certain sponges. Large areas of damaged or dead tissue could result in the settlement and growth of algae, which may prevent the regeneration of new coral tissue at the impact site and may eventually outcompete living tissue to overtake the whole colony. Damaged tissue may also be more susceptible to infection by coral diseases and predation by snails and worms, thereby further hindering or preventing regeneration and growth, and leading to full or partial mortality of the affected colony.

As has been documented in Coast Guard District 7, chain scour around the sinker of a floating ATON creates mobile rubble and maintains unconsolidated sediments. Rubble is not the preferred settlement substrate of most coral species (Boulon et al. 2005; Fox et al. 2003; Jaap 2000), Within a chain scour area, coral recruitment is effectively prevented because coral larvae would likely choose fixed substrate over mobile rubble for settlement (Baird 2001; Harrington et al. 2004; Ritson-Williams et al. 2010b) and any larvae that do settle would be destroyed by chain movement. Numerous studies have documented the deleterious and long-lasting effects of mobile rubble in reef habitats; as storms and currents move the rubble around, coral in the immediate area can be injured or killed (Allingham and Neil 1995; Fox et al. 2003; Jaap 2000; McManus and McManus 2012; Riegl 2001; Risk et al. 2011).

For the corals that settle and grow on ATON components that are serviced regularly (i.e., buoy hulls and sinkers), these organisms are not expected to reach a size where they are reproductively mature (on average that is three or more years of growth) because they would only have one to two years (or less) of growth in-between servicing of the ATON. For the corals that settle on pile-supported structures, which are not regularly cleaned, juvenile and adult coral colonies could be harmed when old piles are removed and replaced.

2.6.2.7 Johnson's seagrass

Navigation aid maintenance activities in Coast Guard district 7 are expected to adversely affect Johnson's seagrass. Potential effects to Johnson's seagrass include turbidity and direct contact with Coast Guard equipment.

Exposure

During detachment or placement of ATON sinkers and chains, during removal and driving of pilings, and while Coast Guard ATON maintenance vessels operate in shallow water, substrate in the immediate vicinity of the ATON could be disturbed resulting in increases in turbidity, particularly in areas with soft substrate types (e.g., mud, sand). Increases in turbidity are expected to quickly subside following completion of the maintenance activity. Any sediments that do not immediately settle to the seafloor are expected to be swept away in either currents and tidal flow and diluted to undetectable levels. For these reasons, water quality impacts resulting from increases in turbidity during ATON maintenance are insignificant and are not likely to adversely affect Johnson's seagrass.

Johnson's seagrass is likely to be adversely affected by ATON maintenance activities that result in the species coming in direct contact with Coast Guard equipment. These activities include spudding down and pile replacement. While the Coast Guard avoids spudding down use in Johnson's seagrass habitat to the extent practicable, sometimes spudding down cannot be avoided in these habitats due to safety concerns (Tech 2014). There are no floating ATON in locations where Johnson's seagrass could occur (Andrew Haley, Coast Guard, personal communication to Eric MacMillan, NMFS, June 6, 2017; Tech 2014), so chain scour is not expected to affect Johnson's seagrass. There are eleven ATON structures located in areas where Johnson's seagrass is present. To estimate the effects of the proposed action on Johnson's seagrass, we estimated the area of habitat which likely contains Johnson's seagrass that may be affected by each of the activities identified above on an annual basis.

- Pile replacement: Replacement of piling structures is expected to impact Johnson's seagrass. When a piling supporting an ATON signal is replaced, the old piling may be left in place or removed, depending on the Coast Guard's evaluation of safety concerns. The new piling is placed close to the old piling, but may impact previously undisturbed benthic habitat. We estimated an impact area based on the number and size of the piles to be installed for ATON located in close proximity to Johnson's seagrass in District 7. As stated above, there are eleven ATON structures located in areas where Johnson's seagrass is present. We cannot accurately predict how many structures will be replaced annually at these ATON, but we do know that approximately 8.35 percent of all structures are rebuilt annually in District 7. Using this proportion, we estimate that on average, one structure is replaced each year in District 7 in areas where Johnson's seagrass could occur. However, in some years, the Coast Guard must replace a higher number of structures in some areas due to extreme weather or other reasons. To conservatively estimate the number of structures that could be replaced in a given year where a higher than normal number of structures must be rebuilt, we double the average number of structures rebuilt. The area

of impact will be the area of the installed piling multiplied by the number of pilings in the structure. Assuming an 18 inch piling is used (the largest piling size used in District 7), this equates to an area of impact of 1.75 square feet (0.16 m^2) per pile replaced.

- Spudding down: Spudding down is when a construction tender lowers steel beams into the bottom of a river or bay to create a temporary stable platform to service an ATON. Spuds must be repositioned sometimes when the vessel is not in the most appropriate location to service the ATON. This generally only occurs during maintenance of fixed aids when pile replacement is required. Many Coast Guard ATON maintenance vessels use dynamic positioning, so no spuds are required to maintain position during a servicing event. When spudding down is required, four spuds are sunk into the seafloor, each spud contacting one square foot of substrate. To estimate the area of impact on ESA-listed species from spudding down, we will assume a worst-case scenario (i.e., worst case scenario in terms of potential impacts to Johnson's seagrass) where the Coast Guard is required to spud down and that all four spuds will be required whenever a fixed structure needs to be replaced. This results in an area of impact of 0.37 m^2 for each structure. To account for the possibility that all four spuds must be repositioned, we double this impact area for each ATON. This result in an impact of 0.74 m^2 for each ATON.

Table 23. Area of Johnson's seagrass habitat affected annually from pile replacement and spudding down.

Max number of fixed ATON serviced per year in seagrass habitat	Average number of pilings per structure in District 7	Habitat affected per pile replaced (m^2; annually)	Habitat affected per spudding event (m^2; annually)	Total habitat area affected annually (m^2)
2	2	0.16 (0.64)	0.74 (1.48)	2.12

It is unlikely that every piling and/or spud would have direct contact with an area of Johnson's seagrass as each ATON is not likely surrounded by 100 percent coverage of seagrass, even if the species has been documented nearby. The actual amount of Johnson's seagrass affected will likely be less because many seagrass beds are mixed, coverage of Johnson's seagrass is not always 100 percent, the Coast Guard will adhere to the PDC which aim to minimize impact to the species, and not every ATON will be serviced by a vessel which must spud down.

Response

We expect that the proposed action will result in reduced densities or the loss of Johnson's seagrass in areas that come into direct contact with ATON equipment. Throughout its range, Johnson's seagrass occurs in dynamic and disjunctive patches. It spreads rapidly, growing horizontally from dense apical meristems with leaf pairs having short life spans (Kenworthy 1997). Kenworthy (1997) suggested that the observed horizontal spreading, rapid growth patterns, and high biomass turnover could explain the dynamic patches observed in distribution studies of this species. While patches may colonize quickly, they may also disappear rapidly. Sometimes they will disappear for several years and then re-establish, a process referred to as "pulsating patches" (Heidelbaugh et al. 2000; Virnstein and Hall 2009; Virnstein and Morris

2007). Based on this life history pattern of naturally patchy distribution and the potential for rapid recolonization, we would expect areas with Johnson's seagrass disturbed during ATON maintenance (i.e., either from drag hook use or spudding down) would have the potential to recolonize after the maintenance event is complete. Any areas smothered by a piling would not be able to recolonize.

2.6.3 Species Exposure and Response Analysis: ATON Establishment and Discontinuance

The physical actions of establishing and discontinuing ATON are nearly identical to those of ATON maintenance and in most cases, the stressors associated with the establishment and discontinuance of ATON are the same as those associated with maintenance of ATON (e.g., turbidity, vessel strike, vessel noise, pile driving, displacement from habitat, and physical contact with ATON components). Additionally, and as applicable, the Coast Guard will follow the PDC described in section 1.3.5 when establishing or discontinuing ATON. Therefore, in most cases, the potential effects of ATON establishment and discontinuance are expected to be the same as those described in section 2.6.2 for ESA-listed fish species, corals, and Johnson's seagrass. For example, when using an impact hammer for pile driving to establish an ATON, ESA-listed fish species are expected to experience harassment and/or harm (as described further in section 2.6.2.2). The exception to this is when new ATON may be established in areas where ESA-listed coral or Johnson's seagrass occurs. When this occurs, previously undisturbed habitat that could be occupied by ESA-listed coral or Johnson's seagrass could be harmed through direct physical contact by the establishment of an ATON. At this time, the Coast Guard is not able to provide information on the exact location, type of aid, method of establishment, and other details of future projects to establish or discontinue ATON. In keeping with the Coast Guard's National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts (Guard 2000), a separate consultation that tiers off of this programmatic consultation would be conducted for each new ATON if the Coast Guard determines that ESA-listed resources may be affected. Through these consultations, the Coast Guard has the ability and authority, in consultation with NMFS, to adjust or amend proposed actions to discontinue or establish ATON to minimize impacts on listed species and to implement terms and conditions to minimize incidental take of listed species. In the unlikely event that there is a jeopardy action on a specific project, either considered alone or in combination with other ATON, the Coast Guard has the ability and authority to work with NMFS to develop a reasonable and prudent alternative to that action.

2.6.4 Risk Analysis of the ATON Program

This section evaluates the policies of the ATON program to ensure that the Coast Guard will not implement actions that adversely affect individuals or designated critical habitats to the degree that could jeopardize the survival or recovery of any species or result in destruction or adverse modification of designated critical habitat. This section also evaluates whether there are monitoring, feedback, and adjustment loops built into the ATON program that ensure corrective actions and adjustments that will protect listed resources.

First, it is worth emphasizing that while the ATON program is unable to prevent all vessel groundings, the program does provide benefits to ESA-listed resources because the system aims to guide mariners into safe waters and away from hazards. In doing so, the system plays a role in protecting ESA-listed resources by preventing direct harm associated with vessel allisions, collisions, and groundings, and the secondary effects of pollution resulting from vessel accidents and associated response and cleanup activities.

The vast majority of maintenance activities under the ATON program will be implemented in accordance with the PDC described in this opinion. For these activities, during the consultation we considered the potential effects of these activities and determined that their implementation, alone or in combination with other maintenance activities, would not jeopardize the survival or recovery of any ESA-listed species or destroy or adversely modify designated critical habitat. For maintenance activities that will not be implemented in accordance with the PDC described in this opinion (e.g., replacement of fixed structures with piles >18 inches in diameter), a separate section 7 consultation will be conducted. This ensures that all maintenance actions implemented by the ATON program will comply with the requirements of section 7(a)(2).

Additionally, the policies guiding the establishment and discontinuance of ATON emphasize minimizing redundant ATON either by not establishing new ATON that do not have their own independent utility in guiding mariners or by discontinuing already established ATON that are considered redundant, potentially confusing to mariners, or that were established where no current need exists. These policies minimize the number of ATON present in the action area and the associated effects of maintaining those ATON on ESA-listed resources. Further, in most cases, the Coast Guard will adhere to the PDC described in this opinion when establishing or discontinuing ATON. Finally, for any action to establish or discontinue an ATON, a separate section 7 consultation will be conducted. This ensures that all actions to establish or discontinue ATON implemented by the ATON program will comply with the requirements of section 7(a)(2).

The Coast Guard also monitors, and reports to NMFS on, the effects of the ATON program on ESA-listed resources. As described further in Section 1.3.7, the Coast Guard will provide NMFS with an annual report that includes information on maintenance activities conducted as well as information on ATON established and discontinued. For maintenance activities that adhered to the PDC described in this opinion, the Coast Guard will compile and provide information to NMFS to confirm that the annual amount or extent of take exempted in Section 2.10 has not been exceeded.

Finally, and in consultation with NMFS, the Coast Guard evaluates if changes need to be made to the PDC or to other aspects of the ATON program to protect ESA-listed resources on an annual basis. In so doing, this consultation established an adaptive management framework for the Coast Guard to ensure that policies and operations of the ATON program (e.g., the PDC) can be adjusted, if needed, to protect ESA-listed resources. This process will ensure the Coast Guard continues to fulfill their obligations under the ESA through time.

2.7 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect the future state, tribal, local, or private actions that are reasonably certain to occur in the action area to be similar to those described in the environmental baseline section of this opinion. The actions include, but are not limited to, fisheries, vessel traffic, oil and gas activities, pollution, and coastal development. With human population expansion in the action area, these actions are expected to intensify over time, though the degree to which this may affect the ESA-listed species considered in this opinion cannot be quantified. Future changes in state and local government and private actions may include variation in land and water-use patterns, including ownership and intensity, any of which could affect listed species or their habitat. It is difficult, and perhaps speculative, to analyze the effects of such actions, considering the broad geographic landscape covered by this opinion, the geographic and political variation in the action area, extensive private land holdings, the uncertainties associated with state and local government and private actions, and ongoing changes in the economy. Adverse effects to riverine and coastal habitat from continued urbanization are reasonably certain to occur. However, state and local governments have regulations in place to minimize these effects to listed species, including regulations regarding construction best management practices, storm water control, and treatment of wastewater.

Based on the best available information, NMFS is not aware of any proposed or anticipated changes in other human-related actions or natural conditions (e.g., over-abundance of land or sea predators, changes in oceanic conditions) that would substantially change the impacts that ESA-listed species covered by this opinion may experience. Although quantifying an incremental change in survival for the species considered in this consultation due to the cumulative effects is not possible, it is reasonably likely that any resultant effects within the action area will have a small, long-term, negative effect on the likelihood of their survival and recovery.

2.8 Integration and Synthesis

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 2.6) to the *Environmental Baseline* (Section 2.5) and the *Cumulative Effects* (Section 2.6.4) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species and Critical Habitat* (Section 2.4).

Sections 2.8.1 through 2.8.5 summarize the probable risks ATON maintenance poses to threatened and endangered species that are likely to be adversely affected when the PDC described in section 1.3.5 are adhered to. These summaries integrate the exposure profiles presented previously with the results of our response analyses for each of the actions considered in this opinion.

Individual actions to discontinue or establish ATON have the potential to adversely affect listed species and their designated critical habitats and we describe those potential effects in section 2.6.3 of this opinion. At this time, the Coast Guard is not able to provide information on the exact location, type of aid, method of establishment, and other details of the future actions to discontinue or establish federal navigation aids. For these actions, analyses of whether adverse effects of specific projects on individuals are sufficient to jeopardize the continued existence of the listed species by reducing the reproduction, numbers, or distribution of the affected species to such an extent as to reduce appreciably the likelihood of both survival and recovery in the wild will occur through project-level consultations if the Coast Guard determines ESA-listed species may be affected. Likewise, analyses of whether adverse effects of specific projects are sufficient to result in destruction or adverse modification of designated critical habitats will also occur through project-level consultations if the Coast Guard determines designated critical habitat may be affected.

Therefore, in section 2.6.4 of this opinion, we included an analysis of the policies of the ATON program to ensure that the Coast Guard will not implement actions in the future that adversely affect individuals or designated critical habitats to a degree that could jeopardize the survival or recovery of any species or result in destruction or adverse modification of designated critical habitat. In this analysis, we concluded that all actions implemented under the ATON program (including operation and maintenance of ATON, and the discontinuance or establishment of ATON), alone or in combination with other specific actions, are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of their critical habitats. First, the ATON program provides benefits to ESA-listed resources by preventing direct harm associated with vessel allisions, collisions, and groundings, and the secondary effects of pollution resulting from vessel accidents and associated response and cleanup activities. Second, the Coast Guard minimizes the number of ATON present in the action area to the extent practicable and the associated effects of maintaining those ATON on ESA-listed resources. The Coast Guard also monitors, and reports to NMFS on, the effects of the ATON program on ESA-listed resources and evaluates if changes need to be made to the PDC or to other aspects of the ATON program to protect ESA-listed resources on an annual basis. In so doing, this consultation established an adaptive management framework for the Coast Guard to ensure that policies and operations of the ATON program (e.g., the PDC) can be adjusted, if needed, to protect ESA-listed resources. This process will ensure the Coast Guard continues to fulfill their obligations under the ESA through time.

Finally, the Coast Guard has the ability and authority, in consultation with NMFS, to adjust or amend proposed actions to discontinue or establish ATON to minimize impacts on listed species and to implement terms and conditions to minimize incidental take of listed species. In the unlikely event that there is a jeopardy action on a specific project, alone or in combination with other ATON, the Coast Guard has the ability and authority to work with NMFS to develop a reasonable and prudent alternative to that action.

2.8.1 Steller Sea Lions: Western DPS

In section 2.6.2.1, we determined that the only stressor associated with the proposed action which is likely to adversely affect Western DPS Steller sea lions is harassment (as defined by NMFS's interim harassment guidance) from servicing an ATON at Sea Lion Rocks. We determined that approximately 160 Western DPS Steller sea lions will be flushed from Sea Lion Rocks annually.

Though flushing from a haulout site or rookery has the potential to result in stampedes that could cause injury or mortality, we determined injury or mortality are not reasonably certain to occur because the maintenance activities will occur after the breeding season when the density of sea lions at haulouts on Sea Lion Rocks is expected to be lower. Because animals are expected to be more spaced apart when ATON servicing occurs, it is not likely that they would trample one another. All instances of behavioral harassment are expected to be temporary (i.e., typically lasting about an hour or the duration of the maintenance event) and occur infrequently (i.e., the aid at Sea Lion Rocks is serviced every two to three years) and sea lions that are flushed would be able to return to their haulout site immediately after the servicing event is finished. With the exception of the potential for direct injury as described above, the primary mechanism by which the flushing response has the potential to affect the fitness of individual animals is through alteration of the animals' energy and/or time budget. However, due to the short-term and infrequent nature of the expected response of Western DPS Steller sea lions to ATON activities at Sea Lion Rocks, the individual and cumulative time and energy costs of these behavioral responses are not likely to alter the time or energy budgets of individual animals. For these reasons, we do not anticipate instances of harassment from ATON activities to result in fitness consequences to individual animals and therefore, we do not expext these instances of harassment to result in changes in reproduction, numbers, or distribution of this species.

Additionally, it is worth noting that a very small percentage of individuals from the Western DPS Steller sea lion population is expected to be harassed annually from Coast Guard ATON maintenance activities. We estimated that 160 individuals will be harassed annually. The most recent abundance estimate for the Western DPS is from 38,491 to 39,611 individuals (Fritz et al. 2016). This means that only approximately 0.41 percent of all Western DPS Steller sea lions will be harassed annually. Further, in recent years, there has been strong evidence that Western DPS Steller sea lion populations are increasing, though there are regional differences across the range in Alaska, with positive trends east of Samalga Pass in the Gulf of Alaska and eastern Bering Sea and negative trends to the west in the Aleutian Islands (Fritz et al. 2016; Muto et al. 2016). Sea Lion Rocks is located east of Samalga Pass. Overall between 2005 and 2015, counts of western

DPS non-pups and pups in Alaska increased at average rates of 2.25 percent per year and 2.26 percent per year, respectively (Fritz et al. 2016). Since 2003, in the region where Sea Lion Rocks is located and where Western DPS Steller sea lions will be harassed (i.e., "Eastern Aleutians and Bering Sea" in Fritz et al. 2016), counts of western DPS non-pups and pups increased at average rates of 1.81 and 3.2, respectively (Fritz et al. 2016). This indicates that, despite the suite of stressors Western DPS Steller sea lions from the Eastern Aleutians and Bering Sea are exposed to (e.g., fisheries, vessel traffic, Coast Guard ATON maintenance activities), population abundance is increasing.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the ATON program continuing into the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*) would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Western DPS Steller sea lions in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from the ATON program continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Western DPS Steller sea lions in the wild by reducing the reproduction, numbers, or distribution of that species.

2.8.2 Fishes

In section 2.6.2.2, we determined that the only stressor associated with the proposed action which is likely to adversely affect ESA-listed fish species is pile driving using an impact hammer. We expect very small numbers of ESA-listed fish relative to their respective populations or sub-populations to be present and exposed to sound levels that would elicit adverse physical effects or behavioral responses. This expectation is supported by the very small area of habitat estimated to be affected by Coast Guard impact pile driving (Table 17) relative to the geographic distribution of these species (in most cases, thousands of square kilometers). The only areas where Coast Guard pile driving activities would overlap with potentially large numbers of ESA-listed fish species is in Coast Guard districts 11 and 13 where ESA-listed Pacific salmonids occur. However, Coast Guard pile driving activities in these districts occur infrequently, are of short duration (typically a few hours), and are not concentrated in small geographic areas where a large number of individuals from a specific population or sub-population could be affected. ESA-listed fishes exhibit significant life history variation even within populations (e.g., Bellinger et al. 2015; Burke et al. 2013; Weitkamp and Neely 2002), indicating that a localized short-term affect on an area in the form of elevated sound levels would not be expected to impact a significant portion of a population or sub-population. For example, Chinook salmon from the Skagit River, a portion of the Puget Sound ESU, are categorized into six populations (Zimmerman et al. 2015). The six populations are named according to the time of river entry (spring, summer, and fall) and location of spawning. Additionally, out-migrant life history varies with individuals out-migrating as fry, sub-yearling parr, or yearling smolts (Zimmerman et al. 2015). Because of this life history variability, we would expect Chinook salmon from the Skagit River to be widely dispersed in space and time in their freshwater and

marine habitats. Therefore, we do not expect a large proportion of individuals from a single population to be grouped together in space and time such that they would be killed or injured by Coast Guard pile driving activities. Further, the minimization measures implemented by the Coast Guard, including only pile driving in designated work windows unless emergency repairs are required to remedy a navigational hazard, will reduce the likelihood that large numbers of individuals from a single population will be affected.

Additionally, it is worth noting that the thresholds used to establish distances around a pile in which fish could be injured are conservative. The interim thresholds established by NMFS and used in this consultation represent the initial onset of injury, not the levels at which fishes will be severely injured or killed (Stadler and Woodbury 2009). Further, even though TTS is not actual injury, but rather a temporary fatiguing of the auditory system, TTS was considered synonymous with injury for the purposes of establishing the interim thresholds because it can potentially increase the risk of predation or reduce foraging success (Stadler and Woodbury 2009; Ward 1997). Popper et al. (2014b) recommended alternative criteria with much higher thresholds for injury and mortality of fishes (e.g., for fishes with a swim bladder not involved in hearing, the threshold for recoverable injury they recommend is 203 dB SEL_{cum} or >207 dB peak; the SEL_{cum} value is 16 dB higher than the threshold used in this consultation). If these criteria were to be applied, the injury and mortality zones would be significantly smaller, and the likelihood of injury or mortality would be much lower. Finally, it's worth noting that the threshold establishes injury for a fish with a weight of two grams. A large percentage of fish that could be exposed to elevated underwater sound from Coast Guard pile driving actions would be much larger, and therefore, less susceptible to injury (Yelverton et al. 1975). However, it should be noted that there are caveats to this assumption as a fish's susceptibility to injury also depends on the state of buoyancy (e.g., a deflated swim bladder could put a fish at lower risk of injury from sound pressure exposure compared to a fish with an inflated swim bladder). While we assume for the purposes of assessing jeopardy that all fish exposed to sound at the threshold for injury could experience fitness consequences, most fish probably will survive if exposed to these sound levels.

It is probable that a small number of ESA-listed fish could be affected annually during pile driving activities. However, adverse effects to the growth and survival of small numbers of individual ESA-listed fishes is unlikely to affect abundance, productivity, or distribution of populations of ESA-listed fish species in the action area. Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the ATON program continuing into the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*) would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of any ESA-listed fish species in the wild by reducing the reproduction, numbers, or distribution of those species. We also conclude that effects from the ATON program continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to

appreciably reduce the likelihood of recovery of any ESA-listed fish species in the wild by reducing the reproduction, numbers, or distribution of those species.

2.8.3 Atlantic and Caribbean Corals

As discussed, we do not have site-specific information that would allow us to estimate the number of ESA-listed coral colonies of each species that will be impacted by ATON maintenance activities at each site. Instead, we rely on an estimate of the habitat area affected by ATON in close proximity to ESA-listed corals as a surrogate for the number of individual coral colonies affected. While some benthic habitat that could contain ESA-listed corals will be impacted by the presence and maintenance of Coast Guard navigation aids, the Coast Guard will minimize effects to ESA-listed corals to the extent practicable by implementing the PDC described in section 1.3.5 of this opinion. These include, but are not limited to, avoiding use of the vessel's anchor or spudding down when conducting maintenance in habitats where corals occur and maximizing the accuracy of sinker replacement on or near reef habitats through the utilization of the ship's most accurate navigation and positioning systems and carefully lowering of sinkers. Additionally, the proposed action provides some benefit to the survival and recovery of the ESA-listed coral species in District 7 because navigation aids keep large vessels near commercial harbors within marked channels and directs these vessels away from hazards that could cause vessel groundings which could result (and over time, would result) in significant negative effects to ESA-listed coral species (e.g., Gittings et al. 1993; Hudson and Goodwin 2001; Lirman et al. 2010b; NMFS 2015c).

The ESA-listed corals in District 7 considered in this opinion consist of many thousands, if not millions, of colonies, occur across a range of thousands of miles, and occur outside of U.S. jurisdictions (Table 20). Relative to each species' geographic distribution, a very small area of habitat that could contain ESA-listed species will be impacted annually by maintenance activities involving pile replacement and spudding down, and impacted continuously through scour.

Table 24. Known geographic distribution and abundance of ESA-listed corals in Coast Guard District 7.

Species	Known distribution	Abundance estimate (number of colonies)
Elkhorn coral (*A. palmata*)	Western Atlantic Ocean, Caribbean Sea, Gulf of Mexico	Hundreds of thousands*
Staghorn coral (*A. cervicornis*)	Western Atlantic Ocean, Caribbean Sea, southwestern Gulf of Mexico	Tens of millions*
Pillar coral (*D. cylindrus*)	Western Atlantic Ocean, Caribbean Sea	Tens of thousands*
Rough cactus coral (*M. ferox*)	Western Atlantic Ocean, Caribbean Sea	Hundreds of thousands*
Lobed star coral (*O. annularis*)	Western Atlantic Ocean, Caribbean Sea, Gulf of Mexico	Tens of millions*
Mountainous star coral (*O. faveolata*)	Western Atlantic Ocean, Caribbean Sea, Gulf of Mexico	Tens of millions*
Boulder star coral (*O. franksi*)	Western Atlantic Ocean, Caribbean Sea, Gulf of Mexico	Tens of millions*

*Minimum abundance information comes from the Final Rule to list 20 species of coral under the Endangered Species Act (79 FR 53851). For these species, the Rule lists an abundance estimate for a subset of areas within the range of the species. The Rule then states that the absolute abundance is higher than this estimate given the presence of the species in many other areas throughout its range.

Additionally, it is worth noting that many of the ATON we assumed were near ESA-listed corals for the purposes of this consultation, may not be. Out of the 202 navigation aids NMFS determined had the potential to be in close proximity to ESA-listed corals, the Coast Guard was able to conduct dive surveys around 69 of them. In 47 of those dive surveys (68 percent), ESA-listed corals were not observed in close proximity to the navigation aid. This indicates that our analysis of the potential effects of Coast Guard navigation aids on ESA-listed corals is conservative because we assumed that corals were present around all aids where a dive survey had not been conducted. Finally, the majority of habitat area affected is from scour and the presence of the sinker (Table 19). With the exception of relatively small areas of previously undisturbed habitat that could be affected when the ATON is repositioned during a servicing event, the habitat impacted likely consists of mobile rubble and unconsolidated sediments lacking any live coral cover because it has been impacted by scour for many years (often decades). For this habitat area, larval settlement and coral colony maturation would be minimized or prevented, but adult coral colonies would not be impacted because chain scour around the sinker of a floating ATON creates mobile rubble and maintains unconsolidated sediments (as opposed to habitat that would support the growth and survival of adult colonies). Suppression of larval settlement in these areas would not affect ESA-listed coral species survival as adult colonies would not be affected. Regarding recovery, these repeated impacts could prevent ESA-listed coral larvae from successfully settling in these specific areas and maturing

into adult coral colonies. However, as noted above, the area of habitat that is affected by chain scour is extremely small in relation to available habitat within these species' ranges. This information suggests that while some ESA-listed coral colonies could be impacted by the proposed action, the effects will be localized and will not affect a large percentage of any species' colonies.

Regarding the corals that may be removed from ATON components during servicing events, it is important to note that corals produce large quantities of larvae, only a small percentage of which survive to settle and grow to sexual maturity. The number of coral larvae that settle on ATON components is expected to be an extremely small proportion of the total number of larvae produced that successfully encounter settlement habitat. For example, as discussed previously, coral larvae could settle on piles supporting fixed structures. The surface area of a typical Coast Guard pile (i.e., 18-inch pile in 15 feet of water) in District 7 is approximately 6.5 m^2 and the Coast Guard will replace approximately 40 piles per year in areas close to ESA-listed coral (indicating a higher likelihood that these larval coral could settle on these aids). This indicates that approximately 260 m^2 of area that could attract larval coral could be impacted annually from removing piles. This is an infinitesimally small portion of the available settlement for the ESA-listed corals (i.e., thousands of square kilometers) considered in this opinion. For these reasons, settlement of ESA-listed coral larvae on ATON components and the removal of any recruits that successfully grow into coral colonies on these components would not impact survival and recovery of coral colonies on natural substrates.

The final listing rule for the species considered in this opinion evaluates each species' vulnerability to extinction based on the following: 1) spatial information – overall distribution and ocean basin, habitat; 2) demographic information – abundance, trends in abundance, relative recruitment rate; and 3) susceptibility to threats based on a species' susceptibility to each of the nine threats. These categories were determined to be good metrics of species status. Thus, an action that causes an adverse change in one or more of these categories could appreciably reduce the likelihood of the survival and recovery of the coral species considered in this opinion. The proposed action will adversely affect coral reef habitat, which could contain ESA-listed coral colonies. However, because take of ESA-listed corals will occur in relatively small, widely separated areas in only a portion of each species' range, leaving the vast majority of ESA-listed coral colonies unaffected by the proposed action, we do not expect the overall distribution of any ESA-listed coral species to be affected. Though we expect minor reductions in the abundance of the ESA-listed coral species considered in this opinion when take occurs, overall, the existence of the federal navigation aid program provides some benefit to ESA-listed coral absolute abundance, trends in abundance, and recruitment rate due to the system's role in preventing large vessel groundings (and associated response actions) particularly in areas of commercial vessel traffic. Finally, the proposed action is not expected to exacerbate any of the nine primary threats identified as posing either current or future extinction risk to ESA-listed corals in the final rule to list those species (79 FR 53852). Of those threats, only sedimentation has the potential to be exacerbated by Coast Guard ATON maintenance activities. However, we determined that the

effects of turbidity and sedimentation on ESA-listed corals from ATON maintenance activities would be localized, temporary, and insignificant.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the ATON program continuing into the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*) would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of any ESA-listed corals species in the Atlantic or Caribbean by reducing the reproduction, numbers, or distribution of those species. We also conclude that effects from the ATON program continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of any ESA-listed coral species in the Atlantic or Caribbean by reducing the reproduction, numbers, or distribution of those species.

2.8.4 Indo-Pacific Corals

In the portions of Coast Guard District 14 where ESA-listed corals occur, coral communities are characterized by high species diversity (79 FR 53852), with a low proportion of ESA-listed species mingled with many non-listed corals. Additionally, each listed species occurring in this region consists of at least millions of colonies (Table 20), with the species range extending thousands of square miles. This results in low densities of ESA-listed coral colonies spread across a large area. For example, *A. globiceps* is considered one of the more common ESA-listed corals in the Indo-Pacific. Veron (2014b) reported that the species only occurred at 3.2 percent of the 2,984 dive sites sampled. At each site where it was sampled, based on an abundance rating on a scale of 1 (low) to 5 (high) at each site where it occurred, this species had a mean abundance rating of 1.95. Based on this semi-quantitative system, the species' abundance was characterized as "uncommon" (Veron 2014b). This information suggests that even though habitat that could contain live coral may be affected by the presence and maintenance of ATON, instances where ESA-listed corals would be affected are not expected to be common. As discussed, we do not have site-specific information that would allow us to estimate the number of ESA-listed coral colonies of each species that will be impacted by ATON maintenance activities at each site. Instead, we rely on an estimate of the habitat area affected in each species' range as a surrogate for the number of individual coral colonies affected. A very small percentage of the total available habitat for each species is expected to be affected by the proposed action. This indicates that while effects to ESA-listed corals could occur, the effects will be localized and will not affect a large percentage of any species' colonies.

As with Caribbean and Atlantic corals, it should be noted that the majority of habitat area affected is from chain scour (Table 21). With the exception of relatively small areas of previously undisturbed habitat that could be affected when the ATON is repositioned during a servicing event, the habitat that is affected by chain scour likely consists of mobile rubble and unconsolidated sediments lacking any live coral cover. For this habitat area, larval settlement and coral colony maturation would be minimized or prevented, but adult coral colonies would not be impacted. Suppression of larval settlement in these areas would not affect ESA-listed coral

species survival as adult colonies would not be affected. Regarding recovery, these repeated impacts could prevent ESA-listed coral larvae from successfully settling in these specific areas and maturing into adult coral colonies. However, the area of habitat that is affected by chain scour is extremely small in relation to available habitat within these species' ranges. The ESA-listed corals in District 14 considered in this opinion consist of millions,of colonies (Table 20) and occur across a range of thousands of kilometers. Because these species are sparsely populated across a wide range, localized impacts to potential coral reef habitat for these species are not expected to impact these species' ability to reproduce. Further, as cited in the final rule to list 20 species of corals (79 FR 53852), habitat availability is not known to be a factor affecting the survival or recovery of any of the ESA-listed species considered in this opinion. Instead, other factors that affect corals over a broad geographic scale are larger drivers of the ability of these species to survive and recover. These factors include ocean warming, disease, ocean acidification, the trophic effects of fishing, and nutrients from anthropogenic sources. Therefore, we do not believe continued impacts to this area of habitat results in an appreciable reduction in the amount of available habitat for ESA-listed corals and these impacts are not expected to affect the ability of these species to survive or recover.

Regarding the corals that may be removed from ATON components during servicing events, it is important to note that corals produce mass numbers of larval individuals, only a small percentage of which find suitable substrate to settle upon and grow. ATON structures only add to the available settlement habitat for these species. The number of coral larvae that settle on ATON structures is expected to be an extremely small proportion of the total number of larvae produced. Settlement of these larvae on ATON structures, and then the removal of any coral colonies that grow on the ATON structures, would not impact survival and recovery of coral colonies on natural substrates.

Further, it's worth emphasizing that the proposed action provides a net benefit to the survival and recovery of the ESA-listed coral species considered in this opinion. Navigation aids keep vessels within marked channels and directs vessels away from known hazards that could cause vessel groundings, anchor damage, and prop scarring, all of which could result (and over time, would result) in significant negative effects to ESA-listed coral species (e.g., Gittings et al. 1993; Hudson and Goodwin 2001; Lirman et al. 2010b; NMFS 2015c).

The final listing rule for the species considered in this opinion evaluates each species' vulnerability to extinction based on the following: 1) spatial information – overall distribution and ocean basin, habitat; 2) demographic information – abundance, trends in abundance, relative recruitment rate; and 3) susceptibility to threats based on a species' susceptibility to each of the nine threats. These categories were determined to be good metrics of species status. Thus, an action that causes an adverse change in one or more of these categories could appreciably reduce the likelihood of the survival and recovery of the coral species considered in this opinion. The proposed action will adversely affect coral reef habitat, which could contain ESA-listed coral colonies. However, because take of ESA-listed corals will occur in relatively small, well-distributed areas in only a portion of each species' range, leaving the vast majority of ESA-listed coral colonies unaffected by the proposed action, we do not expect the overall distribution of any

ESA-listed coral species to be affected. Though we expect minor reductions in the abundance of the ESA-listed coral species considered in this opinion when take occurs, overall, the existence of the federal navigation aid program benefits ESA-listed coral absolute abundance, trends in abundance, and recruitment rate due to the system's role in preventing vessel groundings, anchor damage, and prop scarring. Finally, the proposed action is not expected to exacerbate any of the nine primary threats identified as posing either current or future extinction risk to ESA-listed corals in the final rule to list those species (79 FR 53852). Of those threats, only sedimentation has the potential to be exacerbated by Coast Guard ATON maintenance activities. However, we determined that the effects of turbidity and sedimentation on ESA-listed corals from ATON maintenance activities would be localized, temporary, and insignificant.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the ATON program continuing into the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*) would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of any ESA-listed corals species in the Indo-Pacific by reducing the reproduction, numbers, or distribution of those species. We also conclude that effects from the ATON program continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of any ESA-listed coral species in the Indo-Pacific by reducing the reproduction, numbers, or distribution of those species.

2.8.5 Johnson's Seagrass

The proposed action could adversely affect 1.38 m^2 of Johnson's seagrass annually. This constitutes a reduction in the numbers of plants. However, NMFS believes that because Johnson's seagrass reproduces asexually through fragmentation and growth appears to be rapid, this reduction does not appreciably reduce the likelihood of survival of Johnson's seagrass in the wild. Since ATON maintenance will only affect a small amount Johnson's seagrass at each ATON location, the remaining patches can spread to other nearby, similar areas that are not currently occupied by Johnson's seagrass. Because we expect Johnson's seagrass to persist outside of the direct footprint of piling and spud, the reproductive potential for the species will remain.

Although the proposed action may result in the loss of 2.12 m^2 of Johnson's seagrass from spudding and piling replacement, it will not result in a significant reduction of Johnson's seagrass distribution within the species range because it will not impact any of the other Johnson's seagrass outside of the direct footprint of piling or spud. Likewise, this potential loss of Johnson's seagrass will not cause a fragmentation of the range because some Johnson's seagrass patches will still remain outside of the direct footprint of action which are capable of spreading via asexual fragmentation. NMFS concludes that the proposed action will not appreciably reduce the likelihood of survival of Johnson's seagrass in the wild.

NMFS also concludes that ATON maintenance will not appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild. Recovery for Johnson's seagrass, as described in the

recovery plan (NMFS 2002b), will be achieved when the following recovery objectives are met: (1) The species' present geographic range remains stable for at least ten years, or increases; (2) self-sustaining populations are present throughout the range at distances less than or equal to the maximum dispersal distance to allow for stable vegetative recruitment and genetic diversity; and (3) populations and supporting habitat in its geographic range have long-term protection (through regulatory action or purchase acquisition). NMFS' 2007, five-year review of the status of the species concluded that the first recovery objective has been achieved. In fact, the range has increased slightly northward. ATON maintenance will not impact the status of this objective. Self-sustaining populations are present throughout the range. The species' overall reproductive capacity will be only minimally reduced by the potential loss of 2.12 m^2 of Johnson's seagrass. Additionally, since ATON maintenance will not disturb the seagrass adjacent to each existing ATON structure and the Coast Guard will use the PDC to further reduce any impacts to Johnson's seagrass during ATON maintenance, NMFS expects Johnson's seagrass to persist.

As discussed, Johnson's seagrass occurs in dynamic and disjunct patches. It spreads rapidly, growing horizontally from dense apical meristems with leaf pairs having short life spans (Kenworthy 1997). Therefore, as long as some Johnson's seagrass remains at these ATON sites, it can spread into areas that currently do not contain Johnson's seagrass. Since the proposed action will not disturb all of the Johnson's seagrass estimated to occur at any one ATON site, nor any occurring outside these areas, the potential for a self-sustaining population is not removed. Further, it is worth emphasizing that the proposed action likely provides a net benefit to Johnson's seagrass. Prop scarring is one of the most severe injuries seagrasses experience because they disturb the sediments and uproot seagrasses, damaging the leaves and the root/rhizome systems, as well as the apical meristems which are responsible for the growth and maintenance of a seagrass meadow. Johnson's seagrass is especially vulnerable to these disturbances because it is so shallow rooted (NMFS 2007b). Federal navigation aids keep vessels within marked channels and directs them away from known hazards, minimizing the potential for prop scarring and other vessel related impacts such as groundings and anchor damage.

Based on this information, ATON maintenance will not reduce or destabilize the present range of Johnson's seagrass. The proposed action will not have an adverse effect on the long-term protection of the species. Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the ATON program continuing into the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*) would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Johnson's seagrass in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from the ATON program continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Johnson's seagrass in the wild by reducing the reproduction, numbers, or distribution of that species.

2.9 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the ESA-listed species listed in Table 10.

2.10 Incidental Take Statement

Section 9 of the ESA prohibits the take of endangered species without special exemption. ESA section 9 statutory prohibitions are limited to "endangered" species unless extended to "threatened" species. In the case of threatened species, section 4(d) of the ESA leaves it to the Secretary's discretion whether and to what extent to extend the statutory section 9(a) ''take'' prohibitions, and directs the agency to issue regulations it considers necessary and advisable for the conservation of the species. Take prohibitions have been extended to natural-origin Pacific salmonids from threatened ESUs/DPSs and hatchery produced salmonids with intact adipose fins from threatened ESUs/DPSs (70 FR 37160; 71 FR 5178; 73 FR 55451). Take prohibitions have not been extended to hatchery produced Pacific salmonids with clipped adipose fins from threatened ESUs/DPSs or to threatened coral species. However, consistent with *CBD v. Salazar*, 695 F.3d 893 (9th Cir. 2012), we assessed the amount or extent of take to these threatened species that is anticipated incidental to Coast Guard ATON maintenance activities and include this information in the incidental take statement. Inclusion of these species in the incidental take statement serves to assist the action agency with monitoring of take and provides a trigger for reinitiation if levels of estimated take are exceeded.

"Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. NMFS has not yet defined "harass" under the ESA in regulation. However, on December 21, 2016, NMFS issued interim guidance on the term "harass," defining it as an action that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." For purposes of this consultation, we relied on NMFS' interim definition of harassment to evaluate when the proposed activities are likely to harass ESA-listed species.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.10.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions. Where it is not practical to quantify the number of individuals that are expected to be taken by the action, a surrogate (e.g., similarly affected species or habitat or ecological conditions) may be used to express the amount or extent of anticipated take.

All individual maintenance events that will not undergo separate consultation under section 7 of the ESA must incorporate applicable PDC (see section 1.3.5), and must not exceed the predicted take outlined in

Table 25. Note that, as described previously, pile-setting using vibratory hammers is not expected to result in take of ESA-listed fish species. For any maintenance activities that do not meet these conditions, a separate consultation would be required if ESA-listed resources would be affected. Any specific ATON to be established or discontinued will require a separate consultation if ESA-listed resources may be affected, and an incidental take statement will be provided at that time, as appropriate. 50 CFR 402.14(i)(6).

Table 25. The amount or extent of threatended or endangered species that are likely to be "taken" as a result of exposure to Coast Guard maintenance activities.

Species DPS or ESU	Amount or extent of take
Invertebrates and Plants	
Elkhorn coral (*A. palmata*), Staghorn coral (*A. cervicornis*), Pillar coral (*D. cylindrus*), Rough cactus coral (*M. ferox*), Lobed star coral (*O. annularis*), Mountainous star coral (*O. faveolata*), Boulder star coral (*O. franksi*)	• Annually, harm to 65.6 m^2 of habitat that could contain ESA-listed coral colonies annually from pile replacement and spudding down • Continuous harm from chain scour to 120,879 m^2 of habitat area that could contain ESA-listed coral colonies • Annually, harm to corals attached to a maximum of 40 piles, which could be removed in areas where ESA-listed corals occur • Harm to corals attached to floating aid components during a maximum of 148 servicing events annually in areas where ESA-listed corals occur during
A. globiceps, A. retusa,	• Annually, harm to 18.7 m^2 of habitat within the range of these ESA-listed coral species from pile replacement and spudding down • Continuous harm from chain scour to 125,941 m^2 of habitat area within the range of these ESA-listed coral species • Annually, harm to corals attached to a maximum of 6 piles, which could be removed in areas where ESA-listed corals occur • Harm to corals attached to floating aid components during a maximum of 29 servicing events annually in areas where ESA-listed corals occur during
A. jacquelineae, E. paradivisa, I. crateriformis,	• Annually, harm to 6.2 m^2 of habitat within the range of these ESA-listed coral species from pile replacement and spudding

Species DPS or ESU	Amount or extent of take
	down • Continuous harm from chain scour to 10,351 m^2 of habitat area within the range of these ESA-listed coral species • Annually, harm to corals attached to a maximum of 2 piles, which could be removed in areas where ESA-listed corals occur • Harm to corals attached to floating aid components during a maximum of 3 servicing events annually in areas where ESA-listed corals occur during
A. speciosa	• Annually, harm to 12.5 m^2 of habitat within the range of these ESA-listed coral species from pile replacement and spudding down • Continuous harm from chain scour to 74,185 m^2 of habitat area within the range of these ESA-listed coral species • Annually, harm to corals attached to a maximum of 4 piles, which could be removed in areas where ESA-listed corals occur • Harm to corals attached to floating aid components during a maximum of 17 servicing events annually in areas where ESA-listed corals occur during
S. aculeata	• Annually, harm to 12.5 m^2 of habitat within the range of these ESA-listed coral species from pile replacement and spudding down • Continuous harm from chain scour to 51,757 m^2 of habitat area within the range of these ESA-listed coral species • Annually, harm to corals attached to a maximum of 4 piles, which could be removed in areas where ESA-listed corals occur • Harm to corals attached to floating aid components during a maximum of 12 servicing events annually in areas where ESA-listed corals occur during
Johnson's seagrass	Annually, harm to 2.12 m^2 of habitat area from pile replacement and spudding down
Marine Mammals	
Steller Sea Lion: Western DPS	Annually, up to 160 instances of behavioral harassment annually while servicing the navigation aid at Sea Lion Rocks.
Fish*	
Green Sturgeon - Southern	Annually, 0.0132 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.19 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Bocaccio: Puget Sound/Georgia Basin DPS	Annually, 0.099 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.10 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Yelloweye rockfish: Puget Sound/Georgia Basis DPS	Annually, 0.099 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.10 km^2 of habitat where noise from impact pile driving exceeds thresholds that could

Species DPS or ESU		Amount or extent of take
		cause behavioral harassment.
Atlantic salmon: Gulf of Maine DPS		Annually, 0.0031 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.01 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Shortnose sturgeon		Annually, 0.1998 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 1.16 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Atlantic sturgeon	Gulf of Maine	Annually, 0.0031 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.01 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	New York Bight	Annually, 0.0577 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.39 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	Chesapeake Bay	Annually, 0.0549 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.38 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	Carolina	Annually, 0.1971 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 1.15 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	South Atlantic	Annually, 0.1462 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.72 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Gulf sturgeon		Annually, 0.4540 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.92 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Smalltooth sawfish		Annually, 0.1462 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.72 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Chinook salmon: California Coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Sacramento River winter-run, Snake River fall-run, Snake River spring/summer run, Upper Columbia River spring-run, Upper Willamette River ESUs		Annually, 0.0132 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.19 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Coho salmon: Central California Coast, Lower Columbia River, Oregon Coast, Southern Oregon Northern California coast		Annually, 0.0132 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.19 km^2 of habitat where noise from impact pile driving exceeds thresholds that could

Species DPS or ESU		Amount or extent of take
ESUs		cause behavioral harassment.
Chum salmon: Columbia River, Hood Canal summer-run ESUs		Annually, 0.0099 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.10 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Sockeye salmon: Ozette Lake, Snake River ESUs		Annually, 0.0099 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.10 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Steelhead	Puget Sound, Middle Columbia River, Upper Willamette River, Lower Columbia River, Snake River Basin, Upper Columbia River DPSs	Annually, 0.0099 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.10 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	Northern California, California Central Valley, Central California, South-Central California DPSs	Annually, 0.0037 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.08 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Nassau grouper		Annually, 0.1462 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.72 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Pacific eulachon: southern DPS		Annually, 0.0132 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.19 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Scalloped hammerhead shark	Indo-West Pacific DPS	Annually, 0.0008 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.01 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	Eastern Pacific DPS	Annually, 0.0037 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.08 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
	Central and Southwest Atlantic DPS	Annually, 0.1462 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.72 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.
Giant Manta Ray		Annually, 0.0008 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause harm and 0.01 km^2 of habitat where noise from impact pile driving exceeds thresholds that could cause behavioral harassment.

2.10.2 Effects of the Take

In this opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.10.3 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by the Coast Guard so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02). NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. Minimize the amount and extent of incidental take from ATON maintenance by implementing all applicable appropriate PDC.
2. Ensure completion of a monitoring and reporting program for ATON maintenance activities to confirm that the take exemption for ATON maintenance is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.
3. Ensure completion of a monitoring and reporting program for ATON program activities that were implemented without adhering to the PDC described in this opinion and for instances where ATON were established or discontinued.

2.10.4 Terms and Conditions

To be exempt from the prohibitions of section 9, and any regulations issued pursuant to section 4(d), of the ESA, the Coast Guard must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). These terms and conditions are non-discretionary. If the Coast Guard fails to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

1) The following terms and conditions implement reasonable and prudent measure 1:

a) Every maintenance action completed under this opinion will implement the PDC described in section 1.3.5 of this opinion.
b) For any maintenance actions that cannot be implemented in accordance with the PDC described in section 1.3.5 of this opinion, a separate section 7 consultation will be conducted if ESA-listed may be affected.

2) The following terms and conditions implement reasonable and prudent measures 2 and 3:
   a) The Coast Guard will submit a monitoring report to NMFS by February 1 each year that describes the Coast Guard's implementation of the ATON program under the terms of this opinion. The report will include the information described in Section 1.3.7 of this opinion.
   b) Following the first year of implementation of this biological opinion, the Coast Guard will attend a coordination meeting with NMFS to discuss the annual monitoring report and any actions that will improve conservation under this consultation, or make the program more efficient or more accountable. For future years, the Coast Guard will attend coordination meetings with NMFS on an as needed basis. These future meetings may be requested by NMFS or the Coast Guard.

2.11 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

1) Conduct dive surveys around ATON structures in Districts 7 and 14 where ESA-listed corals could occur.
2) Transplant ESA-listed coral colonies found attached to ATON components that need to be replaced or cleaned.
3) Install environmentally friendly buoys to minimize the effects of ATON on coral reef, seagrass, eelgrass, and other sensitive habitats.
4) Equip Coast Guard vessels capable of pile driving with sound attenuation devices (e.g., cushion blocks, dewatered casings or enclosed bubble curtains).
5) Conduct further training of Coast Guard employees regarding the identification of ESA-listed species.

In order for NMFS' Office of Protected Resources Endangered Species Act Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the Coast Guard should notify the Endangered Species Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

2.12 Reinitiation Notice

This concludes formal consultation for the Coast Guard on the Aids to Navigation program. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) The amount or extent of taking specified in the incidental take statement is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

3 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA, directs federal agencies to consult on "any action authorized, funded, or undertaken, or proposed to be authorized funded, or undertaken, by such agency that may adversely affect any [EFH]" (16 U.S.C. §§ 1801-1884). The MSA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." Adverse effect includes direct or indirect physical, chemical, or biological alterations of the water or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

Consultations can be addressed programmatically to broadly consider as many adverse effects as possible through programmatic EFH conservation recommendations (EFH CRs). 50 CFR 600.920 (j) states that programmatic consultation is appropriate for specified activities, if sufficient information is available that will allow NMFS to develop EFH CRs, which address reasonable and foreseeable adverse impacts to EFH resulting from activities of a program. The purpose of a programmatic consultation is to implement the EFH consultation requirements efficiently and effectively by incorporating many individual actions that may adversely affect EFH into one consultation.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in sections 1.3 and 1.4 of this document. The action area includes habitats designated as EFH for various life history stages of each species and/or management groups managed by the eight regional fishery management councils, as shown in Tables 5.9 - 5.16 of the Biological Evaluation/EFH Assessment.

This analysis is based, in part, on the Biological Evaluation/EFH Assessment provided by the Coast Guard and descriptions of EFH for all federally managed species in all Fishery Management Plans (FMPs) developed by each of the eight Fishery Management Councils and NMFS Atlantic Highly Migratory Species Division, and approved by the Secretary of Commerce.

3.2 Adverse Effects on Essential Fish Habitat

Federally managed species have a variety of behaviors, reproductive strategies, and needs when it comes to the use of their designated habitats. Thus, the potential effects of ATON operations will not be uniform across all species and types of EFH. Additionally, there will be varying degrees of effect on EFH depending on the type of ATON (floating or fixed), and type of operation occurring. The physical actions of establishing and discontinuing ATON are nearly

identical to those of ATON maintenance and in most cases, the stressors associated with the establishment and discontinuance of ATON are the same as those associated with maintenance of ATON. Adverse effects to EFH will occur through (1) increased turbidity in the water column, (2) suspension of sediment-associated contaminants, (3) disturbance and scouring of habitats, and (4) underwater sound levels during pile driving.

A number of adverse effects on EFH due to the establishment, maintenance, or discontinuance of ATON structures were discussed in Chapter 6 of the Coast Guard Biological Evaluation/EFH Assessment. To address the diverse nature of these adverse effects and to minimize them, NMFS has worked with the Coast Guard to produce PDC for each Coast Guard District. Additionally, NMFS has produced a list of EFH CRs for ATON operations.

3.2.1 Turbidity

In-water activities such as pile driving (installation and removal) may result in elevated levels of turbidity and suspended sediments in the water column. The frequency and duration of elevated turbidity depends upon the size and quality of the bottom sediments, and the frequency and duration of the activity. Increases in turbidity can degrade water quality, lower dissolved oxygen levels, and potentially release chemical contaminants bound to the fine-grained estuarine/marine sediments. In-water work areas with fine sediments are likely to have greater turbidity impacts than in areas with coarse sediments (Sabol et al. 2005). High levels of turbidity can reduce the primary productivity of an area (Cloern 1987). Prolonged periods of turbidity and sediment suspension can also reduce feeding, and may cause gill injury (Benfield and Minello 1996, Nightingale and Simenstad 2001). Additionally, prolonged turbidity and sediment suspension can cause stress on marine species, and reduce visibility due to low light levels. Suspended sediment can also mask pheromones used by migratory fishes to reach their spawning grounds and impede their migration and can smother immobile benthic organisms and demersal newly-settle juvenile fish (Auld and Schubel 1978; Breitburg 1988; Newcombe and MacDonald 1991; Burton 1993; Nelson and Wheeler 1997).

In regards to this action, the temporary increase in turbidity and suspended sediment may be offset by the long-term benefit of removing a piling that may be coated with creosote. Creosote is a mixture of checmicals used to treat wood pilings. When water temperatures increase, the chemicals enter the water, effecting marine life. Increased levels of turbidity will be short-term, and are expected to be minor and localized. Elevated turbidity will dissipate with tidal circulation after work ceases. In some instances, seasonal in water work restrictions may be needed to minimize the adverse effects to EFH when sensitive life stages of federally managed species are present.

3.2.2 Suspension of Sediment-Associated Contaminants

The suspension of contaminated sediments during pile installation and removal activities can temporarily degrade water quality in the action area. Suspension of sediments presents the potential for release of contaminants to the water column, and for the uptake of contaminants by

organisms contracting re-suspended material. However, most contaminants are tightly bound in the sediments and are not easily released during short-term resuspension (USACE 2004). Long-term impacts may be associated with newly exposed sediment. Any residual toxic metals and organic contaminants absorbed or adsorbed to fine-grained particulates in the surface layer of sediment may become available to organisms either in the water column or through food chain processes (USACE et al. 2009). In regards to this action, the suspension of sediment-associated contaminants are expected to be minor, temporary and localized. However, in some instances, seasonal in water work restrictions may be needed to minimize the adverse effects to EFH when sensitive life stages of federally managed species are present.

3.2.3 Disturbance and Scouring

As per the Biological Evaluation/EFH Assessment, the Coast Guard has 12,911 floating ATON, or buoys, held in place by chains or wires attached to heavy sinkers placed on the sea floor. As tides and currents move, this causes the chain to circle the sinker, scouring the surrounding substrate. As per Chapter 6 of the Biological Evaluation/EFH Assessment, the Coast Guard found that an average water depth of 60 feet is representative of a large number of floating ATON. Calculating the chain length and scour radius, the scour area around a floating ATON would be 3,019 ft^2. Many Floating ATON can be found near sensitive habitats such as coral and seagrass. During installment, finding a location that is strategic for the Coast Guard while having minimal adverse effects to EFH is crucial. During maintenance, if the sinker is not returned to its original spot, the scour radius can increase in size, and affect adjacent habitats. Floating ATON are usually maintained every three years, unless physical conditions require more frequent visits (Aids to Navigation Manual - Technical, COMDTINST M16500.3A, 2010). PDC and EFH CRs have been provided in order to minimize adverse effects of scour on EFH. Thus, the Coast Guard should maximize the accuracy of sinker replacements on or near coral reef and seagrass habitats in order to minimize adverse effects on surrounding EFH.

Pile driving fixed ATON structures may also adversely affect bottom habitats through the act of "spudding down." Many Coast Guard construction vessels used for fixed ATON installation are equipped with large beams or poles that that lower down and hold the vessel in a fixed location on bottom substrates while construction is taking place. A fixed ATON is generally serviced once every three years (Aids to Navigation Manual - Technical, COMDTINST M16500.3A, 2010). However, it may be serviced multiple times before the pile has to be replaced (Slivinski 2015). Spudding down my disrupt EFH, esepecially seagrasses and coral reef habitats. Disruption if seagrasses may cause the grass to die off for a period of time, or could introduce non-native grasses to the area. Spudding down on coral reefs can cause permanent damage to the habitat. Corals can take many years to recover, or they may not recover at all. Following the PDC and EFH CRs will allow the Coast Guard to minimize the damage to EFH. The act of spudding down is usually temporary, causing short-term effects on EFH. Therefore, those impacts to habitat will be temporary and minimal.

3.2.4 Underwater Sound Levels During Pile Driving

Sound moves through water almost 4.5 times faster than air (Hawkins and Popper 2017). Pile driving into sediment with an impact hammer will increase underwater sound pressures and effect open water column habitats for fish (Iafrate et al. 2016). Intense pulses of sound have been shown to potentially cause physical injury to fish, if this sound wave is received at high levels. (Iafrate et al. 2016). Potential injury due to exposure may increase in shallow waters due to hydrostatic pressure (Iafrate et al. 2016). Sound waves may also cause fish to deviate from their normal behavior, triggering changes in their feeding and breeding grounds, or modify migration patterns (Iafrate et al. 2016). Fish may choose sub-optimal breeding locations or secondary food choices, which could lead to negative effects on the population. As part of the PDC, NMFS has provided in-water work windows for various species that may be more susceptible to negative effects from underwater sound. For other fish species, it is expected that they will utilize other adjacent habitats during pile driving activities, and the elevated sound pressure levels will have no permanent impact on EFH.

3.3 Best Management Practices/Project Design Criteria

Best Management Practices, or PDC, were developed in cooperation with the Coast Guard, and serve to prevent or minimize adverse effects on EFH. The first set of PDC is related to both ESA and EFH and will be implemented nationwide. The next set of nationwide PDC is specific to minimizing impacts to ESA-listed resources. The remaining PDC are organized by Coast Guard District, with separate PDC to minimize adverse effects to ESA-listed resources and on EFH. PDC can be found in Project Design Criteria Section 3.1.2.3. Please note that section 3.1.2.3.4 refers to Coast Guard District 5 Virginia north and Section 3.1.2.3.5 is for Coast Guard District 5 North Carolina and south.

3.4 Essential Fish Habitat Conservation Recommendations

Pursuant to section 305(b)(4)(A) of the MSA, NMFS offers the following EFH CRs to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH.

Coast Guard District 1 and District 5

1. For any ATON activities occurring in the state of New Jersey, the use of creosote is prohibited under New Jersey Code 13.1K-38 (NJ Rev Stat § 13:1K-38), and treated lumber is prohibited in mapped shellfish beds under the State of New Jersey Department of Environmental Protection (N.J.A.C. 7:7E-3.2(a)(l-4)). Maps of shellfish beds are listed in Appendix H.

Coast Guard District 7

2. For any ATON activities occurring in Coast Guard District 7, relocate corals (scleractinian corals and octocorals) within impact areas or on structures in a manner that reflects previous consultation input from NMFS (NMFS 2013e). Relocate corals to a suitable recipient site(s) in similar water depth and physical conditions, and sufficiently

far from impacted areas. The corals should be relocated at regionally appropriate densities. NMFS supports relocation of all corals greater than 5 to 10 centimeters in diameter or height depending on the coral type and morphology. The performance standard for relocation of corals should be 85 percent survival with positive tissue growth and secure substrate attachment after two years of monitoring. No less than 25 percent of the relocated coral colonies are monitored, including at least ten colonies of each of the species relocated. If less than ten colonies of one species are relocated, all of the colonies of that species or genus should be monitored. Monitoring should occur immediately after relocation and for an additional two years with results shared with NMFS Southeast Regional Office.

Coast Guard Districts 11 and 13

3. When practicable, remove treated piling stubs that have been broken or cut. If the treated pile cannot be removed, either drive broken/cut stubs with a pile driver sufficiently below the mudline or cut piles below the mudline to prevent release of contaminants into the water column.
4. When possible, equip Coast Guard vessels or contracted vessels with a containment basin to contain all treated materials and any sediment during the removal (Washington Department of Natural Resources 2017). This is to prevent contaminated sediments from reentering the waterways. If a basin is not possible, line containment area with bales of hay to reduce contaminants and runoff from reentering the water, or some other means of preventing contaminants from entering the water. Contaminated piles, sediments and water should be disposed of at an approved upland facility.

Coast Guard District 14

Pacific island habitats support mainly coral reef related EFH, with diversity in species components and structure a prominent factor across the breath of Pacific Ocean encompassed. NMFS Pacific Island Regional Office (PIR) recognizes the overall benefits of ATON operations to D14/PIR EFH in reducing the potential for ship groundings and associated contaminant releases, and believes these activities should continue without interruption. However, additional characterizations of site specific ATON, surrounding natural resources and habitats will be necessary to further facilitate appropriate consultation to enhance avoidance and minimization of impacts to PIR EFH. The following conservation recommendations provide interim guidance that may help limit potential impacts to PIR EFH, while highlighting further information needed to enhance site-specific impact avoidance and minimization:

5. Biological field assessment and servicing related information specific to Coast Guard ATON within D14.
    a. Provide to NMFS PIRO, within 3 months, a description of each D14 Coast Guard ATON in spreadsheet format that includes the following:
        i. List Light Number (LLNR)

ii. ATON Name
iii. Geographic region
iv. ATON Location
v. Assigned position (AP: geographic coordinates)
vi. ATON Type
vii. APR water depth (ft.)
viii. Mooring chain length (ft.)
ix. Sinker size (lbs.)
x. Expected bottom scour radius (ft.)
xi. Position tolerance (ft.)
xii. Maximum potential scour radius from AP (ft.)
xiii. Maximum historical distance of "set"/"found" location from AP (if available)
xiv. Last service date and type
xv. Anticipated frequency of servicing
xvi. Anticipated scheduling of post replacements
xvii. Service by ship, divers or both?

b. Provide to NMFS PIRO, within one month following each servicing event, the following:
   i. A list of the ATON serviced
   ii. A description of the operation conducted for each ATON
   iii. The distance between "found" and "set" locations, and "found" and "set" locations relative to AP for each servicing that involved lifting or movement of a sinker
   iv. Prior and post-service chain lengths for serviced ATON
c. Collect and forward to NMFS PIRO, within one month of each servicing event, representative photos of corals found growing on ATON structural components for each island area. Sort by and identify ATON LLNR.
d. When servicing, collect and forward to NMFS PIRO general broad-scale photos of ATON sinker and chain or post positions relative to surrounding bottom habitat for all ATON serviced by divers. Sort by and identify ATON LLNR.
e. Meet with NMFS PIRO, within 9 months, to discuss ATON biological sampling options and approaches for each D14 Island area and intended timelines for sampling and reporting. A partnered approach to biological sampling with NMFS should be explored.
f. Implement, within 2 to 3 years, biological sampling protocols across D14 to facilitate appropriate regional and archipelago level impact analyses and EFH consultation. Forward data and completed reports to NMFS PIRO.

6. Test the use of environmental friendly buoy mooring systems including foam buoys, elastic mooring components, and inverse catenary systems (such as S-tethers) (Slivinski 2015). Implement these systems if shown to be reliable and effective. These types of

modifications will very likely lead to substantial reductions in ATON related impacts to bottom habitats.

7. Continue ATON operations using Coast Guard divers wherever possible. The use of divers often allows operations to proceed without the need to move the sinker, and can lead to precise relocations of bottom chains and sinkers if they require replacement. Coast Guard divers service ATON to depths of 90 ft., which includes beacon post and sinker maintenance, chain chafe measurements, hull and chain cleanings and linkage replacements, and hull, chain and sinker replacements.

8. Ship based ATON servicing that requires sinker movement should be done in a manner that minimizes the distance between where sinkers are found and set to reduce shifts in the chain scour zone. Current Coast Guard positioning technology allows for highly accurate ship and ATON positioning with minimal error given reasonable weather and current conditions. Records of sinker "found" and "set" positions, the linear distance between these, the linear distance of each from the assigned position, and any changes to the length of chain and positioning depth should be kept and reported to NMFS Pacific Islands Region.

9. Where possible, relocate buoyed ATON and assigned positions to low habitat impact areas within position tolerance zones. Reevaluate the assigned positions and tolerance zones relative to minimizing impacts where currently feasible.

10. Replacement of posts supporting ATON should be done in a manner that minimizes impacts to corals and surrounding habitat. If corals are found growing on structures that will be removed or in areas where post replacement will cause them harm, coordinate with NMFS PIR to assess potential transplantation options.

11. Corals exceeding 3 inches in a linear dimension that display 1.5 inches or more of three dimensional height that are brought aboard the ship should be carefully removed and temporarily stored in clean enclosed seawater containers for quick dispersal to nearby reef areas not exceeding 40 ft. depth. Corals that break during removal should be similarly treated based on remaining size. The probabilities of survival for removed corals will vary and may be expected to be low, but they will very likely exceed that of corals scraped off and deposited with other tailings at depth. Photo-documentation of a representative sample of the corals removed and dispersed should be collected and sent to NMFS PIR.

12. Avoid anchoring between servicing activities; use docking facilities and established moorings where and when possible. Similarly, anchoring should be avoided when using smaller Coast Guard vessels. If anchoring becomes necessary, ensure such only occurs in broad, diver confirmed sand, non-coral and non-seagrass bottom areas.

3.5 Conclusion

Based on the information provided in the Biological Evaluation/EFH Assessment, the analysis of the effects presented in the ESA portion of this document, and the review of adverse effects on EFH in this section, NMFS concludes that the proposed action will temporarily affect EFH when establishing, maintaining, or discontinuing fixed and floating ATON. These temporary adverse effects on EFH will be minimized by implementing the agreed upon PDC as well as EFH CRs.

3.6 Essential Fish Habitat Statutory Requirement

Please be advised that regulations (50 CFR 600.920(k)) to implement the EFH provisions of the MSA require your office to provide a written response to this letter within 30 days of its receipt and prior to the final action. A preliminary response is acceptable if final response cannot be completed within 30 days. Your final response must include a description of how the EFH CRs will be implemented and any other measures that will be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with the EFH CRs, then you may develop and propose alternative EFH CRs subject to NMFS approval, otherwise those activities for which adverse effects are not fully compensated will not be covered under this programmatic consultation. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established quarterly reporting to determine the number of EFH CRs provided as part of each EFH consultation, and how many are adopted by the action agency. Therefore, NMFS also requests that your response clearly identifes the number of EFH CRs accepted.

3.7 Supplemental Consultation

At this time, the Coast Guard is not able to provide information on the exact location, type of aid, method of establishment, and other details of future projects to establish or discontinue ATON. In keeping with the Coast Guard's National Environmental Policy Act Implementing Procedures and Policy for Considering Environmental Impacts (Guard 2000), a separate consultation that tiers off of this programmatic consultation would be conducted for each new ATON if it is determined that EFH will be adversely affected. Additionally, the Coast Guard must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH CRs (50 CFR 600.920(l)). Additionally, NMFS may revoke or revise this programmatic consultation if it is determined that it is not being implemented as intended or if new information becomes available indicating a significant discrepancy in either the effects analysis or effectiveness of EFH CRs.

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5 APPENDICES

Appendices A through F described the pile driving work windows for ESA-listed species referenced in section 1.3.5 of this opinion. The work windows may be adjusted in consultation with NMFS if new information suggests revisions should be made to be more protective of ESA-listed species. Appendices G through J described the pile driving work windows for EFH referenced in section 1.3.5 of this opinion.

5.1 Endangered Species Act Work Windows

Appendix A: ESA Work Windows for Coast Guard District 1

Atlantic salmon

Conduct any pile driving in rivers where Atlantic salmon are known to occur between November 8 and April 9, as salmon are not likely to be present at that time. Atlantic salmon rivers include the following:

- Dennys River
- East Machias River
- Machias River
- Pleasant River
- Narraguagus River
- Ducktrap River
- Sheepscot River
- Cove Brook
- Penobscot River
- Androscoggin River
- Kennebec River

Atlantic sturgeon (ANS) and Shortnose sturgeon (SNS)

Conduct any pile driving in the spawning areas of the rivers listed below outside of the time of year when the species is likely to be present for spawning.

River	Time of Year	Spawning Area
Kennebec (ME)	SNS: late April – early May ANS: June - July	SNS: below the former Edwards Dam (RKM 59) and downstream of the Veazie Dam (RKM 102) ANS: RKM 53-75, inclusive of waters a few kilometers upstream of where Edwards Dam was removed
Androscoggin (ME)	SNS: late April – early May ANS: June - July	SNS: below Brunswick Dam to the Rt. 201 Bridge (RKM 7.7-8.4) ANS: below the Brunswick Dam (RKM 8.4)
Merrimack (MA)	SNS: April	SNS: near Haverhill (RKM 30-32)
Connecticut (CT/MA)	SNS: late April – late May	SNS: below Turners Falls Dam/Cabot Station at two locations depending on river conditions (RKM 193-194); limited spawning may occasionally occur below Holyoke Dam
Hudson (NY/NJ)	SNS: late April – early May ANS: late May to mid-July	SNS: From Coeymans to below the Federal Dam at Troy (RKM 212-245) ANS: RKM 112; area around Hyde Park (RKM 134); Catskill (RKM 182); upstream of RKM 193

Appendix B: ESA Work Windows for Coast Guard District 5

Atlantic sturgeon (ANS) and Shortnose sturgeon (SNS)

Conduct any pile driving in the spawning areas of the rivers listed below outside of the time of year when the species is likely to be present for spawning. If time of year for spawning is unknown, no work window is required. Information is presented for Coast Guard awareness during ATON maintenance operations.

River	Time of Year	Spawning Area
Delaware (NJ/DE/PA)	SNS: late March – early May ANS: likely April to June	SNS: between Lambertville Rapids and Trenton Rapids (RKM 214-238) ANS: New Castle, DE to Marcus Hook (RKM 100-130); RKM 120-150; between north Philadelphia to Trenton (RKM 176-211)
Pamunkey (VA)	ANS: early fall	ANS: may be as far upstream as RKM 150
James (VA)	ANS: spring and fall	ANS: spring spawn - likely at RKM 77; fall spawn - likely between RKM 77 and the fall line near Richmond, VA at RKM 155
Roanoke River (NC)	SNS: Early Mar – Apr ATS: Feb-Mar; Mid-Aug – Mid-Oct	SNS: Likely same habitat as ATS ATS: ~RKM 204-221, currently most spawning occurs below Roanoke Rapids Dam from RKM 204-221
Tar - Pamlico River (NC)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 80-199, up to Rocky Mount Mill Pond Dam
Neuse River (NC)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: Unknown (but possible from 80-391 RKM up to Milburnie Dam)
Cape Fear River (NC)	SNS: Unknown ATS:~Feb-Apr	SNS: Possible spawning between Lock and Dam #1 and Lock and Dam #3 ATS: ~RKM 65 to Lock and Dam #3
Northeast Cape Fear River (NC)	SNS: Unknown ATS: :~Feb-Apr	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 65-131
Pee Dee River (NC/SC)	SNS: Jan-Apr ATS: Apr-May; Aug-Nov	SNS: Spawning at Gravel Bar in Great Pee Dee River (RKM 206.5) ATS: ~RKM 70-310

Appendix C: ESA Work Windows for Coast Guard District 7

Atlantic sturgeon (ANS) and Shortnose sturgeon (SNS)

Conduct any pile driving in the spawning areas of the rivers listed below outside of the time of year when the species is likely to be present for spawning. If time of year for spawning is unknown, no work window is required. This information is presented for Coast Guard awareness during ATON maintenance operations.

River	Time of Year	Potential Spawning Area
Pee Dee River (NC/SC)	SNS: Jan-Apr ATS: Apr-May; Aug-Nov	SNS: Spawning at Gravel Bar in Great Pee Dee River (RKM 206.5) ATS: ~RKM 70-310
Waccamaw River (Bull Creek) (SC)	SNS: Likely Jan-Apr ATS: No Spawning	SNS: Animal migrate to spawn at Gravel Bar in Great Pee Dee River (RKM 206.5) ATS: No Spawning
Bull Creek (a.k.a. Big Bull Creek) (SC)	SNS: No Spawning ATS: No Spawning	SNS: No Spawning ATS: No Spawning (Migratory pathway)
Black River (SC)	SNS: Likely Jan-Apr ATS: Likely Apr-May; Aug-Nov	SNS: Animal migrate to spawn at Gravel Bar in Great Pee Dee River (RKM 206.5) ATS: Likely RKM 80-253
Sampit River (SC)	SNS: Likely No Spawning ATS: No Spawning	SNS: Animal migrate to spawn at gravel bar in Great Pee Dee River (RKM 206.5) ATS: No spawning
Santee River (SC)	SNS: No Spawning ATS: Likely Apr-May; Aug-Nov	SNS: No spawning ATS: ~RKM 100-114 to the Wilson Dam
Rediversion Canal (SC)	SNS: No Spawning ATS: Unknown	SNS: No spawning ATS: Spawning possible in 8 RKM of canal
North Santee River (SC)	SNS: No Spawning ATS: Unknown	SNS: No spawning ATS: Spawning possible in 29 RKM of river
South Santee River (SC)	SNS: No Spawning ATS: Unknown	SNS: No spawning ATS: Spawning possible in the 27 RKM of river
Tailrace Canal - West Branch Cooper River (SC)	SNS: No Spawning ATS: Unknown	SNS: No spawning ATS: Spawning possible in the 29 RKM of canal; up to Pinopolis Dam
Congaree River (SC)	SNS: Jan-Mar ATS: No spawning	SNS: Spawning on gravel bar at City of Columbia (SC) (RKM 70) ATS: No spawning
Cooper River (SC)	SNS: Jan-Mar ATS: Sept-Early Nov	SNS: ~RKM 56-77 (Spawning at the base of the Pinopolis Dam [RKM 76.8]) ATS: ~RKM 56-77 (Spawning at the base of the Pinopolis Dam [RKM 76.8])
North Fork Edisto River (SC)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 0-155
South Fork Edisto River (SC)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 0-175

River	Time of Year	Potential Spawning Area
Edisto River (SC)	SNS: Unknown ATS: Jul - Oct	SNS: Likely, using same habitat as ATS ATS: ~RKM 79–163 (up to the confluence of the N Fork Edisto and S Fork Edisto)
Combahee - Salkehatchie River (SC)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 100-185
Savannah River (SC/GA)	SNS: Jan-Mar ATS: Aug-Sept	SNS: RKM 72-301 (Likely up to New Savannah Bluff Lock and Dam) ATS: ~RKM 72-301 (Up to New Savannah Bluff Lock and Dam)
Ogeechee River (GA)	SNS: Unknown ATS:	SNS: Likely same habitat as ATS ATS: ~RKM 100-448
Oconee River (GA)	SNS: Jan–Mar ATS: Oct-Nov	SNS: ~RKM 208-418 (Confluence with the Altamaha up to Sinclair Dam) ATS: ~RKM 208-418 (Confluence with the Altamaha up to Sinclair Dam)
Ocmulgee River (GA)	SNS: Jan–Mar ATS: Oct-Nov	SNS: ~RKM 208-541 (Confluence with the Altamaha up to Juliette Dam) ATS: ~RKM 208-541 (Confluence with the Altamaha up to Juliette Dam)
Altamaha River (GA)	SNS: Jan–Mar ATS: Oct-Nov	SNS: ~RKM 200-208 (Up to the confluence of the Oconee and Ocmulgee Rivers) ATS: ~RKM 200-208 (Up to the confluence of the Oconee and Ocmulgee Rivers)
Satilla River (GA)	SNS: Unknown ATS: Unknown	SNS: Unknown (If there, likely same habitat as ATS) ATS: ~RKM 100-378
St. Mary's River (GA/FL)	SNS: Unknown ATS: Unknown	SNS: Unknown ATS: Likely but specific are currently unknown
St. Johns River (FL)	SNS: Unknown ATS: Unknown	SNS: Unknown ATS: Unknown
Unknown - means there may or may not be spawning occurring. *No Spawning* - means we do not think they use the river for spawning.		

Appendix D: ESA Work Windows for Coast Guard District 11

Conduct pile driving activities associated with ATON maintenance in the following areas during the specified times below to minimize impacts to ESA-listed fish:

- Central Valley (Bay-Delta): June 15 - September 15
- Northern and Central California: June 15 - October 15
- San Francisco Bay: June 15 - November 30
- Russian River: June 15 - August 15

- Rivers with California Coastal Chinook: July 1 - September 15
- Southern California: June 1 - October 31

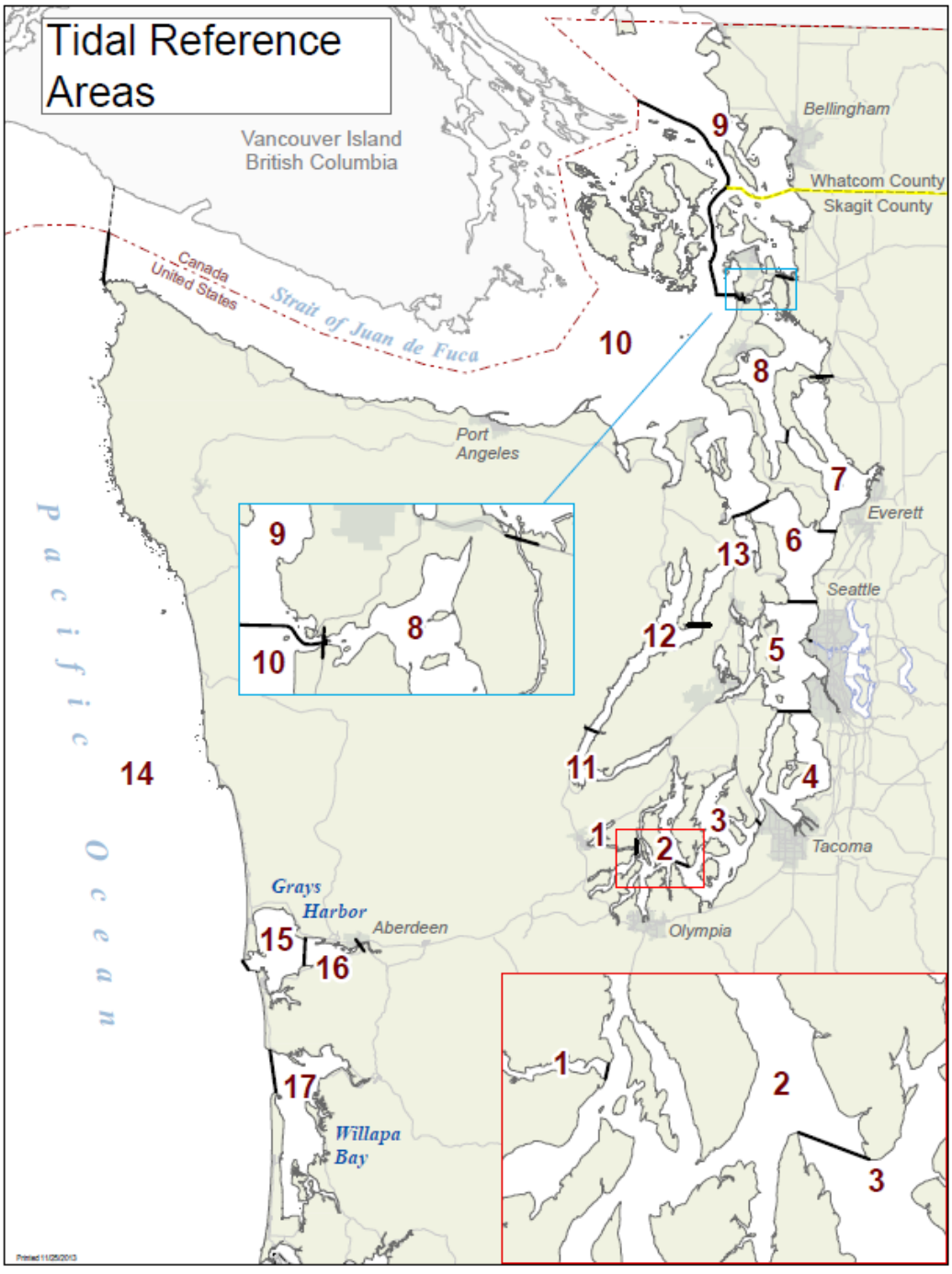
Appendix E: ESA Work Windows for Coast Guard Distict 13

Washington

For freshwater areas in Washington where ESA-listed salmonids occur, conduct pile driving during times when spawning or incubating salmonids are least likely to be present. Unless further guidance is provided by NMFS, follow the guidance of the Washington Department of Fish and Wildlife:
http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf

For marine areas in Washington, conduct pile driving at times of year when the risk to salmonid life is reduced. Unless further guidance is provided by NMFS, follow the guidance of the Washington Department of Fish and Wildlife[40]:
http://apps.leg.wa.gov/wac/default.aspx?cite=220-660-330

[40] See map below for tidal reference areas referenced by Washington Department of Fish and Wildlife.

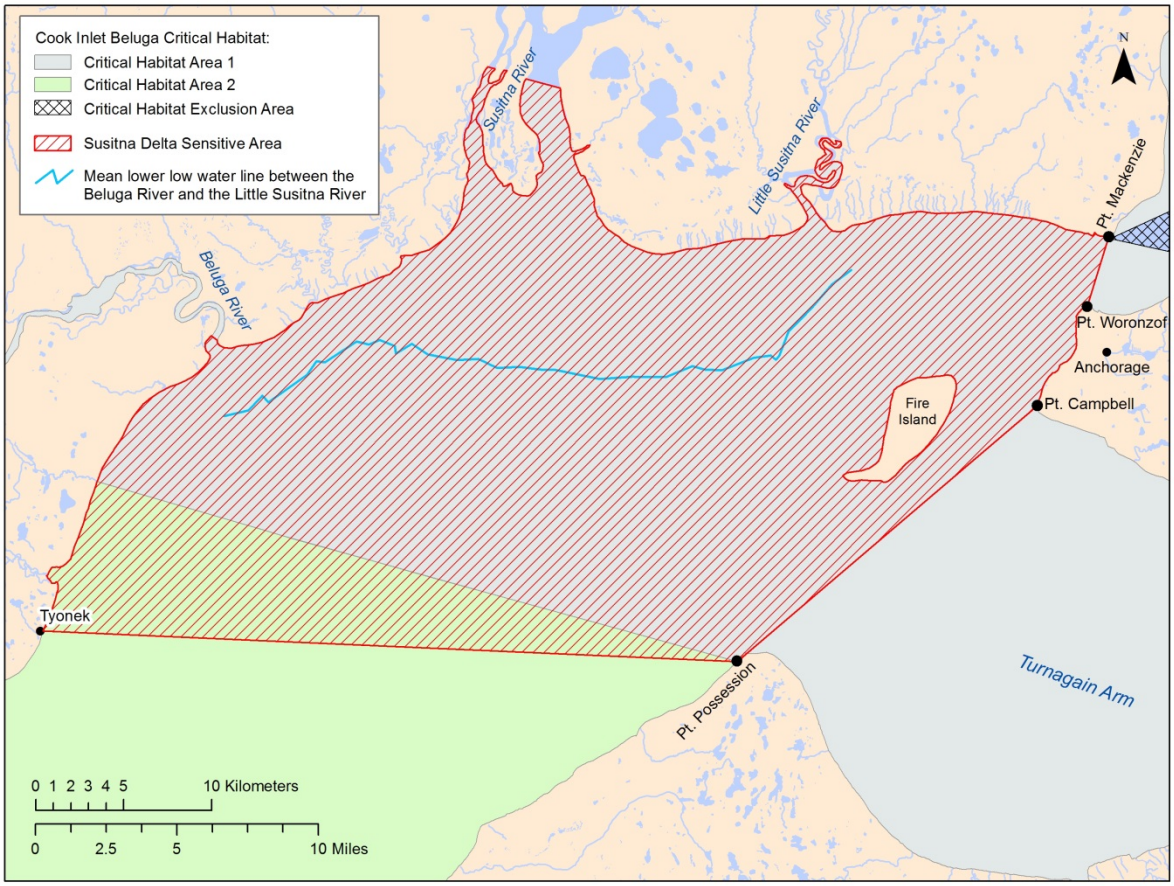


Oregon

For Oregon, conduct pile driving at times of year that will minimize potential impacts to ESA-listed salmonids. Unless further guidance is provided by NMFS, follow the guidance of the Oregon Department of Fish and Wildlife: http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_Work2008.pdf

Appendix F: ESA Work Windows for Coast Guard Distict 17

To minimize impacts to Cook Inlet Beluga whales, no pile driving is permitted from April 15 to October 15 in the Susitna Delta Sensitive Area (see map below).



5.2 Essential Fish Habitat Work Windows

Appendix G: EFH Work Windows for Coast Guard Districts 1 and 5

Time of year (TOY) restrictions are provided so that in-water work (i.e., turbidity and noise producing activities) may be avoided during sensitive life stages of managed species. These standard restrictions take into account the breeding, nursery, and migration stages of managed species which are especially vulnerable to in-water silt-producing activities, noise impacts, or activities which may encroach greater than 25 percent into a waterway interfering with migration.

State	TOY Restrictions
Maine	Winter Flounder: March 15 to June 30 Diadromous Fish: April 1 to June 30 Shellfish: June 1 to October 31
New Hampshire	Winter Flounder/Diadromous Fish: March 16 to November 14
Massachusetts[1]	Winter Flounder: January 15 to June 30 Diadromous Fish: March 1 to June 30 Shellfish: June 1 to October 31
Rhode Island	Winter Flounder: February 1 to June 30 Diadromous Fish: March 15 to June 30 Shellfish: May 1 to October 14
Connecticut[2]	Winter Flounder: February 1 to May 31 Diadromous Fish: April 1 to June 30 Shellfish: May 1 to September 30
New York[3]	Winter Flounder: January 15 to May 31 Diadromous Fish: March 1 to June 30Overwintering Blue Crab and Striped Bass: November 15 to April 15
New Jersey[4]	Winter Flounder: January 1 to May 31 Diadromous Fish: March 1 to June 30 SAV: April 15 to September 30 Overwintering Blue Crab and Striped Bass: November 15 to April 15
Pennsylvania[5]	Diadromous Fish: March 15 to June 30
Delaware	Diadromous Fish: March 15 to June 30 Sandbar Shark: April 15 to September 15 Horseshoe Crab: April 15 to September 15
Maryland	Diadromous Fish: February 15 to June 15 SAV: April 15 to October 15
Virginia	Diadromous Fish: February 15 to June 30 SAV: April 15 to October 15

[1] The Massachusetts Division of Marine Fisheries developed site-specific TOY restrictions by waterbody. The TOY document provided at www.mass.gov/dfwele/dmf/publications/tr_47.pdf may be referenced for applicable locations.
[2] The TOY restriction for work occurring in the Connecticut River, north of Old Saybrook, is from April 1 through June 30.
[3] Diadromous runs may begin March 15 in upstream areas in the Delaware and Hudson Rivers.
[4] Diadromous runs may begin March 15 in upstream areas in the Delaware and Hudson Rivers. There is no winter flounder early life stage EFH south of the Absecon Inlet, New Jersey.
[5] Diadromous runs may begin closer to March 15 in upstream areas in the Delaware River.

All diadromous areas: September 1- November 30. Fall TOY restrictions are not always recommended, but should be used in cases where an action will substantially block the waterway in the fall.

Appendix H: EFH Work Windows for Coast Guard District 5

New Jersey Shellfish Maps

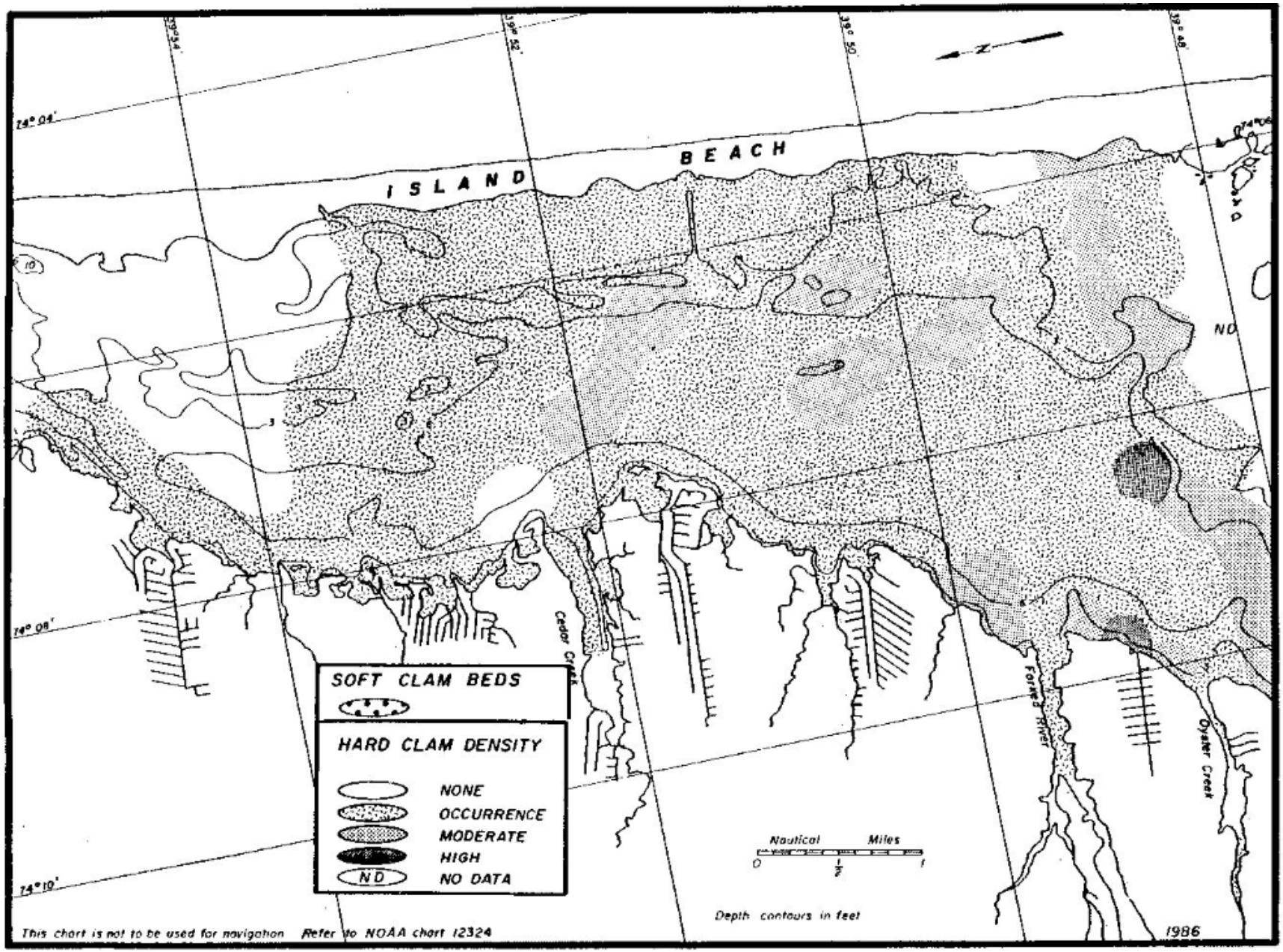
The below detailed shellfish distribution maps depict areas that have a current shellfish density equal to or greater than 0.20 shellfish per square foot, or have a history of natural shellfish production. For a complete review of a particular site, all maps within the time series for that area should be consulted. For example, if a map from 1983 shows the area in question as having a "moderate density" of hard clams, while a newer map shows "low density", the property is still considered shellfish habitat and subject to the shellfish habitat rules as such.

It should be noted that these maps do not include undocumented, regulated shellfish areas. These areas, which are not depicted on these maps, are also regulated as Shellfish habitat by the Division of Land Use Regulation. Conclusive evidence concerning the presence/absence of shellfish requires site inspections and habitat assessments.

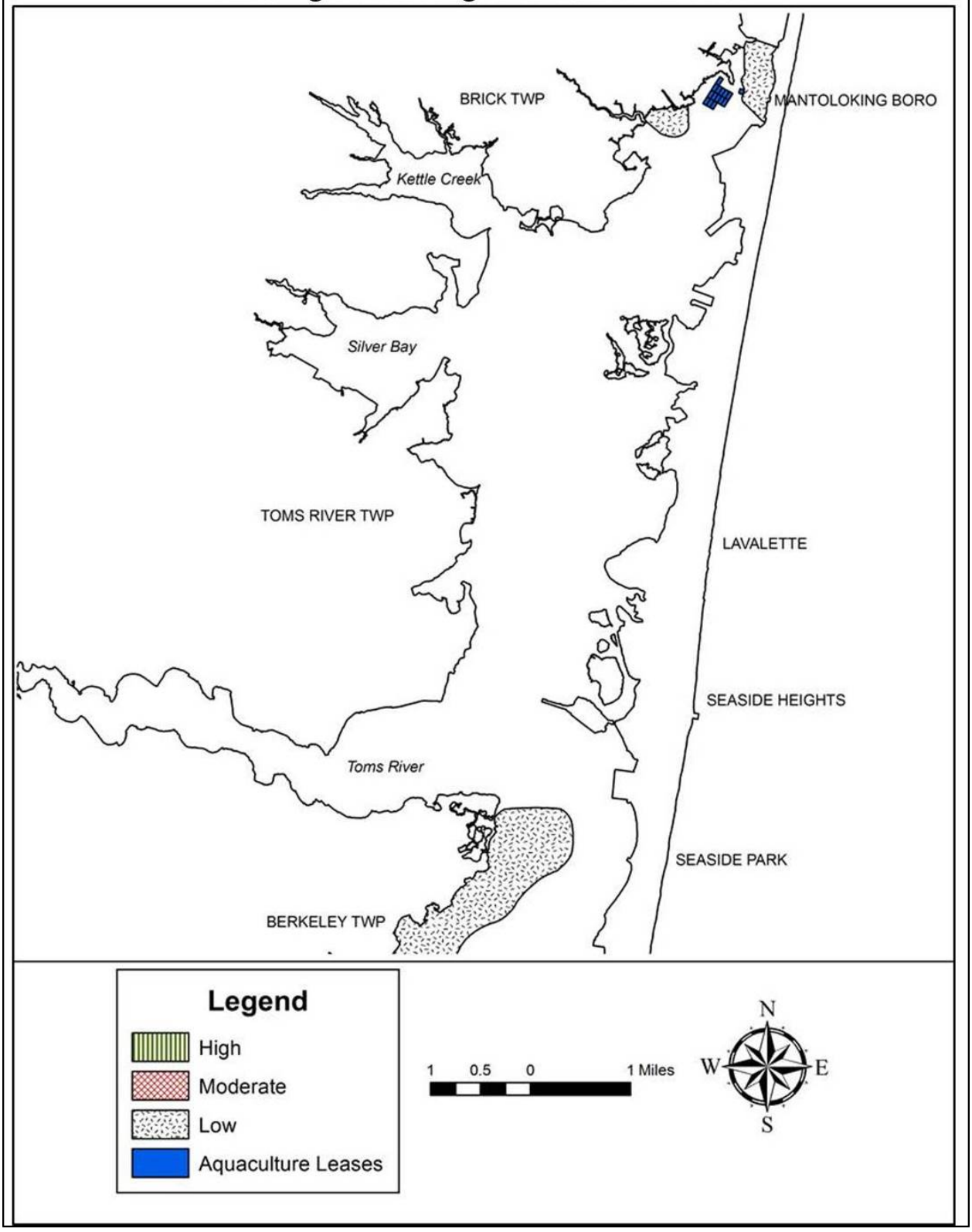
Therefore, these shellfish maps alone are not sufficient to determine the presence/absence of regulated shellfish habitat. This is a compilation of data merely for informational purposes. The NJDEP does not warrant or guarantee the quality or completeness of the content on this website. State of New Jersey shall not be held liable for improper or incorrect use of the data described and/or contained herein. This disclaimer applies both to individual use of the data and aggregate use with other data.

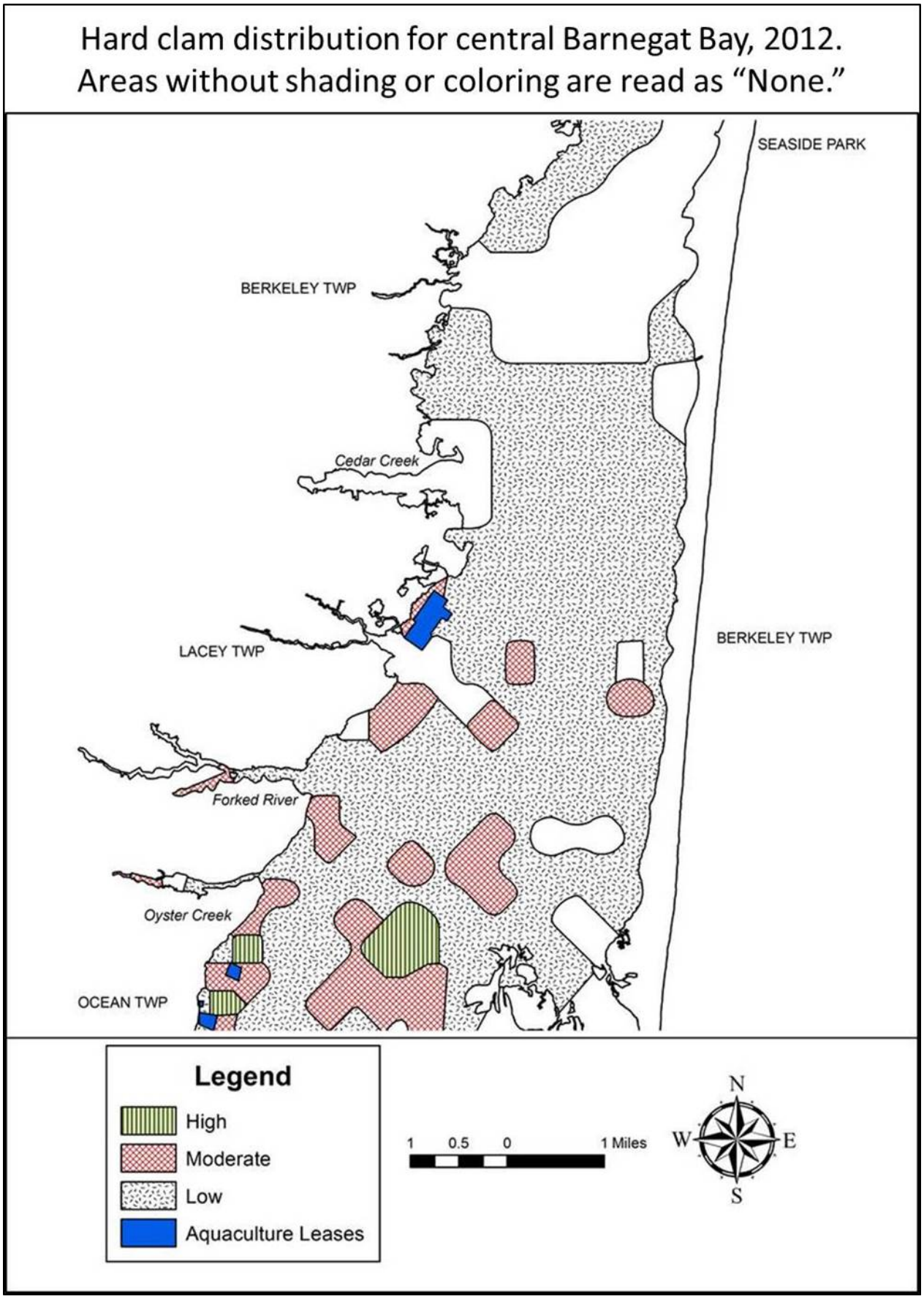
Reference:
http://www.nj.gov/dep/landuse/shellfish.html

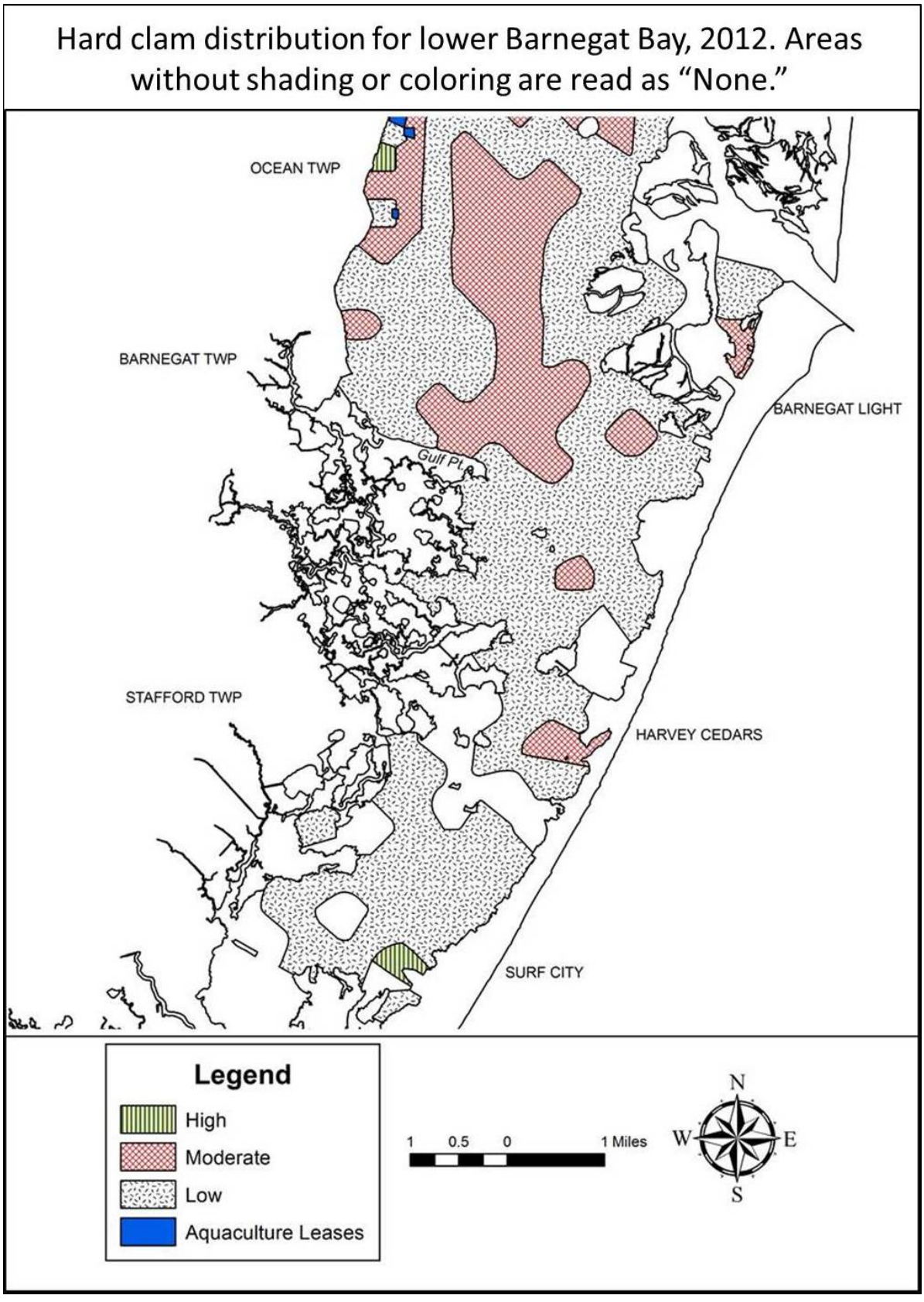
Bayville to Oyster Creek--Soft Clam and Hard Clam



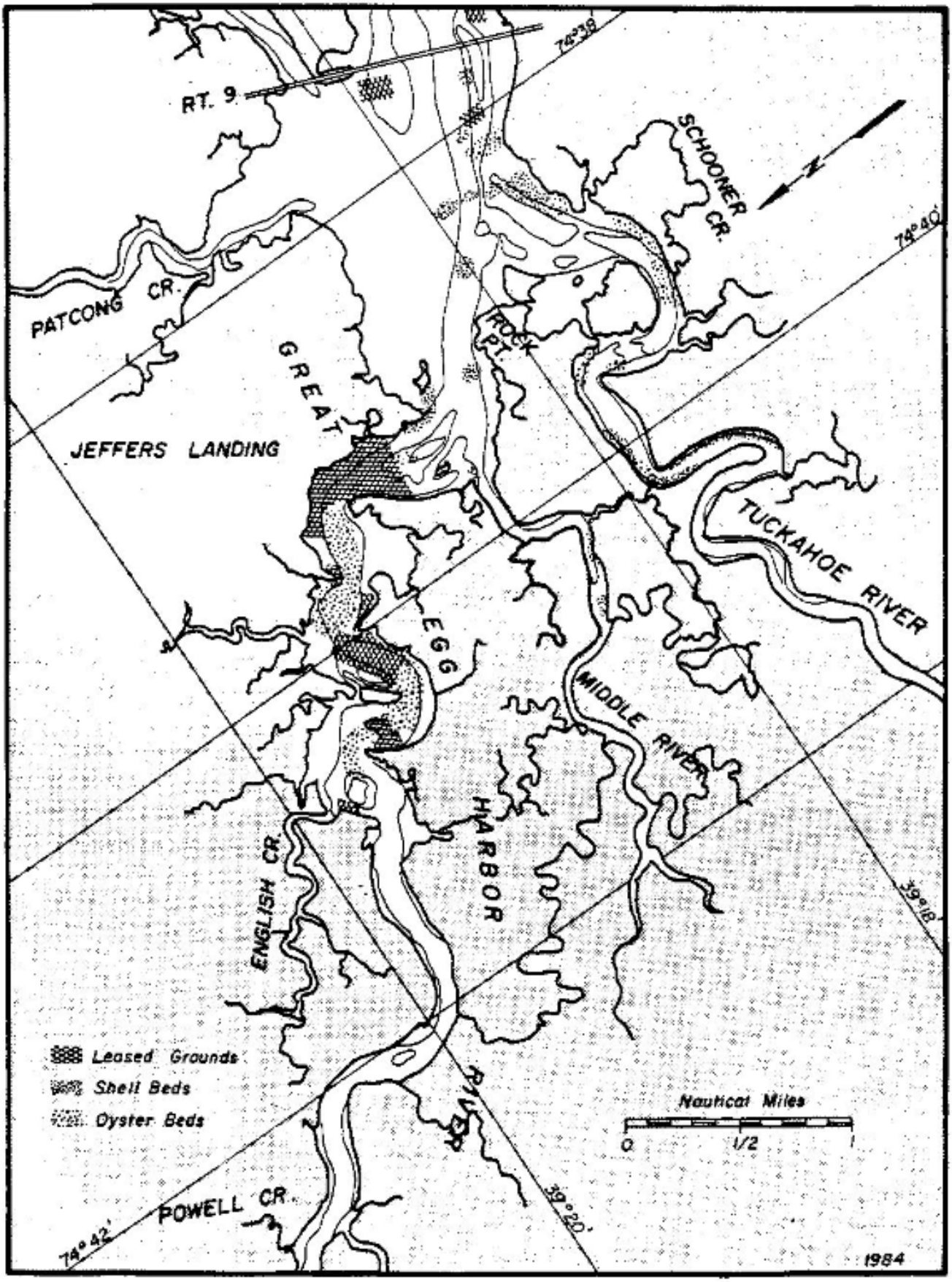
Hard clam distribution for upper Barnegat Bay, 2012. Areas without shading or coloring are read as "None."



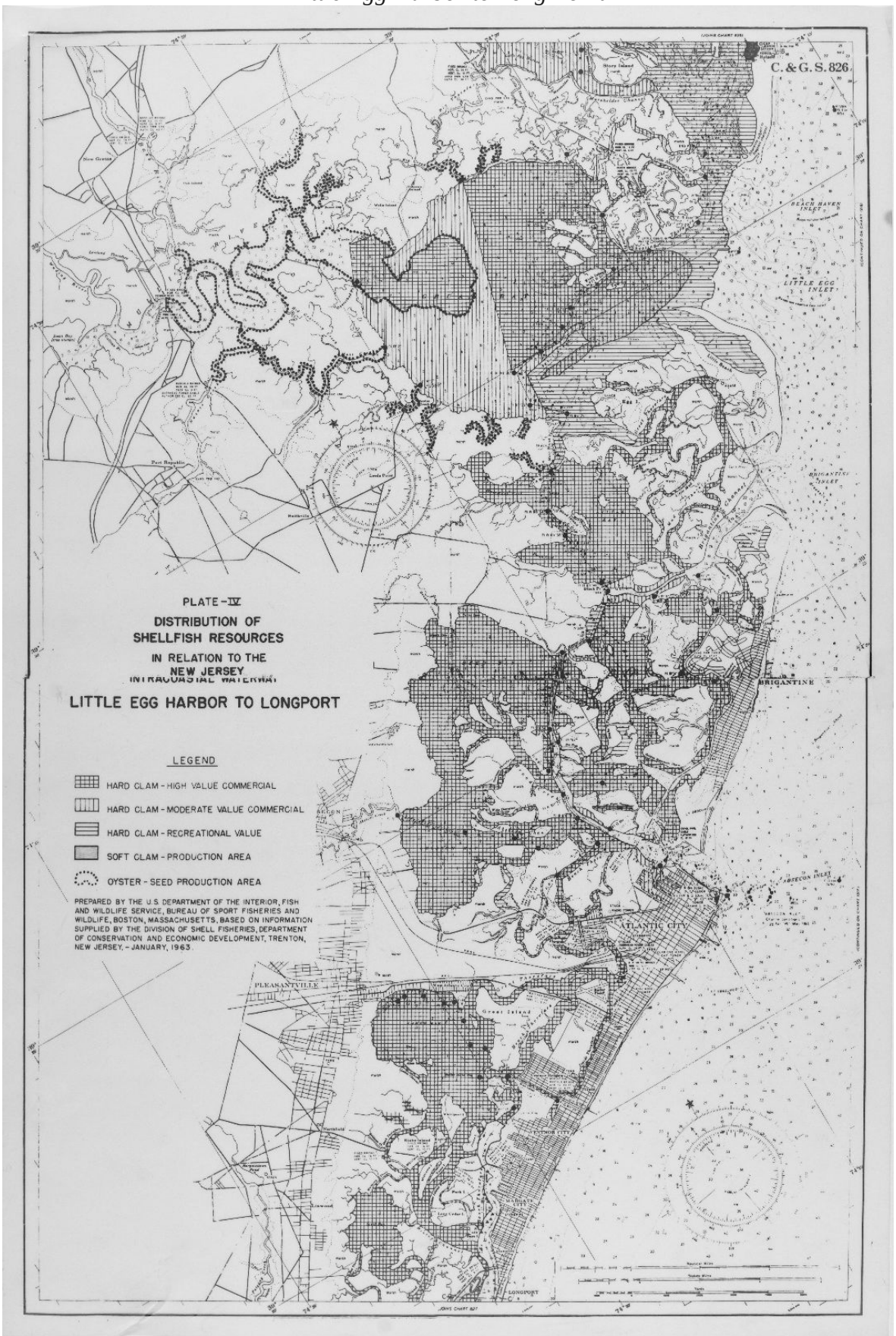

Hard clam distribution for central Barnegat Bay, 2012.
Areas without shading or coloring are read as "None."
SEASIDE PARK
BERKELEY TWP
Cedar Creek
LACEY TWP
BERKELEY TWP
Forked River
Oyster Creek
OCEAN TWP
Legend
High
Moderate
Low
Aquaculture Leases
1 0.5 0 1 Miles
N
W
E
S


Hard clam distribution for lower Barnegat Bay, 2012. Areas without shading or coloring are read as "None."
OCEAN TWP
BARNEGAT TWP
BARNEGAT LIGHT
Gulf Pt.
STAFFORD TWP
HARVEY CEDARS
SURF CITY
Legend
High
Moderate
Low
Aquaculture Leases
1 0.5 0 1 Miles
N
W
E
S

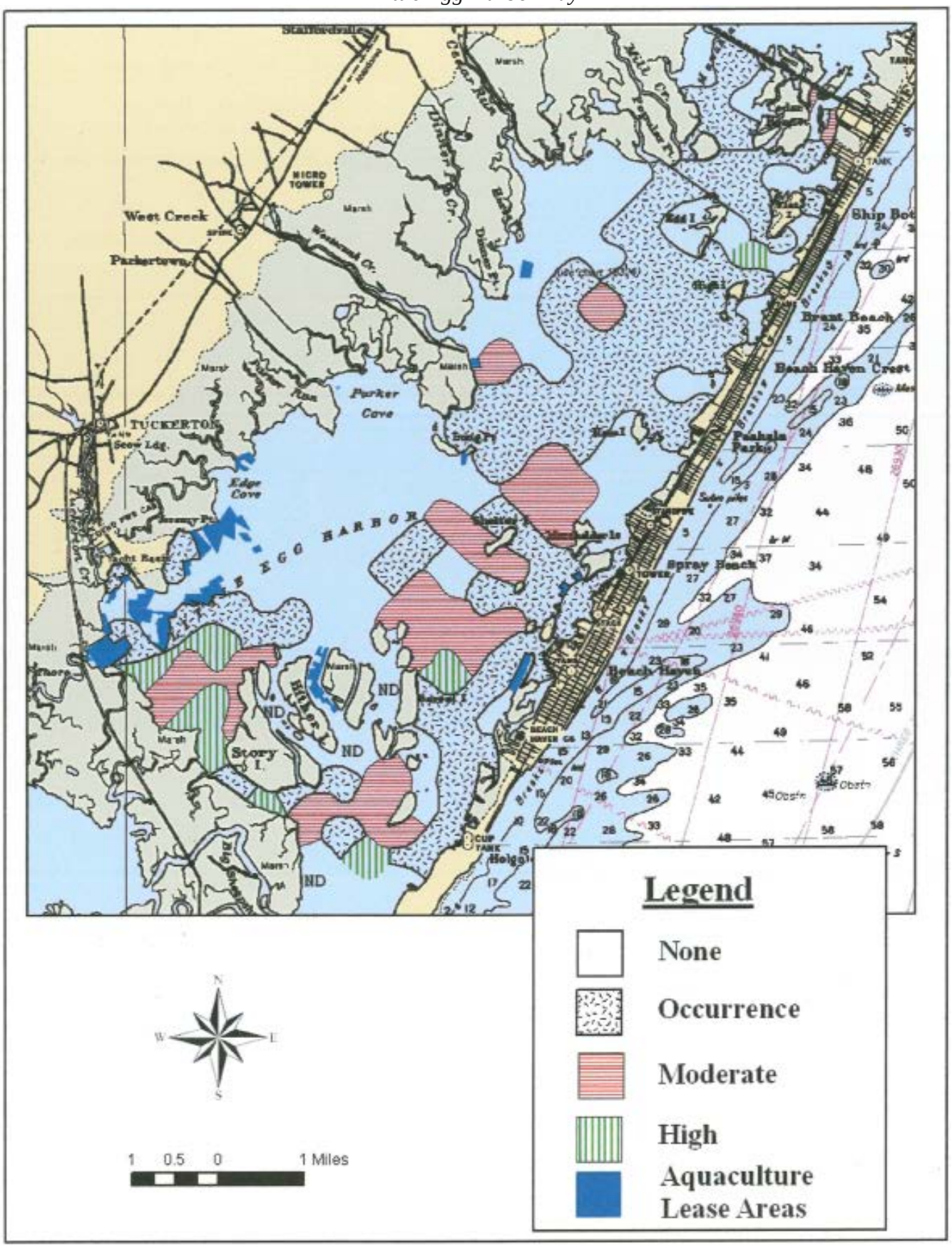
Great Egg Harbor River –Shellfish and Oysters



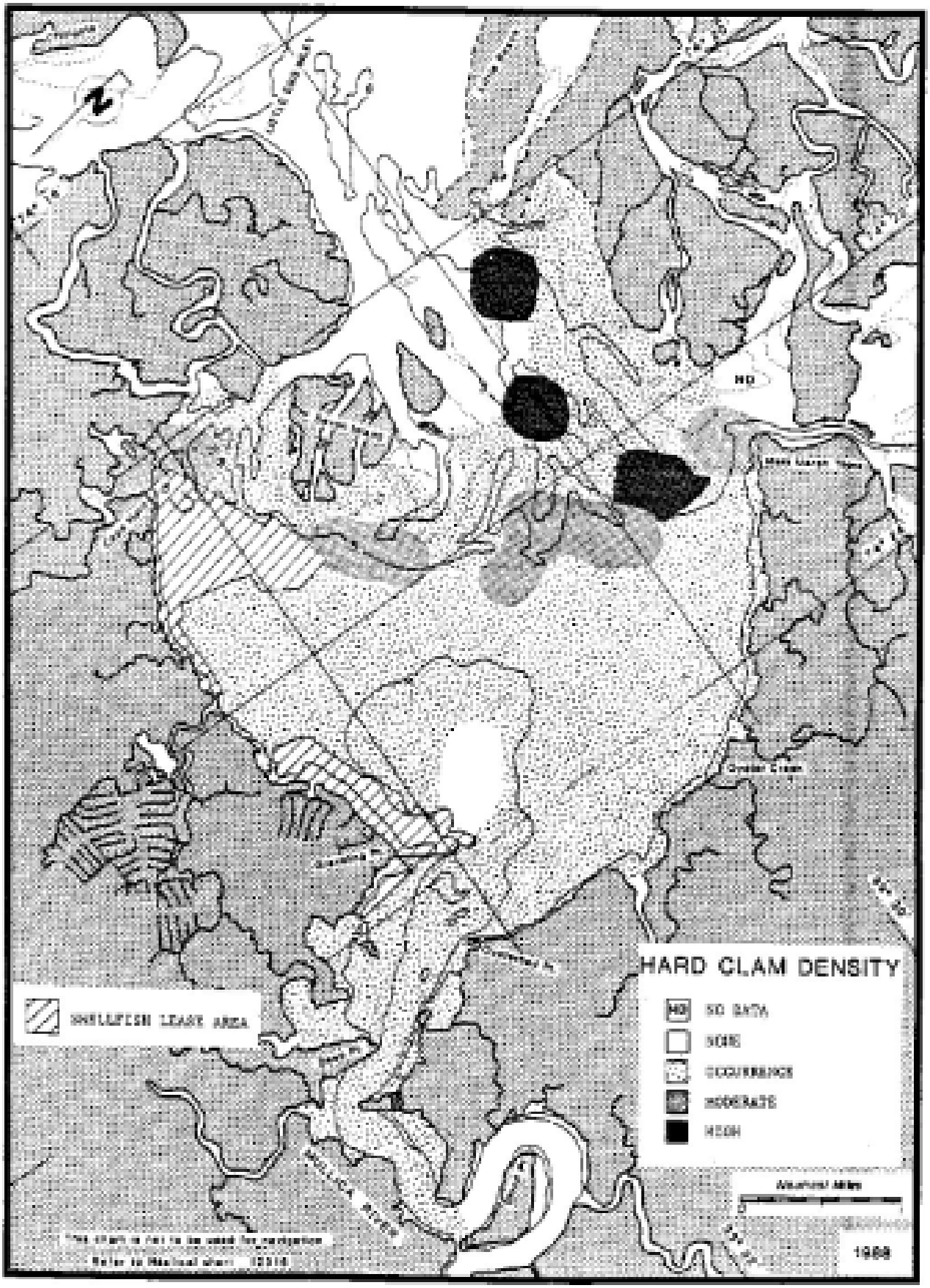
Little Egg Harbor to Long Point



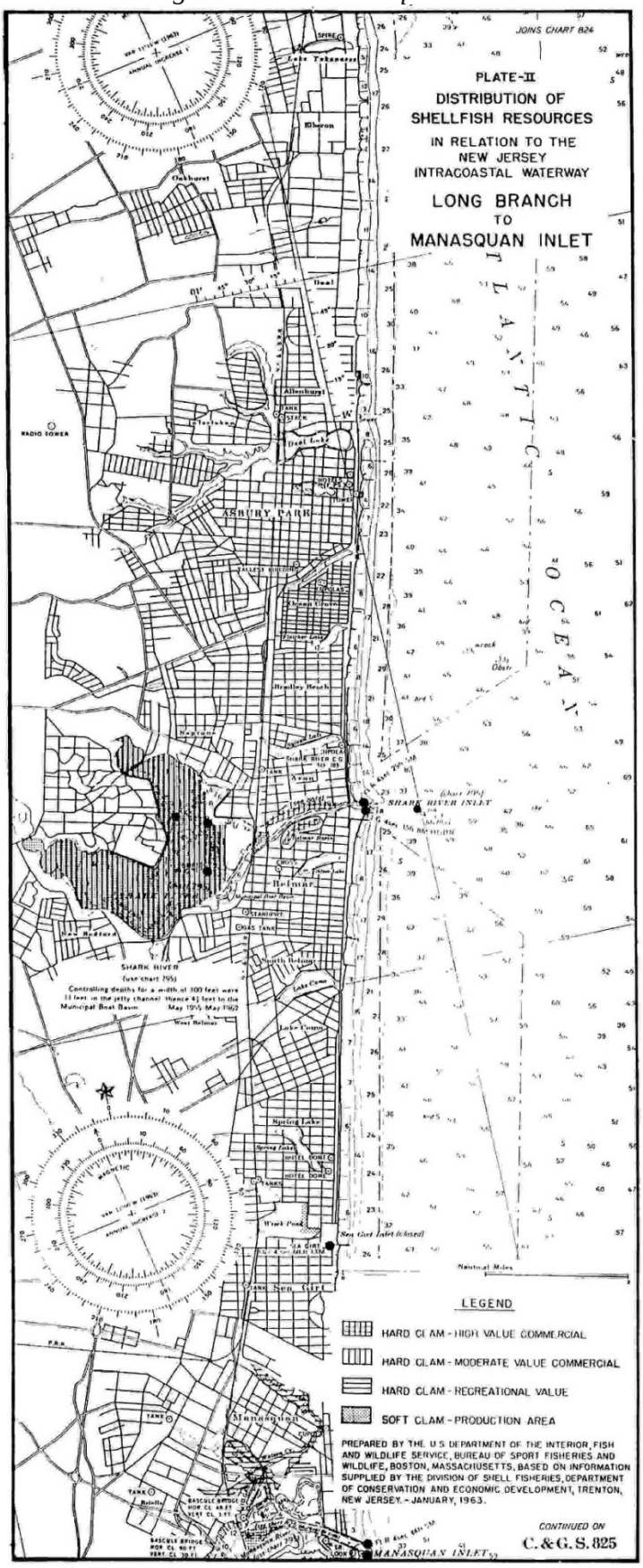
Little Egg Harbor Bay



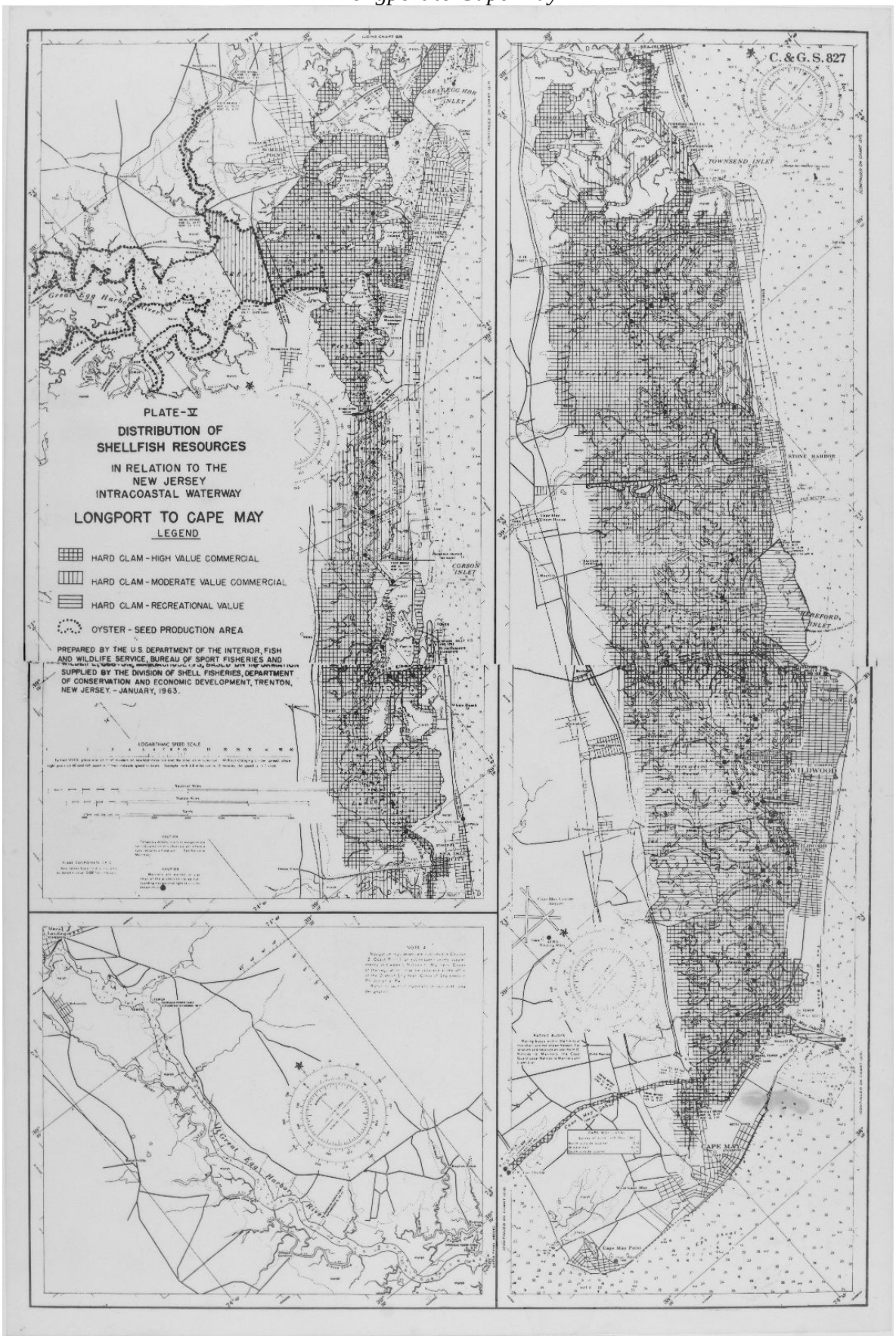
Little Egg Inlet to Mullica River--Hard Clam Density



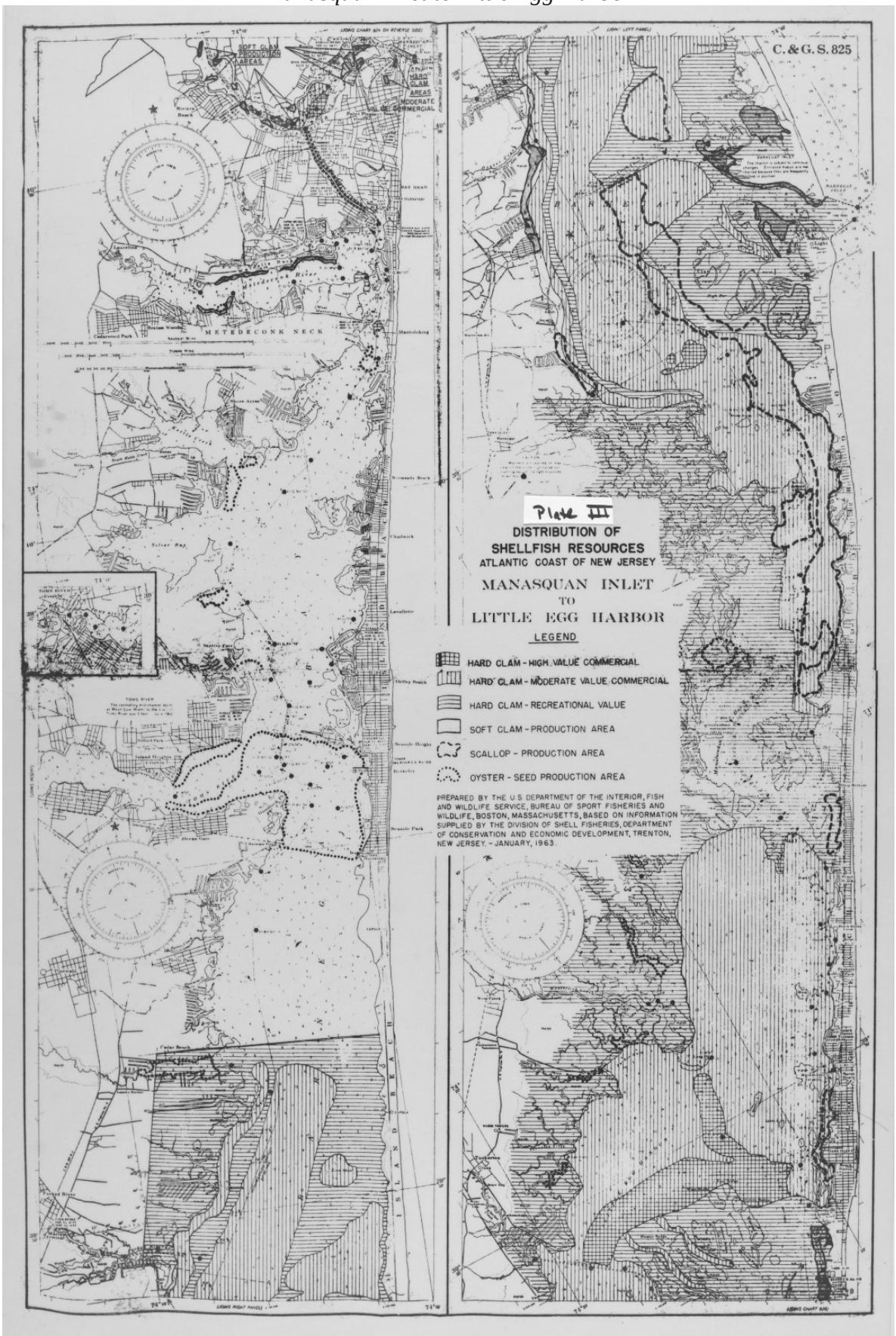
Long Branch to Manasquan Inlet



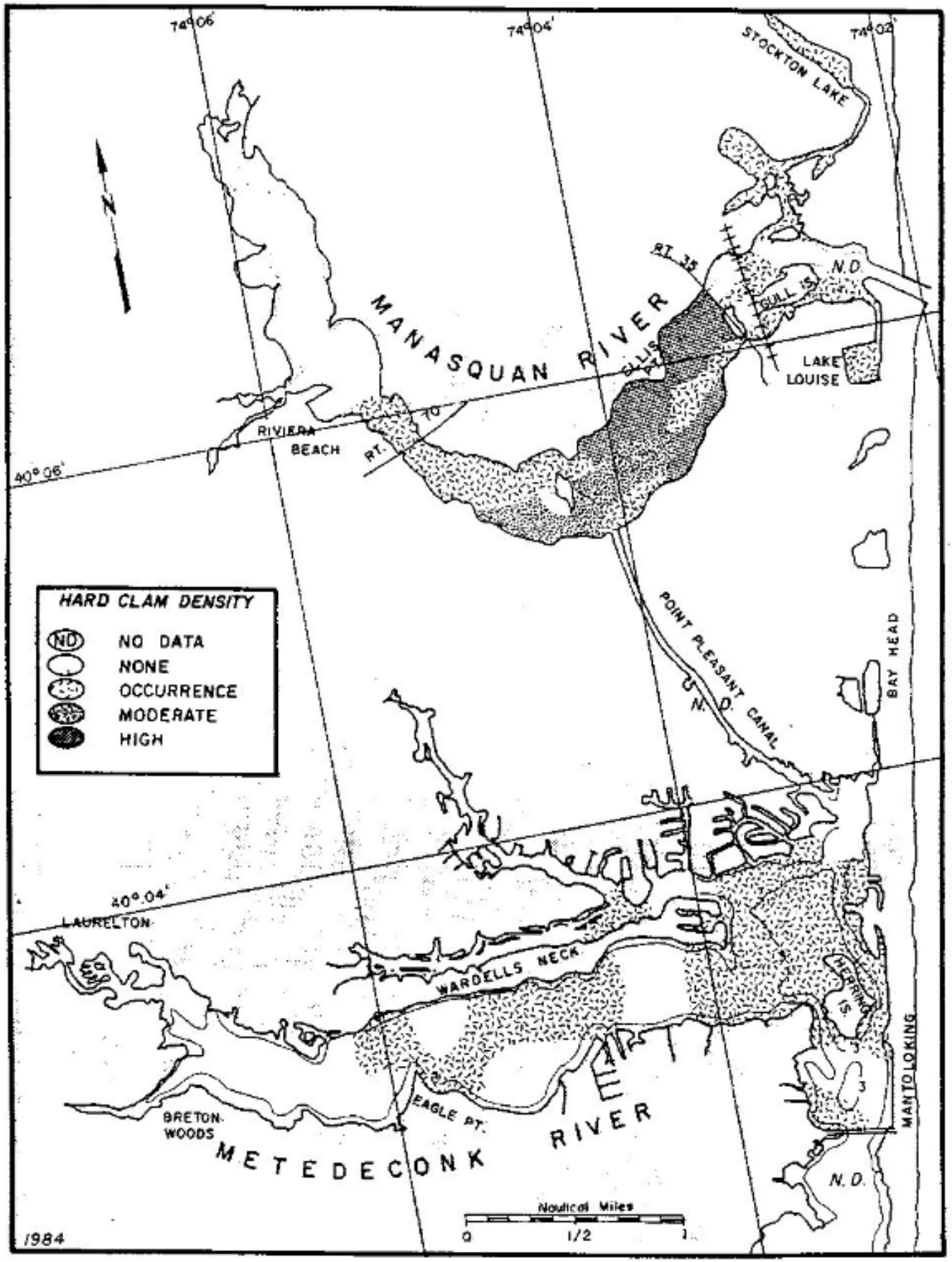
Longport to Cape May



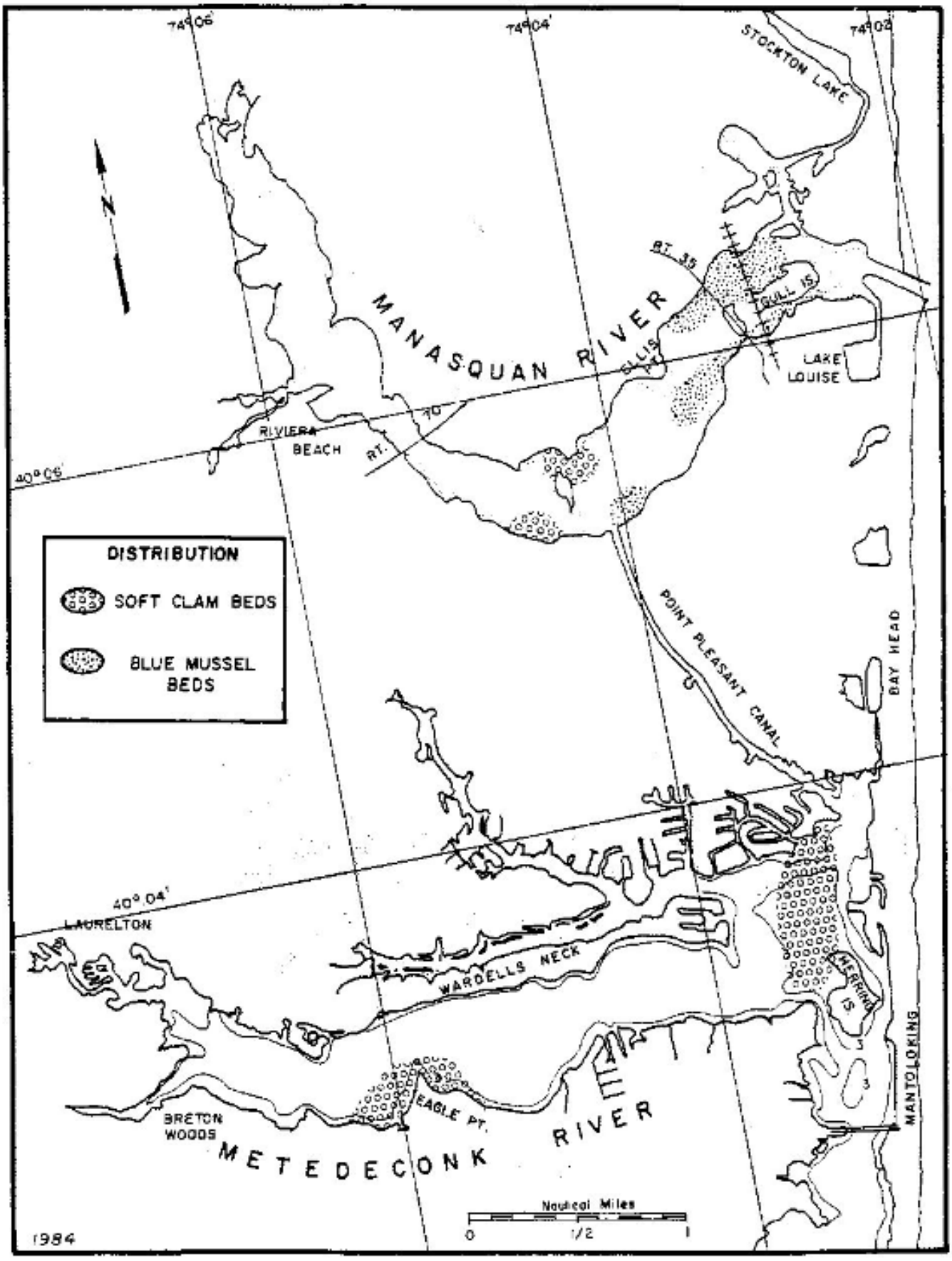
Manasquan Inlet to Little Egg Harbor



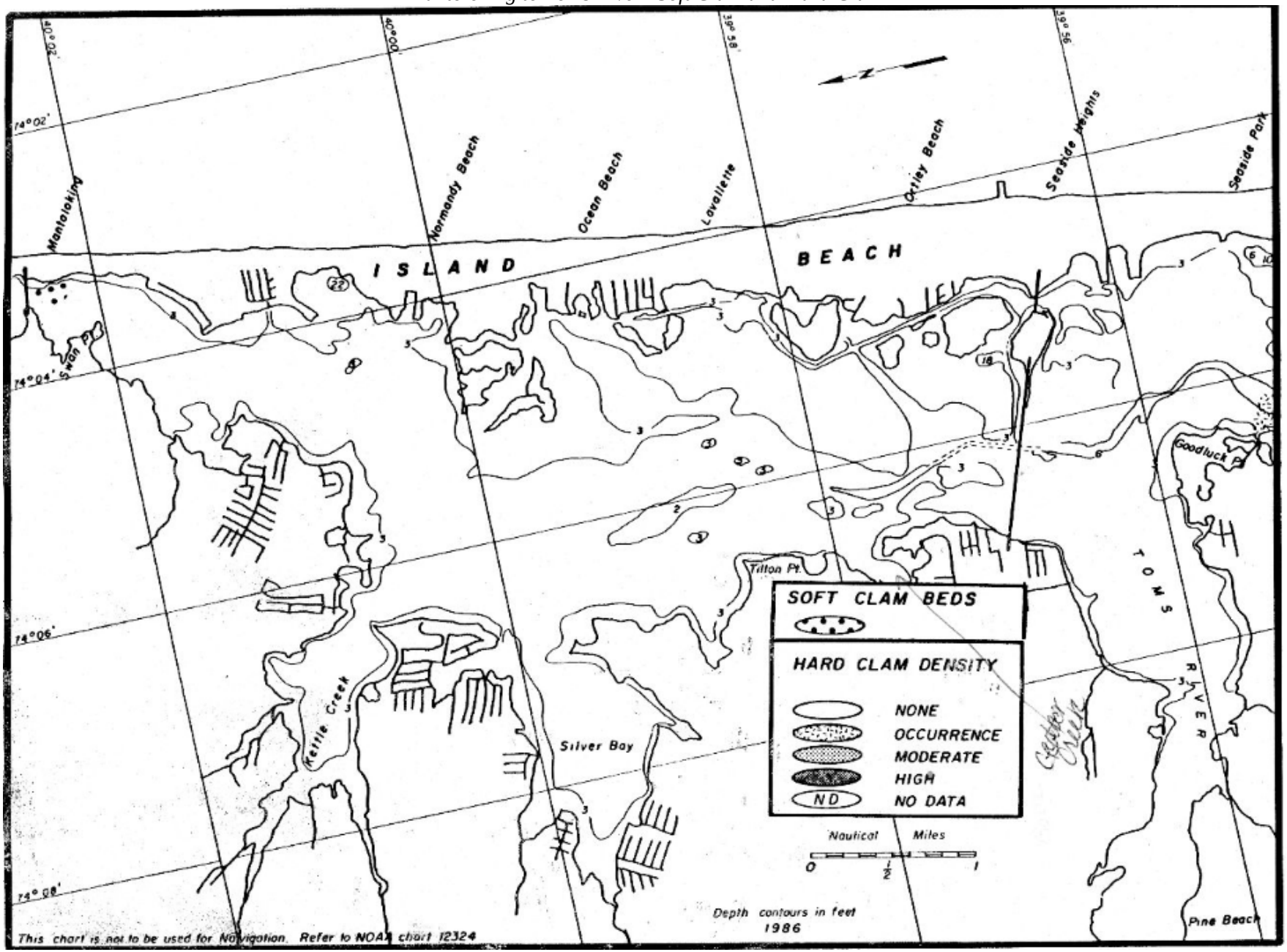
Manasquan and Metedeconk Rivers--Hard Clam Density



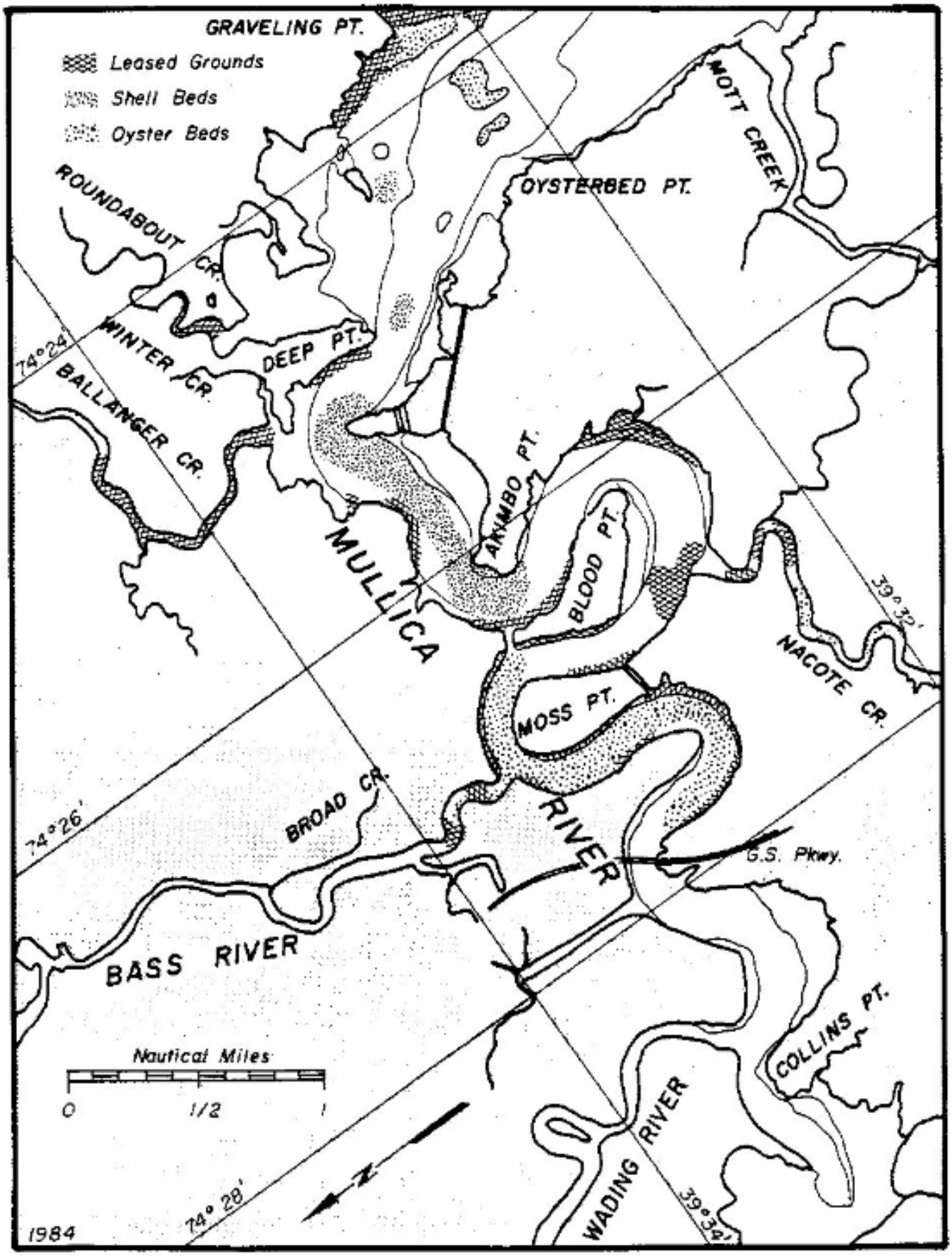
Manasquan and Metedeconk Rivers--Soft Clam and Blue Mussel Beds



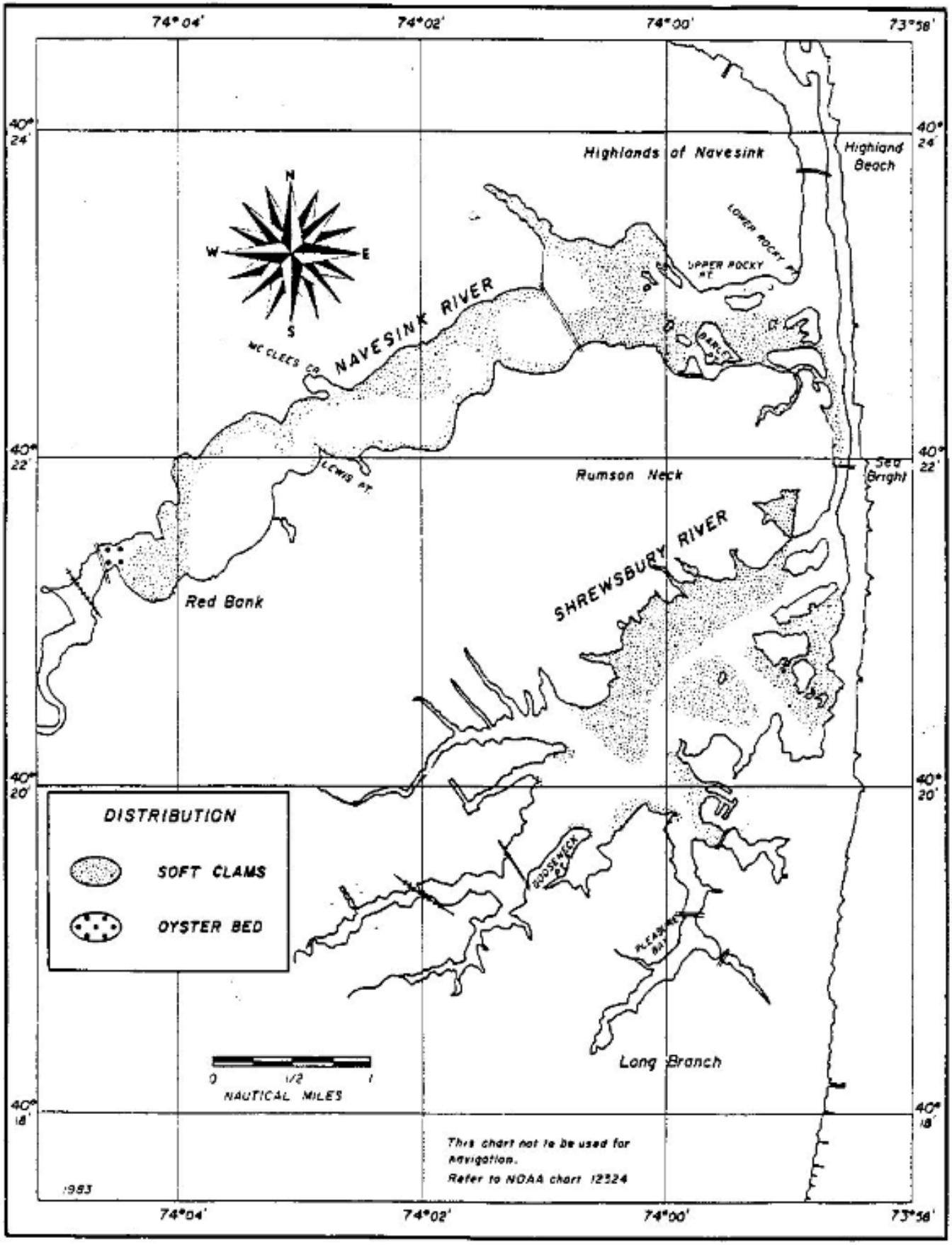
Mantoloking to Toms River--Soft Clam and Hard Clam



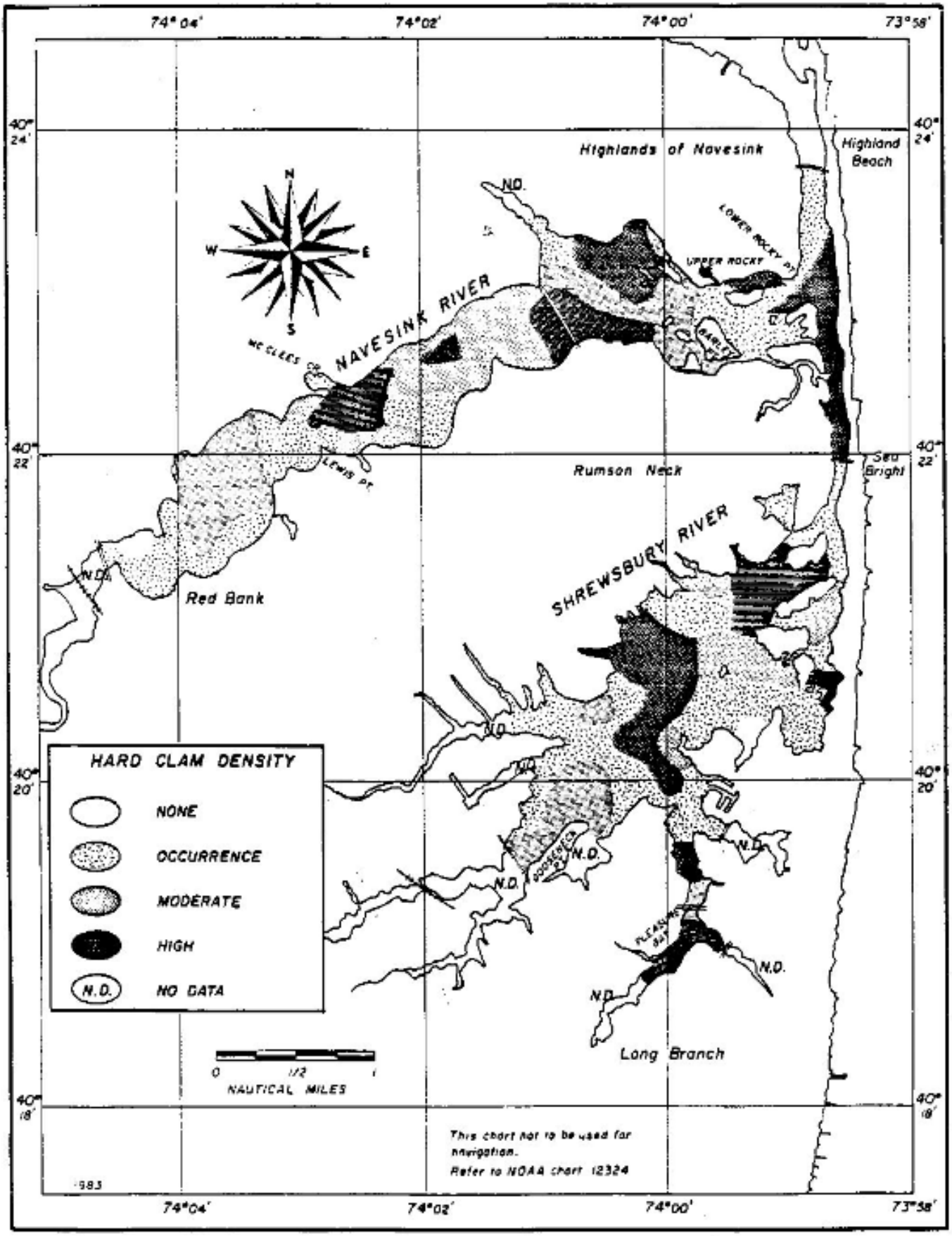
Mullica River –Shell and Oyster Beds



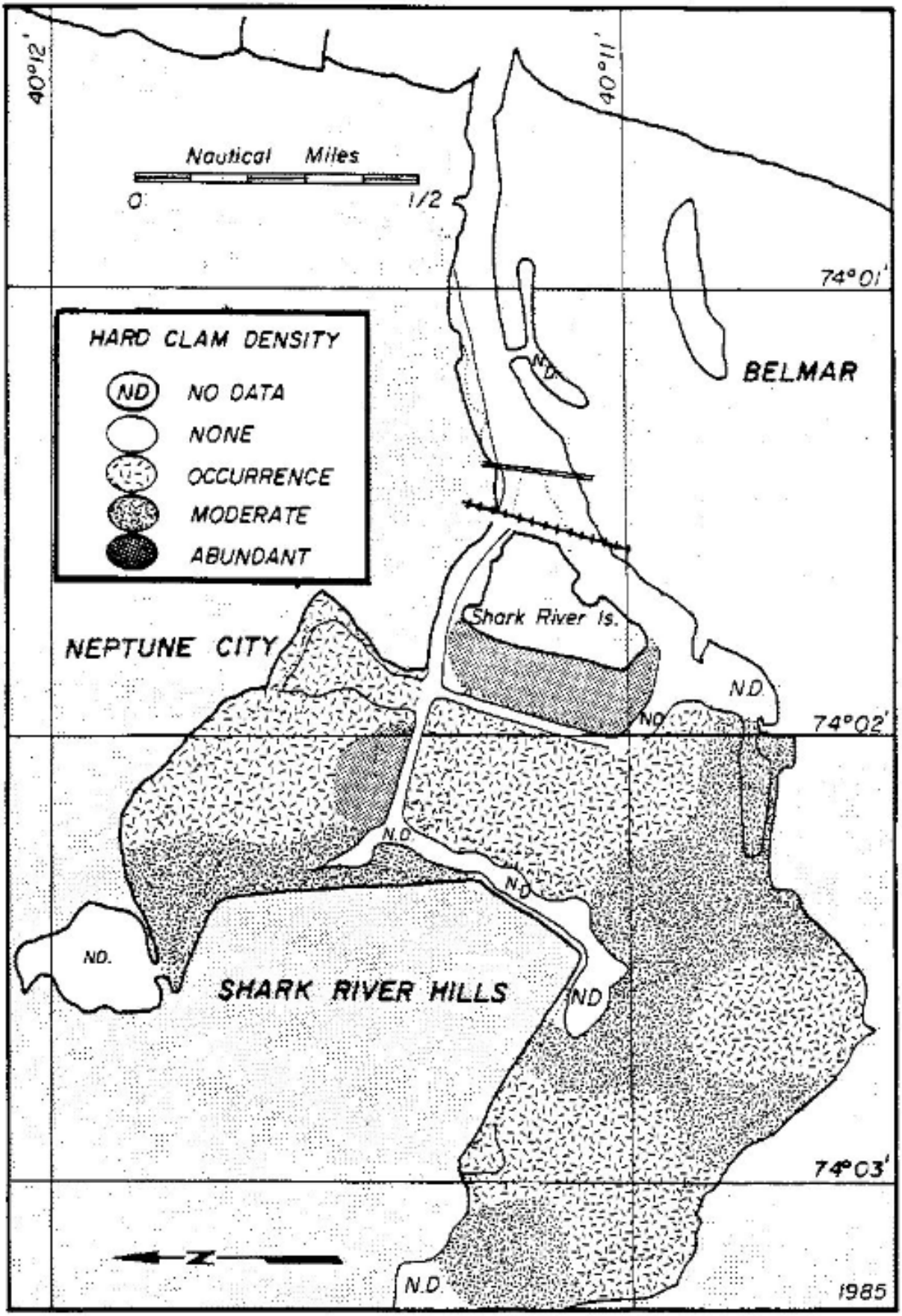
Navesink and Shrewsbury Rivers –Soft clam and Oyster Beds



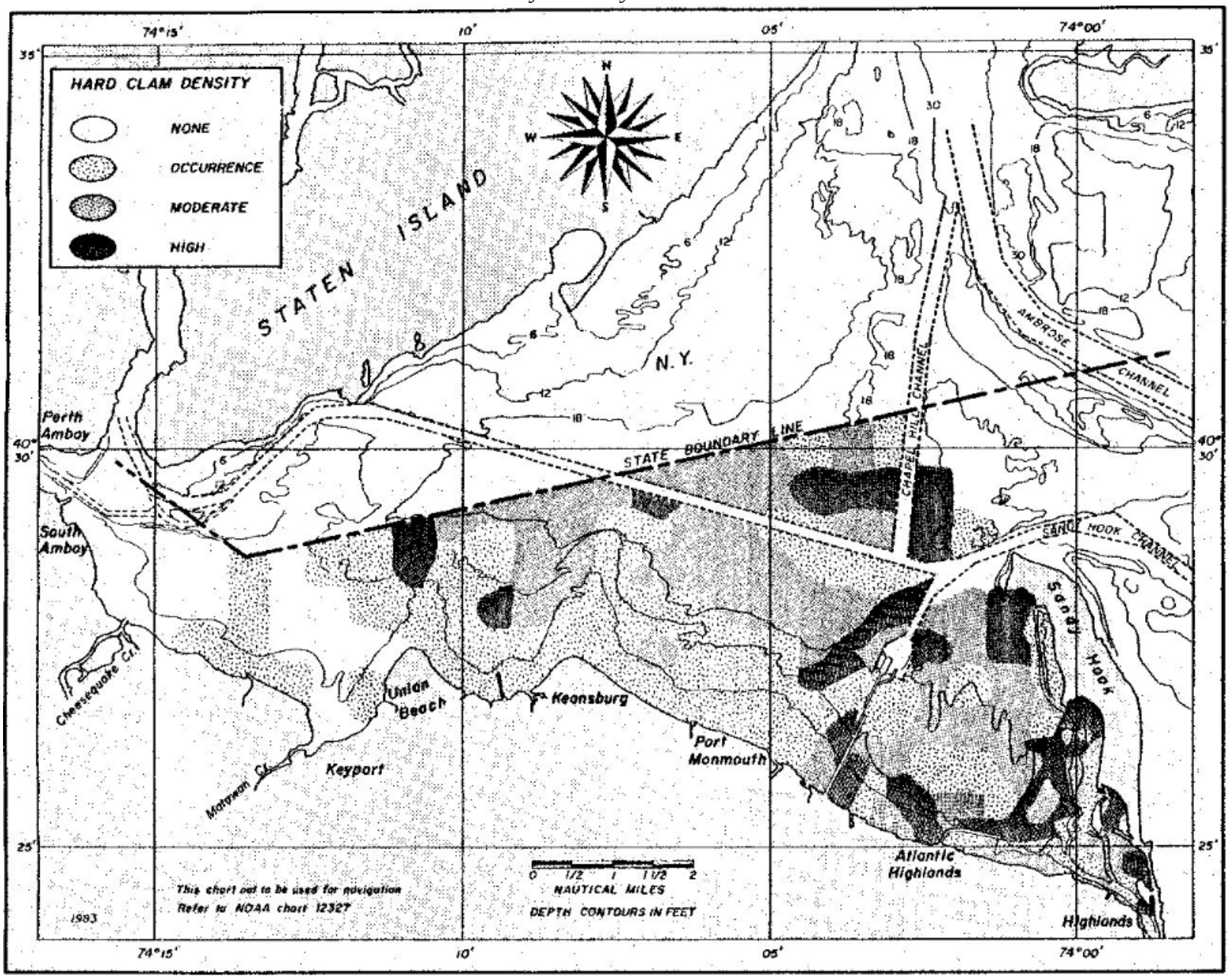
Navesink and Shrewsbury Rivers--Hard Clam Density



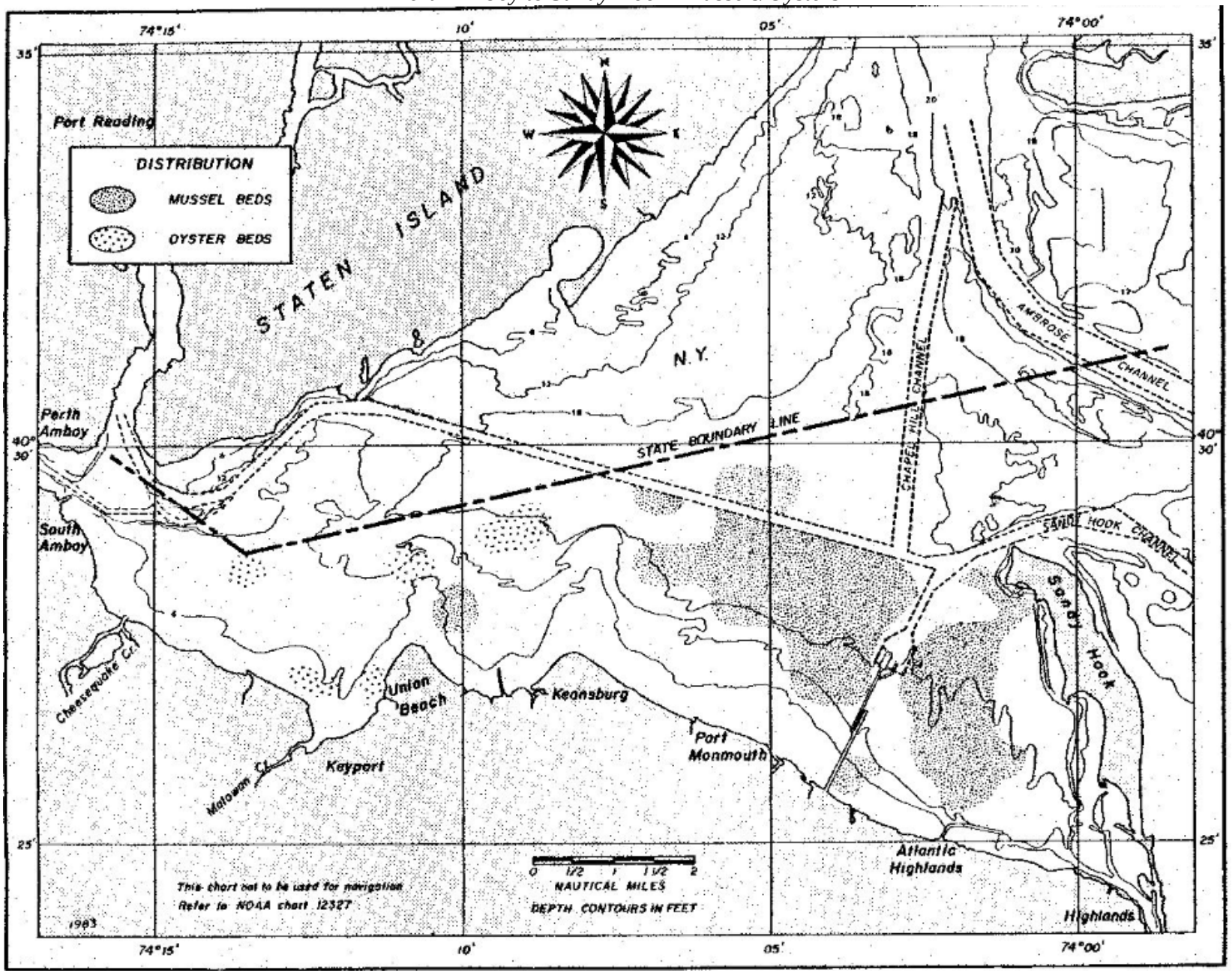
Neptune City/Shark River Hills--Hard Clam



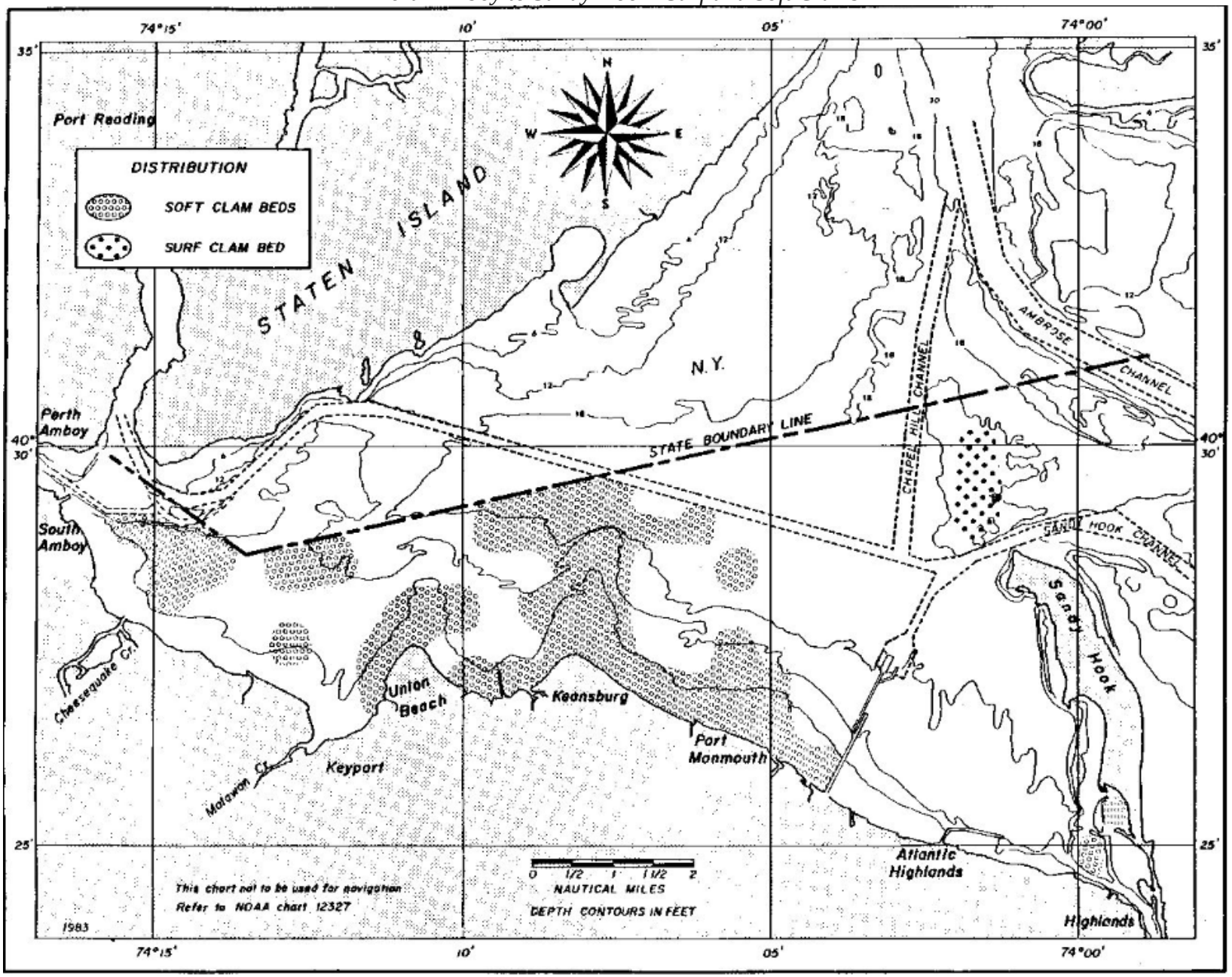
Perth Amboy to Sandy Hook –Hard Clam



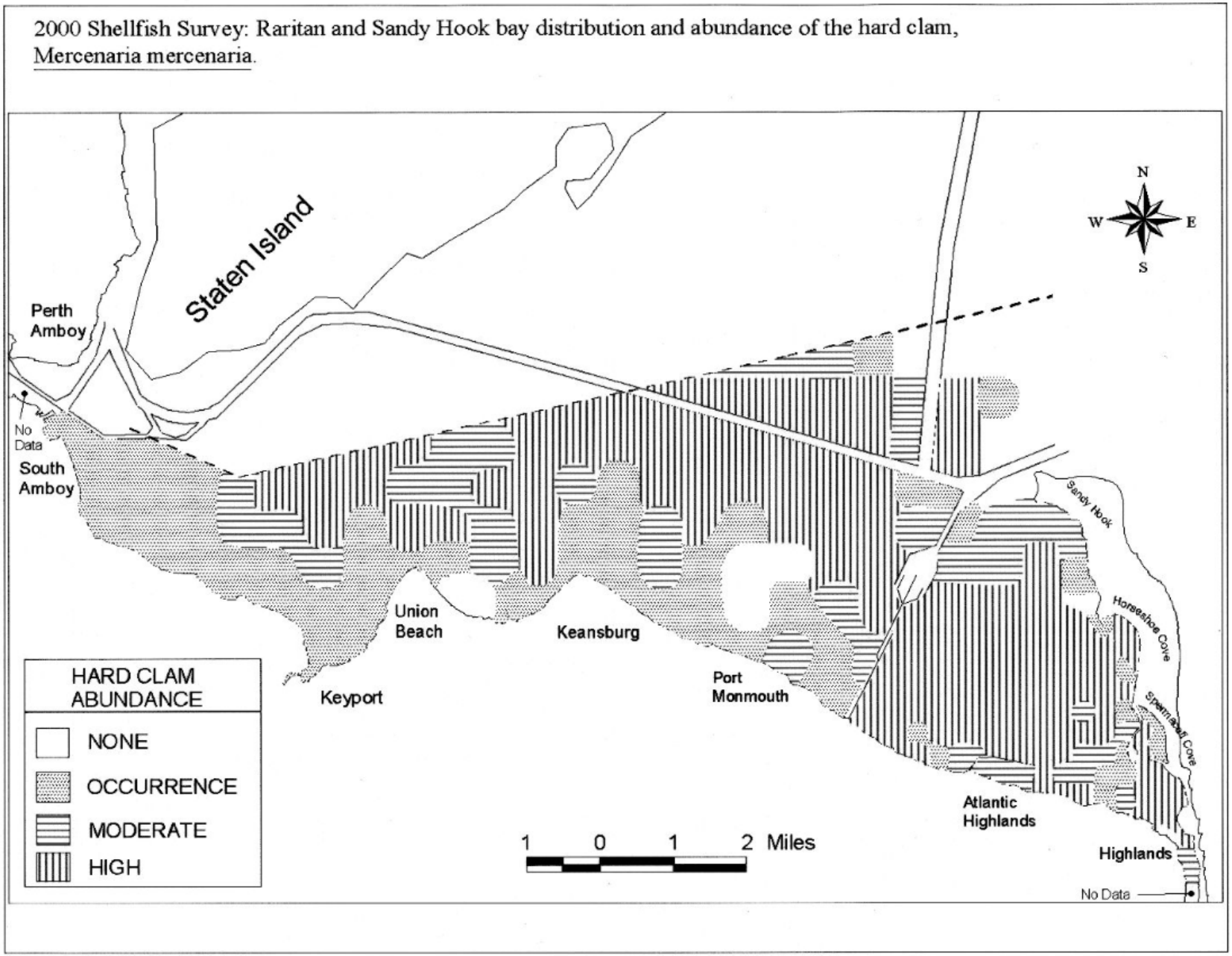
Perth Amboy to Sandy Hook--Mussels/Oysters



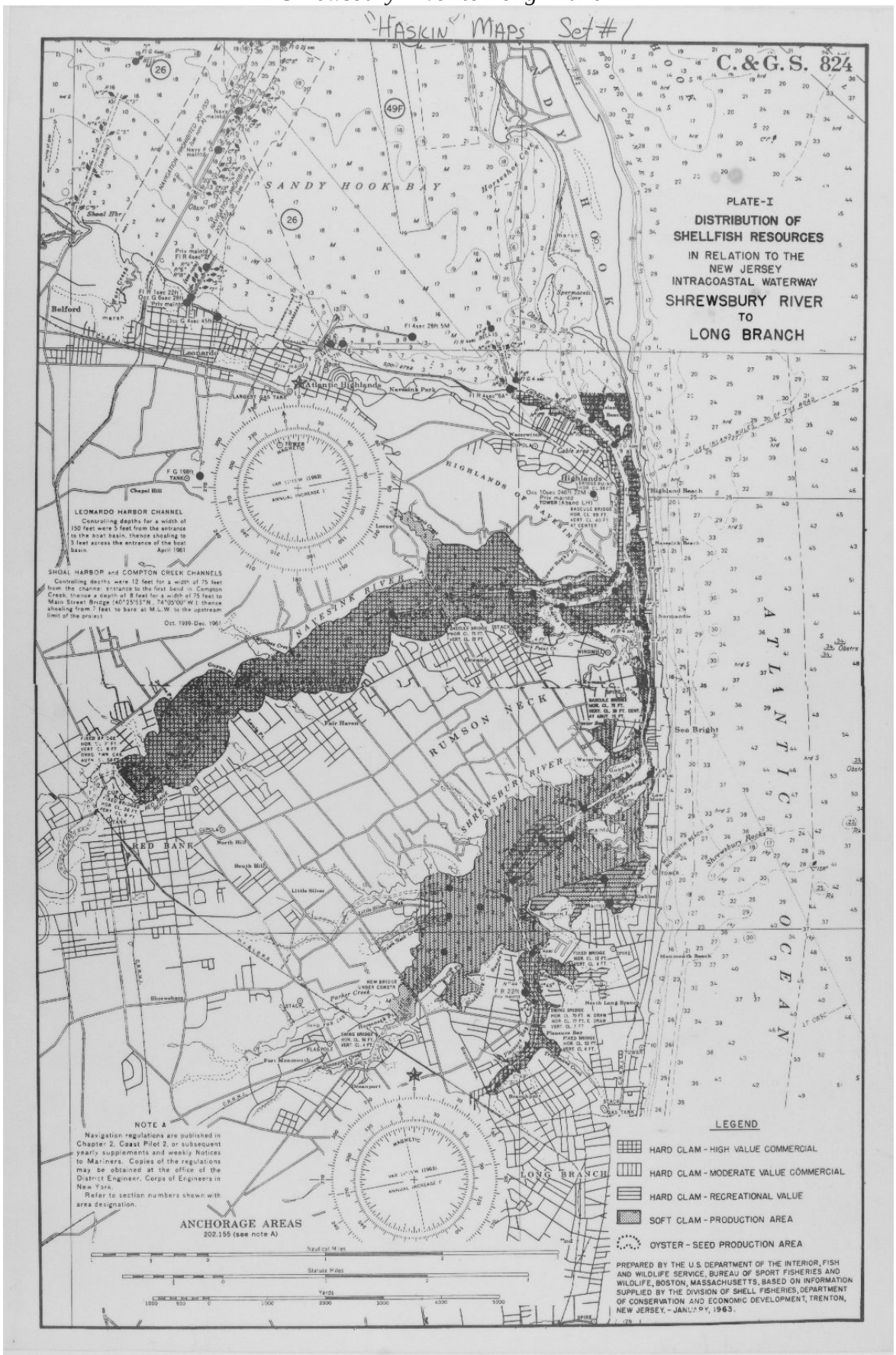
Perth Amboy to Sandy Hook--Surf and Soft Clams



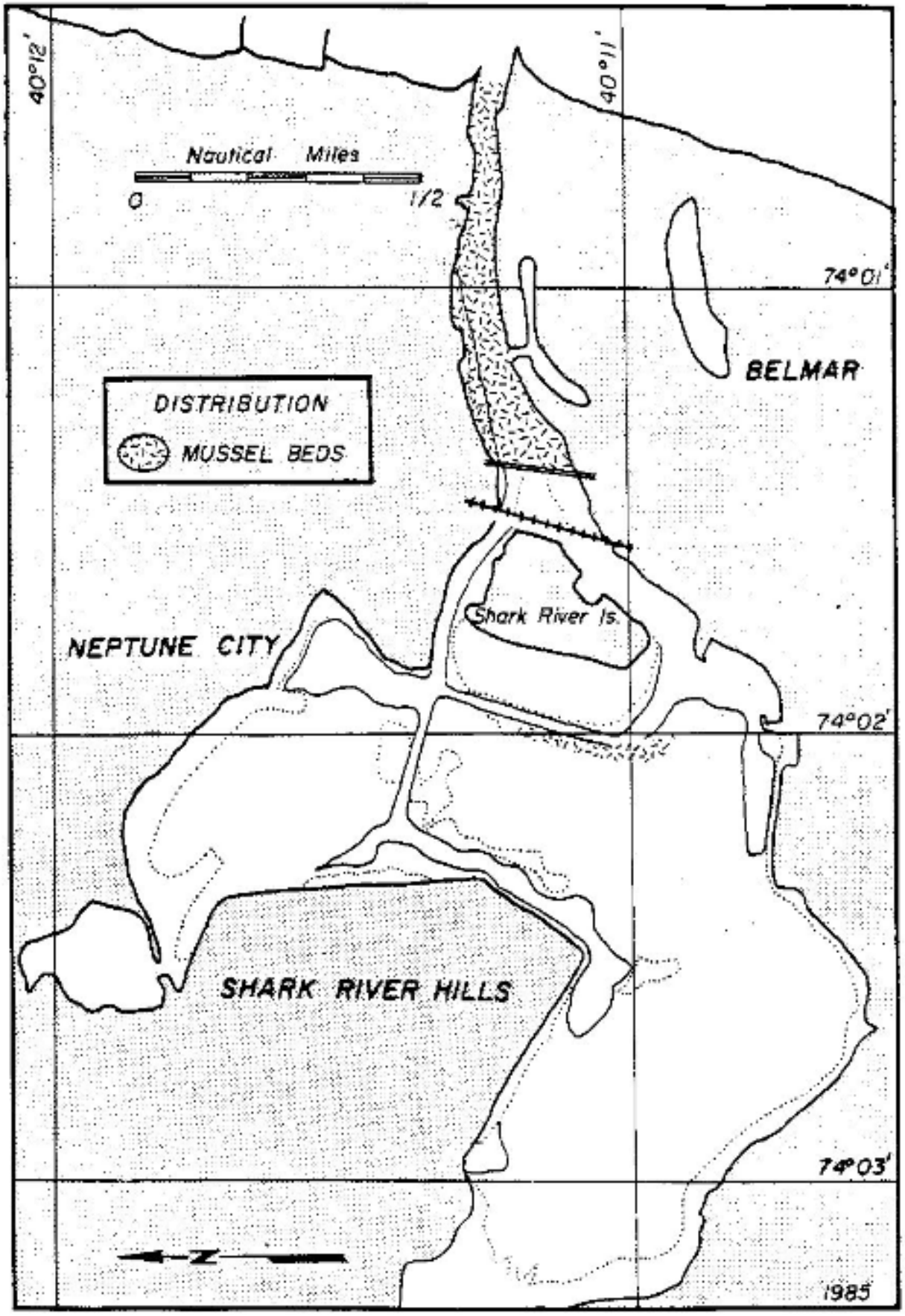
Raritan and Sandy Hook Bay - Hard Clam



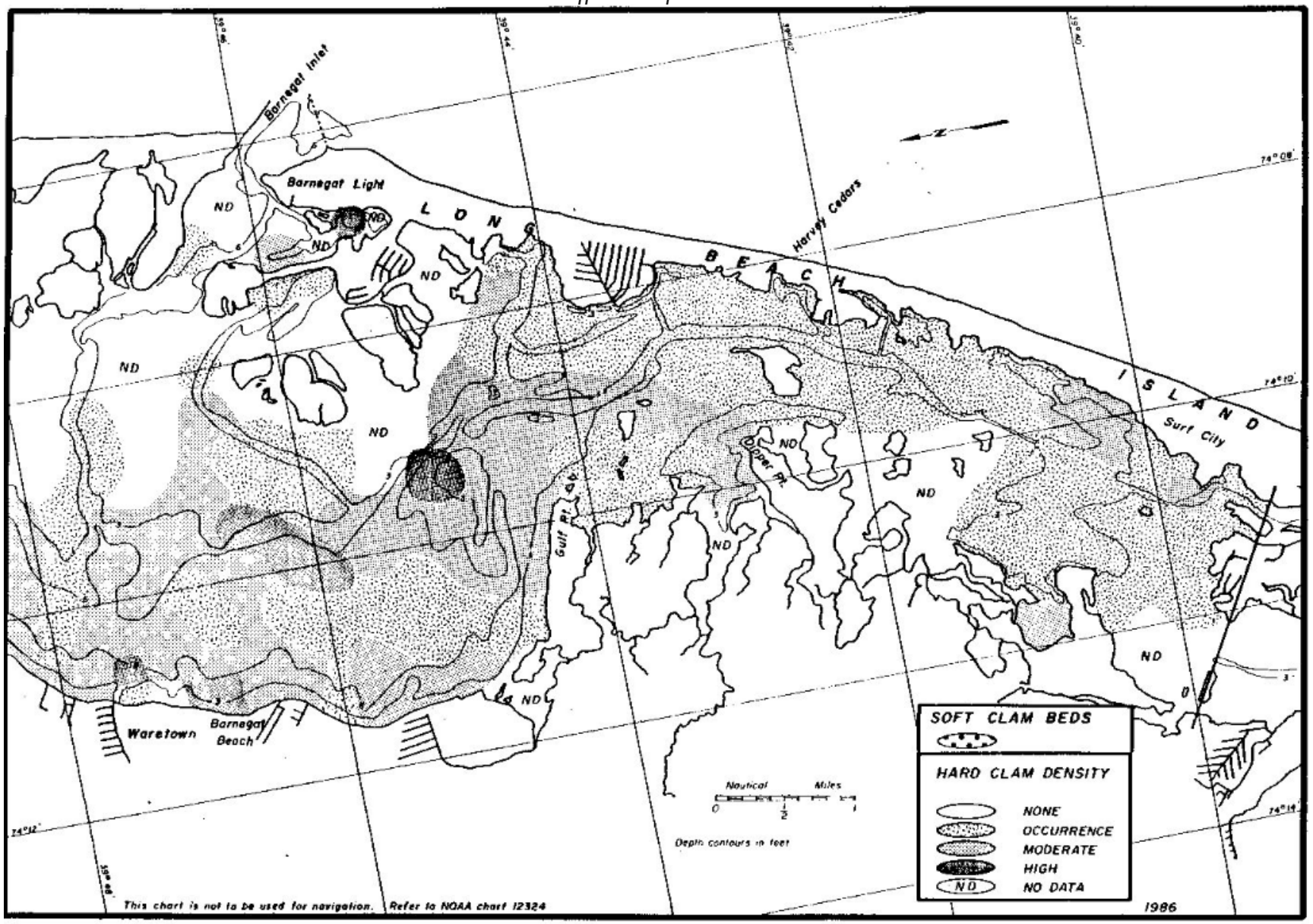
Shrewsbury River to Long Branch



Shark River--Mussel Beds



Waretown to Stafford--Soft Clam and Hard Clam



Appendix I: EFH Work Windows for Coast Guard District 11

San Francisco Bay in water work period: All work within the San Francisco Bay will be completed between June 1 and November 30. These windows are to allow for seasonal migration of Chinook and steelhead through San Francisco Bay to their spawning grounds in various rivers and tributaries that feed into the bay.

Reference:

Sara Azat NOAA Fisheries West Coast Region Santa Rosa Office

Excerpts from NMFS California Eelgrass Mitigation Policy: Implementing Guidelines for California

Eelgrass Habitat Definition

Eelgrass distribution fluctuates and can expand, contract, disappear, and recolonize areas within suitable environments. Vegetated eelgrass areas can expand by as much as 5 meters (m) and contract by as much as 4 m annually (Donoghue 2011). Within eelgrass habitat, eelgrass is expected to fluctuate in density and patch extent based on prevailing environmental factors (e.g., turbidity, freshwater flows, wave and current energy, bioturbation, temperature, etc.). To account for seagrass fluctuation, Fonseca et al. (1998) recommends that seagrass habitat include the vegetated areas as well as presently unvegetated spaces between seagrass patches.

In addition, there is an area of functional influence, where the habitat function provided by the vegetated cover extends out into adjacent unvegetated areas. Those functions include detrital enrichment, energy dampening and sediment trapping, primary productivity, alteration of current or wave patterns, and fish and invertebrate use, among other functions. The influence of eelgrass on the local environment can extend up to 10 m from individual eelgrass patches, with the distance being a function of the extent and density of eelgrass comprising the bed as well as local biologic, hydrographic, and bathymetric conditions (Bostrom and Bonsdorff 2000, Bostrom et al. 2001, Ferrell and Bell 1991, Peterson et al. 2004, Smith et al. 2008, van Houte-Howes et al. 2004, Webster et al. 1998). Detrital enrichment will generally extend laterally as well as down slope from the beds, while fish and invertebrates that utilize eelgrass beds may move away from the eelgrass core to areas around the bed margins for foraging and in response to tides or diurnal cycles (Smith et al. 2008).

To encompass fluctuating eelgrass distribution and functional influence around eelgrass cover, for the purposes of this policy and guidelines, eelgrass habitat is defined as areas of vegetated eelgrass cover (any eelgrass within 1 m2 quadrat and within 1 m of another shoot) bounded by a 5 m wide perimeter of unvegetated area (See Attachment 1 for a graphical depiction of this definition). Unvegetated areas may have eelgrass shoots a distance greater than 1 m from another shoot, and may be internal as well as external to areas of vegetated cover. For isolated patches and on a case-by-case basis, it may be acceptable to include an unvegetated area boundary less than or greater than 5 m wide. The definition excludes areas of unsuitable environmental

conditions such as hard bottom substrates, shaded locations, or areas that extend to depths below those supporting eelgrass. Suitable depths can vary substantially depending upon site-specific conditions. In general, eelgrass does not extend deeper than 12 feet mean lower low water (MLLW) in most protected bays and harbors in Southern California, and is more limited in Central and Northern California embayments. However, eelgrass can grow much deeper in entrance channels and offshore areas.

Avoiding and Minimizing Impacts to Eelgrass

This section describes measures to avoid and minimize impacts to eelgrass caused by turbidity, shading, nutrient loading, sedimentation and alteration of circulation patterns. Not all measures are equally suited to a particular project or condition. Measures to avoid or minimize impacts should be focused on stressors where the source and control are within the purview of the permittee and action agency. Action agencies in coordination with NMFS should evaluate and establish impact avoidance and minimization measures on a case-by-case basis depending on the action and site-specific information, including prevailing current patterns, sediment source, characteristics, and quantity, as well as the nature and duration of work.

1. Turbidity

To avoid and minimize potential turbidity-related impacts to eelgrass:

- Where practical, actions should be located as far as possible from existing eelgrass; and
- In-water work should occur as quickly as possible such that the duration of impacts is minimized.

Where proposed turbidity generating activities must occur in proximity to eelgrass and increased turbidity will occur at a magnitude and duration that may affect eelgrass habitat, measures to control turbidity levels should be employed when practical considering physical and biological constraints and impacts. Measures may include:

- Use of turbidity curtains where appropriate and feasible;
- Use of low impact equipment and methods (e.g., environmental buckets, or a hydraulic suction dredge instead of clamshell or hopper dredge, provided the discharge may be located away from the eelgrass habitat and appropriate turbidity controls can be provided at the discharge point);
- Limiting activities by tide or day-night windows to limit light degradation within eelgrass habitat;
- Utilizing 24-hour dredging to reduce the overall duration of work and to take advantage of dredging during dark periods when photosynthesis is not occurring; or
- Other measures that an action party may propose and be able to employ to minimize potential for adverse turbidity effects to eelgrass.

NMFS developed a flowchart for a stepwise decision making process as guidance for action agencies to determine when to implement best management practices (BMPs) for minimizing

turbidity from dredging actions as part of a programmatic EFH consultation in San Francisco Bay. The parameters considered in the flow chart are relevant to all marine areas of California. This document is posted on the NMFS West Coast Region web page (http://www.westcoast.fisheries.noaa.gov/habitat/habitat_types/seagrass_info/california_eelgrass.html) and may be used to evaluate avoidance and minimization measures for any project that generates increased turbidity.

2. Shading

A number of potential design modifications may be used to minimize effects of shading on eelgrass. Boat docks, ramps, gangways, and similar structures should avoid eelgrass habitat to the maximum extent feasible. If avoidance of eelgrass or habitat is infeasible, impacts should be minimized by utilizing, to the maximum extent feasible, design modifications and construction materials that allow for greater light penetration. Action modifications should include, but are not limited to:

- Avoid siting over-water or landside structures in areas where shading of eelgrass habitat would occur;
- Maximizing the north-south orientation of the structure;
- Maximizing the height of the structure above the water;
- Minimizing the width and supporting structure mass to decrease shade effects;
- Relocating the structure in deeper water and limiting the placement of structures in shallow areas where eelgrass occurs to the extent feasible; and
- Utilizing light transmitting materials in structure design.

Construction materials used to increase light passage beneath the structures may include, but are not limited to, open grating or adequate spacing between deck boards to allow for effective illumination to support eelgrass habitat. The use of these shade reducing options may be appropriate where they do not conflict with safety, ADA compliance, or structure utility objectives.

NMFS developed a stepwise key as guidance for action agencies to determine which combination of modifications are best suited for minimizing shading effects from overwater structures on eelgrass as part of a programmatic EFH consultation in San Francisco Bay. The parameters considered in the flow chart are relevant to all marine areas of California. This document is posted on the West Coast Region web page (http://www.westcoast.fisheries.noaa.gov/habitat/habitat_types/seagrass_info/california_eelgrass.html) and may be used to evaluate avoidance and minimization measures for any project that results in shading.

3. Circulation patterns

Where appropriate to the scale and nature of potential eelgrass impacts, action parties should evaluate if and how the action may alter the hydrodynamics of the action area such that eelgrass

habitat within or in proximity to the action area may be adversely affected. To maintain good water flow and low residence time of water within eelgrass habitat, action agencies should ensure actions:

- Minimize scouring velocities near or within eelgrass beds;
- Maintain wind and tidal circulation to the extent practical by considering orientation of piers and docks to maintain predominant wind effects;
- Incorporate setbacks on the order of 15 to 50 meters from eelgrass habitat where practical to allow for greater circulation and reduced impact from boat maneuvering, grounding, and propeller damage, and to address shading impacts; and
- Minimize the number of piles and maximize pile spacing to the extent practical, where piles are needed to support structures.

For large-scale actions in the proximity of eelgrass habitats, NMFS may request specific modeling and/or field hydrodynamic assessments of the potential effects of work on characteristics of circulation within eelgrass habitat.

4. Nutrient loading

Where appropriate to the scale and nature of potential eelgrass impacts, the following measures should be considered for implementation to reduce the potential for excessive nutrient loading to eelgrass habitat:

- diverting site runoff from landscaped areas away from discharges around eelgrass habitat;
- implementation of fertilizer reduction program;
- reduction of watershed nutrient loading;
- controlling local sources of nutrients such as animal wastes and leach fields; and
- maintaining good circulation and flushing conditions within the water body.

Reducing nutrient loading may also provide opportunities for establishing eelgrass as mitigation for project impacts.

5. Sediment loading

Watershed development and changes in land use may increase soil erosion and increase sedimentation to downstream embayments and lagoons.

- To the extent practicable, maintain riparian vegetation buffers along all streams in the watershed.
- Incorporate watershed analysis into agricultural, ranching, and residential/commercial development projects.
- Increase resistance to soil erosion and runoff. Sediment basins, contour farming, and grazing management are examples of key practices.
- Implement best management practices for sediment control during construction and maintenance operations (e.g., Caltrans 2003).

Reducing sediment loading may also provide opportunities for establishing eelgrass as mitigation for project impacts in systems for which sedimentation is a demonstrable limiting factor to eelgrass.

CAULERPA CONTROL PROTOCOL

A. Background Information:
Caulerpa taxifolia ("*Caulerpa*") is a green alga native to tropical waters that typically grows in limited patches. A particularly cold tolerant clone (tolerant of temperatures at least as low as 10 °C for a period of three months) of this species has already proven to be highly invasive in the Mediterranean Sea and efforts to control its spread have been unsuccessful. In areas where the species has become well established, it has caused ecological and economic devastation by overgrowing and eliminating native seaweeds, seagrasses, reefs, and other communities. In the Mediterranean, it is reported to have harmed tourism and pleasure boating, devastated recreational diving, and had a significant impact on commercial fishing both by altering the distribution of fish as well as creating a considerable impediment to net fisheries. Currently, *C. taxifolia* has been detected, but eradicated in two locations in southern California and other infestations of *Caulerpa* species may also exist but remain undetected.

This alga and potentially other *Caulerpa* species pose a substantial threat to marine ecosystems in California, particularly to the extensive eelgrass meadows and other benthic environments that make coastal waters such a rich and productive environment. The eelgrass beds and other coastal resources that could be directly impacted by an invasion of *Caulerpa* are part of a food web that is critical to the survival of numerous native marine species including those of commercial and recreational importance.

In September 2001, Assembly Bill 1334 was enacted by the State of California banning the transport, sale, and possession of nine potentially invasive species of *Caulerpa*, including *C. taxifolia*. The other species include *C. mexicana, C. racemosa, C. cupressoides, C. sertularioides, C. ashmeadii, C. floridana, C. scalpelliformis, and C. verticillata.* In order to detect existing infestations as well as avoid the spread of these invasive species within other systems, the following provisions have been established for California nearshore coastal and enclosed bays, estuaries, and harbors from Morro Bay to the U.S./Mexican border. This protocol outlines the certification, survey, and reporting guidelines required when surveying for the species listed above with the exception of those exempted areas listed in Section G.

B. Definitions:
Disturbing Activity – a work activity (i.e., bulkhead repair, pile driving, dredging, placement of navigation aids, etc.) initiated by a permit holder which could fragment or disseminate *Caulerpa.*

Area of Potential Effect (APE) – the area surrounding an authorized project site that could be affected by a Disturbing Activity related to the implementation of the project work. This includes the project footprint, areas where equipment is stored or moored, areas where vessel prop-wash could occur in association with work, or in-water disposal areas used by the project. It does not include EPA designated deep-ocean disposal sites.

High Growth Period – March 1 to October 31.

Infected System – any bay, harbor, estuary, or lagoon in which *Caulerpa* has been identified, regardless of where the infestation occurs geographically within the system. Following eradication and subsequent verification surveillance for at least two High Growth Periods, an Infected System may be re-designated as a "*Caulerpa*-Free System" by the National Marine Fisheries Service (NOAA Fisheries) and California Department of Fish and Game (CDFG). There are no currently identified infected systems. Prior infected systems where eradication was successfully completed include:

Agua Hedionda Lagoon
Huntington Harbour (including Seal Beach Weapons Station/National Wildlife Refuge and Anaheim Bay)

NOAA Fisheries/CDFG Contacts – the designated federal and state agency contacts for submittal of survey reports and reports of *Caulerpa* findings. All submitted material must be provided to these agencies at the following addresses:

National Marine Fisheries Service
Southwest Regional Office
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802
Attn: Robert Hoffman
ph.: (562) 980-4043
fx.: (562) 980-4092
e-mail: Bob.Hoffman@noaa.gov

Calif. Dept. of Fish & Game
South Coast Region
4949 Viewridge Drive
San Diego, CA 92124
Attn: William Paznokas
ph.: (858) 467-4218
fx.: (858) 467-4299
e-mail: wpaznokas@dfg.ca.gov

Survey Area **–** the area over which surveys are conducted, typically synonymous with the Area of Potential Effect.

Survey Level **–** the level of intensity of the survey within the survey area. Survey levels are defined as either:

1. *Surveillance Level* – General survey coverage providing a systematic subsampling of the entire APE during which at least 20 percent of the bottom is inspected and widespread occurrences of *Caulerpa* would be expected to be identified if present. Surveys may be accomplished using diver transects, remote cameras, and acoustic surveys with visual ground truthing. Other proposed methodologies may be approved on a case-by-case basis by NOAA Fisheries and CDFG.

2. *High Intensity Level*– More intensive survey using a systematic sub-sampling of the entire APE during which at least 50 percent of the bottom is inspected. Surveys may be accomplished using diver or remote camera transects. Other proposed methodologies may be approved on a case-by-case basis by NOAA Fisheries and CDFG.

3. *Eradication Level* – This is the most intensive survey using a systematic and comprehensive survey of the entire APE during which 100 percent of the bottom is inspected. Surveys must be accomplished using divers moving at a rate appropriate to the

site conditions to ensure that all areas are comprehensively searched irrespective of site conditions which may complicate surveys. Other proposed methodologies may be approved on a case-by-case basis by NOAA Fisheries and CDFG.

Surveyors – Individuals conducting *Caulerpa* surveys must be certified by NOAA Fisheries or CDFG. That certification shall consist of passing an exam demonstrating their ability to identify banned *Caulerpa* species in the State of California. Upon successfully passing that exam, individuals shall be certified for a set two-year period beginning December 1, 2004 and expiring on December 1, 2006. Recertification may be completed up to 120 days prior to expiration of current certification. Any individual who fails the exam may retake the exam once within a six month period.

C. Reporting Requirements:

1. Surveys conducted in accordance with requirements outlined in this document shall be submitted to the NOAA Fisheries/CDFG Contacts within 15 days of completion of each survey. Surveys shall be completed by certified Caulerpa surveyors and submitted on the attached survey form or in a suitable reproduction of the form fields.

2. If *Caulerpa* is identified at a permitted project site during a survey or at any other time prior, during, or within 120 days after completion of authorized activities, the NOAA Fisheries/CDFG Contacts shall be contacted within 24 hours of first noting the occurrence.

3. For survey actions requiring input or coordination with NOAA Fisheries/CDFG Contacts, please provide information in a timely fashion and allow at least 5 working days for agency coordination and feedback.

D. Surveys within *Caulerpa*-Free System:

The following survey conditions shall apply to permitted Disturbing Activity within *Caulerpa*-Free Systems.

1. Prior to initiation of any permitted Disturbing Activity , a pre-construction survey of the project APE shall be conducted to determine the presence or absence of *Caulerpa*. This survey shall be conducted at a Surveillance Level. Survey work shall be completed not earlier than 90 days prior to the Disturbing Activity and not later than 30 days prior to the Disturbing Activity and shall be completed, to the extent feasible, during the high growth period of March 1 – October 31.

   Surveys outside of the high growth period shall be allowed on a case-by-case basis by the appropriate regulatory agency in consultation with NMFS and CDFG.

2. In the event that *Caulerpa* is detected, the Disturbing Activity shall not be conducted until such time as the infestation has been isolated, treated or the risk of spread from the proposed Disturbing Activity is eliminated in accordance with section F.

3. Exemptions – Individual, privately owned boat docks and related structures are exempt from provisions 1 and 2 of this section when such facilities are found in *Caulerpa*-Free

Systems and permitted activities are limited to structural repairs, replacement, modification, and pile driving and do not include dredging or other significant bottom disturbing activities.

E. Surveys within Infected Systems:

The following survey conditions shall apply to permitted Disturbing Activity within Infected Systems.

1. Prior to initiation of any permitted Disturbing Activity within an Infected System, two surveys, initiated not less than 60 days apart, shall be conducted within the project APE during the High Growth Period. The first survey shall be conducted using High Intensity Level techniques and the second survey shall be conducted using Eradication Area Level techniques.

2. At least one survey shall be conducted within 45 days of initiation of permitted Disturbing Activity dredging (a "Pre-Act Survey"). This survey could be the second (Eradication Area Level) survey conducted during the High Growth Period. However, project delays may require that a third survey be conducted prior to initiation of Disturbing Activity in order to meet this 45 day requirement. If a third survey is required, this survey shall be conducted at a either a High Intensity Level or Eradication Area Level as determined by the NOAA Fisheries/CDFG Contacts based upon site circumstances and proximity to infestations. To determine appropriate survey level, please contact the NOAA Fisheries/CDFG Contacts with project specific information.

3. If the Disturbing Activity extends for over 90 calendar days, the portions of the APE that would be expected to be impacted by a Disturbing Activity within the subsequent 90 days must be re-surveyed at a High Intensity Level. This subsequent survey must be conducted within 15 days following the first 90 days. Prolonged activities would require a repetition of this phased survey requirement.

4. If dredged material is removed from the APE and placed elsewhere in the marine environment, then no sooner than 60 days after placement of the dredged materials and during the next High Growth Period, the applicant shall conduct a Surveillance Level survey at all disposal areas except where material is disposed of within an existing EPA designated deep ocean disposal site. The specific survey requirements shall be determined by NOAA Fisheries and CDFG on a case-by-case basis.

F. If Caulerpa is Found:

1. If *Caulerpa* is found, then the NOAA Fisheries/CDFG Contacts shall be notified within 24 hours of the discovery.

2. All *Caulerpa* assessment and treatment shall be conducted under the auspices of the CDFG and NOAA Fisheries as the state and federal lead agencies for implementation of *Caulerpa* eradication in California.

3. Within 96 hours of notification, the extent of the *Caulerpa* infestation within the project APE shall be fully documented. *Caulerpa* eradication activities shall be undertaken using

the best available technologies at the time and will depend upon the specific circumstances of the infestation. This activity may include in situ treatment using contained chlorine applications, and may also incorporate mechanical removal methods. The eradication technique is subject to change at the discretion of NOAA Fisheries and CDFG and as technologies are refined.

4. The efficacy of treatment shall be determined prior to proceeding with permitted activities. To determine effectiveness of the treatment efforts, a written Sampling and Analysis Plan (SAP) shall be prepared. The plan shall be developed in conjunction with the CDFG and NOAA Fisheries and shall be approved by these agencies prior to implementation.

5. This policy does not vacate any additional restrictions on the handling, transport, or disposal of *Caulerpa* that may apply at the time of permit issuance or in the future. It is incumbent upon the permittee to comply with any other applicable State or Federal regulations, restrictions, or changes to the Protocol that may be in effect at the time of initiation of permitted activities.

G. Exempted Areas and Activities From the Requirements of Sections B-D.

1. The Channel Islands off of southern California including all areas of Anacapa, San Miguel, Santa Cruz, Santa Rosa, San Clemente, San Nicolas, and Santa Barbara Islands. The exempted area also applies to all of Santa Catalina with the exception of the Avalon and Two Harbors areas.

2. Pile driving activities by the U.S. Navy in San Diego Bay and Ports of Los Angeles, Long Beach, and San Diego.

Caulerpa Survey Reporting Form

This form is required to be submitted for any surveys conducted for the invasive exotic alga *Caulerpa taxifolia* that are required to be conducted under federal or state permits and authorizations issued by the
U.S. Army Corps of Engineers or Regional Water Quality Control Boards (Regions 8 & 9). The form has been designed to assist in controlling the costs of reporting while ensuring that the required information necessary to identify and control any potential impacts of the authorized actions on the spread of
Caulerpa. Surveys required to be conducted for this species are subject to modification through publication of revisions to the *Caulerpa* survey policy. It is incumbent upon the authorized permittee to ensure that survey work is following the latest protocols. For further information on these protocols, please contact: Robert Hoffman, National Marine Fisheries Service (NOAA Fisheries), (562) 980-4043, or William Paznokas, California Department of Fish & Game, (858) 467-4218).

Report Date:	
Name of bay, estuary, lagoon, or harbor:	
Specific Location Name: (address or common reference)	
Site Coordinates: (UTM, Lat./Long., datum, accuracy level, and an electronic survey area map or hard copy of the map **must** be included)	
Survey Contact: (name, phone, e-mail)	
Personnel Conducting Survey (if other than above): (name, phone, e-mail)	
Permit Reference: (ACOE Permit No., RWQCB Order or Cert. No.)	
Is this the first or second survey for this project?	

Was *Caulerpa* Detected?: (if *Caulerpa* is found, please immediately contact NOAA Fisheries or CDFG personnel identified above)	**_____Yes, Caulerpa was found at this site and _____has been contacted on_____date.** **_____No, Caulerpa was not found at this site.**	
Description of Permitted Work: (describe briefly the work to be conducted at the site under the permits identified above)		
Description of Site: (describe the physical and biological conditions within the survey area at the time of the survey and provide insight into variability, if known. Please provide units for all numerical information).	*Depth range:*	
	Substrate type:	
	Temperature:	
	Salinity:	
	Dominant flora:	
	Dominant fauna:	
	Exotic species encountered (including any other	
	Other site description notes:	
Description of Survey Effort: (please describe the surveys conducted including type of survey (SCUBA, remote video, etc.) and survey methods employed, date of work, and survey density (estimated percentage of the bottom actually viewed).	*Survey date and time*	
	Horizontal visibility in	
	Survey type and methods:	
	Survey personnel:	

Describe any limitations encountered during the survey efforts.	*Survey density:*	
	Survey limitations:	
Other Information: (use this space to provide additional information or references to attached		

Appendix J: EFH Work Windows for Coast Guard District 13

Washington

WAC 220-660-330

Authorized work times in saltwater areas.

(1) **Description:** The department applies timing windows to reduce the risk of impacts to fish life at sensitive life stages. In-water work is not allowed during critical periods of the year unless a person can take mitigation measures to eliminate risk during critical periods.

(2) **Fish life concerns:** Work in or near salt waters of the state can harm fish life at sensitive life stages including spawning, incubation, juvenile migration, rearing, and feeding. Therefore, work must occur at times of the year when the risk to fish life is reduced unless the risk can be avoided.

(3) **Authorized work times:** The department must specify authorized work times for hydraulic projects when it issues HPAs. The department will allow work waterward of the OHWL for the following times, areas, and species.

(a) Tidal Reference Areas 1 through 17; March 1 through October 15 for projects in or adjacent to documented Pacific sand lance spawning beds.

(b) Tidal Reference Areas 1 through 17; October 15 through May 15 for projects in or adjacent to juvenile lingcod settlement and nursery areas. April 1 through December 31 for projects in or adjacent to lingcod nests.

(c) Tidal Reference Areas 1 through 17; September 30 through March 15 for projects in or adjacent to juvenile rockfish settlement and nursery areas.

(d) Tidal Reference Area 14; October 1 through May 15 for projects in or adjacent to documented razor clam beds.

(e) Tidal Reference Areas 1 through 17; the authorized times and areas for protection of migrating juvenile salmonids in the nearshore, and for projects in documented Pacific herring spawning beds and in or adjacent to documented surf smelt are listed in the following table:

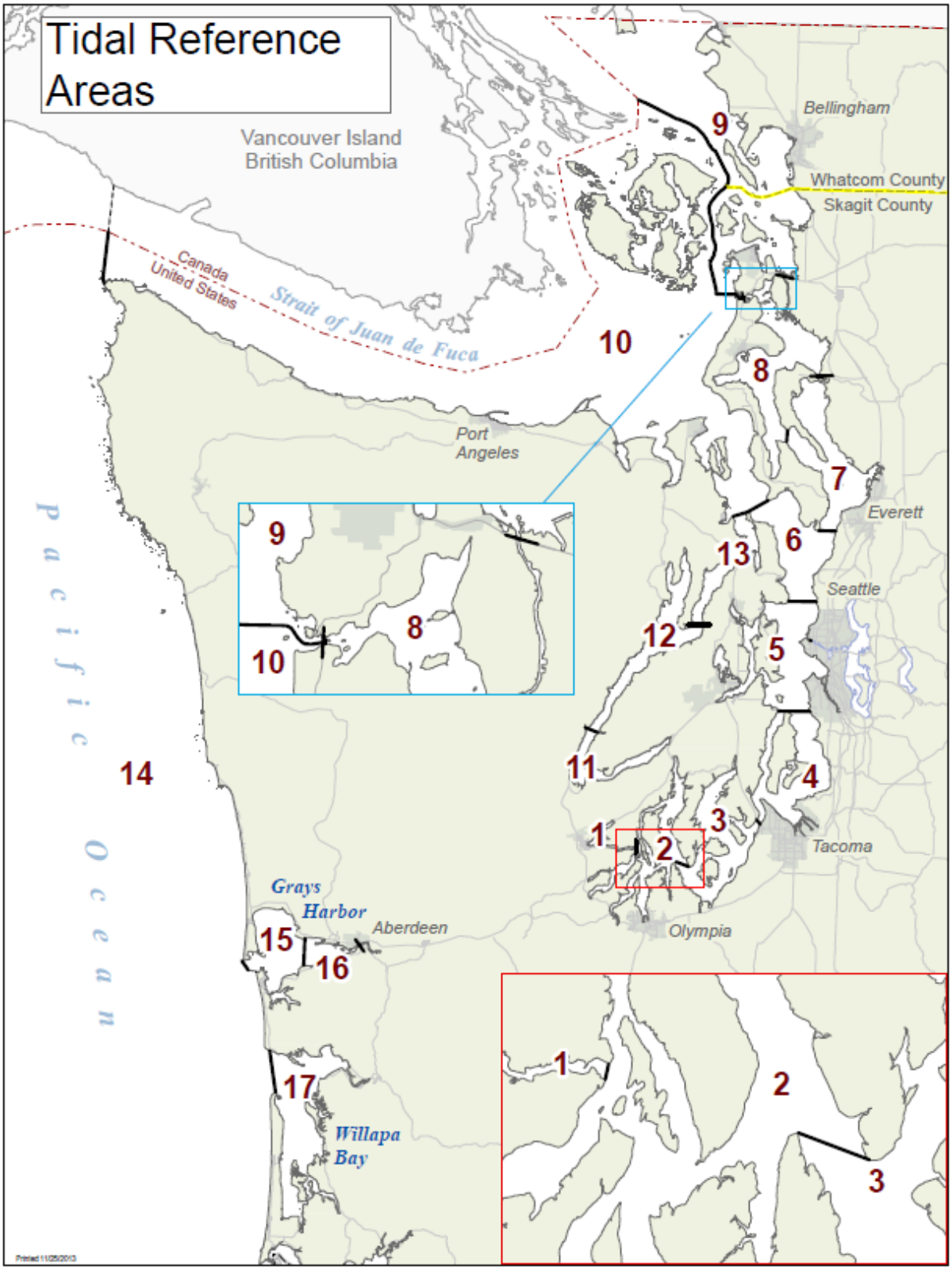
Table 4
Authorized Times for Protection of Juvenile Salmonid Migration, Feeding and Rearing Areas and Pacific Herring Spawning and Surf Smelt Spawning Beds

AUTHORIZED TIMES			
Tidal Reference Area	**Juvenile Salmonid Migration, Feeding and Rearing Areas**	**Surf Smelt Spawning Beds**	**Herring Spawning Beds**
1	July 15 - February 15	(not present)	April 1 - January 15
2	July 15 - February 15	April 1 - June 30	April 1 - January 15
3	July 15 - February 15	May 1 - September 30	April 1 - January 15
4	August 1 - February 15 for all work except dredging in all areas except Commencement Bay. September 1 - February 15 for dredging in all areas except Commencement Bay. July 15 - February 15 for all work in Commencement Bay.	April 15 - September 30	April 15 - January 15
5	August 1 - February 15 for all work except dredging. September 1 - February 15 for dredging in all areas except Duwamish Waterway. October 16 - February 15 for dredging in the Duwamish Waterway upstream of the East and West Waterways.	April 1 - August 31 in all areas except Eagle Harbor and Sinclair Inlet. In Eagle Harbor and Sinclair Inlet, authorization is conditional upon inspection because year-round spawning occurs.	May 1 - January 15
6	July 15 - February 15 for all work except dredging. September 1 - February 15 for dredging.	April 1 - August 31	(not present)
7	July 15 - February 15 for all work except dredging in Port Gardner and the Snohomish River. September 15 - February 15 for dredging in Port Gardner.	Authorization is conditional upon inspection because year-round spawning occurs.	April 15 - January 31

AUTHORIZED TIMES			
Tidal Reference Area	**Juvenile Salmonid Migration, Feeding and Rearing Areas**	**Surf Smelt Spawning Beds**	**Herring Spawning Beds**
	September 1 - February 15 for dredging in the Snohomish River.		
8	August 1 - February 15	Authorization is conditional upon inspection, because year-round spawning occurs.	April 15 - January 31
9	August 1 - February 15	Authorization is conditional upon inspection, because year-round spawning occurs.	April 15 - January 31 south of a line running due west from Governor's Point. June 15 - January 31 north of a line running due west from Governor's Point.
10	July 15 - February 15 July 15 - January 15 for all work from Tala Point to the Dungeness River. September 1 - March 1 San Juan Islands.	April 1 - July 31 except in the San Juan Islands where authorization is conditional upon inspection because year-round spawning occurs.	May 1 - January 15
11	July 15 - January 15	March 1 - September 15	April 1 - January 15
12	July 15 - January 15	March 1 - August 31	April 15 - February 15
13	July 15 - January 15	February 16 - July 31	April 15 - January 15
14	July 15 - February 15	October 1 - June 30	(not present)
15	July 15 - February 15	(not present)	February 1 - March 31
16	July 15 - February 15	(not present)	March 15 - January 31
17	July 15 - February 15	(not present)	March 15 - January 31

Reference:

Washington State Legislature. Authorized work times in saltwater areas. http://apps.leg.wa.gov/wac/default.aspx?cite=220-660-330


Tidal Reference Areas
Vancouver Island
British Columbia
Canada
United States
Strait of Juan de Fuca
Bellingham
Whatcom County
Skagit County
Port Angeles
Everett
Seattle
Tacoma
Olympia
Aberdeen
Grays Harbor
Willapa Bay
Pacific Ocean
9
10
8
7
6
13
12
5
11
4
3
1
2
14
15
16
17

Reference:

http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/Tidal%20Reference%20Area%20Map.pdf

Oregon

Oregon in water work period: All work within the active channel will be completed in accordance with the Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife resources (ODFW 2008, or the most recent version; listed below), except as follows:

- All in-water work in the Willamette River mainstem between Willamette Falls and the confluence with the Columbia River must be completed between July 1 and October 31.
- All in-water work in the Lower Willamette River must be completed between July 31 and October 31.
- All in-water work in the Columbia River mainstem below Bonneville Dam, except pile driving, must be completed between November 1 and December 31.
- Pile driving in the Columbia River mainstem below Bonneville Dam must be completed between October 1 and November 31.

Reference:

Genevieve Angle NOAA Fisheries West Coast Region Willamette Office; Endangered Species Act Section 7 Formal Programmatic Opinion, Letter of Concurrence and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations Revisions to Standard Local Operating Procedures for Endangered Species to Administer Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES IV In-water Over-water Structures). Army Corps of Engineers, Portland District, Operations and Regulatory Branches. April 2012. http://www.nwp.usace.army.mil/Portals/24/docs/environment/SLOPES-IV/2012_04-05_SLOPES_IV_in-over-water.pdf