Endangered Species Act – Section 7 Consultation

PIFSC ASRAMP Cruise 2018 Biological Opinion

Action Agency:	National Marine Fisheries Service, Pacific Islands Region, Sustainable Fisheries Division
Activity:	PIFSC American Samoa Reef Assessment and Monitoring Program research cruise.
Consulting Agency:	National Marine Fisheries Service, Pacific Islands Region, Protected Resources Division
NMFS File No. (PCTS):	PIR-2017-10255
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Approved By:	Michael D. Tosatto Regional Administrator, Pacific Islands Region
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1. Introduction

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16U.S.C. 1536(A)(2)) requires each Federal agency to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" an ESA-listed species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS; for marine species or their designated critical habitat) or the U.S. Fish and Wildlife Service (U.S. FWS; for terrestrial and freshwater species or their designated critical habitat). Federal agencies are exempt from this formal consultation requirement if they have concluded that an action "may affect, but is not likely to adversely affect" ESA-listed species or their designated critical habitat, and NMFS or the U.S. FWS concur with that conclusion (50 CFR 402.14 (b)).

If an action is likely to adversely affect a listed species, the appropriate agency (either NMFS or FWS) must provide a biological opinion (opinion) to determine if the proposed action is likely to jeopardize the continued existence of listed species (50 CFR 402.14(e)). "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 a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." (50 CFR 402.02)

This document represents the NMFS' Opinion of the effects on marine species protected under the ESA under NMFS jurisdiction that may result from the 2018 American Samoa Rapid Assessment and Monitoring Program cruise to be conducted aboard the NOAA vessel Hi'ialakai by the Pacific Islands Fisheries Science Center (Science Center), Coral Reef Ecosystem Division that is scheduled to take place from February 2018 through early May of 2018. This Opinion is based on the review of the November 20, 2017 and December 4, 2017 Biological Evaluations (NMFS 2017 a, b) provided for this research cruise, the 2015 Biological Opinion on the research cruise (NMFS 2015), published and unpublished scientific information on the biology and ecology of threatened and endangered marine species of concern in the action area, monitoring reports and research in the region, and relevant scientific and gray literature (see Literature Cited).

2. Consultation History

The Science Center first approached the NMFS Pacific Islands Regional Office Protected Resources Division (PRD) on November 20, 2017 to request concurrence on their "may affect, not likely to adversely affect" determination made for this cruise for the following species: green sea turtles – Central North Pacific and Central South Pacific Distinct Population Segment (DPS), hawksbill sea turtles, leatherback sea turtles, olive Ridley sea turtles, loggerhead sea turtles (North Pacific DPS), Hawaiian monk seals, sperm whales, false killer whales – main Hawaiian Islands insular DPS, fin whales, blue whales, humpback whales, sei whales, North Pacific right whales, scalloped hammerhead sharks (Indo-West Pacific and Central Pacific DPS), oceanic whitetip shark (*Carcharhinus longimanus*), manta ray (*Manta birostris*), chambered nautilus (*Nautilus pompilius*), and coral species *Acropora globiceps, Acropora retusa, Acropora*

speciosa, *Acropora jacquelineae*, *Euphyllia paradivisa*, and *Isopora crateriformis*. On November 27, 2017, we informed them that the collection of ESA listed corals was likely to adversely affect individuals and that we needed more information to reinitiate formal ESA consultation.

The Science Center sent an additional request to PRD on December 4, 2017 to reinitiate formal consultation for the proposed directed-take from voucher specimen collection (Part 2) during the research cruise, which the Science Center determined may adversely affect the ESA-listed coral species *Acropora globiceps*, *Acropora jacquelineae*, *Acropora retusa*, *Acropora speciosa*, *Euphyllia paradivisa*, and *Isopora crateriformis*. While no take prohibitions currently exist for these coral species, the Science Center has the obligation to insure these species are not jeopardized by its research. Based on the information contained in the BE provided by the Science Center, and available scientific literature, we determined there was sufficient information to initiate the ESA consultation, and Formal consultation was re-initiated for the coral species *Acropora globiceps*, *Acropora jacquelineae*, *Acropora retusa*, *Acropora speciosa*, *Euphyllia paradivisa*, and *Isopora crateriformis*, on December 5, 2017, resulting in this Opinion. This is not the first formal consultation conducted for this research cruise. In 2015 we found their proposed action, which consisted of similar research in the same action area, was not likely to jeopardize the continued existence of the following species: *Acropora globiceps*, *Acropora jacquelineae*, *Acropora retusa*, *Acropora speciosa*, *Euphyllia paradivisa*, and *Isopora crateriformis* (NMFS 2015). No critical habitat is designated for these threatened coral species, therefore none can be affected.

3. Description of the Proposed Action

The Science Center is proposing to conduct research cruises to the Pacific Remote Island Areas and American Samoa regions once every three years. However, this opinion covers only the upcoming 2018 research cruise and the retrieval of the equipment in approximately three years. The Science Center intends to reinitiate consultations as necessary for any future cruises. The data collected from the surveys would have a beneficial effect on the scientific understanding of the abundance and distribution of marine organisms and oceanographic conditions of the coral reef ecosystems of the region.

All ship operations will be conducted aboard NOAA vessels and carried out in accordance with NOAA policies and procedures including navigational and visual surveys, fueling, responding to unexpected spills, and disposal of waste. The maximum speed of the R/V Hi'ialakai is eleven knots, but the transit speed would be approximately nine knots and most survey operations would be conducted at even lower speeds. The Science Center has developed a series of protected species avoidance and minimization measures into the final cruise instructions as part of the NMFS Lecky, Murawski, and Merrick guidance documents dated March 20, 2008, June 25, 2009, and July 5, 2012, respectively.

Small boats, launched from the ship, will be used to take scientists from the ship to the research sites or between research sites. Approximately 700 seafloor instruments would be deployed or recovered during the research cruise to monitor oceanographic and ecological conditions. The instruments will be recovered during the next research cruise to the area in 3 years. Best

practices for instrument deployment and recovery are followed and are designed to minimize unnecessary contact with live reef by the staff while installing the instruments.

3.1 Cruise Part 1- Miscellaneous Environmental Research

The activities that will be conducted during Part 1 of the cruise would include: 1) ecosystem monitoring via dive surveys of the species composition, abundance, percent cover, size distribution, recruitment and general health of fishes, corals, other invertebrates, and algae of shallow water (<35 m) coral reef ecosystems; 2) deployment, retrieval and/or service an array of oceanographic monitoring equipment; 3) monitoring of nearshore physical and ecological factors associated with ocean acidification and general water quality; 4) collection of shallow water coral cores to examine calcification/growth rates; 5) conducting plankton tows and collection of water samples, coral and algal biopsies, coral skeletal and tissue samples of non ESA-listed species, crown-of-thorns starfish arms, macroalgal samples, and benthic grabs (coral rubble); 6) conducting shipboard conductivity temperature depth casts at each island/atoll 15 kilometers (km) offshore; and 7) using photomosaics to collect coral community composition data.

The operational details include the following:

3.1.1. Ecosystem monitoring of fishes, corals, other invertebrates and algae

Towed Diver Surveys

Shallow water habitats around each island, bank, or reef will be surveyed visually using pairs of divers towed 60 meters (m) behind a 19-foot safe boat. The vessel will tow the divers at 3 kts or less. In each towed-diver buddy team, one diver is tasked with quantifying the benthos while the other quantifies fish populations. Each towed-diver survey lasts 50 minutes, is broken into 10 five-minute segments, and covers approximately 2 km.

Coral Demographics Surveys

A stratified random sampling design will be employed to rapid ecological assessment survey sites in depths from 0-30 m. Coral colonies whose center falls within 0.5 m of either side of the transect line will be identified to lowest taxonomic level. In addition, the following estimates and empirical measurements are made for each coral colony: morphology noted, size (maximum diameter to nearest centimeter (cm)), partial mortality estimated as percent of colony (both ‘recent’ and ‘old’ dead), the cause of recent mortality identified if possible (e.g. predation by crown of thorns starfish or gastropods), condition (including disease, bleaching, skeletal growth anomaly, pigmentation response, etc.) with the extent and level of severity noted.

Stationary Point Counts

Stationary point counts are the main method used by the Science Center to survey reef fish assemblages. At each randomly selected site replicate surveys will be conducted by a pair of divers, surveying adjacent visually estimated cylinders of 7.5 m radius, centered on the divers. Each diver records the number, size, and species of all fishes present or passing through the cylinder in the course of the survey. The surveys consist of two components: 1) a five minute species listing component –the aim of which is to build a list of species present or passing through the cylinder; and 2) an enumeration component, in which each diver records the number and sizes of fishes of those listed species in a series of instantaneous visual sweeps of their cylinder.

3.1.2 Deploy, retrieve and/or service an array of oceanographic monitoring equipment

Subsurface Temperature Recorders

The subsurface temperature recorders (Figure 1) are configured to continuously record high-resolution temperature data. The recorders are approximately 25-30 cm in length and 2.54 cm in diameter. Divers will replace old recorders by diving on currently existing recorder sites and picking up the old recorder, 1.4 kilogram (kg) anchor and mooring ties and replace the recorder and housing unit. The recorder housing unit consists of an in-house fabricated 30 cm block of PVC and two 1.4 kg rubber covered dive weights. Each housing unit including the recorder will be secured to dead coral with heavy duty cable ties. Approximately 123 recorders will be retrieved and replaced with 123 new recorders in various shallow water locations (<35 m) across all island/atoll areas.

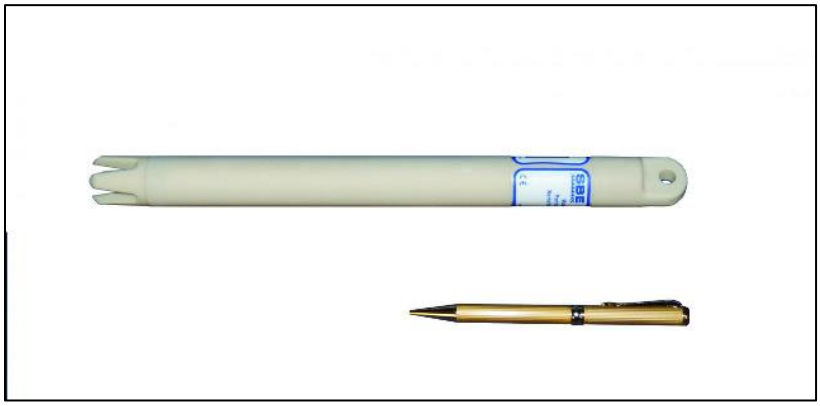

Figure 1. Subsurface Temperature Recorder

Autonomous Reef Monitoring Structures

The autonomous reef monitoring structures (Figure 2) are small, long term collecting devices designed to mimic the structural complexity of a coral reef and attract colonizing invertebrates. They consist of a tier of nine 23 cm x 23 cm Type I polyvinyl chloride plates stacked in an alternating series of open and obstructed formats attached to a 36 cm x 46 cm base plate. They are secured to the sea floor (live corals will be avoided) with cable ties and stainless steel stakes and remain in place for approximately 1-3 years when they are retrieved and processed in a laboratory. Approximately 42 reef monitoring structures from the 2015 cruise will be retrieved and replaced with 42 new ones in various shallow water locations (<35 m).

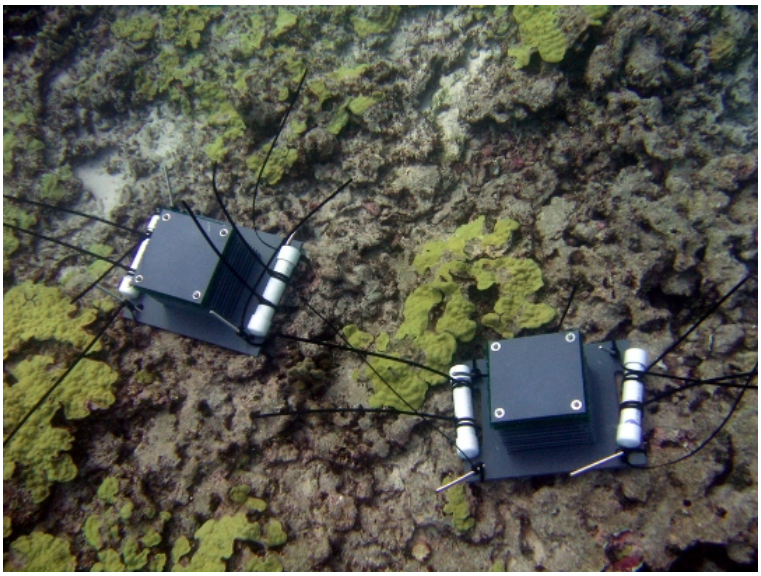

Figure 2. Autonomous Reef Monitoring Structures

Calcification Accretion Units

Rates of net calcium carbonate accretion are monitored with calcification accretion units (Figure 3), which allow for recruitment and colonization of crustose coralline algae and hard corals. Each unit consists of two polyvinyl chloride plates (10 cm x 10 cm) separated by a 1 cm spacer and mounted on a stainless steel rod installed by divers on the seafloor avoiding live corals. Approximately 445 units from the 2015 cruise will be retrieved and replaced with 445 new units during this cruise and will remain on the seafloor for 1-3 years.

Figure 3. Calcification Accretion Unit

Bioerosion Monitoring Units

The bioerosion monitoring units (Figure 4) are used to measure rates of bioerosion and community composition of organisms that settle on each unit. They consist of a calcium carbonate block (5 cm x 2 cm x 1 cm) that is attached to each installed calcification accretion unit. Retrieved blocks would be re-scanned by X-ray microtomography and sampled for bioeroding organisms. Pre- and post-scans would be used to estimate bioerosion rates of the calcium carbonate reef framework. A maximum total of 85 units will be deployed during this cruise and picked up during later cruises.

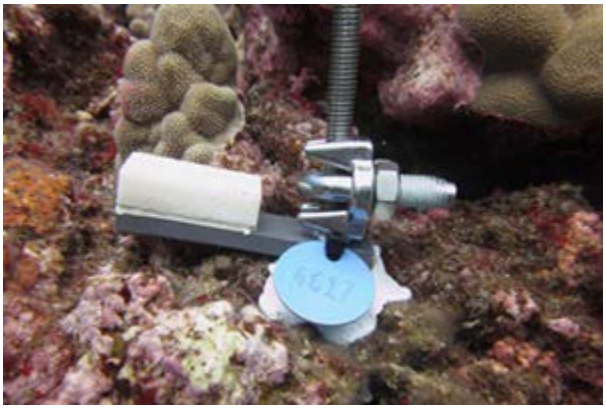

Figure 4 Bioerosion Monitoring Unit

Ecological Acoustic Recorders

The recorders (Figure 5) are passive acoustic devices developed specifically for monitoring marine mammals, fish, crustaceans, other sound-producing marine life, and human activity in marine habitats. Five were set up during the 2015 cruise and will be retrieved during this cruise. No new recorders will be set up during this cruise.

Figure 5. Ecological Acoustic Recorder

Instrument Array Composition (aka “diurnal suite”)

A suite of oceanographic instruments will be deployed for a maximum of 48 hours at a time to quantify the variability of the diurnal carbonate chemistry signal on the reef. This suite of

instrumentation is also called the “diurnal suite” and consists of the following instruments (described below in detail): one Nortek Aquadopp acoustic Doppler current profiler, one Satlantic SeaFET in-situ pH sensor, one Sea-Bird Electronics (SBE) 19-plus V2 SeaCAT profiler conductivity, temperature depth recorder, and nine programmable underwater collectors. A maximum of nine diurnal suites will be deployed at a time. Each diurnal suite will be contained in two standard milk crates with a footprint of 66 x 66 x 56 cm and be deployed on the seafloor on dead coral substrate and secured via rubber coated dive weights.

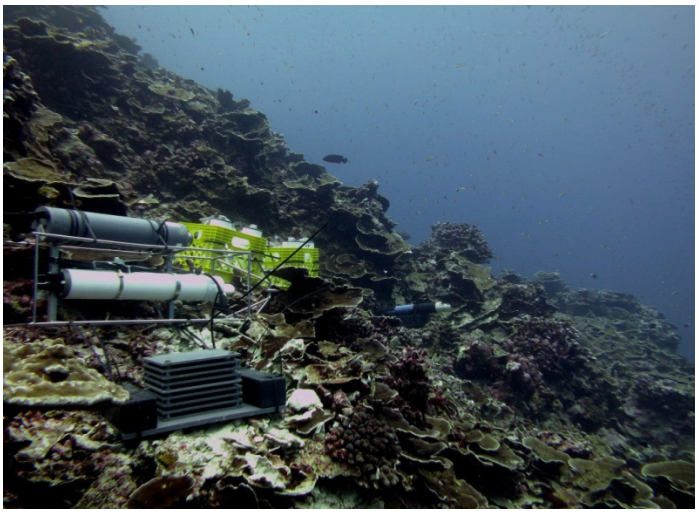

Figure 6. Ocean Acidification Diurnal Suite deployed at Jarvis Island.

SBE SeaCAT Profiler

The SBE SeaCAT Profiler measures conductivity, temperature and pressure at 4 scans/second (4 Hertz) and provides high accuracy and resolution, for a wide range of research and monitoring applications. The SBE SeaCAT measures 57.5 cm in length and 9.9 cm in diameter, weighs 2.3 kg and its housing is made of acetal copolymer plastic.

Nortek Aquadopp Acoustic Doppler Current Profiler

The Nortek Aquadopp profiler (Figure 7) is to measure how fast water is moving across the water column and is comprised of a horizontally-mounted high resolution current profiler that will be operated at a frequency of one megahertz and will be deployed for 24-48 hours at a time. The profiler has a cone-shaped 3-beam pattern, with a nominal beam width of 3.4º a maximum tilt of 30° and a measurement range of 12 – 20 m. Each Aquadopp profiler measures approximately 57.3 cm x 7.5 cm.

Figure 7. Nortek Aquadopp Acoustic Doppler Current Profiler

Satlantic SeaFET ocean pH sensor

The Satlantic SeaFET ocean pH sensor is an ion selective field effect transistor type sensor for accurate long-term pH measurements in salt water and is utilized for ocean acidification and coral reef research. The SeaFET measures 50.8 cm in length and 11.4 cm in diameter; it weighs 0.1 kg and has a maximum depth range of 50 m.

Programmable Underwater Collectors

A total of nine programmable underwater collectors will be deployed as part of the diurnal suite. The collectors are used to automatically collect multiple water samples at depth at pre-programmed time intervals over a period of 24-48 hours. Each collector is approximately 25 x 30 x 20 cm and weighs 9 kgs.

Sea Surface Temperature Buoy

The Science Center will retrieve one sea surface temperature buoy will during the cruise and no additional buoys will be deployed. The buoy is (28 cm x 23 cm) and weighs 9 kg in seawater and is moored to the seafloor via screw anchor. The buoy carries one SeaBird model SBE39 temperature recorder that transmits hourly temperature and daily GPS data position in near real time.

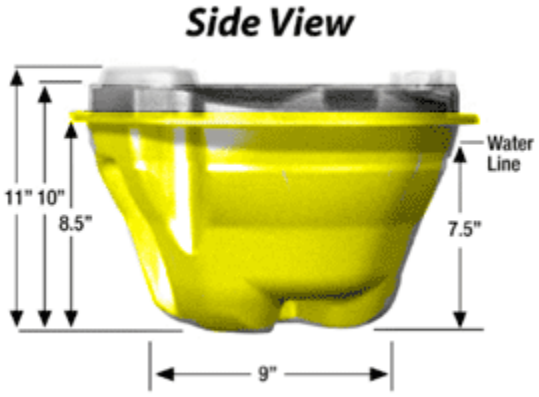

Figure 8. Sea Surface Temperature Buoy.

Oceanographic Sensor Packages

Two packages containing six different oceanographic sensors in each package will be temporarily deployed on fore reefs at Howland and Baker Islands including: 1) the submersible autonomous moored instrument (SAMI) pH; 2) partial pressure of carbon dioxide (pCO_2) sensors; 3) HOBO temperature loggers; (4) Photosynthetically Active Radiation (PAR) sensors; 5) oxygen sensors; and 6) Seabird MicroCAT.

Both the pH and pCO_2 sensors (Figures 9 and 10) are 55 cm in length and 15.2 cm in diameter. The pH sensor measures marine pH and the pCO_2 sensor measures the partial pressure of carbon dioxide. The Seabird MicroCAT is 14 cm in length and 6 cm wide and measures conductivity and temperature. The SAMI pH and pCO_2 sensors, and the Seabird MicroCAT will be secured by (20 cm x 20 cm x 20 cm) cinder blocks and cable ties, or metal stakes and placed in sandy areas near the forereef. The HOBO temperature logger is 11.4 cm in length and 3.0 cm in diameter and will be secured on dead substrate near the forereef with cable ties. The PAR sensor is 4.1 cm high and 3.2 cm in diameter and measures light intensity for the frequencies relevant to photosynthesis. The ocean oxygen sensor is 11 cm x 6 cm x 4 cm and measures dissolved oxygen in the ocean. Both the PAR and oxygen sensor would be attached to the frame. The sensor package footprint would be approximately 61 cm x 61 cm x 61 cm, with one deployed on the east side of both Howland and Baker Island and one on the west side. All the aforementioned sensors will be deployed for approximately five days in duration and retrieved upon departure.

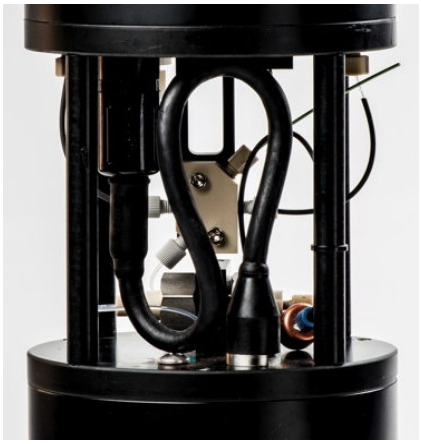

Figure 9 SAMI pH sensor

Figure 10. pCO_2 sensor

Figure 11 . Left is the HOBO oxygen sensor and the right is the photosynthetically active radiation sensor.

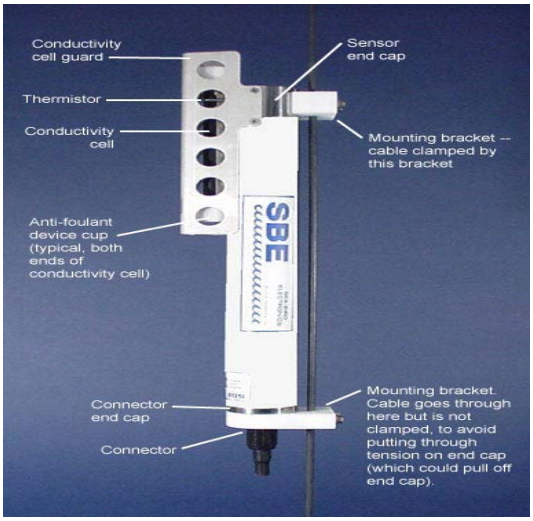

Figure 12. Seabird MicroCAT

High Frequency Acoustic Recording Package (HARP)

The crew will recover one high frequency acoustic recording package (Figure 13) that was previously deployed at Howland Island during the 2015 cruise. To recover the package, the crew will transmit an acoustic signal from the surface that will release the package. Once the package is spotted at the surface, recovery will be conducted directly by the Hi‘ialakai using the aft crane or by small boat. The package consists of three parts: 1) hydrophones to convert sound pressure into a voltage signal that is amplified and filtered; 2) a Data Acquisition System that records and stores sound; and 3) digital disk drives to store data. No new HARPs will be deployed.

Figure 13. High Frequency Acoustic Recording Package

3.1.3 Collection of shallow water coral cores

The Science Center will collect coral cores from the non-ESA listed *Porites* spp. opportunistically to examine growth/calcification rates in recent decades and assess potential early impacts of ocean acidification. A two- to three-person dive team will locate a suitable coral colony and use a pneumatic drill with a masonry drill bit and powered by a SCUBA tank to extract the core. A maximum of five cores will be collected within a close proximity (3-5 m) to each other at each sampling location and no more than 115 shallow water non-listed coral cores will be collected during the entire cruise.

3.1.4 Conduct plankton tows, water samples, coral and algal biopsies, coral skeletal and tissue samples, crown-of-thorns starfish arms, macroalgal samples, and benthic grab (coral rubble) samples

Crew will collect plankton samples to further characterize coral reef biodiversity using a plankton net. The net is 50 cm in diameter with an 80 micrometer mesh size and a 1 liter cod end jar attached to the net with a flow meter that will be trailed 2-3 yards behind the stern of a small boat moving 1-2 knots. Each plankton tow will last approximately five minutes. Scuba divers will collect water samples with Niskin water sampling bottles. Coral-algal biopsies will be collected by taking small biopsies (1 cm) of coral-algal interactions occurring on several non-listed coral species. Coral skeletal and tissue biopsies will also be taken for coral disease studies from non-listed corals during this research cruise.

3.1.5 Conduct four shipboard CTD casts at each island/atoll area

Oceanographic data will be collected offshore of each of the islands and atolls via the shipboard CTD. The CTD instrument package consists of a rosette carousel with 12 10-liter Niskin water

bottles. The rosette will be lowered by winch, to a maximum sampling depth of 1,000 m then hauled back to the surface. Each CTD deployment will last approximately one hour. The vessel will maneuver minimally during this time to maintain a vertical cable position while the CTD is in the water. CTD casts will be conducted offshore (15 km) four times per island/atoll area for a maximum of 76 casts.

3.2 Cruise Part 2: Collection of Voucher specimens

Part 2 of the research cruise is the collection of voucher specimens of six ESA-listed coral species *Acropora globiceps*, *Acropora jacquelineae*, *Acropora retusa*, *Acropora speciosa*, *Euphyllia paradivisa*, and *Isopora crateriformis*.

Collections will be based upon provisional identification of the ESA-listed species in the field. Because high-resolution digital photographs can provide adequate information concerning colony morphology, specimens required for taxonomic verification need only be large enough to examine the skeletal architecture (e.g., polyp structure and coenosteum patterning) with a dissecting microscope; hence specimens will be no more than 7 cm maximum diameter (or length for branching species). Coral tissue samples will be carefully collected using bone cutters or hammer and chisel (as necessary).

Whether for taxonomic verification, genetic analysis, or histological analysis of coral diseases, up to a maximum of 10 specimens representing each coral species (taxon) will be collected over the duration of the cruise. However, because these ESA-listed species are uncommon and the chances of encountering them are low (based on previous experience), it is expected that no more than five specimens per taxon will be collected. In no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. No more than two type specimens will be collected for each suspected new coral species.

Taxon	Number of specimens	Total size of specimens
Acropora globiceps	10	236 cm^2
Acropora retusa	10	236 cm^2
Acropora speciosa	10	236 cm^2
Acropora jacquelineae	10	236 cm^2
Euphyllia paradivisa	10	770 cm^2
Isopora crateriformis	10	385 cm^2
Totals	60	2099 cm^2 (~0.209 m^2)

Table 1. Proposed collection of ESA-listed coral species.

In approximately three years the Science Center will return to retrieve all of the monitoring equipment that is deployed during this cruise. They will use the same methods to retrieve the gear that they use to deploy it, which is by trained scientific divers from small vessels. We do not

expect the retrieval of gear to have any different effects on listed species than those considered in the deployment of gear.

4. Action Area

The cruise will take place over 106 days (94 operational days) during February 1 – May 17, 2018 and is divided into: Leg I – transit across the central and western Pacific Ocean, from Pearl Harbor, Hawai‘i to Pago Pago Harbor, American Samoa, with dive operations occurring en route at Johnston Atoll, Howland, Baker and Swains Islands and Tutuila; Leg II – Tutuila, American Samoa; Leg III – Transit from Pago Pago, to the Manu‘a Islands (Ofu, Olosega and Ta‘u) and Rose Atoll and returning to Pago Pago; and Leg IV: transit across the western and central Pacific Ocean to Pearl Harbor, Hawai‘i with dive operations occurring en route at Jarvis Island, Palmyra Atoll, and Kingman Reef. Coral samples are expected to be collected opportunistically throughout the deployment based upon provisional identification of the ESA listed species in the field.

5. Evidence Available for the Consultation

To conduct our analyses, we considered lines of evidence available through published and unpublished sources that represent evidence of adverse impacts or the absence of such consequences. In particular, we considered information contained in NMFS's final ruling to list 20 coral species as threatened under the ESA (79 FR 53851 (Sept. 10, 2015)), status review (Veron 2014), prior consultations (NMFS 2015 a, b) and interim guidance for recovery.

We supplemented this information by conducting electronic searches of literature published in English or with English abstracts using research platforms in the *Science Direct, PubMed, and Google Scholar*. These platforms allowed us to cross search multiple databases for journals, open access resources, books, proceedings, web sites, for literature on the biological, ecological, and fisheries sciences.

For our literature searches, we used paired combinations of the keywords such as *Acropora*, regeneration rates, American Samoa, coral disease, climate change, and many others to search these electronic databases. Electronic searches have important limitations, however. First, often they only contain articles from a limited time span. Second, electronic databases commonly do not include articles published in small or obscure journals or magazines. Third, electronic databases do not include unpublished reports from government agencies, consulting firms, and non-governmental organizations. To overcome these limitations, we identified additional papers that had not been captured in our electronic searches and searched their literature cited sections and bibliographies. We acquired references that, based on a reading of their titles and abstracts, appeared to comply with our keywords. If a references' title did not allow us to eliminate it as irrelevant to this inquiry, we acquired the reference.

6. Status of Listed Species

The Science Center determined that the proposed action may affect but was not likely to adversely affect the 17 ESA-listed marine species shown in Table 2a, and determined that the action may adversely affect the 6 ESA-listed corals is Table 2b.

Species Common Name	Species Scientific Name	Listing Status	Date Listed	Federal Register Citation
Table 2a. Species and critical habitat Not likely to be adversely affected by the proposed action.				
Green Sea Turtle	*Chelonia mydas*			
Central North Pacific DPS		Threatened	4/06/2016	81 FR 20057
Central South Pacific DPS		Endangered	4/06/2016	81 FR 20057
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	07/28/1978	43 FR 32800
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/1970	35 FR 8491
Olive ridley sea turtle	*Lepidochelys olivacea*	Threatened	07/28/1978	43 FR 32800
Loggerhead Sea Turtle North Pacific DPS	*Caretta caretta*	Endangered	9/22/2011	76 FR 58868
Indo-West Pacific Scalloped Hammerhead shark DPS	*Sphyrna lewini*	Threatened	07/03/2014	79 FR 38213
Oceanic White-tip shark	*Carcharhinus longimanus*	Threatened	1/30/2018	83 FR 4153
Giant Manta Ray	*Manta birostris*	Threatened	2/21/2018	83 FR 2916
Chambered Nautilus	*Nautilus pompilius*	Proposed Threatened	10/23/2017	82 FR 48948
Sperm Whale	*Physeter macrocephalus*	Endangered	12/02/1970	35 FR 18319
Main Hawaiian Islands Insular False killer whale DPS	*Pseudorca crassidens*	Endangered	11/28/2012	77 FR 70915
Hawaiian Monk Seal	*Monachus schauinslandi*	Endangered	11/23/1976	41 FR 51611
Blue Whale	*Balaenoptera musculus*	Endangered	12/2/1970	35 FR 18319
Fin Whale	*Balaenoptera physalus*	Endangered	12/2/1970	35 FR 18319
Sei Whale	*Balaenoptera borealis*	Endangered	12/2/1970	35 FR 18319
North Pacific Right Whales	*Eubalaena japonica*	Endangered	3/6/2008	73 FR 12024
Monk Seal Critical Habitat				
Table 2b. Species likely to be adversely affected by the proposed action				
	Acropora globiceps	Threatened	09/10/2014	79 FR 53852
	A. jacquelineae	Threatened	09/10/2014	79 FR 53852
	A. retusa	Threatened	09/10/2014	79 FR 53852
	A. speciosa	Threatened	09/10/2014	79 FR 53852
	Euphyllia paradivisa	Threatened	09/10/2014	79 FR 53852
	Isopora crateriformis	Threatened	09/10/2014	79 FR 53852

Table 2. Scientific name, ESA status, listing date, and Federal Register reference for listed species considered in this consultation.

6.1 Species Not Likely to be Adversely Affected by the Proposed Action

In order to determine that a proposed action is not likely to adversely affect ESA-listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or completely beneficial. As defined in the joint U.S. FWS-NMFS Endangered Species Consultation Handbook, beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs[1]. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: 1) be able to meaningfully measure, detect, or evaluate insignificant effects; or 2) expect discountable effects to occur (U.S. FWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species.

The Science Center biological evaluation (NMFS 2017a) and supplemental material describe five primary potential impacts or stressors to listed marine resources within the action area:

1. Temporary disturbance from human activity;
2. Entanglement;
3. Collisions with vessels; and
4. Exposure to waste and discharge.

1. Temporary disturbance from human activities

Most of the activities proposed on the cruise will take place in shallow water (< 35 m) via SCUBA divers. A potential stressor from these activities is the interaction of divers with listed species. SCUBA operations related to research activities could potentially result in the dive team encountering a sea turtle, marine mammal, shark, or manta ray. However, dive teams would not approach any protected species, and any animal would likely leave the work area on its own with minimal and insignificant changes in its behavior.

The potential exists for temporary disturbance to listed species from small boat operations or deployment of the small boat or ship-based CTD or deployment and operation of the plankton net. Disturbance may occur in the water where animals would quickly and harmlessly flee or temporarily alter their behavior to investigate personnel and deployment activities. However, all individuals involved in the proposed action would carefully monitor their work area at all times for the presence of marine protected species. Thus, we expect disturbance to be limited to harmless startling and fleeing with no adverse impacts to feeding, breeding, or resting behaviors.

Given that animals would likely avoid the area during the proposed activities, and the Science Center's proposed best management practices, we would expect that any disturbances related to the activities associated with dive operations, coral reef survey and monitoring,

[1] Take" is defined by the ESA as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. 16 U.S.C. § 1532(19) NMFS defines "harass" as to "create 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." 50 C.F.R. 222.102. NMFS defines "harm" as "an act which actually kills or injures fish or wildlife." 50 CFR 222.102. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering.

deployment/retrieval of oceanographic monitoring equipment, operation of small boats, and scientific collections would be infrequent, temporary in nature, and never reach the scale that would affect the individual's health or result in significant changes in behavioral patterns. Accordingly, we expect that temporary disturbance from human activities would have insignificant effects on all ESA-listed marine species listed in Table 2 a.

2. Entanglement

Operation of the CTDs, the plankton net, and retrieval of the HARP pose a small entanglement risk to ESA-listed species. Additionally, although the Hi'ialakai is unlikely to anchor at any point, the small vessels may drop anchor if there is no mooring buoy in place. Anchors are always dropped in rubble or sand to prevent damage to corals and other benthos. All lines in the water would be constantly monitored and removed if any protected marine species are observed in the immediate vicinity and lines holding the CTDs would be held taut to keep the equipment in place. The net has a small mouth (50 square cm) and is towed behind the ship at the ocean surface at approximately 1-2 knots from a small boat. Based on available data to date, there has never been an interaction between this type of gear and a listed species. Furthermore, mitigation measures such as pre-survey scanning and constant monitoring will be used to ensure there are no interactions with listed species. Based on the small size of the net opening, the slow speed of the boat, and the mitigation measures in place, Science Center we expect that the risk of entanglement for sea turtles, marine mammals, chambered nautilus, manta ray, and sharks listed in table 2a is extremely unlikely and that potential entanglement of these species in CTDs or plankton nets would be discountable.

3. Collisions with vessels

Trained lookouts will be used to insure to the greatest extent possible that no listed species are in the vicinity of project activities including transit of the vessel to and from the action area, while also decreasing the likelihood of collisions with listed species. NMFS estimates all marine vessels statewide take an average of 577,872 annual trips. This includes fishing and non-fishing vessels (NMFS 2008). Given the high vessel traffic volume around Hawaii, collisions between cetaceans and vessels are relatively rare events. The vessel will travel at slow speeds (less than nine knots) and use trained lookouts to avoid collisions with listed species. Based on the BMPs described above, the use of a couple of vessels for this action, and the low density of listed species throughout the entire action area, we expect that collision with a sea turtle, marine mammal, chambered nautilus, manta ray, or shark listed in Table 2 a is extremely unlikely and therefore discountable.

4. Exposure to waste and discharge

All NOAA vessels are well-maintained and ship waste would not be allowed to discharge into waters of the action area. The crew are well prepared to quickly deal with spills should they occur. The likelihood of either event occurring during the cruise is considered to be negligible and therefore we would not expect listed species to be exposed to vessel wastes. Even if a spill were to occur, we would expect it highly unlikely that any individual of any of the listed species or their habitat would be exposed to a volume of wastes that would result in a meaningful behavioral response, and would be even less likely to invoke a response that would injure any individual of any listed species in Table 2. Therefore, we expect that that effects of wastes and

discharges would have discountable effects on sea turtles, marine mammals, chambered nautilus, manta rays, or sharks in Table 2a.

Hawaiian monk seal critical habitat
None of the activities described above will be conducted in Hawaiian monk seal critical habitat. The ship will travel through the critical habitat on their way to and from the monitoring locations. The Hi‘ialakai will use slow speeds and lookouts to minimize collisions, and their presence will have little effect on the conservation value of the critical habitat. The minimal vessel movement, along with the implementation of BMPs, is not likely to reduce adequate prey quality and quantity for adult or juvenile monk seals, and therefore is not likely to reduce the conservation value of the critical habitat in the action area. All potential effects to habitat are expected to be temporary, of short duration and small in scale, and therefore insignificant and not likely to adversely affect listed specie

Summary
Based on consideration of the record and best available scientific information about the proposed action and the biology and expected behaviors of the ESA-listed marine species and designated critical habitat, NMFS concurs with: 1) the list of ESA-listed species and critical habitat (Table 1 a) potentially exposed to the effects of the action; 2) the suite of identified stressors; and 3) the science center’s assessment of exposure risk and significance of exposure to those stressors. We concur that the likelihood of impacts from Part 1 of the cruise will be insignificant or discountable for listed sea turtles, marine mammals, sharks, manta ray, nautilus, and insignificant for designated critical habitat for Hawaiian monk seals. This concludes our analysis of these species in this consultation; the remainder of the consultation will focus on effects to ESA-listed corals from Part 2 of the cruise.

6.2 Species Likely to be Adversely Affected

Part 2 of the Science Center research cruise concerns the collection of voucher specimens from the ESA-listed corals. The collection of specimens from ESA-listed coral species would be for morphometric, genetic, histological, and physiological studies. This part of the cruise involves “take” as defined by the ESA, and is therefore considered “likely to adversely affect” the species listed in Table 2 b, and thus these species are considered further in this opinion.

6.2.1. *Acropora globiceps*

Distribution and Abundance: *A. globiceps* has been reported from the central Indo-Pacific, the oceanic west Pacific, and the central Pacific (IUCN, 2010). It is common and relatively widespread in the north-south direction, but somewhat restricted in the east-west direction and has a narrow depth range (Richards 2009). Richards (2009) estimates the range of the species at 5 million km^2, and within its range are found on upper reef slopes, reef flats, and adjacent habitats in depth ranging from 0 to 8 m. Based on Richards *et al.* (2008) and Veron (2014), the absolute abundance of this species is likely at least tens of millions of colonies.

Biological Characteristics: Colonies of this species are usually small and digitate, with the size and shape dependent on the amount of wave action that a colony is exposed to. Colonies are uniform blue or cream in color (Veron, 2000). It appears similar to *Acropora gemmifera*, but in

strong wave action is similar to *Acropora monticulosa*. The species is a hermaphroditic spawner with lecithotrophic (yolk-sac) larvae.

Threats to the Species: The biggest threat to this coral species is global climate change due to the increase of CO_2 emissions from the burning of fossil fuels. The impact of increased atmospheric CO_2 on the world's oceans is to increase water temperatures and lower pH. Increasing ocean temperatures are directly responsible for bleaching events around the world that have led to significant coral mortalities; while increasing temperatures may work in tandem with coral diseases to reduce coral health and survivorship (Bruno *et al*., 2007). As the oceans warm it is likely that there will also be a greater stratification of ocean water, which will decrease vertical mixing of nutrient-rich waters resulting in nutrient-poor surface waters (Behrenfeld *et al*., 2006). Acidification of the world's ocean (lower pH) will potentially impact corals by reducing calcification rates, increasing erosion, and affecting reproduction. Reduced calcification rates may force corals to respond in one of three ways: corals may grow slower; corals may grow at the same rate, at the cost of reducing skeletal density; or corals may divert energy from other processes (such as reproduction) to maintain the same growth rate (Hoegh-Guldberg *et al.*, 2007). An increasingly acidic ocean may cause corals to calcify more slowly and become more fragile, this would impede reef growth and decrease the ability of corals to recover from habitat damage resulting from disturbances such as hurricanes, vessel groundings, and anchoring (Brainard *et al*., 2011). Although research has been inconclusive, acidification may impact development and physiology, fertilization and settlement success of coral larvae (Portner et al., 2004, Albright et al., 2008, Albright et al., 2010).

There is very little information on threats to the species specific to *Acropora globiceps*, so the information for the genus *Acropora* is provided. *Acropora* are among the most susceptible corals to bleaching (Carpenter et al. 2008; Marshall and Baird, 2000; McClanahan *et. al*. 2007; McClanahan *et. al*., 2005). Experiments have shown that acidification has had negative effects on calcification, productivity, and has impaired the fertilization and settlement of *Acropora* species (Anthony *et al*., 2008; Marubini *et al*., 2003; Reneger and Riegel, 2005; Schneider and Erez, 2006; Anthony *et al*., 2008; Crawley *et al*., 2010; Albright *et al*., 2010). Available information indicates that species of the genus are moderately to highly susceptible to disease (Aronson and Precht, 2001; Bruckner and Hill, 2009).

Conservation of the Species: Records confirm that *A.* globiceps occurs in 22 Indo-Pacific ecoregions[2] that encompass the following countries' EEZs: Australia, Federated States of Micronesia, Fiji, French Pacific Island Territories, Indonesia, Japan, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Pitcarin Islands, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and Vietnam (79 FR 53851 (Sept. 10, 2014)).

The scope of regulatory mechanisms in the countries where the species is found varies in terms of those that utilize them and the extent to which those regulatory mechanisms are applied (see Appendix C), but the most common regulations in place for this species are those regarding reef

[2] Ecoregion used throughout this Opinion are based on Veron (2014). See Reference section for citation.

fishing, area management for protection and conservation, and collection laws (79 FR 53851 (Sept. 10, 2014)).

6.2.2 *Acropora jacquelineae*

Distribution and Abundance: *Acropora jacquelineae* has been reported from the central Indo-Pacific (IUCN, 2010), and has been found in Indonesia and Papua New Guinea (Richards *et al.*, 2008b). Richards (2009) calculated the geographic range of the species at 2 million km^2, and within its range has been reported as uncommon (Veron 2000). The species occurs in numerous habitats including, lower reef slopes, walls and ledges, mid-slopes, and upper reef slopes protected from wave action, in depths ranging from 10 to 35 m (79 FR 53851). Based on Richards et al. (2008) and Veron (2014), the absolute abundance of the species is likely at least a million colonies.

Biological Characteristics: Colonies of *Acropora jacquelineae* are flat plates up to one m in diameter (Brainard *et al*., 2011). Viewed from above, plates are covered with a mass of fine delicately-curved axial corallites giving an almost moss-like appearance. Colonies are uniform grey-brown or pinkish in color (Veron 2000). The species is a hermaphroditic spawner with lecithotrophic (yolk-sac) larvae.

Threats to the Species: See the general information in the paragraphs describing climate change under *A. globiceps*. There is very little information on threats to the species specific to *Acropora jacquelineae,* see genus information provided under *A. globiceps*.

Conservation of the Species: *A. jacquelineae* occurs in 12 Indo-Pacific ecoregions that encompass five countries' EEZs including: Federated States of Micronesia, Indonesia, Papua New Guinea, Solomon Islands, and Timor-Leste (79 FR 53851 (Sept. 10, 2014)).
The scope of regulatory mechanisms in the countries where this species is found varies in terms of those that utilize them and in the extent to which those regulatory mechanisms are applied, but the most common regulations in place for this species are those regarding reef fishing, and area management for protection and conservation (79 FR 53851 (Sept. 10, 2014)).

6.2.3 *Acropora retusa*

Distribution and Abundance: *Acropora retusa* occurs across a wide range globally, reported in the Red Sea, Madagascar, South Africa, Chagos in the Indian Ocean, the Solomon Islands and the central Pacific (Veron 2000, Veron and Wallace, 1984). The species has been reported as common in South Africa, and uncommon throughout the rest of its range (Veron 2000; Veron and Wallace, 1984). Richards (2009) estimated the species range at 68 million km^2, and within its range occupies several shallow depth habitats (one to five m) including reef slopes and back-reef areas, such as upper reef slopes, reef flats, and lagoons. Based on Richards *et al.* (2008) and Veron (2014), the absolute abundance of the species is likely at least one million colonies.
Biological Characteristics: *Acropora retusa* are typically seen as flat plates with short thick digitate branches (Brainard *et al*., 2011), and is similar in appearance to *Acropora branchi*, *Acropora gemmifera*, and *Acropora monticulosa*. Colonies are brown in color (Veron 2000; Veron and Wallace, 1984). The species is a hermaphroditic spawner with lecithotrophic (yolk-sac) larvae.

Threats to the Species: See the general information in the paragraphs describing climate change under *A. globiceps*. There is very little information on threats to the species specific to *Acropora retusa,* see the genus information provided under *A. globiceps*.

Conservation of the Species: Records confirm that *A. retusa* occurs in 23 Indo-Pacific ecoregions that encompass many countries' EEZs including: Brunei, Federated States of Micronesia, Fiji, the French Pacific Islands Territories, India, Indonesia, Japan, Kenya, Madagascar, Malaysia, Mauritius, Mozambique, Cook Islands, Tokelau, Niue, Palau, Papua New Guinea, Samoa, Seychelles, Solomon Islands, South Africa, Sri Lanka, Tanzania, Tonga, Tuvalu, Tuvalu, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and Vietnam (79 FR 53851 (Sept. 10, 2014)).

The scope of regulatory mechanisms in the countries where this species is found varies in terms of those that utilize them and the extent to which those regulatory mechanisms are applied, but the most common regulations in place for this species are those regarding reef fishing, and area management for protection and conservation (79 FR 53851 (Sept. 10, 2014)).

6.2.4 *Acropora speciosa*

Distribution and Abundance: *Acropora speciosa* is reported to have a moderately broad range (Richards 2009), and has been reported in Fiji, Indonesia, Papua New Guinea, Australia, the Philippines, Polynesia, and Micronesia (Brainard *et al*, 2011). Richards (2009) estimated its range at 20 million km^2, and within its range occupies lower reef slopes and walls, especially those with clear waters. The species is found in depths ranging from 20 to 40 m, and has even been found in "mesophotic habitats" (40 – 150 m). Using an area correction for the population estimate made in Richards *et al.* (2008), the total population size for *A. speciosa* has been estimated at over 10 million colonies, with and an effective population size of at least 1.2 million colonies.

Biological Characteristics: Colonies of *A. spe*ciosa form thick cushions or brush-like branches, and can be elongate, radial, or tubular in shape (Brainard 2011), and is similar in appearance to *A. echinata* and *A. granulosa*. Colonies usually appear cream in color and have colored branched tips (Veron 2000). Based on information from other *Acropora* species, *A. speciosa* is most likely a hermaphroditic spawner with lecithotrophic (yolk-sac) larvae.

Threats to the Species: See the general information in the paragraphs describing climate change under *A. globiceps*. There is very little information on threats to the species specific to *Acropora speciosa,* see the genus information provided under *A. globiceps*.

Conservation of the Species: Records confirm that *A. speciosa* occurs in 26 Indo-Pacific ecoregions and several countries' EEZs including: Australia, Brunei, China, Federated States of Micronesia, the French Pacific Island Territories, Indonesia, Malaysia, Maldives, Marshall Islands, Palau, Papua New Guinea, Philippines, Solomon Islands, Taiwan, Timor-Leste, the Pacific Remote Islands Areas, and Vietnam (79 FR 53851 (Sept. 10, 2014)).
The scope of regulatory mechanisms in the countries where this species is found varies in terms of those that utilize them and the extent to which those regulatory mechanisms are applied, but the most common regulations in place for this species are those regarding reef fishing, and area management for protection and conservation (79 FR 53851 (Sept. 10, 2014)).

6.2.5 *Euphyllia paradivisa*

Distribution and Abundance: *Euphyllia paradivisa* has a restricted range; it is only found in the Coral Triangle Region (Brainard *et al*., 2011). The species inhabits environments protected from wave action on upper reefs slopes, mid-slope terraces, and lagoons in depths from 2 to 25 m. Based on Richards *et al.* (2008) and Veron (2014), the absolute abundance of the species is likely at least tens of millions of colonies.

Biological Characteristics: Colonies of *Euphyllia paradivisa* are made up of branching separate corallites (Brainard *et al*., 2011). The taxonomy was described as having no taxonomic issues but having tentacles similar to *E. divisa* and skeleton that is the same as *E. glabrescens, E. paraglabrescens*, and *E. paraancora*. Colonies are pale greenish-grey in color with lighter colored tips (Veron 2000).

Threats to the Species: See the general information in the paragraphs describing climate change under *A. globiceps*. Due to its limited distribution, there is a lack of information on the susceptibility of *E. paradivisa* to many of the threats that corals face at this time. The species experienced high bleaching levels during the event that occurred in Palau (Bruno *et al*., 2001) during the 1997-98 incident, but its susceptibility to acidification, disease, and predation are largely unknown (Brainard *et al*., 2011). Species of the genus *Euphyllia* are major contributors in the aquarium trade, but due to the similarity in appearance among the species, the nature of the specific threat is unknown (Brainard *et al*., 2011). The major concern with the species would appear to be its limited distribution, especially since the area of its distribution is highly disturbed, and its apparent uncommon occurrence throughout its range (Brainard *et al*., 2011).

Conservation of the Species: Records confirm that *E. paradivisa* occurs in eight Indo-Pacific ecoregions, and in numerous countries' EEZs including: Brunei, Fiji, the French Pacific Island Territories, Indonesia, Malaysia, Tokelau, Niue, Papua New Guinea, Philippines, Samoa, Timor-Leste, Tonga, Tuvalau, American Samoa, and Vietnam (79 FR 53851 (Sept. 10, 2014)).

The scope of regulatory mechanisms in the countries where this species is found varies in terms of those that utilize them and the extent to which those regulatory mechanisms are applied, but the most common regulations in place for this species are those regarding reef fishing, and area management for protection and conservation (79 FR 53851 (Sept. 10, 2014)).

6.2.6 *Isopora crateriformis*

Distribution and Abundance: Although there are some questions regarding the distribution due to similarity in *Isopora* species, *Isopora crateriformis* occurs from Sumatra to American Samoa (Wallace 1999; Veron 2000). The species is found primarily in reef flats and upper reef slopes most commonly in shallow, high-wave energy environments, from low tide to at least 12 m depth, and from mesophotic depths (<50m). Richards (2009) calculated the geographic range of the species at about 11 million km^2. Based on the results from Richards *et al.* (2008) and Veron (2014), the absolute abundance of the species is likely at least millions of colonies.

Biological Characteristics: Colonies of *I. crateriformis* are typically flat encrusting plates (Brainard *et al*., 2011). Based on its encrusting morphology, the species is not prone to asexual reproduction via fragmentation and are considered hermaphroditic (containing both male and female gametes) brooders. Colonies release sperm into the water column, however fertilization

occurs internally within the polyp. Planula develop within the polyp after fertilization. This results in fewer and larger offspring which are released several weeks later allowing for more efficient settlement. Colonies of the species are generally brown in color (Veron 2000).

Threats to the Species: See the general information in the paragraphs describing climate change under *A. globiceps*. Although there is little species specific information, *I. crateriformis* has been reported to tolerate high temperatures better than other species at the family level in both the American Samoa and Fiji bleaching events from recent years (Craig *et al*., 2001; Lovell 2000). With scant information on the species with regard to acidification, disease, and predation; *I. crateriformis* is considered to have similar susceptibility to these threats as other members of the family *Acroporidae* (Brainard *et al*., 2011).

Conservation of the Species: Records confirm that *I. crateriformis* occurs in 13 Indo-Pacific ecoregions that encompass several countries' EEZs including: Australia, Brunei, Fiji, French Pacific Island Territories, Indonesia, Kiribati, Malaysia, Tokelau, Niue, Papua New Guinea, Philippines, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, and American Samoa (79 FR 53851).

The scope of regulatory mechanisms in the countries where this species is found varies in terms of those that utilize them and the extent to which those regulatory mechanisms are applied, but the most common regulations in place for this species are those regarding reef fishing, and area management for protection and conservation (79 FR 53851 (Sept. 10, 2014)).

7. Environmental Baseline

The environmental baseline for a biological opinion includes past and present impacts of all state, federal or private actions and other human activities in the action area, 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). The Consultation Handbook further clarifies that the environmental baseline is "an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area." (U.S. FWS and NMFS 1998). The purpose of describing the environmental baseline in this manner in a biological opinion is to provide context for effects of the proposed action on listed species.

The past and present impacts of human and natural factors leading to the status of the species addressed by this opinion within the action area include fishery interactions, vessel groundings, pollution, marine debris, and climate change. The environmental baseline for the ESA-listed marine species addressed by this opinion are described below.

During the Science Center Cruise in 2015 where they proposed to collect voucher specimens of ESA-listed corals, none were collected (Pers. Comm. Hoku Johnson). As previously described, this opinion considers the proposed action of the NOAA ship Hi'ialakai for the research cruise. The research cruise will include the waters of American Samoa, the Pacific Remote Islands, and the intervening waters to those locations and the home port of the Hi'ialakai. The intended cruise

will take the vessel from Honolulu to Johnston Atoll, and Howland and Baker Islands, before moving on to American Samoa. After completing the work in American Samoa, the cruise will continue on to Jarvis Island, Palmyra, and Kingman Reef before transiting back to Honolulu.

The islands and atolls of the Rose Atoll Marine National Monument and the Pacific Remote Islands Marine National Monument are some of the most isolated in the world and any major population centers are at a minimum hundreds, and in most cases, thousands of kilometers away. Within the Pacific Remote Island Monument, the only inhabited island is Palmyra which houses a small continuously manned research facility. In American Samoa, the only significantly inhabited island is Tutuila, population approximately 60,000, which is 240 km from Rose Atoll Monument.

American Samoa consists of five main islands and two coral atolls. The largest and most populous island is Tutuila, with the Manu'a Islands, Rose Atoll, and Swains Island also included in the territory. The work to be conducted by the research cruise will be within the areas designated as the National Marine Sanctuary of American Samoa and the Rose Atoll Monument.

Originally established as the Fagatele Bay National Marine Sanctuary, on July 26, 2012, the Sanctuary was expanded to include five other units, and the name was changed to the National Marine Sanctuary of American Samoa (FR 77 43942). The additions included: the bay area of Fagalua/Fogama, and the waters around part of Aunu'u, Ta'u, and Swain's Island and Rose Atoll. These additions increase the size of the Sanctuary from 0.25 square miles to 13,581 square miles, of which 99 % was from the addition of the Rose Atoll Monument.

The regulations established for the Sanctuary included general prohibitions that include, discharging any material or other matter within the Sanctuary; disturbing the benthic community by dredging, filling, dynamiting or otherwise altering the seabed; and anchoring. Fishing prohibitions established include the use of poisons or explosives, any type of fixed net, and the use of a bottom trawl. Also, the take of live rock or coral is prohibited (take was already prohibited in territorial waters less than 60 under ASCA 24.0927 (a) and in federal waters under 50 CFR 665.125(c)). Prior to the establishment of these regulations, the ESA-listed corals considered in this opinion were at potential risk from many of these activities, mostly around Tutuila where the majority of the population of American Samoa resides; since their enactment, the ESA-listed corals at are minimal risk from local anthropogenic impacts. Although these same regulations apply to Rose Atoll, the atoll's distance from the major population centers in American Samoa has always prevented impacts to ESA-listed corals from locally derived human-caused impacts.

The Rose Atoll Monument was established by Presidential Proclamation 8337on January 6, 2009. The Monument consist of the emergent and submerged lands and waters that lie approximately 50 nautical miles from the mean low water line of Rose Atoll. The area within the Monument covers an area of approximately 13,451 square miles. Commercial fishing within the entire Monument is prohibited, recreational and charter fishing is prohibited within 12 nautical miles of the atoll, and the atoll's distance from any major population centers prevents local derived anthropogenic impacts to ESA-listed corals.

The Pacific Remote Islands which consist of the islands and atolls of Baker, Howland, Kingman, Jarvis, Johnston, Palmyra, and Wake were designated as the he Pacific Remote Islands Marine National Monument by Presidential Proclamations 8336 on January 6, 2009. When established in 2009, the Monument consisted of the waters and submerged and emergent lands that lie within approximately 50 nautical miles from the mean low water lines of the islands and atolls mentioned above, an area of approximately 86,888 square miles. On September 25, 2014, the Pacific Remote Islands monument was expanded to the extent of the Economic Exclusive Zone (200 nm) for Jarvis, Wake and Johnston which increased the total area to 308,316 square miles (Proclamation 9173). Commercial fishing is prohibited within the Pacific Remote Islands Monument, including those waters added in the expansion, and the islands and atolls are all uninhabited (except for Palmyra) and are isolated by thousands of kilometers of ocean from any major population centers which prevents locally caused human impacts.

The limited amount of authorized access to the Sanctuary and monuments is by permission from the managers for research and exploration, and by the managers themselves for management-related activities. Within the Pacific Remote Island Monument, the primary site of activity is on Palmyra where the U.S. Fish and Wildlife Service, the Nature Conservancy, and their research partners have formed the Palmyra Atoll Research Consortium. Since 2009, the U.S. FWS has issued an average of 25 per year. Most of these research projects occurred on Palmyra. Currently, the only regular NOAA presence in the Pacific Remote Island Monument is the research cruises that take place once every three years. These numbers speak to the minimal risk that the ESA-listed species of corals are under due to locally derived human-related impacts (such as vessel groundings, discharge, etc.) that are the direct result of the regulatory environment for the Sanctuary and monuments.

Although their isolation provides some level of protection from local stressors, the islands and atolls of the Sanctuary and monuments are not immune to the impacts from the global phenomenon of climate change. The global mean temperature has risen by 0.76^{o} C over the last 150 years, and much of that increase has occurred over the past 50 years (Solomon *et al*., 2007). This temperature change is due largely to the increased levels of the greenhouse gas carbon dioxide (CO_2) which has steadily increased from approximately 280 ppm at the start of the Industrial Revolution to over 390 ppm by 2009 (WDCGG 2010).

Increased levels of CO_2 are due primarily to the burning of fossil fuels and human development that has resulted in deforestation around the world. The major impacts to the world's oceans have been the increase in water temperatures as the earth warms, acidification (lower pH) from the increased CO_2 absorbed by the oceans, and rising sea levels due to glacial melt from the increasing global temperatures.

Globally, climate change is adversely affecting many coral species. Increasing water temperatures has been linked to widespread and accelerated bleaching and mass mortalities of corals around the world over the past 25 years (Brainard *et al.*, 2011). Ocean acidification, which changes the calcium carbonate saturation state of seawater, may affect fertilization and larval settlement in corals, and could decrease growth and calcification rates (Brainard *et al*., 2012). Corals are generally slow growing organisms that often have a narrow depth range preference that is optimum for the symbiotic algae that produces much of the food corals survive on; if sea

levels rise faster than corals are able to keep pace with, the wavelengths of light that reach them may not be useable by the algae they rely on.

The incidence of climate-related events to the corals within the Sanctuary and monuments have been minimal compared to many areas around the world. This could be primarily due to relative stability of the Pacific waters in these areas and the general lack of other locally caused anthropogenic stressors that many corals closer to inhabited areas face, or may be an artifact of the overall lack of monitoring of these areas due to their isolation.

8. Effects of the Action

In this section of a biological opinion, NMFS assesses the probable effects of the proposed action on threatened and endangered species. “Effects of the action” refer to direct and indirect effects of the action on a species or it’s designated critical habitat, together with the effects of other activities that are interrelated and interdependent with that action that would be added to the environmental baseline. “Direct effects” are caused by exposure to the action related stressors that occur at the time of the action. “Indirect effects” are those that are likely to occur later in time (50 CFR 402.02). The “effects of the action” are considered within the context of the “Status of the Species,” together with the “Environmental Baseline” and “Cumulative Effects” to determine if the proposed action can be expected to have direct or indirect effects on a species that appreciably reduces its likelihood to survive and recover in the wild by reducing its reproduction, number, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination.

Approach: NMFS determines the effects of the action using a sequence of steps. The first step identifies stressors (or benefits) associated with the proposed action with regard to listed species. The second step identifies the magnitude of stressors (e.g., how many individuals of a listed species will be exposed to the stressors; *exposure analysis*). In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to a proposed action’s effects, and the populations or subpopulations those individuals represent. The third step describes how the exposed individuals are likely to respond to these stressors (e.g., the mortality rate of exposed individuals; *response analysis*).

The final step in determining the effects of the action is establishing the risks those responses pose to listed resources (*risk analysis*). The risk analysis is different for listed species and designated critical habitat. Our jeopardy determinations must be based on an action’s effects on the continued existence of threatened or endangered species as those species have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of populations that comprise them, viability (probability of extinction or probability of persistence) of listed species depends on viability of their populations. Similarly, the continued existence of populations are determined by the fate of individuals that comprise them; populations grow or decline as individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. We begin by identifying the probable risks the action poses to listed individuals that are likely to be exposed to an action's direct and indirect effects. Our analyses then integrates those individuals' risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," which are changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable responses to an action's effects on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness. When individually listed plants or animals are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent. Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. On the other hand, when listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise. If we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment tries to determine if those fitness reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the 'Status of Listed Species', 'Environmental Baseline', and 'Cumulative Effects' sections of this opinion) as our point of reference. Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise. This introduction summarizes stressors and interactions resulting from the proposed action. It is included here to set the stage for the following sections.

NMFS has determined that the stressors associated with Part 2 of the proposed action includes the "take" of polyps from a coral colony, and the resulting stresses associated with the removal of this coral tissue that is collected. When NMFS listed the coral species considered in this opinion, it used the concept of the ''physiological colony'' as the entity that can be considered an individual. Thus, the final rule (Final Rule 79 FR 53982 (Sept. 10, 2014)) considers the ''individual'' for each of the listed species to be the colony. Polyps are not considered individuals, sexually- and asexually-produced colonies are considered individuals.

This stressors are the same for all the coral species listed in Table 2 b. The following sections will focus on the exposure, response and risk to each individual species from the collection of voucher specimens.

8.1 Indirect Effects to ESA-listed coral species resulting from Part 1 of the Cruise.

All in-water survey activities related to Part 1 of the cruise have the potential to result in damage to coral. SCUBA operations related to the surveys could potentially result in accidental contact by divers (fins or other diver gear) of ESA-listed coral species. However, the use of highly qualified divers, extensive dive training, and adherence to best practices designed to minimize unnecessary contact with live reef, diminish any incidental effects on ESA-listed coral species. Also, efforts will be made to identify the six corals listed as threatened that occur in the action area and avoid working in those areas while conducting surveys and non-ESA listed coral collections. The impacts to ESA-listed corals from Part 2 of the cruise are analyzed later in this Opinion.

Interactions with ESA-listed coral species while performing macroalgae collections is also highly unlikely, and thus discountable, given that this procedure deliberately avoids corals, corals generally do not settle on fleshy macroalgae or crustose coralline algae. Given the active avoidance of ESA-listed corals when conducting surveys and collections on non-ESA listed corals, and the low relative abundance of ESA-listed coral species in the action area, it is expected that damage to ESA-listed coral species through survey and collections will be extremely unlikely to occur and therefore discountable.

Oceanographic monitoring sensors have the potential to damage coral reefs, including ESA-listed corals. However, sensors will be secured to dead substrate using cinder blocks, cable ties and/or metal stakes. The footprint of the instrument packages is approximately 61 cm x 61 cm x 61 cm and therefore relatively small. The sensors will be secured in calmer areas with less wave action by experienced SCUBA divers and would be deployed for no more than five days. The collection sensors will also be packaged together and secured to the seafloor via cinder blocks, zip ties, and metal stakes. Based on the relatively small footprint, low number of sensor packages and installation of each package by highly qualified and experienced SCUBA divers, damage to adjacent coral reefs and ESA-listed corals is extremely unlikely and therefore discountable.

Physical damage to ESA-listed corals from coring, biopsy, and tissue sampling of non-listed species would be unlikely to occur. ESA-listed coral species would be avoided during coring and tissue sampling activities, and all scientific divers involved in the process will have training in coral species identification so that they could avoid listed corals when sampling non-listed coral species.

During the cruise, NOAA Ship Hi‘ialakai would only anchor in extreme inclement weather or if an emergency arises (e.g. medevac, mechanical issues, etc.). Small boats will anchor occasionally (most of the time small boats “live boat” when divers are down) when conducting SCUBA operations. Small boats will adhere to the following best management practices when deploying anchors: 1) anchors are lowered rather than thrown; 2) anchors would be deployed on sandy substrate or dead coral rubble to prevent damage to corals; 3) a diver would check the anchor to ensure it does not drag or entangle any benthos; and 4) if there is a mooring buoy near

a dive site, the small boat would tie off at the buoy instead of anchoring. Additionally, damage to protected coral species via Science Center small boat anchoring has never been observed.

When the monitoring equipment is retrieved in approximately three years the same BMPs will be used by the Science Center to avoid impacts to corals. Areas with listed corals are going to be avoided when monitoring equipment is deployed. Considering that listed corals are rare in the action area, that researchers are going to avoid listed corals during deployment, and the use of BMPs, we expect that damage to ESA-listed will be extremely unlikely to occur and therefore discountable

In summary, based on the limited distribution of the ESA-listed corals in the action area, strict adherence to BMPs in place to avoid damage to corals during surveys, sensor deployment/recovery, collection, and avoidance of areas where listed corals are located; NMFS agrees that the potential risk to ESA-listed corals from the proposed activities of Part 1 of the cruise are discountable.

8.2 Direct collection of ESA threatened corals

The proposed action would include the directed take of voucher specimens of Acropora globiceps, A. jacquelineae, A. retusa, A. speciose, Euphyllia paradivisa, Isopora crateriformis. As noted in the proposed action section of this opinion, coral tissue samples will be carefully collected from threatened corals using bone cutters or hammer and chisel (as necessary). The maximum number of samples is listed in Table 1. None of the individual specimens will constitute a complete colony. In the case of E. paradivisa, the biopsy metrics considered for these harvests are based on the skeletal features and not the extended soft tissue of the polyp. Due to the growth pattern of E. paradivisa and maximum allowable extent of harvest, the resultant individual specimen is expected to be a singular branched polyp with or without buds. Two polyps per E. paradivisa specimen would be the maximum expected harvest per 7 cm sample.

For all species of threatened corals, the removal and loss of tissue and subsequent regrowth of tissues has energetic costs that could slow other growth and reproduction, exposed areas of coral skeleton are prone to bioerosion and overgrowth by algae and certain sponges, and damaged and stressed tissue may be more susceptible to infection by coral diseases that may hinder or prevent healing to the point that the colony dies. Even so, coral colonies will continue to exist even if numerous polyps die, or if the colony is broken apart or otherwise damaged. The sampling described in this opinion would potentially injure and negatively affect colony polyps, but given the small sample size (and associated sampling protocol), and the colonial nature of corals, we would not expect significant injury would occur to any colony of any species. As such, the proposed specimen samples would not likely represent a serious threat to the health or survival of the colony sampled of any species.

8.2.1 Risk to *Acropora globiceps*

The species has a range that stretches across the central Indo-Pacific, the oceanic west Pacific, and the central Pacific (IUCN, 2010), an area that encompasses approximately 5 million km^2. Although uncommon in the action area, the species is estimated to have an absolute abundance of at least tens of millions of colonies (Richards *et al.*, 2008 and Veron 2014).

NMFS believes that the magnitude and intensity of the impact from the directed take of voucher specimens from *A. globiceps* would be mitigated by the following factors: 1) The small number of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) The infrequent surveys (cruises to a particular jurisdiction occur once every three years); 3) The use of random sample design (sites are randomly chosen so revisiting the same site is unlikely); and 4) The strict adherence to Best Management Practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself.

Because of these factors, the proposed action is expected to have a negligible effect on any colony sampled, with no significant injury, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

8.2.2 Risk to *Acropora jacquelineae*

The species occurs in numerous habitats including, subtidal reef slopes and back-reef habitats, lower reef slopes, walls and ledges, mid-slopes, and upper reef slopes protected from wave action. The total area encompassed by the species is approximately 2 million km^2. Although reported as uncommon throughout much of its range, the species has an estimated total population in the tens of millions, and an effective population size of million colonies (Richards *et al.,* 2008 and Veron 2014).

NMFS believes that the magnitude and intensity of the impact from the directed take of voucher specimens from *A. jacquelineae* would be mitigated by the following factors: 1) The small number of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) The infrequent surveys (once every three years); 3) the use of random sample design (sites are randomly chosen so revisiting the same site is unlikely); and 4) the strict adherence to best management practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself. Because of these factors, the proposed action is expected to have a negligible effect on any colony sampled, with no significant injury to it, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

8.2.3 Risk to *Acropora retusa*

The species is reported to occur only in shallow depths, but inhabits several habitat types, including, shallow reef-slopes and back-reef areas and ranges across a large area that encompasses an estimated 68 million km^2. Although reported as uncommon in the action area,

the absolute abundance of the species is likely at least a million colonies across its entire range (Richards *et al.*, 2008 and Veron 2014).

NMFS believes that the magnitude and intensity of the impact from the directed take of voucher specimens from *A. retusa* would be mitigated by the following factors: 1) the small number of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) the infrequent surveys ; 3) the use of random sample design, and 4) the strict adherence to best management practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself.
Because of these factors, the proposed action is expected to have a negligible effect on any colony sampled, with no significant injury to it, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

8.2.4 Risk to *Acropora speciosa*

The species has a moderately broad range that stretches across approximately 20 million km^2, and may extend farther since colonies of the species have been found in the poorly studied mesophotic depths. Although uncommon in the action area, the total population size of the species is estimated to be tens of millions colonies, with and an effective population size of at least a million colonies (Richards et al., 2008 and Veron 2014).

NMFS believes that magnitude and intensity of the impact from the directed take of voucher specimens from *A. speciosa* would be mitigated by the following factors: 1) the small number of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) the infrequent surveys ; 3) the use of random sample design ; and 4) the strict adherence to best management practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself.
Because of these factors, the proposed action is expected to have a negligible effect on any colony sampled, with no significant injury to it, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

8.2.5 Risk to *Euphyllia paradivisa*

The species has a range that is restricted to the Coral Triangle Region (Brainard *et al.*, 2011). Although reported as uncommon in the action area, the estimated absolute abundance of the species across its entire range is likely at least tens of millions of colonies (Richards *et al.*, 2008 and Veron 2014).

NMFS believes that the magnitude and intensity of the impact from the directed take of voucher specimens from *E. paradivisa* would be mitigated by the following factors: 1) the small number

of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) the infrequent surveys ; 3) the use of random sample design ; and 4) the strict adherence to best management practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself. Because of these factors, the proposed action will have a negligible effect on any colony sampled, with no significant injury to it, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

8.2.6 Risk to *Isopora crateriformis*

The species has a geographic range that extends across an area of approximately 11 million km2, part of which (the central Pacific portion) is expected to have less than average warming in the future (79 FR 53851 (Sept. 10, 2014)). Although reported as uncommon in the action area, the species has an estimated absolute abundance of at least millions of colonies (Richards *et al.*, 2008 and Veron 2014).

NMFS believes that the magnitude and intensity of the impact from the directed take of voucher specimens from *I. crateriformis* would be mitigated by the following factors: 1) the small number of colonies from which specimen material would be collected compared to the estimated abundance of the species; 2) The infrequent surveys ; 3) the use of random sample design ; and 4) the strict adherence to best management practices for sampling coral species which includes: sampling no more than one specimen of the target taxa present at any of the survey sites and not sampling if it is judged that collection may inhibit the capacity of the colony to replenish itself. Because of these factors, the proposed action is expected to have a negligible effect on any colony sampled, with no significant injury to it, and therefore represents negligible risk to any sampled populations. We therefore conclude that the proposed action presents negligible risk to the overall species. NMFS considers the risk negligible that project-related effects from sampling the coral colonies would appreciably reduce the likelihood of the survival and recovery of the species in the action area, and across their global range.

9 Cumulative Effects

Cumulative effects are limited to the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this opinion (50 CFR 402.02). Cumulative effects, as defined in the ESA, do not include the continuation of actions described under the environmental baseline, and future Federal actions that are unrelated to the proposed action are not considered in this section.

The impacts from fisheries, vessel groundings, pollution, and marine debris (as described in the Environmental Baseline section) within the Sanctuary and monuments are expected to be minimal. The prohibition on commercial fishing within monuments, and the sometimes vast distances between the islands and atolls and inhabited islands provides significant protection from all forms of anthropogenic stressors, and limits the number of entities that would be capable

of accessing these areas and might seek to do so. The managers of the sanctuary and the monuments are authorized to provide opportunities for research and exploration; but unauthorized access, except for innocent passage or other internationally recognized uses of the seas, is not permitted. This regulatory environment limits the number of vessels and researchers that will have access to these areas, and thereby reduces the risk from groundings, pollution and marine debris.

Anthropogenic release of CO_2 and other greenhouse gases is considered the largest contributor to global climate change, and it is expected that the release of those gases is not only likely to continue, but the rate of their release is expected to increase during the next century (Brainard *et al*. 2011), unless substantial changes are made to lower the emission of greenhouse gases and to slow the pace of deforestation. The earth is committed to a certain level of additional warming because of the level of greenhouse gases already emitted; therefore, global climate change is expected to continue to impact coral species, especially those species that are dependent on shallow coastal reefs and shorelines. There is uncertainty associated with the analysis of potential impacts of climate change on species and ecosystems (Barnett 2001). The effects of climate change will not be globally uniform (Walther *et al.* 2002) and information regarding the magnitude of future climate change is speculative and fraught with uncertainties (Nicholls and Mimura 1988).

In particular, there is no comprehensive assessment of the potential impacts of climate change within the action area. In addition to the uncertainty of the rate, magnitude, and distribution of future climate change and its associated impacts, ecological systems evolve in an ongoing fashion in response to stimuli of all kinds, including climatic stimuli (Smit *et al.*, 2000). Therefore, the 'seriousness' of climate change impacts may be modified by adaptations of various kinds (Tol *et al.*, 1998). However, the adaptability of species and ecosystems are also unknown.

For example, research has indicated that corals may be able to expel less tolerant symbionts, and replace them with those that are more heat tolerant (Baker *et al*., 2004; Oliver and Palumbi, 2010). And, while it is possible that warmer ocean temperatures may extirpate corals from areas they currently occupy, there is also the possibility that some species may be able to colonize areas that are presently uninhabitable due to changes in water temperature, chemistry, or other factors.

Impact assessment models that include adaptation must make assumptions (about when, how, and to what conditions adaptations might occur) based on theoretical principles, inference from observations, and arbitrary selection, speculation, or hypothesis (see review in Smit *et al*, 2000).

The effects of global climate change (the most significant of which for corals are the combined direct and indirect effects of rising sea surface temperatures and ocean acidification) are currently affecting corals on a global scale, particularly in parts of the Caribbean. Thermal stress can induce bleaching (where the coral expels its symbiotic zooxanthellae), which often causes mortality of the affected colony. Increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals, and for some species it can induce bleaching more so than thermal stress. It also tends to decrease growth and

calcification rates. The return frequency of bleaching events at some sites has exceeded the ability of the reefs and coral species to recover there. Brainard *et al*. (2011) report that those effects likely represent the greatest risk of extinction to ESA corals over the next century.

Field observation and models both predict increasing frequency and severity of bleaching events, causing greater coral mortality and allowing less time to recover between events. Therefore, the effects of global climate change could have synergistic effects on impacted corals within the action area. The ability of impacted corals to recover from the effects of the proposed action could be reduced due to the effects of elevated temperatures and increased ocean acidity, and the longer it takes for impacted corals to recover from the effects of the proposed action, the more likely it becomes that the effects of climate change would synergistically impact those corals. However, the degree to which those synergistic impacts may affect corals over the time required for them to recover from project impacts is unknown.

NMFS expects that recovery following the end of sampling activities would be relatively fast, and the possible synergistic impacts of climate change combined with the effects of the proposed action are not expected to be significant for the corals considered in this opinion.

10 Integration and Synthesis of Effects

The purpose of this biological opinion is to determine if the proposed action is likely to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. This is done by considering the effects of the action within the context of the status of listed species' together with the environmental baseline and the cumulative effects', as described in the approach section (beginning of Section 6 Effects of the Action).

We determine if mortality of individuals of listed species resulting from the proposed action is sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In order to make that determination, we use a population's base condition (established in the status of listed species and environmental baseline sections of this opinion) as context for the overall effects of the action on affected populations. Finally, our opinion determines if changes in population viability, based on the effects of the action and the cumulative effects, are likely to be sufficient to reduce viability of the species those populations comprise. The following discussion summarizes the probable risk the proposed action poses to the coral species identified in Section 3.

10.1 *Acropora globiceps*

A maximum of 10 specimens from this species would be collected from a total area of 236 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to

disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

A. globiceps is distributed throughout much of the Indo-Pacific and has been described as common and relatively widespread in its north-south range. The species occurs across 22 different ecoregions encompassing 20 different countries and territories, with a range estimate of 5 million km^2. The species abundance has been estimated in the tens of millions of colonies. Although considered common and widespread, the species has been described as restricted in its east-west distribution, and limited in the habitats it occupies. Colonies are generally found on upper reef slopes and reef flats, and within these habitats the species has a limited depth range of 0 – 8 m.

The effects of fisheries, vessel groundings, pollution and marine debris on this species, although possible, are expected to be minimal due to the regulatory environment in place for the sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998) provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard. Survival means: the species' persistence beyond the conditions leading to its endangerment, with sufficient resilience to allow recovery from endangerment. Namely, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficiently large population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter. Recovery means: improvement in the status of a listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act. That is, recovery is the process by which species' ecosystems are restored and/or threats to the species are removed so self-sustaining and self-regulating populations of listed species can be supported as persistent members of native biotic communities.

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species' resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the

proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *A. globiceps* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

10.2 *Acropora jacquelineae*

A maximum of 10 specimens from this species would be collected, these specimens would have a total area of 236 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

The distribution of *A. jacquelineae* has been reported across much of the central Indo-Pacific, encompassing 12 ecoregions from five countries and territories. Estimates for the species have put its range at approximately two million km^2, and its population in the tens of millions, with an effective population size of over three million. The species can be found in numerous habitats, and in a wide depth range, but has been reported as uncommon in the habitats that it occupies.

The effects of fisheries, vessel groundings, pollution and marine debris, although possible, are expected to be minimal due to the regulatory environment in place for the Sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998) provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard (please refer to the *Acropora globiceps* discussion in this section for definitions).

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *A. jacquelineae* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

10.3 *Acropora retusa*

A maximum of 10 specimens from this species would be collected, these specimens would have a total area of 236 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

A. retusa occurs across a wide range globally, and occurs in 23 Indo-Pacific ecoregions that span more than 30 countries and territories. Estimates have put the species range at 68 million km^2, and its population at over a million colonies. The species reportedly occupies numerous habitats, but has a limited depth range of one – five m, and although it has been reported as common in South Africa, it has been described as uncommon across the rest of its range.

The effects of fisheries, vessel groundings, pollution and marine debris, although possible, are expected to be minimal due to the regulatory environment in place for the Sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998) provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard (please refer to the *Acropora globiceps* discussion in this section for definitions).

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *A. retusa* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

10.4 *Acropora speciosa*

A maximum of 10 specimens from this species would be collected, these specimens would have a total area of 236 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

A. speciosa occurs across much of the western Pacific, and has been reported in 26 Indo-Pacific ecoregions that span 16 countries and territories. Estimates have put the species range at 20 million km^2, and its total population at over 10 million colonies, and its effective population size of 1.2 million colonies.

The effects of fisheries, vessel groundings, pollution and marine debris, although possible, are expected to be minimal due to the regulatory environment in place for the Sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998)

provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard (please refer to the *Acropora globiceps* discussion in this section for definitions).

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *A. speciosa* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

10.5 *Euphyllia paradivisa*

A maximum of 10 specimens from this species would be collected, these specimens would have a total area of 770 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

E. paradivisa has a restricted range, limited only to the Coral Triangle Region. The species range covers 8 ecoregions, across 15 countries and territories. Although limited in range, the species occupies several various habitats and has a moderate depth range of 2 – 25 m. The species absolute abundance has been estimated at tens of millions of colonies.

The effects of fisheries, vessel groundings, pollution and marine debris, although possible, are expected to be minimal due to the regulatory environment in place for the Sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998) provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard (please refer to the *Acropora globiceps* discussion in this section for definitions).

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *E. paradivisa* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

10.6 *Isopora crateriformis*

A maximum of 10 specimens from this species would be collected, these specimens would have a total area of 385 cm^2. No complete colony would be collected, and in no case will specimens be collected from a colony if it is judged that doing so might inhibit the capacity of the colony to replenish itself. Although the removal of a portion of the colony does make the colony more susceptible to disease or algal infection, and there may be some short-term reduction in fitness of the colony, the sample does not represent a significant threat to the health or survival of the colony.

There is some question regarding the distribution of *I. crateriformis*, but the species appears to range from Sumatra to American Samoa, an area encompassing over 11 million km^2, 13 Indo-Pacific ecoregions, and 18 countries and territories. The species has an absolute abundance of at least a few million colonies.

The effects of fisheries, vessel groundings, pollution and marine debris, although possible, are expected to be minimal due to the regulatory environment in place for the Sanctuary and monuments. This is not expected to change significantly in the future, even if the request for access increases, as the managers have protection of the resources as their primary responsibility. Climate change impacts will continue, and likely accelerate, as the world's oceans continue to warm and its chemistry changes. However, the impact and time scale of these effects on the

trajectory of the affected coral populations in the action area, and across the species range is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

We considered to what extent the effects of the action affect survival and recovery of this species. The NMFS and U.S. FWS' ESA Section 7 Handbook (U.S. FWS and NMFS 1998) provides further definitions for *survival* and *recovery*, as they apply to the ESA's jeopardy standard (please refer to the *Acropora globiceps* discussion in this section for definitions).

As no colonies are expected to perish because of sampling and minimal injury to any colony will occur, the proposed action is expected to have a negligible effect on the species resilience, reproduction, and it is not expected to reduce its numbers, or distribution, or impact its size classes, or genetic heterogeneity.

No recovery plan currently exists for this species against which we can assess the effects of the proposed action on recovery. However, given that impacts from the proposed action are expected to result in minimal injury, with no expected loss of a colony as a result of sampling, the proposed action is not expected to significantly impact reproduction or to impede the recovery of the species. We do not expect the proposed action to affect the ability of the overall population to grow and to successfully reproduce. The proposed action is expected to have no effect on the overall size of the population. We do not expect the proposed action to negatively affect the species ability to meet their lifecycle requirements, or its recovery.

To summarize, when considering the effects of the proposed action, together with the status of the listed species, the environmental baseline, and the cumulative effects, we believe that the non-lethal takes of *I. crateriformis* colonies associated with the proposed action are not expected to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

11 Conclusion

The purpose of this biological opinion is to determine if the proposed action is likely to jeopardize the continued existence of listed species (i.e., jeopardy determination) or result in destruction or adverse modification of 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 a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02).

After reviewing the current status of the coral species *A. globiceps, A. jacquelineae, A. retusa, A. speciosa, E. paradivisa,* and *I. crateriformis,* the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' opinion that proposed action is not likely to jeopardize the continued existence of *A. globiceps, A. jacquelineae, A. retusa, A. speciosa, E. paradivisa,* and *I. crateriformi*s.

12 Incidental Take Statement

Section 9 of the ESA and protective regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species without a special exemption. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. 50 CFR 402.02. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS).
The proposed action results in the directed take of the ESA-listed threatened species listed in Table 3 below. Currently there is no take prohibition for any of the species in this table. Thus, an ITS is not required to provide an exemption to the prohibition of take under section 9 o. However, consistent with the decision in *Center for Biological Diversity v. Salazar*, 695 F.3d 893 (9th Cir. 2012), this ITS is included to serve as a check on the no-jeopardy conclusion by providing a reinitiation trigger so the action does not jeopardize the species if the level of take analyzed in the biological opinion is exceeded.

Taxon	Number of specimens	Total size of specimens
Acropora globiceps	10	236 cm^2
Acropora retusa	10	236 cm^2
Acropora speciosa	10	236 cm^2
Acropora jacquelineae	10	236 cm^2
Euphyllia paradivisa	10	770cm^2
Isopora crateriformis	10	385 cm^2
Totals	60	2099 cm^2 (~0.209 m^2)

Table 3. Amount and extent of take by the proposed action.

12.1 Impact of the Take

In this biological opinion, NMFS determined that the level of take anticipated from the proposed action is not likely to jeopardize the *Acropora globiceps*, *Acropora jacquelineae*, *Acropora retusa*, *Acropora speciosa*, *Euphyllia paradivisa*, and *Isopora crateriformis*.

12.2 Reasonable and Prudent Measures

In order to ensure the federal action agency is tracking take and is not violating the no jeopardy conclusion of this biological opinion, the federal action agency must follow the reasonable and prudent measure described below, along with terms and conditions found in section 12.3. This measure is non-discretionary and must be undertaken by the Science center:

- NMFS Science Center shall collect information documenting the take of coral species during directed research activities, and share this information with the Pacific Islands Regional Office Protected Resources Division.

12.3. Terms and Conditions

NMFS Science Center shall undertake and comply with the following term and condition to implement the reasonable and prudent measure identified in Section 12.2 above. This term and condition is non-discretionary, and if NMFS Science Center fails to adhere to this term and condition, the protective coverage of this biological opinion may lapse.

- NMFS Science Center shall collect data and photographs on the exact coral species (including number of colonies) sampled and the total size of specimens sampled during directed coral research. This information will include a summary of observed effects to the coral sampled and the condition of the coral after the sampling was completed. Science Center will use this data to ensure they have not exceeded the level of take proposed and found in the Description of the Proposed Action and Action Area section of this biological opinion. Science Center will submit this this information to the Pacific Islands Regional Office Protected Resources Division Section 7 Program after the research cruise as soon as practicable.

13 Reinitiation Statement

This concludes formal consultation on the Science Center proposed 2018 research cruise. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated take for any species is exceeded;
2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;
3. The agency action is subsequently modified in a manner that may affect listed species or critical habitat to an extent in a way not considered in this opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

14 Conservation Recommendations

The Protected Resources Division of the NMFS Pacific Islands Regional Office has reviewed the information contained in the BE provided by the Science Center for the American Samoa Rapid Assessment and Monitoring Program, and believes the BMPs already in place for the Science Center do not warrant any further recommendations from our office with regards to this action.

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