Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Issuance of Scientific Research Permit 18761-2R to the University of California, Santa Cruz, for research on black abalone (*Haliotis cracherodii*) in California, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973

NMFS Consultation Number: WCR-2020-02534
ARN 151422WCR2020PR00186

Action Agency: Protected Resources Division, West Coast Region, NOAA National Marine Fisheries Service

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?*	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?*	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Black abalone (*Haliotis cracherodii*)	Endangered	Yes	No	Yes	No
Guadalupe fur seals (*Arctocephalus townsendi*)	Threatened	*No	NA	*No	NA
Steller sea lions (*Eumetopias jubatus*), eastern Distinct Population Segment	Delisted	*No	NA	*No	NA

*Please refer to section 2.12 for the analysis of species or critical habitat that are not likely to be adversely affected. Note that the eastern Distinct Population Segment of Steller sea lions was delisted in 2013, but critical habitat for the species as a whole remains designated.

Consultation Conducted By ...A National Marine Fisheries Service

Issued By: Chris E. Yates

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Date: November 12, 2020

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List of Acronyms

ARM	Abalone Recruitment Module
ARMP	Abalone Recovery and Management Plan
BML	Bodega Marine Laboratory
CDFW	California Department of Fish and Wildlife
CE	Categorical Exclusion
CINP	Channel Islands National Park
DQA	Data Quality Act
ESA	Endangered Species Act
EFH	Essential Fish Habitat
ITS	Incidental Take Statement
MARINe	Multi-Agency Rocky Intertidal Network
MLPA	Marine Life Protection Act
MSA	Magnuson-Stevens Act
NMFS	National Marine Fisheries Service
PFMC	Pacific Fishery Management Council
PIT tag	Passive-integrated transponder tag
PRD	Protected Resources Division
RPM	Reasonable and Prudent Measures
SWFSC	Southwest Fisheries Science Center
UCSC	University of California, Santa Cruz
USGS	United States Geological Survey
UW	University of Washington
WCR	West Coast Region
WS-RLO	Withering Syndrome Rickettsiales-like organism

1. **INTRODUCTION**

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared this biological opinion (opinion) in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR Part 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR Part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the NMFS Long Beach Office and Portland Office.

1.2 Consultation History

On July 15, 2020, the NMFS WCR PRD received an application from Dr. Peter Raimondi, University of California, Santa Cruz (UCSC), California, to renew their permit to "take"[1] endangered black abalone as part of an ongoing program to monitor black abalone population status, trends, genetics, and recruitment along the California coast.

We solicited public comments on the permit application from July 17 to August 17, 2020, via a notice published in the Federal Register (85 FR 43540; July 17, 2020). We did not receive any public comments on the permit application.

This consultation is on the proposal to issue Scientific Research Permit 18761-2R to Peter Raimondi, UCSC, to authorize research on endangered black abalone. Issuance of the permit constitutes a Federal action that may affect marine species listed under the ESA.

This opinion analyzes the research activities that may be authorized under Permit 18761-2R and evaluates their effects on ESA-listed resources, primarily endangered black abalone in the wild.

[1] Under the ESA, a take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to do any of the preceding.

1.3 Proposed Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

PRD proposes to issue Permit 18761-2R under the authority of Section 10(a)(1)(A) of the ESA to Peter Raimondi, UCSC, to authorize research activities for wild black abalone, as described in the permit application and summarized below. The proposed permit would authorize the research activities for a period of five years.

Permit 18761-2R would authorize researchers to continue most of the research activities authorized under the current permit (Permit 18761). All of the research activities would address and implement important recovery actions identified in the draft Black Abalone Recovery Plan (NMFS 2020). Only trained field biologists would conduct the research activities.

Table 1 summarizes the seven main research activities to be authorized under Permit 18761-2R and the duration and frequency of each. In the sections following the table, we describe each of the research activities in more detail and identify those aspects that are likely to affect listed species, or the physical, chemical, and biotic environment.

We considered, under the ESA, whether or not the proposed action would cause any other activities that would have consequences on listed species or their critical habitat and determined that it would not. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur.

Table 1. Summary of Research Activities Under Permit 18761-2R: Purpose, Actions Involving Take of Black Abalone, Location, Season, Duration, and Frequency.

Activity	Purpose	"Take" Actions	Location	Season	Duration	Frequency
Long-term monitoring surveys	Evaluate black abalone population abundance, size frequency, distribution, and health	Survey, count, measure black abalone	Rocky intertidal sites throughout California (approximately 109 sites)	Daytime low tide series, typically during fall to spring months	5 years	1-2 times per site per year; up to 4 times per year at select sites
Abalone habitat surveys	Document black abalone densities, habitat quality, and habitat associations	Survey, count, measure black abalone	Segments of the California coast encompassing rocky intertidal habitat	Daytime low tide series, typically during fall to spring months	5 years	Up to one time per year within each segment
Reconnaissance surveys for projects (e.g., jetty, breakwater repair) or in response to unexpected events (e.g., oil spills, landslides)	Evaluate black abalone presence, habitat quality, and effects of projects and events	Survey, count, measure black abalone	Rocky intertidal sites throughout California	Daytime low tide series	5 years	One-time per site as needed to evaluate presence of black abalone and critical habitat
Development and deployment of abalone recruitment modules (ARMs)	Monitor juvenile recruitment	Installation, monitoring, and removal of ARMs	At least three rocky intertidal sites, with six ARMs per site	Throughout the year	Five years	Monitoring: 2-3 times per year
Non-lethal collection of tissue samples or swab samples for genetic analysis	Evaluate the genetic structure and diversity of black abalone populations	Collection of epipodial clips or swab samples	Rocky intertidal sites throughout California	Throughout the year	At least one year	Opportunistically, but typically during monitoring surveys
Collection of dead and obviously unhealthy black abalone	Determine the cause of death and detect disease outbreaks	Collect dead and obviously unhealthy black abalone	Rocky intertidal sites throughout California	Throughout the year	5 years	Opportunistically, but typically during monitoring surveys
Collection of empty shells	For use in research, outreach, and education	Collect empty black abalone shells	Rocky intertidal sites throughout California	Throughout the year	5 years	Opportunistically, but typically during monitoring surveys

1.3.1 Description of Research Activities

Black abalone long-term monitoring surveys

Researchers have been monitoring black abalone throughout the California coast since the mid-1970s. Most of these researchers are part of the Multi-Agency Rocky Intertidal Network (MARINe), formed by the Bureau of Ocean Energy (formerly the Minerals Management Service) to coordinate rocky intertidal monitoring efforts. MARINe uses standardized methods to monitor rocky intertidal populations such as black abalone throughout the U.S. West Coast, including at over 80 sites in California (https://marine.ucsc.edu/).

The long-term monitoring surveys provide valuable data on the status and trends of black abalone populations in California. Since black abalone was listed in 2009, NMFS has issued two ESA permits allowing researchers to continue the long-term monitoring surveys: Permit 14400, issued to the Channel Islands National Park (CINP) in 2010, and Permit 18761, issued to UCSC in 2016. Permit 18761-2R would allow the long-term monitoring surveys to continue over the next five years.

Researchers will conduct monitoring during low tides when black abalone are exposed to air. Researchers will use non-destructive search methods; that is, they will not move or break boulders and rocks and will not remove organisms from the substrate. Counts will be conducted using two methods: (1) timed counts, where researchers search for all abalone in an area over a set amount of time (usually 30 minutes, or longer to allow a more complete search); and (2) fixed plot counts, where researchers search for all abalone within a fixed area. Plots are marked with stainless steel bolts which are drilled into and attached to the rock with marine epoxy at the corners of the plots. Plots are outlined by wrapping a line or measuring tape around the bolts. At most sites, researchers have already installed steel bolts to mark the plots and do not expect to install additional bolts. Plot sizes range from one square meter to tens of square meters.

Researchers will record the number and size (shell length) of black abalone observed. Abalone will not be removed from the rock, but are measured by placing adjustable calipers on the shell, taking care not to touch the mantle tissue. Rulers may also be used to estimate shell length without touching the animal. Researchers may use a lumber crayon to temporarily mark the abalone shell to indicate it was previously measured. Actual contact with each abalone would last only a few seconds.

Juvenile and adult black abalone of both sexes will be counted and measured. Life stage can be determined by the shell length, but the proportion of females to males would not be determined because that would require removing individuals from the rock to examine the gonads.

While conducting the surveys, researchers will avoid stepping on vulnerable species, such as mussels, and will wear soft-soled shoes to minimize crushing organisms on the reefs. Researchers will also approach monitoring sites slowly and quietly to minimize disturbing pinnipeds and seabirds at or near the sites. The monitoring surveys will typically be conducted once or twice per year at each site where black abalone are found; two sites in San Luis Obispo

County are monitored up to four times per year. At some sites, temperature loggers may be installed on the rocky substrate using epoxy and the data downloaded once or twice per year.

Abalone habitat surveys

In addition to the long-term monitoring surveys, researchers have conducted abalone habitat surveys to assess the abundance and distribution of black abalone and black abalone habitat throughout the coast. The purpose of the abalone habitat surveys is to evaluate black abalone habitat preferences and densities at a coast-wide scale. These surveys are conducted along large continuous segments of rocky intertidal habitat, demarcated by natural obstacles, changes in habitat, or areas of unsuitable habitat (e.g., sandy beach). Segments range from tens to hundreds of meters alongshore. Because they cover a broader geographic area, the abalone habitat surveys provide information on black abalone presence, abundance, and habitat in areas outside of the long-term sites. Researchers conduct abalone habitat surveys opportunistically when funding is available, at most once per year over the next five years.

Similar to the long-term monitoring surveys, researchers will conduct monitoring during low tides and will use non-destructive search methods to survey the designated segment of coast. Researchers will assess the overall habitat quality for the survey area and for the microhabitat occupied by each black abalone. They will record the number of black abalone observed and measure the shell length and nearest neighbor distance (i.e., the shortest distance to another black abalone) for each individual. Researchers may touch the abalone and mark their shells with a lumber crayon, but will not remove abalone from the substrate.

Researchers will limit any contact with abalone to only a few seconds. They will also avoid stepping on vulnerable species and wear soft-soled shoes to minimize crushing organisms on the reefs. Researchers will also conduct surveys during times of year when there will be the least disturbance to pinnipeds and seabirds and will approach sites slowly and quietly to further minimize disturbance. No bolts will be installed to mark the survey area.

Reconnaissance surveys for projects or unexpected events

Reconnaissance surveys may be required for specific projects and in response to unexpected events and circumstances (e.g., oil spills, landslides, sedimentation events). The purpose of these surveys is to provide information on the presence, abundance, and distribution of black abalone and black abalone habitat within the area affected by, or potentially affected by, project activities and unexpected events and circumstances.

For example, a survey for black abalone may be required for projects that occur in or may affect rocky intertidal habitat, to evaluate the presence of black abalone and the quality of their habitat within the affected area. Surveys may be conducted following a landslide, to evaluate the presence of black abalone and the quality of habitat in adjacent areas that may be affected by further sedimentation.

The size of the survey area would vary, depending on the spatial scale of the activity and its effects, but would likely be comparable to the long-term monitoring sites and abalone habitat

survey areas. The survey would be conducted one time, to identify the presence of black abalone and its critical habitat.

Similar to the long-term and abalone habitat surveys described above, researchers will conduct monitoring during low tides and use non-destructive search methods. Researchers will record the number of black abalone observed and their habitat and may also measure the shell length and nearest neighbor distance for each individual. Researchers may touch the abalone and mark their shells with a lumber crayon, but will not remove abalone from the substrate.

Researchers will limit any contact with abalone to only a few seconds. They will also avoid stepping on vulnerable species and wear soft-soled shoes to minimize crushing organisms on the reefs. Researchers will approach sites slowly and quietly to minimize disturbance to pinnipeds and seabirds. Researchers will not install bolts to mark the survey area.

Development and deployment of abalone recruitment modules (ARMs)

Researchers will test different recruitment module designs to develop an optimal design for monitoring juvenile recruitment. The purpose of these modules is to enhance our ability to monitor and assess juvenile recruitment and survival, which are difficult to assess given the cryptic nature of juvenile black abalone. Designs include stacked tiles (four 15cm by 15cm square stone tiles or five 10cm by 10cm square PVC tiles) separated by washers. Other similar designs may be used that include PVC tiles, stone blocks, or other tile materials. Researchers will attach the modules to bedrock with screws (~ 6.5cm) and concrete wall anchors. The modules will be placed next to crevices, boulders, or rock shelves for protection.

Researchers plan to deploy the modules at three sites along the California coast and Channel Islands, with up to six modules per site. Researchers will monitor the modules two to three times per year to check for black abalone. When monitoring the modules, researchers will carefully disassemble and reassemble the modules to minimize disturbing black abalone and to avoid crushing individuals. Researchers will record the number and size of black abalone found on the modules.

At the end of the study, researchers will remove all modules and mounting materials (screws, anchors, epoxy). Any black abalone remaining on the modules will be carefully moved (using a plastic spatula, or another instrument with a thin profile, if needed) to nearby suitable habitat. Researchers may also use kelp to entice the animals to feed and extend their foot muscle, making it easier to remove the animals from the substrate.

Non-lethal collection of tissue samples and swab samples for genetic analysis

Researchers will collect genetic samples (swab samples or epipodial clippings) to assess population structure for black abalone throughout their range. Researchers plan to collect genetic samples from 10 -12 individual black abalone per site, at up to 35 sites throughout the range.

Researchers will test a field swabbing technique, as a less invasive alternative for collecting genetic samples. Researchers will use the tip of a buccal swab to swab the surface of any

exposed soft tissue or the shell of an individual abalone. Duplicate swabs will be collected for each abalone.

If the swabbing method does not provide enough genetic material for analysis, researchers will instead collect epipodial clippings. To collect epipodial clippings, researchers will use tweezers to grasp the end of one epipodial tentacle on the side or posterior of the abalone and cut the tentacle 1-2 millimeters from its base (Hamm and Burton 2000).

For both methods, researchers will not remove abalone from the substrate. Samples will be placed in vials filled with preservative solution (e.g., 70% or higher concentration of ethanol), if needed, and sent to facilities conducting the genetic analysis. These facilities include the UCSC (Shapiro Lab), California Department of Fish and Wildlife (CDFW)/University of California, Davis (UC Davis) (Moore lab), University of Washington (Friedman lab), and the NMFS Southwest Fisheries Science Center (SWFSC) (Hyde lab).

Collection of dead or obviously unhealthy black abalone

Researchers will visually assess the health of each abalone by observing whether the mantle is visible below the shell, or whether the abalone appears active by moving or clamping down on the rock in response to the person's presence or to a light touch. Of particular concern is the disease called withering syndrome, which killed a large number of black abalone in the 1980s and 1990s and was identified as the primary threat to the species (VanBlaricom et al. 2009). Symptoms include the inability to hold onto the substrate or to resist any pressure, extreme lethargy, and a withered or shrunken and discolored foot muscle.

The permit will authorize researchers to collect up to 500 dead or obviously unhealthy black abalone per year for pathology and histology studies and to identify disease or toxin outbreaks. Abalone are dead if they are unresponsive and no longer attached to the substrate. Abalone are considered to be obviously unhealthy if they are noticeably shrunken, unable to adhere firmly to the substrate, and do not actively attempt to right themselves when placed upside down on the substrate. Each dead or obviously unhealthy abalone will be placed in individual plastic bags, properly labeled, and immediately frozen or preserved as instructed by pathologists. Whole animals or tissue samples will be shipped to laboratories for analysis. The permit identifies the following laboratories as approved to receive whole animals or tissue samples: the CDFW/UC Davis Moore lab, the UCSC Shapiro lab, the NMFS SWFSC Hyde lab, and the University of Washington Friedman lab. Additional laboratories may be added to the list of approved facilities upon request.

Collection of empty shells

The permit will allow researchers to collect empty black abalone shells for research. Researchers expect to collect up to 10 shells per year. The shells will be archived at UCSC or distributed to authorized facilities.

Permit conditions

Research permits lay out the conditions to be followed before, during, and after the research

activities are conducted. These conditions are intended to: (a) manage the interaction between scientists and listed black abalone by requiring that research activities be coordinated between the permit holder and NMFS; (b) minimize impacts on listed species; and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. NMFS will use annual reports to monitor the actual number of black abalone that are taken each year by scientific research activities and will adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

The proposed permit conditions refer to the following personnel under the permit: Permit holder, principal investigator, and co-investigator. "Permit holder" means the person, institution, or agency that is ultimately responsible for all activities of any individual who is operating under the authority of the permit. "Permit holder" refers to the permit holder or any employee, contractor, or agent of the permit holder. "Principal investigator" means the individual primarily responsible for the taking, importation, exportation, and any related activities conducted under the permit. "Co-investigator" means an individual who is qualified and authorized to conduct or directly supervise activities conducted under the permit without the on-site supervision of the Principal Investigator.

The proposed permit conditions include the following:

General Conditions

1. The Permit Holder must ensure that listed species are taken only at the levels, by the means, in the areas, and for the purposes stated in the permit application, and according to the conditions in the permit.
2. The Permit Holder must not intentionally kill, or cause to be killed, any listed species unless the permit specifically allows intentional lethal take.
3. The Permit Holder must obtain approval from NMFS before changing sampling locations or research protocols.
4. If a mass mortality of black abalone is detected, the Permit Holder must notify NMFS of the location(s) and potential cause(s) of the mass mortality as soon as possible but no later than two days after detecting the mass mortality.
5. This permit does not authorize takes of any protected species other than black abalone, including those species under the jurisdiction of the USFWS. Should other protected species be encountered during the research and enhancement activities authorized under this permit, researchers should exercise caution and remain a safe distance from the animal(s) to avoid take, including harassment. In particular, researchers must scan the area for Guadalupe fur seals (see the description in the attachment to this permit) and, if one or more individuals are present, researchers must remain a safe distance to avoid disturbing the animal(s).
6. The person(s) actually doing the research must carry a copy of the permit while conducting the authorized activities.
7. The Permit Holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

8. The Permit Holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.
9. The Permit Holder may not transfer or assign this permit to any other person as defined in Section 3(12) of the ESA. This permit ceases to be in effect if transferred or assigned to any other person without NMFS' authorization.
10. NMFS may amend the provisions of this permit after giving the Permit Holder reasonable notice of the amendment.
11. The Permit Holder must obtain all other Federal, state, and local permits/authorizations.
12. If the Permit Holder violates any permit condition they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA section 10(d) findings are no longer valid.

Duration of Permit

1. Researchers may conduct activities authorized by this permit through December 31, 2025. This permit expires on the date indicated. A renewal for this permit can be applied for through the NOAA Fisheries APPS website (https://apps.nmfs.noaa.gov/index.cfm). A completed application must be submitted within six to nine months of the expiration date in order to be considered for a renewal without a break in coverage.
2. If authorized take or mortality is exceeded or likely to be exceeded, the researchers must cease permitted activities and notify NMFS as soon as possible, but no later than within two business days. The Permit Holder must also submit a written incident report as described in the permit. NMFS may grant authorization to resume some or all permitted activities based on review of the incident report and in consideration of the Terms and Conditions of the permit.

Conditions related to field monitoring activities

1. The Permit Holder must provide written notification of planned field work to NMFS at least two weeks prior to initiation of a field trip or season, including: the intended field study locations and/or survey routes, estimated dates of research, lead researcher, and number and roles of participants.
2. Co-investigators must coordinate permitted activities with the Principal Investigator before conducting field work.
3. To the maximum extent practical, co-investigators must coordinate with other co-investigators on the permit conducting the same or similar permitted activities, in the same locations, and/or at the same times of year to avoid unnecessary disturbance of animals. Specifically, co-investigators must coordinate with the appropriate point of contact for each area listed in the permit, at least two weeks prior to conducting permitted activities in those areas.
4. Researchers must wash all field gear and equipment with fresh water between survey sites to avoid the potential introduction and spread of disease and non-indigenous species between

sites.

5. Genetic tissue sampling: Animals may not be removed from the substrate. Epipodial samples must be collected from epipodial tentacles on the sides or posterior of each animal and must be taken at least 1-2 mm from the base of the tentacle. Swab samples may be collected by wiping a flexible, soft-tipped swab against the surface of the abalone's shell or soft tissue (e.g., the foot muscle or by inserting the swab into a respiratory pore). NMFS SWFSC will serve as the final repository for genetic tissue samples.
6. Collection of dead and obviously unhealthy white abalone: White abalone may be collected for further analysis if they are determined to be dead or obviously unhealthy (according to Moore 2019).
    a. Dead abalone are those that are unresponsive and not attached to the substrate.
    b. Obviously unhealthy abalone are those that are noticeably shrunken (i.e., epipodial tentacles do not extend beyond the margin of the shell and can no longer be seen); unable to adhere firmly to the substrate (e.g., the abalone can be dislodged easily from the substrate by hand); and do not actively attempt to right themselves when placed upside down on the substrate. Abalone that fit this description are expected to die within days and may be collected to determine the cause of death.

<u>Conditions related to abalone recruitment module development and deployment</u>

1. Before installing modules in the crevices, researchers must search the crevice for any black abalone. If black abalone are present, researchers must install the modules far enough away (at least 10 cm from any individual) to avoid disturbing the abalone.
2. Prior to moving modules between sites, researchers must remove any non-native species and unnecessary native species from the modules. Unnecessary native species include other snails or invertebrates that are not used by black abalone, for example, as habitat, camouflage, or food.
3. Researchers must handle black abalone with extreme care, especially when monitoring the abalone recruitment modules. When moving black abalone from the recruitment modules, researchers must carefully remove the abalone to avoid injuring the animals, using kelp, a plastic spatula, or another instrument with a thin profile if needed.

<u>Number and Kind(s) of Protected Species, Location(s), and Manner of Taking</u>

1. The take table in the permit application outlines the number of black abalone that may be taken, and the locations, manner, and time period in which they may be taken.
2. Researchers working under this permit may collect visual images (e.g., still photographs, motion pictures) as needed to document the permitted activities, provided the collection of such images does not result in takes of protected species.
3. The Permit Holder may use visual images collected under this permit in printed materials (including commercial or scientific publications) and presentations, provided the images and recordings are accompanied by a statement indicating that the activity was conducted pursuant to Permit No. 18761-2R. This statement must accompany the images and recordings

in all subsequent uses or sales.

4. Upon written request from the Permit Holder, approval for photography, filming, or audio recording activities not essential to achieving the objectives of the permitted activities, including allowing personnel not essential to the research (e.g. a documentary film crew) to be present, may be granted by NMFS.
    a. Where such non-essential photography, filming, or recording activities are authorized they must not influence the conduct of permitted activities or result in takes of protected species.
    b. Personnel authorized to accompany the Researchers during permitted activities for the purpose of non-essential photography, filming, or recording activities are not allowed to participate in the permitted activities.
    c. The Permit Holder and Researchers cannot require or accept compensation in return for allowing non-essential personnel to accompany Researchers to conduct non-essential photography, filming, or recording activities.
5. Biological Samples:
    a. The permit holder is responsible for all of the biological samples collected from listed species, including whole specimens, tissue samples, and shells. Such samples are subject to the Terms and Conditions of this Permit.
    b. All biological samples collected from black abalone obtained under the permit shall be identified by a unique number and maintained according to accepted curatorial standards. After completion of initial research goals, any remaining samples or specimens shall be maintained by the Permit Holder or deposited into a bona fide scientific collection that meets the minimum standards of collection, curation, and data cataloging as established by the scientific community.
    c. The Permit Holder may not transfer biological samples to researchers other than those specifically identified in the application without prior written approval from NMFS.
6. Commercial culture and sale of black abalone, including parts (e.g., shells), is forbidden.

Reports

1. The Permit Holder must submit annual, final, and incident reports, and papers or publications resulting from the research authorized herein to NMFS. Reports may be submitted:
    a. Through the online APPS website at https://apps.nmfs.noaa.gov, or
    b. By email attachment to the NMFS contact listed on the first page of this permit.
2. The Permit Holder must submit written incident reports related to serious injury and mortality events, or to exceeding authorized takes, to NMFS as soon as possible but not more than two days from when the incident occurred. The incident report must include a complete description of the events and identify the steps that will be taken to reduce the potential for additional research-related mortality or exceedance of authorized take.
3. The Permit Holder must submit an annual report to NMFS at the conclusion of each year for

which the permit is valid. Annual reports are due by January 31st for the previous reporting year. Falsifying annual reports or permit records is a violation of this permit. Annual reports must describe the research and monitoring activities and include the following:

a. A summary of field monitoring activities to date, including a description of annual long-term monitoring, abalone habitat surveys, and one-time or more frequent monitoring (e.g., for projects or in response to unexpected circumstances); the effects of monitoring activities on black abalone and their habitat; measures taken to minimize those effects; and the effectiveness of those measures.

b. A summary of field monitoring results to date, including the number of black abalone counted and measured, general locations or regions, health assessment results, genetic analysis results, and the number of abalone unintentionally killed.

c. A summary of abalone recruitment module development and deployment activities to date, including a description of the module design(s); the number deployed, the general locations/region and number of sites; monitoring frequency, methods, and results; the effects of deployment and monitoring activities on black abalone and their habitat; measures taken to minimize those effects; and the effectiveness of those measures.

d. A summary of biological samples, parts, and specimens collected, stored, and transferred among facilities, including a description of analyses conducted, education and outreach activities, and the final disposition of the samples, parts, and specimens.

4. The Permit Holder must submit a final report to NMFS within 90 days after expiration of the permit (March 31, 2021), or, if the research concludes prior to permit expiration, within 90 days of completion of the research.

5. Research results must be published or otherwise made available to the scientific community in a reasonable period of time, taking care to protect sensitive location data for abalone in the wild.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The proposed action is likely to adversely affect endangered black abalone and designated black abalone critical habitat. We analyze these effects on black abalone and its critical habitat below. The action area also overlaps with the occupied range for Guadalupe fur seals (*Arctocephalus townsendi*) and with designated critical habitat for Steller sea lions (*Eumetopias jubatus*). We determined that the proposed action is not likely to adversely affect Guadalupe fur seals and is not likely to adversely affect Steller sea lion critical habitat. Our analysis is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "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). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation of critical habitat for black abalone uses the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44976, 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

We based our analysis of the effects on the information provided in the draft categorical exclusion (CE), the permit application, the draft permit, the black abalone listing decision and supporting documents, the black abalone critical habitat designation and supporting documents, the five-year status review update, scientific and technical reports from government agencies, peer-reviewed literature, and personal communications or unpublished data from abalone experts.

We also considered the biological opinions prepared for two related Scientific Research Permits: (a) Permit 14400 issued to the Channel Islands National Park (CINP) in 2010; and (b) Permit 18761 issued to UCSC in 2016. The opinions for Permits 14400 and 18761 are relevant to this analysis, because the monitoring activities under Permit 18761-2R would continue the monitoring activities covered under these two previous permits. In the 2010 and 2016 Opinions, NMFS concluded that issuance of Permits 14400 and 18761 would adversely affect, but would not be likely to jeopardize the continued existence of endangered black abalone. NMFS also concluded that issuance of the permits may adversely affect but was not likely to adversely modify critical habitat for black abalone.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and

listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

Two factors affecting the rangewide status of black abalone and its critical habitat are climate change and ocean acidification. Climate change effects may increase susceptibility to disease, reduce kelp growth, and alter the distribution of rocky intertidal habitat along the coast. Ocean acidification can affect reproduction, development, growth, and survival of black abalone, as well as the growth of important algal species. In the sections below, we discuss the potential effects of climate change and ocean acidification in more detail.

2.2.1 Rangewide status of black abalone

Black abalone are marine snails with a univalve shell, typically 5 to 9 open respiratory pores, an anterior head, and a large muscular foot used for movement as well as to clamp down onto hard substrates to avoid being dislodged by wave action (Cox 1960). Black abalone occupy rocky habitats from the upper intertidal to 6 meters depth. Historically, black abalone occurred from Crescent City (Del Norte County, California) to southern Baja California (Geiger 2004), but the current range is from Point Arena, California, to Bahia Tortugas, Mexico (74 FR 1937, 14 January 2009). Black abalone are most commonly observed in the middle and lower intertidal, in habitats with complex surfaces and deep crevices that provide shelter for juvenile recruitment and adult survival (Leighton 1959, Cox 1960, Leighton and Boolootian 1963, Douros 1985, Douros 1987, Miller and Lawrenz-Miller 1993, VanBlaricom et al. 1993, Haaker et al. 1995, Leighton 2005). They are able to withstand extreme variations in temperature, salinity, moisture, and wave action, and are usually strongly aggregated, with some individuals stacking two or three on top of each other (Cox 1960, Leighton 2005).

Abalone are broadcast spawners, meaning that individuals release their gametes into the water column and rely on external fertilization. Thus, abalone must be in close enough proximity to one another to successfully reproduce. Abalone also have a short planktonic larval stage (about 3-10 days) before settlement and metamorphosis (McShane 1992). Larval black abalone are believed to settle on rocky substrate with crustose coralline algae, which serves as a food source for post-metamorphic juveniles, along with microbial and diatom films (Leighton 1959, Leighton and Boolootian 1963, Bergen 1971). Reproductive maturity is reached at a size of about 50 mm shell length in females and about 40 mm in males (Leighton 1959, Ault 1985). Spawning has not been observed in the wild, but likely occurs from spring to early autumn (Leighton 1959, Leighton and Boolootian 1963, Webber and Giese 1969, Leighton 2005).

Based on fisheries and long-term monitoring data since the 1970s, black abalone are believed to be naturally rare at the northern (north of San Francisco; Morris et al. 1980) and southern (south of Punta Eugenia; P. Raimondi, pers. comm., cited in VanBlaricom et al. 2009) extremes of the species' range. Areas of highest abundance occurred south of Monterey, particularly at the

Channel Islands off southern California (Cox 1960, Karpov et al. 2000). Rogers-Bennett et al. (2002) estimated a baseline abundance of 3.54 million black abalone in California, based on landings data from the peak of the commercial and recreational fisheries (1972-1981). This estimate provides a historical perspective on patterns in abundance and a baseline against which to compare modern day trends. We note, however, that black abalone abundances in the 1970s to early 1980s had reached extraordinarily high levels, particularly at the Channel Islands, possibly in response to the elimination of subsistence harvests by indigenous peoples and large reductions in sea otter population. Thus, our understanding of black abalone abundance and distribution for this time period may not accurately represent conditions prior to commercial and recreational harvest of black abalone in California.

Beginning in the mid-1980s through the 1990s, black abalone populations declined dramatically due to the spread of withering syndrome (Tissot 1995), a disease caused by a pathogen that affects the animal's digestion and causes starvation leading to foot muscle atrophy, lethargy, and death (Friedman et al. 2003, Braid et al. 2005). Withering syndrome results in rapid (within a few weeks) and massive (reductions of over 80%) mortalities in affected populations (Neuman et al. 2010). Overall, populations throughout southern California and as far north as Cayucos declined in abundance by more than 80%; populations south of Point Conception declined by more than 90% (Neuman et al. 2010). Historical abalone harvest contributed to some degree, but the primary cause of these declines was withering syndrome. The disease has also affected populations in Baja California, but little is known about the species' status in Mexico.

Populations north of Cayucos have not yet exhibited signs of the disease, but all are likely infected by the pathogen. Abalone may be exposed to and infected by the pathogen without showing symptoms; however, once symptoms develop, the animals succumb to death rapidly (Friedman et al. 1997a, Friedman et al. 2000, Friedman et al. 2002). The pathogen has been detected in all coastal marine waters off southern California to Sonoma County and at Southeast Farallon Island (Moore et al. 2002, Friedman and Finley 2003; pers. comm. with Jim Moore, CDFW, 20 November 2015; pers. comm. with Jim Moore, CDFW, cited in VanBlaricom et al. 2009).

Most black abalone populations affected by withering syndrome remain at low densities, below the estimated levels needed to support successful reproduction and recruitment (0.34 abalone per m^2; Neuman et al. 2010). Populations not yet affected by the disease (north of Cayucos) have densities greater than this threshold value (1.1 to 10.5 abalone per m^2), whereas populations affected by the disease (south of Cayucos) have densities well below this threshold value (0 to 0.5 abalone per m^2) (Neuman et al. 2010).

Despite these low densities, researchers have observed evidence of recent recruitment and increases in abundance at several locations throughout southern California, including the Palos Verdes Peninsula, Laguna Beach, Santa Cruz Island, San Miguel Island, and San Nicolas Island (Richards and Whitaker 2012, Eckdahl 2015; unpublished data by Glenn VanBlaricom, U.S. Geological Survey, 22 June 2015). These observations for black abalone, and similar observations for other abalone species in California, indicate that we need to consider additional factors when assessing population viability. Recent studies also indicate the potential for disease resistance in wild black abalone populations. A bacteriophage has been discovered that infects the pathogen, reduces its lethal effects, and improves the survival of infected abalone (Friedman

and Crosson 2012, Crosson et al. 2014, Friedman et al. 2014). Genetic-based disease resistance may also exist and is the subject of ongoing studies at the University of Washington (VanBlaricom et al. 2009).

Elevated water temperatures resulting from local discharges, warm water events, and climate change could exacerbate disease effects on black abalone. Disease transmission and manifestation is intensified when local sea surface temperatures increase by as little as 2.5 ºC above ambient levels and remain elevated over a prolonged period of time (i.e., a few months or more) (Friedman et al. 1997b, Raimondi et al. 2002, Harley and Rogers-Bennett 2004, Vilchis et al. 2005). The disease appears to progress northward along the coast with increasing coastal warming and El Niño events (Tissot 1995, Altstatt et al. 1996, Raimondi et al. 2002), and poses a continued threat to the remaining healthy populations. In 2015-2016, researchers observed increased numbers of diseased individuals at the long-term monitoring sites, likely due to warmer water conditions (pers. comm. with Karah Ammann, UCSC, on 8 March 2016). It is not yet known how elevated water temperatures may affect the bacteriophage and genetic resistance.

Climate change and ocean acidification may also have range-wide effects of black abalone. In addition to increasing susceptibility to disease, warming ocean temperatures could reduce the growth of macroalgae (an important food source for black abalone) and shift the distribution of black abalone if temperatures in the southern part of the range increase above the optimal range. Sea level rise could alter the distribution and availability of rocky intertidal habitat. Black abalone may be able to adapt to changes in their habitat conditions, depending on the time frame over which these changes occur, but some populations and habitats may be lost.

Ocean acidification could hinder normal growth, development, and survival of black abalone by altering pH levels, carbonate availability, and the growth of crustose coralline algae (an important component of juvenile settlement habitat) (Crim et al. 2011). Studies on other abalone species indicate varying effects depending on the species, life stage, the degree to which pH levels decrease, and the presence of other stressors. Although we lack black abalone specific information, potential effects include reduced reproduction, abundance, and recruitment. Studies specific to black abalone are needed to evaluate the potential effects of ocean acidification at different life stages and under multiple stressors.

Overall, black abalone populations throughout California face high risk in each of four demographic risk criteria: abundance, growth rate and productivity, spatial structure and connectivity, and diversity (VanBlaricom et al. 2009). Although we know withering syndrome has affected populations in Baja California, little information exists regarding the species' status in that portion of the range. Long-term monitoring data in California indicates that populations affected by the disease remain at low abundance and density. The disease continues to progress northward along the coast with warming events, threatening the remaining healthy populations (Raimondi et al. 2002). The declines in abundance have potentially resulted in a loss of genetic diversity, though this needs to be evaluated. Although some sites in southern California have shown evidence of recruitment, natural recovery of severely-reduced abalone populations will likely be a slow process. Elevated water temperatures and ocean acidification are range-wide threats that have the potential to exacerbate disease effects, reduce habitat quality and availability, and reduce the survival, growth, and development of black abalone. Recovering the species will involve protecting the remaining healthy populations and increasing the abundance

and density of populations that have declined, while also finding practical ways to address ongoing and emerging threats. Continued long-term monitoring will be critical to track and evaluate the species' status and the progression of withering syndrome along the coast.

2.2.2 Rangewide status of black abalone critical habitat

NMFS designated critical habitat for black abalone in 2011 (76 FR 66806; 27 October 2011). The designation encompasses rocky intertidal and subtidal habitat (to a depth of 6m) within five segments of the California coast between Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as on the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island. Essential habitat features include rocky substrate (e.g., rocky benches formed from consolidated rock or large boulders that provide complex crevice habitat); food resources (e.g., bacterial and diatom films, crustose coralline algae, and detrital macroalgae); juvenile settlement habitat (rocky substrates with crustose coralline algae and crevices or cryptic biogenic structures); suitable water quality (e.g., temperature, salinity, pH) for normal survival, settlement, growth, and behavior; and suitable nearshore circulation patterns to support successful fertilization and larval settlement within appropriate habitat.

Critical habitat areas within the non-disease affected region (north of Cayucos) were generally identified as areas of high conservation value, because they serve as a refuge from withering syndrome, support stable populations with evidence of recruitment in some areas, and contain habitat of good to excellent quality that is able to support larger numbers of black abalone. Within the disease-affected region (south of Cayucos), changes to critical habitat features have occurred. For example, at some sites once dominated by black abalone, the decline in black abalone numbers has resulted in a shift in the invertebrate and algal community. Increased growth of encrusting species like *Phragmatopoma* tube worms may reduce habitat suitability for adults (e.g., by filling in cracks and crevices) and for larval settlement (e.g., by reducing the surface area for crustose coralline algae to grow) (Toonen and Pawlik 1994, Miner et al. 2006, VanBlaricom et al. 2009, NMFS 2011). However, in general, these critical habitat areas continue to provide a high conservation value to the species, because they contain habitat of good to excellent quality that is able to support black abalone, with evidence of recruitment observed at a few sites (e.g., on San Nicolas Island and Santa Cruz Island; VanBlaricom et al. 2009).

Climate change and ocean acidification may have range-wide effects on black abalone critical habitat. As discussed above, elevated water temperatures associated with climate change may reduce the quantity and quality of food resources (macroalgae) and shift water temperatures above the optimal range for black abalone, affecting the survival, health, and growth of abalone. Sea level rise could result in the loss of rocky intertidal habitat, shifting populations to subtidal conditions. Ocean acidification is predicted to reduce pH levels, affecting water quality to support normal growth and development of black abalone as well as the growth of crustose coralline algae to support juvenile settlement (Crim et al. 2011, O'Leary et al. 2017). Changes in pH levels at the local scale may vary and will be important for assessing the effects on black abalone and their critical habitat (Feely et al. 2004, Feely et al. 2008, Feely et al. 2009, Hauri et al. 2009).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for this consultation consists of rocky intertidal habitats within the U.S. portion of the range of black abalone, from Point Arena (Mendocino County) to the U.S./Mexico border. This includes rocky intertidal habitat on the Farallon Islands, Año Nuevo Island, and the eight Channel Islands. The action area also includes facilities and laboratories throughout the range of black abalone and the U.S. West Coast where specimens, samples, parts, and shells would be sent for analysis. The facilities, laboratories, and coastal marine waters within this action area are connected through their transit routes.

Black abalone have been found at sites throughout the California coast and at the offshore islands. Researchers may conduct field activities within rocky intertidal habitats throughout the species range in California, but would typically work at established long-term monitoring sites. We do not provide a map of these sites, to protect the location of existing black abalone populations.

Research activities involving black abalone genetic samples, shells, other parts, and specimens would occur at facilities throughout the coast, including the University of Washington, CDFW Shellfish Health Lab in Bodega Bay, UCSC, and NMFS SWFSC La Jolla lab. Other facilities may be added to the permit if they meet the permit conditions.

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

Because the action area overlaps with the species' range throughout California and encompasses the entire critical habitat designation, the description of the status of the species and critical habitat in Section 2.2 of this opinion applies to the action area. In this environmental baseline, we discuss how specific factors and activities have affected black abalone and their critical habitat within the action area. These factors and activities include monitoring conducted under Permit 14400 (issued to the CINP in 2010) and Permit 18761 (issued to UCSC in 2016), continued effects of disease, historical overfishing and ongoing harvest, habitat degradation, climate change, predation, and pollution, as well as ongoing conservation efforts.

2.4.1 Environmental baseline for black abalone

Effects of past and ongoing monitoring activities

MARINe and other abalone researchers have been monitoring black abalone throughout the California coast since the mid-1970s as part of the long-term monitoring surveys, abalone habitat surveys, and surveys related to projects or unexpected events and circumstances. Prior to the ESA listing in 2009, no ESA permit was required. After the ESA listing, monitoring activities were conducted under Permit 14400 from 2010 to 2016 and under Permit 18761 from 2016 to the present. Under these permits, researchers monitored black abalone populations throughout the California coast to evaluate their abundance, density, size frequency, distribution, habitat, and health.

Monitoring activities were similar to those described for the proposed permit. Researchers counted, measured, and assessed the health and habitat of individual black abalone throughout the coast. These monitoring activities resulted in little to no observable disturbance to individual black abalone and their habitat. Researchers deployed abalone recruitment modules at a few sites at the Channel Islands, Point Reyes National Seashore, and Golden Gate National Recreation Area. Although no black abalone were observed on the modules, these test deployments confirmed that the modules can withstand intertidal conditions. Researchers also collected swab samples from a few individuals, noting minimal disturbance to individual black abalone. Analysis of the samples confirmed that this non-invasive method obtains sufficient amounts of DNA for the genetic analyses. Finally, researchers also collected dead or obviously unhealthy black abalone for further analysis.

Unlike the proposed permit, Permit 14400 also allowed researchers to tag up to 100 black abalone at two sites, with visual tags and passive-integrated transponder (PIT) tags attached to the shell with marine epoxy. The purpose of the tagging studies was to track the movement of individual black abalone. The tagging activities caused minor, temporary stress to individual black abalone and minor disturbance to the habitat. Permit 18761 allowed researchers to translocate juvenile black abalone between sites using the modules. Researchers did not carry out this translocation because no black abalone were found on the modules.

Overall, research activities conducted under the permits resulted in minor disturbance to black abalone and their habitat. The minor effects were greatly outweighed by the benefits of the research activities. The monitoring and research studies provided critical information to assess the status and trends of populations pre- and post-disease, as well as before and after unexpected events such as landslides and vessel groundings. Pre-project surveys also provided information on black abalone presence and habitat quality, to inform ESA consultations and implementation of measures to reduce effects on black abalone and their habitat. Continued monitoring is necessary to inform future management decisions and recovery efforts.

Effects of disease

Withering syndrome is an ongoing threat to black abalone populations in the action area. Researchers monitor the health of black abalone during monitoring surveys and collect dead or

obviously dying animals for further analysis if withering syndrome is suspected. Of particular concern are elevated water temperatures, which can accelerate rates of disease transmission and disease-induced mortality (Ben-Horin et al. 2013). Increased water temperatures can occur at the local scale (e.g., when coastal facilities like power plants discharge thermal effluent) or rangewide (e.g., due to El Niño events). Climate change may increase the severity, frequency, and duration of warm water events such as the 2014/2015 North Pacific marine heatwave (Di Lorenzo and Mantua 2016).

Withering syndrome caused mass mortalities in the 1980s and 1990s. Since the early 2000s, no additional mass mortalities have been reported. From May 2015 through March 2016, researchers found more withered individuals than in the past 5-10 years, including potentially withered black abalone at sites north of Cayucos, near Santa Cruz (pers. comm. with Karah Ammann, UCSC, on 8 March 2016). The abnormally warm ocean temperatures in 2014 and 2015 off California likely contributed to the increase in withered animals. However, researchers did not observe mass mortalities associated with this warm water event. As described in section 2.2.1 (Rangewide status of black abalone), two factors may ameliorate the effects of withering syndrome: (a) the bacteriophage that reduces the lethal effects of the pathogen and (b) potential genetic resistance to the disease (Friedman and Crosson 2012, Crosson et al. 2014, Friedman et al. 2014).

Other abalone diseases (e.g., Herpes virus, Vibrio) have emerged over the past several decades and pose a potential risk to black abalone if they were to be introduced to wild populations. To date, no outbreaks have been observed in wild black abalone populations in California, but great care is needed to closely monitor and manage potential pathways through which pathogens and invasive species can be introduced (e.g., import, transfer for aquaculture, research, food and hobby markets).

Historical overfishing and ongoing illegal harvest

Commercial and recreational dive fisheries for abalone in California developed from 1913 to 1928, but black abalone were not intensively harvested until after other, more marketable species were depleted, and were not documented until 1940. Fisheries for black abalone closed in 1993, in response to the severe declines caused by harvest and disease (Tissot 2007). Rogers-Bennett et al. (2002) estimated that approximately 3.5 million black abalone were harvested during the peak decade of black abalone commercial fishing from 1972 to 1982, with an additional 6,729 black abalone harvested in the recreational fishery during that period. The commercial data demonstrate a trend of serial depletion of abalone species in California and indicate that excessive commercial harvest was a contributing factor to the depletion of black abalone and other California abalone populations (Karpov et al. 2000).

Harvest of black abalone remains prohibited throughout California, but illegal harvest continues to be a source of mortality. The high demand for abalone on the black market provides a strong incentive for illegal harvest. The virtual absence of black abalone in rocky intertidal habitats that are accessible and near highly populated areas in California is an indication of the effects of illegal harvest. CDFW documented 201 black abalone illegal harvest cases between 1993 and 2012, involving a total of 3,069 black abalone (unpublished data, Ian Taniguchi, CDFW, 13 July

2015). These documented cases likely do not represent all illegal harvest cases for this time period.

The relative effect of illegal harvest on black abalone status and recovery is poorly understood and requires further evaluation. In 2020, CDFW and researchers throughout the California coast noted an increase in the number of people visiting the rocky intertidal and harvesting or temporarily removing invertebrates (CDFW Press Release dated 7 August 2020; John Ugoretz unpublished observations, MARINe meeting, 3 October 2020). This increase in human use activities poses a direct threat to black abalone populations because of the potential increase in illegal harvest as well as trampling of intertidal habitats. The increased harvest activities may also indirectly affect black abalone by altering the invertebrate community. This further underscores the importance of the ongoing long-term monitoring program for black abalone, to document the effects of human use activities on their populations.

Effects of other factors

Spills and spill response activities, particularly oil spills, pose a risk to black abalone populations depending on the type and amount of material spilled, the location, local environmental conditions, and the status of impacted populations. NMFS is currently developing guidance on appropriate spill response activities and post-monitoring efforts to minimize and monitor the effects on abalone. The oil spill at Refugio Beach in 2015 resulted in oiling of rocky intertidal habitat, including an area where black abalone were found along the Santa Barbara coast (pers. comm. with Jack Engle and Pete Raimondi, 6 June 2015). Efforts are ongoing to address the effects on black abalone and their habitat.

As described above, elevated water temperatures appear to accelerate disease transmission and mortality rates. Elevated water temperatures may also affect black abalone populations directly by reducing survival and growth (TERA Corp 1982b) and indirectly by reducing the growth of kelp and other macroalgae, which are important food resources for black abalone, or by contributing to harmful algal blooms, which can kill abalone (De Wit et al. 2014). The geographic scale of effects may also vary, from local areas affected by anthropogenic sources of thermal effluent (e.g., thermal discharges from coastal power plant facilities) to broad regions affected by long- and short-term climate change (e.g., global climate change, ENSO events, and marine heat waves).

Ocean acidification is an emerging threat that could reduce larval survival and shell growth and increase shell abnormalities (Crim et al. 2011). The effects vary by species, life stage, the degree to which pH levels decrease, and the presence of other stressors. For black abalone in particular, our understanding of ocean acidification effects is highly uncertain. This uncertainty is due to the lack of studies involving black abalone, as well as variability in local conditions throughout the coast, natural variation in ocean pH, and potential species adaptability. Black abalone may be better able to adapt to the effects of ocean acidification than other calcifying marine organisms, because they experience natural fluctuations in pH levels in the intertidal and in the California Current Ecosystem (Feely et al. 2004, Feely et al. 2008, Feely et al. 2009, Hauri et al. 2009). Additional studies are needed to evaluate the potential effects of ocean acidification on black abalone and to identify actions to address the effects.

Sedimentation events, such as landslides, also pose a threat to black abalone and their habitat. In May 2017, the Mud Creek landslide along the central California coast buried about a quarter mile of coastline, including black abalone habitat. Following the landslide, erosion moved sediment further north and south along the coast, burying and unburying rocky intertidal habitat adjacent to the landslide. Fires and fire response activities within coastal watersheds could exacerbate sedimentation risks as well as introduce toxins to coastal waters. This is particularly a concern in 2020 with multiple fires throughout California. Researchers are analyzing the potential risk of sedimentation and runoff to healthy black abalone populations along the central California coast.

Numerous entities have highlighted predation by sea otters as a threat to black abalone, and one that may increase as sea otters and black abalone recover. Researchers have observed sea otters feeding on black abalone, but have little information on predation levels and the population-wide effects. Many factors need to be considered to assess the level of risk, including the abundance of sea otters and black abalone within areas of co-occurrence; black abalone micro-distribution within rocky reefs (e.g., deep in crevices); predation rates; and population recovery rates for both species. As sea otter populations recover, predation pressure on black abalone may increase. The level of increase is difficult to predict, given that black abalone are intertidal and less accessible than other abalone species, and sea otters exhibit different predation strategies, specializing on certain prey items. Field observations suggest that healthy black abalone populations can co-exist with healthy sea otter populations. For example, healthy black abalone populations exist along the central California coast where sea otters have been present for a long time (Raimondi et al. 2015), and both black abalone and sea otter populations have been increasing at San Nicolas Island since 2010 (pers. comm. with Glenn VanBlaricom, UW/USGS, on July 13-15, 2015). Recovery for both species needs to be closely coordinated.

Most other threats to black abalone within the action area occur infrequently, have a narrow geographic and/or temporal scope, or have uncertain, indirect, and/or low effects on black abalone. These threats include activities that alter habitat at a local scale, such as breakwater and jetty repairs, wharf repairs, and rock slope protection. Other threats such as sea level rise and benthic community shifts (e.g., due to the absence or reduced presence of abalone) have a broader geographic scope. However, the effects on black abalone are uncertain and/or low. For example, we currently lack information to evaluate how potential habitat changes resulting from sea level rise might affect the survival and recovery of black abalone. Abalone may be able to adapt to shifts in habitat, because sea level rise is likely to occur over a long period of time. Environmental pollutants and toxins likely pose a low risk given the limited geographic scope and uncertain effects on black abalone, but single events can affect populations at the local level. For example, Martin et al. (1977) documented black abalone mortalities in Diablo Cove in the 1970s, resulting from the local power plant's release of effluent containing toxic levels of copper. Larval entrainment poses a low risk, given the small number of intakes (e.g., at power plants and desalination plants) along the coast and the small area affected (likely limited to the area directly around the intake).

Ongoing conservation efforts

The action area includes sites within the Redwood National Park, Point Reyes National Seashore, Golden Gate National Recreation Area, Channel Islands National Park, and Cabrillo National Monument, as well as the Gulf of the Farallones, Monterey, and Channel Islands National Marine Sanctuaries, and various state parks and marine protected areas designated under the state's Marine Life Protection Act (MLPA). These areas contain rocky intertidal habitats important for black abalone and other intertidal species. Existing regulations under these systems may provide protection to black abalone and its habitat.

Implementation of CDFW's Abalone Recovery and Management Plan (ARMP; adopted in December 2005) raises awareness of abalone and focuses efforts on abalone conservation and management throughout California. CDFW prioritizes enforcement against abalone poaching, closely monitors state aquaculture facilities, and strictly regulates the transfer of abalone for aquaculture, research, and/or food and hobby markets.

2.4.2 Environmental baseline for black abalone critical habitat

We identified several activities and factors that have affected and may continue to affect critical habitat features. Factors such as sea level rise, elevated water temperatures, and ocean acidification could affect the essential physical and biological habitat features throughout the designated critical habitat. For example, shifts in water temperatures and sea level rise related to global climate change may increase temperatures above the optimal range for black abalone and alter the distribution of rocky intertidal habitats along the California coast. Ocean acidification may reduce water quality and affect the growth and survival of larvae. How these factors affect critical habitat presently and in the future is difficult to assess, however, given the high uncertainty in predictions, especially at local scales, and in our understanding of how black abalone may respond to changes in conditions.

Sedimentation events have buried black abalone critical habitat along segments of the coast. For example, the Mud Creek landslide in 2017 buried approximately 1500 meters of black abalone critical habitat (Bell and Raimondi 2020). In addition to burying habitat, sedimentation and runoff events can affect rocky substrates by filling in crevices with finer sediments, as well as reduce water quality by increasing turbidity and introducing toxins and nutrients into coastal waters.

Other factors and activities that could affect critical habitat would have a more narrow geographic scope. Activities such as in-water construction, coastal development, sediment disposal associated with road maintenance (''sidecasting''), and sand replenishment may cause increased sedimentation, erosion, turbidity, or scouring in rocky intertidal and subtidal habitats. For example, a few beach nourishment projects have been proposed in southern California and should consider and monitor the effects of sediments on rocky intertidal habitats downstream and upstream of the nourishment sites. Discharge of thermal effluent from coastal facilities (e.g., power plants) can increase local water temperatures, introduce elevated levels of certain metals or contaminants into the water, or alter nearshore water circulation patterns (Martin et al. 1977, Tenera Environmental Services 1999, Crowe et al. 2000). Vessel groundings and oil spills

damage rocky substrates and introduce chemicals or materials that reduce habitat quality. For example, a vessel grounding at Point Piedras Blancas in 2014 introduced metal ballast onto the reef that may leach chemicals into the environment or cause direct physical damage to black abalone at the site (Lonhart et al. 2014). The Refugio oil spill in Santa Barbara in 2015 introduced oil into rocky intertidal habitats, including an area where black abalone were found (pers. comm. with Jack Engle and Pete Raimondi, 6 June 2015).

Overall, critical habitat remains in good condition to support black abalone survival and recovery. Reductions in the quality of habitat features have occurred due to factors such as shifts in community structure following the decline of black abalone, reductions in water quality associated with coastal power plant discharges, and impacts to rocky substrate due to recent vessel groundings, oil spills, and landslides. However, these changes have primarily been limited to a few sites within the designated critical habitat. Past black abalone monitoring activities have had little impact on critical habitat. In general, the monitoring areas are not subject to high levels of human disturbance given their location away from human population centers and limited accessibility.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

We use the "exposure-response-risk" approach to analyze the effects of the proposed research activities on black abalone and its critical habitat. This approach involves first evaluating the exposure of individual black abalone and critical habitat to the effects of the action. Next, we evaluate how individual black abalone and critical habitat are likely to respond to those effects. We then evaluate how those responses would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success) or the conservation value of those critical habitat areas. Finally, we evaluate the risk to black abalone at the individual, population, and species level, to evaluate whether the proposed action could appreciably reduce the species' likelihood of surviving and recovering in the wild. We also evaluate the risk posed to critical habitat to evaluate whether the proposed action could appreciably reduce the conservation value of critical habitat.

In our analysis of effects, we consider the proposed permit conditions described under Section 1.3 (Proposed Action) and their effectiveness at reducing adverse effects on black abalone and their critical habitat. We expect the Permit Holder to comply with the proposed permit conditions, because the Permit Holder complied with all of the permit conditions under the current permit (18761).

2.5.1 Effects of the action on black abalone

Permit 18761-2R would authorize ongoing and new research activities that directly affect black abalone, including monitoring activities that involve touching, measuring, swabbing, and handling individual black abalone, as well as collection of epipodial clippings, empty shells, and dead or obviously unhealthy individuals. Table 1 summarizes the annual take of black abalone that would be allowed under Permit 18761-2R.

Table 2. Proposed annual take of wild black abalone under Permit 18761-2R.

Life Stage	Research Component	Take Action	Number of individuals	Estimated Mortality
Adult, juvenile	Monitoring (long-term surveys, abalone habitat surveys, project or event related surveys)	Count/survey; Monitor; Measure	10,000	1*
Adult, juvenile	Recruitment module deployment	Count/survey; Monitor; Measure; Handle/Release; Mortality	300	3*
Adult, juvenile	Genetic sampling (swab samples and epipodial samples)	Monitor; Tissue Sample	600	0
Adult, juvenile	Collection of dead or obviously unhealthy abalone	Removal from the wild; Transfer/transport, dead	500	500
Adult, juvenile	Collection of empty shells	Removal from the wild; Transfer/transport	10	NA

*Mortalities: We do not expect the research activities to kill any black abalone. However, in the unlikely event that an accident occurs, a small number of mortalities have been included and analyzed. Note that all dead or obviously unhealthy abalone that are collected will die, but not due to collection.

Monitoring (long-term, abalone habitat, and project- or event-related surveys)

The proposed permit would allow researchers to count and measure up to 10,000 black abalone per year. This estimate is based on the numbers of black abalone observed over the past five years under Permit 18761 and accounts for potential increases in population abundance over the next five years. Researchers typically monitor sites once per year. Monitoring activities include counting individuals, measuring shell length, marking the shell with a lumber crayon, measuring nearest neighbor distances, and assessing the health and habitat of individuals.

We expect monitoring activities to cause minor, temporary stress to individuals, with little to no long-term effects. Researchers will not remove abalone from the substrate. As much as possible, researchers will avoid touching living tissues, such as the mantle, and will limit any contact with the shell or mantle to a few seconds. Black abalone may respond to touch by temporarily clamping down more tightly onto the substrate. Rarely, an abalone may become more active and move, which could expose it to greater risk by predators or being dislodged by waves. More often, this results in the abalone seeking shelter and better protection. The effects on individual abalone would be similar to that of waves or another organism (e.g., shore crabs, drift macroalgae) touching the individual.

Individual black abalone could be stepped on during survey activities and may be killed, injured, or clamp down more tightly to the substrate, depending on the amount of pressure exerted on the individual. The likelihood of stepping on a black abalone is very low and the likelihood of death as a result is even lower. Abalone are generally found within crevices and researchers generally wear soft shoes and are very careful where they step on the reef. Thus, we consider it very unlikely for researchers to step on black abalone when conducting monitoring activities.

Indirect effects on black abalone habitat may result from the installation of bolts (to mark fixed plots) or temperature loggers to the substrate, or from trampling. Installation activities include drilling bolts into the substrate, or attaching bolts or temperature loggers to the substrate using marine epoxy. At most sites, bolts and temperature loggers have already been installed and no additional installation is expected. No toxic effects have been observed from the marine epoxy. Given the small area required for installation of the bolts and equipment (e.g., one square inch to a few square inches), the effects on black abalone habitat are expected to be low.

Trampling of rocky intertidal reefs has been shown to reduce species richness and diversity, as well as increase the proportion of bare rock (Van De Werfhorst and Pearse 2007). Specifically, sessile invertebrates like mussels and barnacles may be crushed (Smith and Murray 2005) and the algal community may shift from one dominated by foliose species to one dominated by low profile species (Brosnan and Crumrine 1994, cited in Van De Werfhorst and Pearse 2007). We expect trampling effects to be minimal, given the low frequency and duration of monitoring surveys. Researchers will minimize effects on the habitat by wearing soft-soled shoes and avoiding walking on vulnerable species such as mussels.

Development and deployment of abalone recruitment modules

The proposed permit would allow researchers to develop and deploy abalone recruitment modules at sites throughout the California coast. The proposed permit would allow researchers to handle, count, and measure up to 300 black abalone per year while monitoring the modules for recruits. Researchers will monitor and measure black abalone on the modules up to three times per year. At the end of the deployment, researchers will remove the modules and all mounting materials from the intertidal habitat. Abalone found on the modules will be carefully removed and placed in suitable habitat nearby.

We expect minor effects on habitat. The modules will cover a small area of substrate (up to a 15cm by 15cm area per module) compared to the total substrate available per site. However, the modules will also provide additional structure. Effects on habitat would be temporary, because researchers will remove the modules and all mounting materials at the end of the studies.

We expect module deployment, monitoring, and removal activities to cause minor, temporary stress to individual black abalone, with little to no long-term effects. Researchers will not install modules within 10cm of any abalone. When monitoring the modules, researchers will carefully disassemble the modules to avoid moving or crushing any abalone. We expect abalone to respond by clamping down more tightly to the substrate or becoming more active and moving.

Abalone may be injured when moved from the modules to the substrate. The most common

injuries would be small cuts to the foot muscle. To minimize injury, researchers will use plastic spatulas or other instruments with a thin profile and blunt edge. Researchers may also use kelp (a natural food source) to entice abalone to move off the modules. In captive facilities, researchers routinely use similar methods to remove abalone from the substrate, with little to no injuries. We expect the potential for injuries to be low and that any injuries would be minor. Based on observations in captive facilities, abalone appear to be able to recover from minor scrapes and cuts. Injured animals may experience some reduction in growth during the recovery period, but we do not expect long-term effects on growth or on survival or reproductive development.

While we do not expect the activities to kill any abalone, the permit allows for up to three mortalities per year in the event of an accident (e.g., an abalone is crushed while disassembling or reassembling the modules). However, the potential for mortality is low.

Collection of tissue samples and swab samples for genetic analysis

The proposed permit would allow researchers to collect swab samples or tissue samples from up to 600 black abalone per year, for genetic analysis. To collect swab samples, researchers would use a buccal swab to swab the soft tissue or shell of the abalone. If this method does not produce enough material for genetic analysis, then researchers would collect epipodial clippings. Researchers would not remove abalone from the substrate.

We expect swab sampling to cause minor, temporary stress to individuals, with little to no long-term effects. Touching the animals may cause them to clamp down more tightly onto the substrate; in rare cases, abalone may move to seek shelter. Tissue sampling using the epipodial clipping method would injure the abalone, but we expect injuries to be minor and unlikely to cause long-term harm or injury to the animals. The epipodial clipping method is well established and has been used to collect tissue samples from abalone in the field and in captivity, with minimal effects on individuals (Hamm and Burton 2000, Gruenthal and Burton 2005, Coates et al. 2014, Gruenthal et al. 2014).

Collection of dead or obviously unhealthy black abalone

The proposed permit would allow researchers to collect up to 500 dead or obviously unhealthy black abalone per year. This number is based on the potential increase in disease-related mortalities during warm water events. To reduce the likelihood that a healthy abalone may be collected and killed, researchers would only collect abalone that are identified as dead or obviously unhealthy (see criteria in Section 1.3.1. of this Opinion, under "Collection of dead or obviously unhealthy abalone"). Abalone identified as dead or obviously unhealthy are either already dead or expected to die within a few days. Specimens, samples, and/or parts would be frozen or preserved and sent to labs for necropsy and analysis.

Collection of empty shells

The proposed permit would allow researchers to collect empty black abalone shells for research. Shells may be old or fresh from animals that died recently. Researchers may use the shells for research, such as evaluating shell length frequency, mortality rates, signs of predation (e.g., holes

bored by octopus), isotope analysis, or the feasibility of collecting genetic material from shells. Shells may not be sold.

Population and Species-Level Effects

We evaluate how the effects of the proposed research activities at the individual level may affect black abalone at the population and species level. We conclude by evaluating whether the proposed activities could appreciably reduce the species' likelihood of surviving and recovering in the wild. We consider the effects of the proposed research activities within the context of the species' status and recovery needs.

We expect most of the proposed research activities to cause minor, sublethal effects on individual black abalone, with little to no long-term effects. Sublethal effects include mild stress and minor injuries (e.g., minor scrapes or cuts to the foot muscle). In most cases, we expect individual abalone to experience mild stress. Abalone typically clamp down more tightly to the substrate, but in some instances, abalone may move, usually deeper into a crevice for more shelter. Based on the researchers' personal observations and best professional judgment, we expect animals to recover quickly from this stress and return to a relaxed state with little to no effects on survival, growth, or reproductive development. Proposed activities may injure some individuals, although there is a low likelihood of this occurring. Injuries are also expected to be minor and at most result in temporary reductions in growth that are not likely to result in effects at the population or species level.

The proposed permit would allow up to four black abalone to die each year due to monitoring activities (up to one mortality per year) and module deployment and monitoring activities (up to three mortalities per year). We do not have a population abundance estimate for black abalone, but we do know that the population in California consists of at least 7,750 black abalone, based on the number of black abalone observed in long-term monitoring surveys in 2019. The loss of four individuals per year represents a small percentage (0.05%) of the black abalone population in California. We do not expect the loss of four individuals per year to affect viability at the population or species level. Over the last ten years, research activities under Permits 14400 and 18761 have not resulted in any reported mortalities of black abalone. Therefore, we expect actual mortality to be less than four individuals per year.

Researchers may also collect up to 500 dead or obviously unhealthy black abalone per year. The loss of up to 500 black abalone per year is a much more substantial proportion of the known population in California (6.5%). However, these abalone would already be dead or expected to die within a few days whether or not they are collected. Removal of dead or obviously unhealthy abalone may benefit other abalone at the site by reducing the potential for further spread of disease. To reduce the likelihood that a healthy abalone may be collected and killed, researchers will only collect abalone that are dead or obviously unhealthy (i.e., noticeably shrunken, unable to adhere firmly to the substrate, not actively attempting to right themselves when placed upside down on the substrate).

In summary, we expect that the research activities to be conducted under the proposed permit may result in minor stress and injuries to black abalone. Generally, we expect individual abalone

to recover quickly from the stress or injuries. At most, individual abalone may experience short-term reductions in growth. A limited number of black abalone may die, though the likelihood is very low. We expect the benefits of the proposed research to greatly outweigh the potential adverse effects. The proposed research would provide valuable information on the species' abundance, size frequency, spatial distribution, genetics, and health throughout California. The information collected is needed to evaluate the species' status and progress toward recovery, as well as to assess the potential effects of projects and unexpected events on black abalone. The information would also inform other important recovery actions, such as disease studies, emergency response plans, and population restoration efforts.

2.5.2 Effects of the action on black abalone critical habitat

Monitoring activities and deployment of recruitment modules under the proposed permit will occur within black abalone critical habitat and may affect rocky substrates and juvenile settlement habitat. We expect the potential effects to critical habitat to be minor. Researchers will use non-destructive search methods to survey abalone and will minimize trampling effects. The installation of bolts (to mark survey plots) or of temperature loggers would affect rocky substrate, but the effects would be minor, affect a small area (approximately one square inch), and would not reduce the value of the habitat for black abalone. Installation of recruitment modules would affect rocky substrate, but the effects would be minor and affect a small area (approximately 15cm by 15cm surface area per module; up to six modules per site). Effects would also be temporary because all modules and mounting materials (epoxy, screws, anchors) would be removed at the end of the studies. We conclude that the proposed research activities are not likely to destroy or adversely modify designated black abalone critical habitat.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Disease and other factors, as described in the Environmental Baseline (Section 2.4) are likely to continue to affect the black abalone and its critical habitat into the future. Two factors of particular concern are the increased human use activities in California's intertidal zones and the increased sedimentation and runoff risk due to the massive fires in central and southern California in 2020.

Increased human use activities include collection of intertidal invertebrates for consumption as well as for observation and could result in increased illegal harvest of black abalone. In southern California, even low levels of harvest could wipe out black abalone populations that are just beginning to increase in numbers. We do not know whether and how much human use activities in the intertidal may increase in the future. Although CDFW closed all abalone fisheries in 2018, additional enforcement, outreach, and education are needed to protect abalone populations.

The massive fires that occur in California have the potential to threaten black abalone populations, particularly the healthy populations that remain along the central and south-central California coast. Potential effects includes burial by sedimentation, lethal and sublethal effects from toxins (e.g., from runoff of fire retardants and burned infrastructure), and increased fine sediments that can clog gills and increase turbidity in coastal waters. Analyses are underway to evaluate the risks to black abalone populations and their critical habitat.

NMFS issued a draft recovery plan for black abalone for public comment in January of 2020 and intends to finalize that plan in the coming months. The plan is a guide for NMFS and our partners to focus resources and implement priority actions for the conservation and recovery of black abalone. Recovery actions identified in the plan include long-term population monitoring, population and habitat restoration within areas affected by disease, disease research and management plans, emergency response plans, coordination with Mexico, and outreach and education. Issuance of the final plan is expected to increase collaboration and on-the-ground recovery efforts for black abalone.

We did not identify additional state or private activities that are reasonably certain to occur within the action area and that could result in cumulative effects on black abalone and black abalone critical habitat. In general, development activities are not allowed in rocky intertidal habitat. Oil spills and the introduction of pathogens could occur within the action area; however, we would not consider these activities to be reasonably certain to occur, given the unpredictability and uncertainty in the timing, location, scope, and severity of such events.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 Black abalone

Black abalone populations have declined throughout a large portion of the species' range (south of Cayucos), primarily due to historical overfishing and mass mortalities caused by withering

syndrome. In areas affected by the disease, populations remain at low abundance and density and are subject to demographic risks such as reduced reproduction and recruitment, loss of genetic diversity, and poor connectivity among populations. However, recruitment has been observed at a few sites in southern California, indicating some natural recovery is occurring. Populations north of Cayucos remain healthy and stable, but withering syndrome may spread northward with warm water events. Other threats, such as illegal and elevated water temperatures, continue to affect black abalone populations. Oil spills, sedimentation events, and other pathogens also pose a potential threat to the species. Threats of sedimentation and illegal harvest may increase in the coming years, given the massive fires and increases in intertidal harvest and human use activities observed this year. At the same time, ongoing and future conservation efforts provide benefits to the species by increasing public awareness of abalone conservation issues and enhancing management, protections, and enforcement. These efforts include implementation of California's ARMP, the designation of marine protected areas under California's MLPA process, disease research, and development of the black abalone recovery plan.

The research activities under the proposed permit would provide critical information to assess black abalone status and trends throughout California and to inform species management and recovery. The research activities directly address recovery actions identified in the draft black abalone recovery plan (NMFS 2020). Monitoring surveys provide valuable data on population presence, abundance, size frequency, distribution, and disease. Development and deployment of abalone recruitment modules would inform our understanding of juvenile recruitment and survival. Collection of swab or epipodial samples would support analysis of genetic structure and diversity, to inform future population restoration efforts. And collection of dead or obviously unhealthy abalone would allow detection of disease outbreaks and assessment of the continuing effects of withering syndrome on wild populations.

The proposed research activities involve interacting with the abalone (touching, handling, sampling) and may result in mild stress to individuals. Collection of epipodial clippings will injure individuals; monitoring or moving abalone from the modules may also cause injuries. However, we expect injuries to be minor and cause at most a short-term reduction in growth, with no long-term effects on growth, survival, or reproductive development. The proposed permit would allow for limited mortality as a result of the research activities (up to four mortalities per year). This represents the loss of a very small proportion (at most 0.05%) of the population. The proposed collection and removal of dead or obviously unhealthy black abalone would kill the individuals that are removed, but those individuals are expected to die whether they are collected or not.

Considering the status of the species, the environmental baseline, and cumulative effects, we do not expect the research activities under the proposed permit to reduce fitness at the population or species level. The proposed research activities would provide fundamental information on black abalone status to inform effective management and recovery strategies. For example, the proposed monitoring will provide data to evaluate how increased sedimentation and human use activities affect black abalone populations and will inform management and conservation actions to respond to these threats.

2.7.2 Black abalone critical habitat

Black abalone critical habitat remains in good condition to support black abalone survival and recovery. Most effects on critical habitat have been limited to narrow geographic areas. For example, changes in community structure have been observed at a few sites following the decline of black abalone. Thermal effluent from a coastal power plant has increased local water temperatures at one of the sites. A landslide buried a localized area of critical habitat along the central California coast. Factors that could affect critical habitat on a larger geographic scale include sea level rise, ocean acidification, and elevated water temperatures resulting from climate change. The effects of these factors on critical habitat are highly uncertain. The massive fires this year are expected to increase sedimentation and runoff along the central and southern California coast. Researchers are assessing the potential risks to black abalone critical habitat.

We would expect the research activities under the proposed permit to have little to no effect on black abalone critical habitat. Monitoring activities would result in minor trampling of the habitat, with little effect overall as shown by past monitoring activities. Deployment of recruitment modules would have minor effects on small areas within a few sites. Considering the status of critical habitat, the environmental baseline, and cumulative effects, we do not expect research activities under the proposed permit to reduce the conservation value of designated black abalone critical habitat. We expect the proposed research activities to provide valuable information on the quality and quantity of critical habitat throughout the coast. This information may be used to assess changes in habitat quality over time, such as with the expected increase in sedimentation and runoff effects following the California fires this year. This information may also be used to identify potential sites for habitat or population restoration efforts in the future under the recovery plan.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of black abalone and is not likely to destroy or adversely modify its designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be

prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

For the action considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this opinion would be carried out under a permit that allows the permit holder to directly take black abalone. The actions are considered to be direct take rather than incidental take because in every case their actual purpose is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition given above. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above (Table 2 in Section 2.5.1). Those amounts constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. This concept is also reflected in the reinitiation clause below.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

(1) In addition to the existing MARINe database for black abalone monitoring data, the permit holder and researchers under the permit should consider developing a central database for biological samples collected and analyzed. The database should include the following information for each sample: collection date and location, name of collector, reason for collection, description of specimen (whole animal, parts, sample, or shell), where the sample/specimen is archived, and a summary of analysis results.

We request notification if this conservation recommendation is implemented, to stay informed of actions to minimize or avoid adverse effects, or benefit listed species and their habitat.

2.11 Reinitiation of Consultation

This concludes formal consultation for NMFS' proposal to issue a permit to Peter Raimondi, UCSC, to take black abalone for research purposes pursuant to the provisions of Section 10(a)(1)(A) of the ESA.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS 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 identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological

opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis section (2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

2.12 "Not Likely to Adversely Affect" Determinations

NMFS does not anticipate the proposed action will adversely affect Guadalupe fur seals or designated critical habitat for Steller sea lions.

Guadalupe fur seals may occur in the action area, but are not likely to be encountered during the proposed research activities. Guadalupe fur seals are considered rare in California waters, with a few sightings on San Miguel Island (Melin and DeLong 1999), San Nicolas Island (Stewart and Yochem 1984), and throughout the central California coast (http://sanctuarysimon.org/monterey/sections/specialSpecies/guadalupe_fur_seal.php). Although Stewart and Yochem (1984) observed two individuals at San Nicolas Island in October, Guadalupe fur seals generally occur in the action area during summer months. Thus, they are not likely to be at or near the monitoring sites during the proposed monitoring activities, which will generally occur during the fall through spring months. We conclude that the research activities under the proposed permit are not likely to adversely affect Guadalupe fur seals, because the probability of encountering Guadalupe fur seals is extremely unlikely and therefore discountable. The permit will require researchers to scan the area for pinnipeds and will provide a description of Guadalupe fur seals to ensure researchers can distinguish them from other species. If a Guadalupe fur seal is observed at or near the monitoring sites, researchers will suspend their activities at the site and immediately vacate the area to avoid disturbing the animals.

The eastern DPS of Steller sea lions was delisted in 2013 (78 FR 66139, 04 November 2013). However, the critical habitat designation encompasses critical habitat for both the delisted eastern DPS and the listed western DPS and remains in effect within the eastern DPS's range. Designated critical habitat for Steller sea lions includes all major rookeries and associated air and aquatic zones in California that support Steller sea lion reproduction, foraging, rest, and refuge (58 FR 45269, 27 August 1993; 50 CFR § 226.12). Within the action area, this includes the major Steller sea lion rookeries on Año Nuevo Island, Southeast Farallon Island, Sugarloaf Island, and Cape Mendocino. The research activities under the proposed permit may occur within Steller sea lion critical habitat; however, these activities would not be expected to measurably change any habitat feature or disrupt the ability of Steller sea lions to use these areas for reproduction, foraging, rest, or refuge. We conclude that because none of the permitted activities would measurably affect any PBFs, all effects on critical habitat would be insignificant, and therefore the proposed research activities are not likely to adversely affect the conservation value of designated critical habitat for Steller sea lions.

In summary, we conclude that the proposed action is not likely to adversely affect Guadalupe fur seals and designated critical habitat for Steller sea lions.

3. MAGNUSON-STEVENS ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the effects analysis in Section 2.5 of this biological opinion and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (PFMC 1998), Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

In this instance, because no adverse effects on habitat are expected, no effects on EFH are anticipated either. The proposed research actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific groundfish, salmon, and coastal pelagic species depend. All the actions are of limited duration, minimally intrusive, and are discountable in terms of their effects, short- or long-term, on any habitat parameter important to the fish.

The action agencies must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

3.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is NMFS WCR PRD. Other interested users could include the permit applicant (Peter Raimondi, UCSC), co-investigators listed on the permit application, and abalone researchers. Individual copies of this opinion were provided to the NMFS WCR PRD. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

3.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

3.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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