UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
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Long Beach, California 90802-4213

September 10, 2019

Memorandum for: The Record

From: Chris E. Yates
Assistant Regional Administrator, Protected Resources Division
West Coast Region
National Marine Fisheries Service

Subject: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, on the issuance of Scientific Research and Enhancement Permit 18116 to National Marine Fisheries Service, West Coast Region, for field planting and research on white abalone (*Haliotis sorenseni*) in California, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973

Attached is the NOAA National Marine Fisheries Service's (NMFS) biological opinion (opinion) pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531et seq.) for the proposed issuance of Permit 18116 to the National Marine Fisheries Service (NMFS) West Coast Region (WCR), for scientific research and enhancement activities involving endangered white abalone (*Haliotis sorenseni*) in California.

We conclude that issuing Permit 18116 is likely to adversely affect white abalone but not likely to jeopardize their continued existence. We do not discuss effects on critical habitat because NMFS has not designated critical habitat for white abalone due to the concern over poaching. The proposed permit activities are not likely to adversely affect ESA-listed black abalone or their designated critical habitat.

This concludes formal consultation on this action. Consultation on this issue must be reinitiated if: (1) the amount or extent of incidental taking specified in the Incidental Take Statement 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 biological opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

We also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would not adversely affect the EFH of Pacific Coast groundfish or salmon (Pacific Fishery Management Council 2005, 2014). Therefore, we have included the results of that review in Section 3 of this document.

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

Issuance of Scientific Research and Enhancement Permit 18116 to the National Marine Fisheries Service, West Coast Region, for field planting and research on white abalone (*Haliotis sorenseni*) in California, pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973

NMFS Consultation Number: WCRO-2019-01993
Administrative Record Number: 151422WCR2019PR00172

Action Agency: Protected Resources Division, West Coast Region, 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?
White Abalone (*Haliotis sorenseni*)	Endangered	Yes	No	NA[1]	NA
Black Abalone (*Haliotis cracherodii*)	Endangered	No[2]	NA	No[3]	NA

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

For Barry A. Thom
Regional Administrator

Date: *September 10, 2019*

[1] NMFS has not designated critical habitat for white abalone.
[2] Refer to Section 2.12 for an analysis of species that are not likely to be adversely affected.
[3] Refer to Section 2.12 for an analysis of critical habitat that is not likely to be adversely affected.

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AoP	Aquarium of the Pacific, Long Beach, CA
BART	Baby Abalone Recruitment Trap
BML	Bodega Marine Laboratory
CaXC	*Candidatus* Xenohaliotis californiensis
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
CICESE	Center for Scientific Research and Higher Education of Ensenada, Baja California
CIMRI	Channel Islands Marine Resource Institute
CMA	Cabrillo Marine Aquarium
DQA	Data Quality Act
EA	Environmental Assessment
ECO	Environmental Consultation Organizer
EFH	Essential Fish Habitat
ENSO	El Niño-Southern Oscillation
ESA	Endangered Species Act
FR	Federal Register
ITS	Incidental take statement
MSA	Magnuson Stevens Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWFSC	Northwest Fisheries Science Center
OPR	Office of Protected Resources
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
PRD	Protected Resources Division
ROV	Remotely operated vehicle
RPM	Reasonable and Prudent Measure
SAFE	Short-term Abalone Fixed Enclosure
SE	Standard error
SEM	Standard error of the mean
SL	Shell length
SWFSC	Southwest Fisheries Science Center
TBF	The Bay Foundation
UC Davis	University of California, Davis
UCSB	University of California, Santa Barbara
UW	University of Washington
WCR	West Coast Region
WDFW	Washington Department of Fish and Wildlife

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 the biological opinion (opinion) and incidental take statement (ITS) portions of this document 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 402.

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 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). A complete record of this consultation is on file at the NMFS WCR Long Beach Office.

1.2 Consultation History

On 25 August 2018, the NMFS WCR PRD submitted an application for a Permit (18116) to conduct experimental outplanting studies with endangered white abalone along the Southern California Bight. The NMFS WCR Permits Team reviewed the application and requested additional information from NMFS WCR PRD prior to accepting the application as complete.

On 28 September 2018, the Permits Team solicited public comments on the permit request via a notice published in the *Federal Register* (83 FR 48596). The 30-day public comment period ended on 26 October 2018. No public comments were received.

On 15 February 2019, the NMFS WCR PRD submitted a revised application. The NMFS WCR Permits Team reviewed and accepted the application as complete. On 14 March 2019, the Permits Team solicited public comments on the revised application via a notice published in the *Federal Register* (84 FR 9309). The 30-day public comment period ended on 15 April 2019. We received two public comments. One comment expressed support for white abalone conservation and recovery under the ESA. The other comment spoke against any government funding for the proposed experimental outplanting, stating that the outplanting sites are subject to warming water temperatures and pollution. We note that issuing a permit does not provide government funding for the proposed experimental outplanting and that the researchers will consider factors such as water temperatures, water quality, and habitat quality when selecting outplanting sites.

On 18 June 2019, the Permits Team coordinated with NMFS WCR PRD to discuss potential permit conditions. After considering the applicant's comments, the Permits Team developed the draft permit conditions and we initiated consultation on 26 July 2019. We also drafted an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA), to evaluate the effects of the proposed action on the human environment.

This consultation is on the proposal to issue Scientific Research and Enhancement Permit 18116 to the NMFS WCR PRD. This permit would authorize NMFS WCR PRD to conduct experimental outplanting studies along the Southern California coast using captive-bred white abalone. All of the white abalone used in the studies would come from captive facilities operating under Permit 14344-2R, issued to the University of California at Davis' Bodega Marine Laboratory (BML). The outplanted individuals would include captive-bred larvae, juveniles, and adults. The purpose of the experimental outplanting studies is to develop optimal outplanting strategies for restoring white abalone populations in the wild. The expiration date of the proposed permit would be 31 December 2023. Issuing this permit is a Federal action that may affect marine species listed under the ESA.

In this Opinion, we analyze the research and enhancement activities that may be authorized under Permit 18116 and evaluate their effects on ESA-listed resources, namely endangered white abalone. To analyze the effects on white abalone, we considered the information provided in the permit application, the Environmental Assessment, the draft permit conditions, the white abalone listing decision and supporting documents, the white abalone recovery plan, scientific and technical reports, peer-reviewed literature, and personal communications and unpublished data from abalone experts.

We also considered the EAs, Biological Opinions, and annual reports prepared for Permit 14344 and Permit 14344-2R, issued in 2011 and 2016 to BML, and for Permit 1346-01, issued in 2004 to Tom McCormick at the Channel Islands Marine Research Institute (CIMRI). The analyses and reports for Permit 1346-01 and Permit 14344 are relevant because the permits authorized outplanting activities similar to those that would be authorized under Permit 18116. The analyses and reports for Permit 14344-2R are relevant because the animals held under Permit 14344-2R would be used in the outplanting activities under Permit 18116.

In the EAs for Permits 1346-01 (NMFS 2004a) and Permit 14344 (NMFS 2011a) and the CE for Permit 14344-2R, NMFS concluded that issuing the permits will not significantly impact the quality of the human environment. In the opinions for Permit 1346-01 (NMFS 2004b), Permit 14344 (NMFS 2011b), and Permit 14344-2R (NMFS 2016), concluded that issuing the permits would adversely affect, but would not be likely to jeopardize the continued existence of endangered white abalone.

1.3 Proposed Federal Action

"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).

The Permits Team proposes to issue Permit 18116 to NMFS WCR PRD under the authority of section 10(a)(1)(A) of the ESA. Permit 18116 will authorize NMFS WCR PRD and other personnel named on the permit as co-investigators to outplant captive-bred white abalone into the wild within the Southern California Bight, primarily along the Southern California coast. Permit 18116 will also allow NMFS WCR PRD and the co-investigators to monitor white abalone at the outplant sites, including outplanted white abalone and any wild white abalone that may be encountered. Outplanting and monitoring wild populations are two of the key recovery actions identified in the white abalone recovery plan (NMFS 2008).

The captive-bred white abalone to be used in the proposed outplanting activities under Permit 18116 will come from the white abalone captive propagation program (under Permit 14344-2R, issued to BML). These include captive-bred white abalone larvae, juveniles, and adults. To prepare for outplanting, the white abalone may need to be assessed, tagged, treated for pathogens, and transported. To prepare for outplanting, the following activities will be conducted at captive facilities under Permit 14344-2R and are already analyzed in the biological opinion for that permit:

- Measuring shell length and weight;
- Tagging with external tags (e.g., numbered tags or passive integrated transponder (PIT) tags glued to the shell);
- Tissue sampling for genetic analysis (e.g., epipodial clippings, swab samples);
- Assessing animal health (for withering syndrome, shell-boring organisms, and sabellids);
- Shell waxing (to remove shell epibionts) and antibiotic treatments (for infections); and
- Transporting the animals to the staging facility.

The following activities will be conducted under Permit 18116:

- Marking by notching the shell (not covered under Permit 14344-2R);
- Using anesthetics to remove abalone from the tanks for transport;
- Transport from captive facilities to field outplanting sites;
- Outplanting the white abalone to field sites;
- Monitoring the white abalone after outplanting (measuring shell length, identifying tags);
- Collecting fecal and genetic tissue samples, shells, and dead and obviously unhealthy abalone.

Permit 14344-2R also authorizes the collection of white abalone from the wild to serve as broodstock in the captive propagation program, and the reintroduction of those broodstock to the wild. Although reintroduction of the wild-collected broodstock will be conducted under Permit 14344-2R, the monitoring of these individuals once they are reintroduced to the wild would be conducted under Permit 18116. Researchers under Permit 14344-2R and Permit 18116 may coordinate efforts to reintroduce the wild-collected broodstock to the same sites and in aggregation with the captive-bred adults outplanted under Permit 18116.

The activities under Permit 18116 would “take” white abalone listed as endangered under the ESA. Take as defined under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." This ESA Section 7 consultation considers the effects of the proposed activities on endangered white abalone. The purposes of the outplanting studies are to evaluate and develop optimal outplanting strategies for restoring white abalone in the wild and to increase the local abundance and density of white abalone populations in the Southern California Bight. Three approaches would be evaluated using larval, juvenile, and adult white abalone, to determine how the methods and abalone life stage, size, density, and habitat quality affect the survival and growth of outplants. NMFS would coordinate closely with BML on permit activities, because the proposed activities under Permit 18116 are closely tied to the captive propagation program implemented under Permit 14344-2R. In the following sections, we briefly summarize the seven main components of the research and enhancement activities that would be authorized under Permit 18116:

(1) Outplanting site selection;
(2) Experimental larval outplanting;
(3) Experimental juvenile and small adult outplanting;
(4) Experimental adult outplanting;
(5) Marking methods (notching the shell);
(6) Anesthetizing the animals; and
(7) Post-outplant monitoring.

1.3.1 Outplanting site selection

Outplanting would take place within the U.S. portion of the range of white abalone, in the Southern California Bight. Researchers would initially focus outplanting studies at four locations:

(1) Palos Verdes in Los Angeles County;
(2) La Jolla in San Diego County;
(3) Point Loma in San Diego County; and
(4) The California Channel Islands.

Researchers would identify outplanting sites at these locations. The sites would be defined by the immediate area where outplanting would be done and a larger area to be monitored after outplanting. Researchers would conduct surveys and select outplanting sites with the following features:

- Proximity of land-based resources (such as culture facilities and/or vessels) to the outplanting site, to ease logistical and financial burdens;
- Presence of wild white abalone since the ESA listing decision in 2001;
- Presence of low relief (< 1 m relief) rocky habitat;
- Presence of intermittent sand channels;
- A diverse macroalgal community and the presence of coralline encrusted rock; and
- Water depths between approximately 50 and 100 ft (approximately 15 to 30 m).

During the surveys, divers would identify and measure any abalone observed. Abalone shells would be identified to species, measured, and returned to the site unless needed (e.g., for verifying species identification). Divers would score physical and biological habitat variables and the overall habitat quality (i.e., poor, fair, excellent). Divers would also collect water samples to analyze for the pathogen that causes the disease called withering syndrome. The pathogen is likely to be present at all potential outplanting sites, given that it has been detected in all coastal marine waters of southern California (Moore et al. 2002). Analyzing water samples would provide baseline information on the occurrence and prevalence of the pathogen prior to outplanting.

1.3.2 Experimental larval outplanting

Researchers would conduct experimental larval outplanting using captive-bred larvae produced under Permit 14344-2R and ready for settlement. Larval outplanting may occur at any time of year depending on production success at the captive facilities, but would most likely occur between February and July, when the captive propagation program conducts spawning events. Researchers estimate they would outplant up to approximately 50 million larvae per year, though actual numbers would depend on larval production. The following describes the basic outplanting design, which may be adjusted as needed depending on the number of available larvae.

At each outplanting location, researchers would set up four sites, two low-density sites and two high-density sites. Each site would cover approximately 625 m^2 and contain eight plankton net tents (approximately 0.5 m diameter per tent) clustered in the center. In a given outplant location, the distance between sites would depend on the presence of appropriate habitat and what would be logistically feasible to monitor post-outplanting. The distance between plankton net tents at each site would depend on the presence of appropriate habitat.

Researchers would target a density of 50,000 to 100,000 larvae per plankton net tent, for a total density of 400,000 (low) to 800,000 (high) larvae per site. Researchers may adjust the number of plankton net tents or the site size depending on the number of larvae available. The timing of larval deployment (i.e., deploy larvae to all eight tents at one time versus staggered deployments over several time periods) would depend on the number of larvae available, weather conditions, and vessel and diver availability.

Researchers would transport the larvae from the captive facilities to the outplanting sites by placing the larvae in large, aerated plastic bags. The plastic bags would be placed in coolers to maintain water temperatures close to those at the facility and at the outplant site. The coolers would be transported by vehicle and by vessel to the field site. At the field site, researchers would transfer the larvae to a PVC pump module (Figure 1). Once transferred to the PVC pump, divers would deploy the larvae within 24 hours. Divers would take the PVC pump modules to the outplanting sites and use the pump to deploy the larvae into a plankton net tent (Figure 1), designed to retain larvae until settlement. At 48 hours after deployment, divers would remove the plankton net tents.

Divers would monitor the outplant sites every twelve months over the life of the permit to evaluate white abalone survival, growth, and habitat characteristics. Researchers would compare outplant survival and growth between sites (low versus high density) and geographic locations. Divers would measure any white abalone observed and collect a genetic sample (e.g., an epipodial clipping or swab sample; see “Post-outplant monitoring” below for more details) to verify the species and determine the abalone’s origin (outplanted or wild). Empty shells may also be collected for further assessment and educational purposes. If time and resources allow, photographs and fecal samples (see “Post-outplant monitoring” below for more details) may be collected to assess abalone health.

Figure 1. PVC pump module used for deploying larval abalone into plankton net tents (bottom). Photo by Ariadne Reynolds, The Bay Foundation.

1.3.3 Experimental juvenile and small adult outplanting

Researchers would conduct experimental outplanting using captive-bred juveniles and small adults produced under Permit 14344-2R. Abalone would be selected based on their health, size, and genetics and may be tagged with an external tag (e.g., visual tag or PIT tag glued to the shell) and/or marked by notching the shell (see “Tagging Methods” below). Outplanting may occur at any time of year depending on availability of abalone and specific site characteristics. Researchers plan to conduct up to four outplantings per 12-month time period at each geographic location, though the actual number may be greater or less depending on the availability of juveniles and small adults.

Two methods would be used to outplant juveniles and small adults: (1) Baby Abalone Recruitment Traps (BARTs); and (2) Short-term Abalone Fixed Enclosures (SAFEs). Researchers estimate outplanting up to 110,000 juveniles and small adults per year, though actual numbers may be greater or less depending on production and health. Outplanting would primarily involve abalone that are not infected with the pathogen that causes withering syndrome. However, infected abalone may also be used for outplanting, if the pathogen is already present at the outplant site (determined based on water sample analysis or the presence of infected abalone at the site).

The following describes the basic design for each method, which may be adjusted as needed depending on the number of abalone available.

Baby Abalone Recruitment Traps (BARTs)

BARTs are fixed, semi-protected cages (approximately 36” x 28” x 14”) made of heavy gauge steel wire mesh with black PVC coating (approximately 2” x 4” mesh), frequently used as lobster traps. The cages are filled with substrates (e.g., cut cement cinder blocks, natural rock) to anchor the cage to the ocean floor and provide refugia for abalone.

At each outplanting location, researchers would set up two to six sites, with two to four BARTs per site. At each site, divers would set up a permanent leadline array consisting of four 20-m lengths of leadline arranged in a star pattern to create an octagonal plot with spokes from the center 10 m in length (Figure 2). The leadlines would be secured into the substrate using railroad spikes. The area encompassed by the center 5 m would be designated the inner zone and the area encompassed by 5m to 10 m would designated the outer zone. The entire array would cover an area of approximately 290 m^2. Prior to outplanting, divers would survey the array sites to characterize the habitat, specifically noting the following: fish abundance, benthic predator abundance, macroinvertebrate abundance, algal percent cover, substrate, and rugosity. If possible, predators would be collected and relocated at least 0.5 km away from the array site.

Either two or four BARTs would be moved into the inner zone, at least 2 m from each other. Abalone would be introduced to the BARTs by hand planting or using PVC tubes. Researchers would target about 240 to 800 abalone per BART, for a total of 480 to 3,200 abalone per site. The actual number of abalone per site would depend on availability.

For the hand-planting method, researchers would transport abalone from the captive facilities to the outplanting sites by placing the abalone in mesh bags. For the PVC tube method, researchers would transport abalone from the captive facilities to the outplanting sites by placing the abalone in the PVC tubes at no more than seven days prior to the outplanting. The PVC tubes (approximately 20” long and 4-6” in diameter) have perforations along the side to allow for water flow and square pieces of flat PVC (“doors”) to cover each end of the tube. The doors would be held in place by an elastic band that is connected by a dissolvable zinc link. The links would dissolve between 6 and 20 hours after exposure to seawater, to allow for a delayed release of abalone from the tubes at night, when predation risk is lower. The tubes would be housed in larger temperature-controlled tanks with high water flow, stocked with algae every other day, and flushed to remove waste every day while at the staging facility. Researchers would target densities of up to 100 abalone per tube for abalone less than 40 mm shell length (SL) and up to 60 abalone per tube for abalone greater than 40 mm SL.

On the day of the outplanting, researchers would place the abalone (whether in mesh bags or PVC tubes) in large coolers filled with seawater for transport by vehicle and by vessel to the outplanting site. Researchers would provide proper aeration and water temperatures for the abalone throughout transport. At the outplant site, divers would either hand plant abalone from the mesh bags into the BARTs, or place four to eight tubes inside the BARTs or attached to the outside of the BARTs (e.g., using zipties). Divers would check the tubes at 24 and 48 hours after outplanting and remove tubes containing no abalone. If tubes contain less than 10 abalone, divers would gently remove the animals from the tubes and place them in the BART. If tubes contain more than 10 abalone, divers would leave the tubes in place and remove the animals during a later survey.

Divers would monitor the outplant sites at 6, 12, and 24 months post-outplanting to evaluate white abalone survival, growth, and habitat characteristics. Divers would conduct invasive surveys using flashlights to search for abalone in cracks and crevices and under movable substrates within the site and outside of the site area. Live abalone would be counted, identified as tagged or notched, and measured with calipers for shell length. Empty shells would be collected to estimate mortality and to determine what may have killed the abalone. Dead and/or obviously unhealthy white abalone would also be collected for further analysis to determine the cause of death (see "Post-outplant monitoring" below for more details). Habitat would be characterized by assessing algae, fish, and associated species, and predators may be moved outside of the outplant site. If funding and resources allow, monitoring would be conducted at 3, 6, 9, 12, and 24 months post-outplanting, and photographs, fecal samples, and genetic samples collected as needed for further analysis.

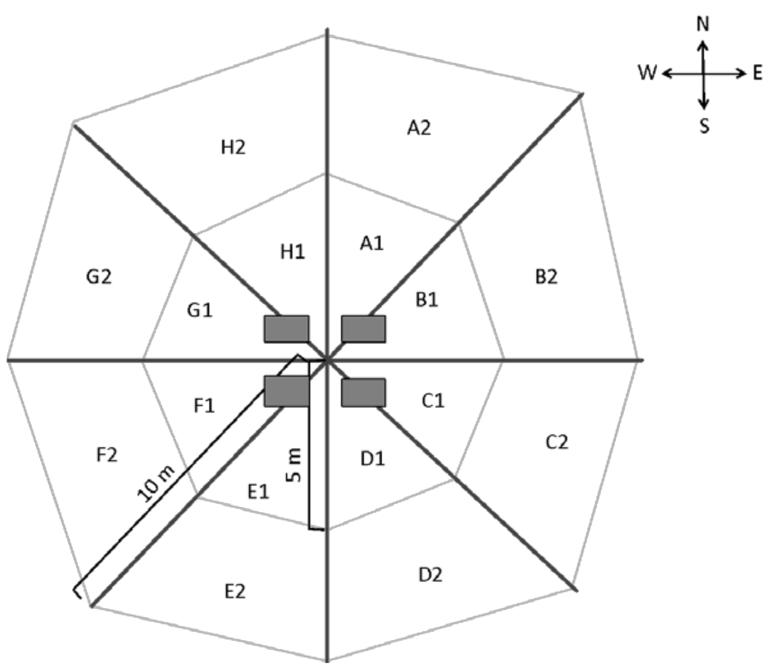

Figure 2. Generalized schematic of the permanent leadline array that denote a site and the zone labels. The dark grey rectangles represent the BARTs. Sites will have 2 or 4 BARTs.

Short-Term Abalone Fixed Enclosure (SAFE) Modules

SAFE modules are semi-protected, non-permanent cages (approximately 18.5" x 14" x 10") that are made of PVC pipe encased in mesh that allows for ample water flow, keeps out most predators, and prevents abalone and their food (macroalgae) from escaping. The cage is secured to a concrete base (approximately 14" x 10") that anchors the cage to the ocean floor. The purpose of the SAFE modules is to allow abalone time to acclimate to the ocean environment before being released from the modules to seek out natural shelter.

At each outplanting location, researchers would set up two low density and two high-density sites. Each site would cover approximately 625 m^2 and contain ten (low density) or twenty (high density) clustered SAFE modules. The SAFE modules would be clustered in the center of each site, on flat surfaces adjacent to rocky reefs. As much as possible, divers would avoid placing the SAFEs on rocky substrate. The distance between modules would depend on the presence of appropriate habitat at the site. The distance between sites would depend on the presence of appropriate habitat and what is logistically feasible to monitor post-outplanting.

Researchers would target a density of 40 to 60 abalone per SAFE module, for a total of approximately 400 to 600 abalone per low-density site and approximately 800 to 1,200 abalone per high-density site. Researchers may adjust the number of abalone depending on their availability. The timing of stocking (i.e., stocking all SAFE modules at one time versus staggering the stocking over several time periods) would depend on the number of abalone available, weather conditions, and vessel and diver availability.

To transport the abalone from the captive facilities to the outplanting sites, researchers would place the abalone in closed containers that permit water exchange (e.g., PVC tubes with perforations, mesh bags, critter keepers). These containers would be placed in coolers filled with seawater and transported by vehicle and by vessel to the outplanting site. Researchers would maintain proper aeration and water temperatures throughout transport.

At the field sites, divers would introduce about 40 to 60 abalone to each SAFE, along with ample native algae for food. At approximately two and a half weeks after deployment, additional food would be placed in each module. After approximately five weeks, divers would lift the cages off the concrete bases on one side to create a gap through which the abalone can crawl to seek out natural shelter. Approximately one to two weeks later, divers would remove the cages from the concrete bases. Divers would carefully remove any abalone adhering to the cages and hand place them into surrounding sheltered habitat. The concrete bases would remain in place until the next re-stocking event.

Divers would monitor the outplant sites quarterly over the life of the permit to evaluate white abalone survival, growth, health, and habitat characteristics. Outplant survival and growth would be compared between sites (low versus high density), habitat features (e.g., rugosity), and geographic locations. For tagged abalone, divers would measure the shell length, record tag numbers, visually assess their health, and collect a genetic sample (e.g., an epipodial clipping or swab sample). Empty shells may also be collected for further assessment and educational purposes. If time and resources allow, divers would also: (a) monitor the outplant sites weekly for the first two weeks after outplanting; (b) measure and collect genetic samples from all live, untagged white abalone to verify the species and determine their origin (outplanted or wild); (c) collect fecal samples to assess abalone health; (d) take photographs of individual abalone; and (e) collect dead and/or obviously unhealthy white abalone for further analysis to determine the cause of death. See the "Post-outplant monitoring" section below for more details about these activities.

1.3.4 Experimental adult outplanting

Researchers will outplant up to 2,500 adult (≥ 60 mm SL) captive-bred white abalone over the life of the permit. Criteria used to select these individuals will include, but are not limited to, the following: (a) the individuals are deemed healthy; and (b) the individual's genetic composition is well represented in the captive population; or (c) the individual has not spawned in captivity despite repeated spawning attempts. Adult outplanting may occur at any time of year. All adults will be tagged with visual tags glued to the shell and/or PIT tags, as authorized under Permit 14344-2R.

Outplanting will primarily involve abalone that are not infected with the pathogen that causes withering syndrome. However, infected abalone may also be used for outplanting, if the pathogen is already present at the outplant site.

The researchers would transport adult abalone from the captive facilities by placing them in mesh bags that permit water exchange, place the bags into coolers filled with seawater, and transport the coolers by vehicle and by vessel to the outplanting site. Researchers will maintain proper aeration and water temperatures throughout transport.

At the field sites, divers will hand place up to 33 adults per site (ideally approximating a 50/50 ratio of males to females). Adults will be placed within approximately one to five meters from one another on appropriate substrate. The outplantings would create aggregations that are each less than 25 m^2 in area at up to 76 sites in the wild. Captive-bred adults may be outplanted to the same sites and in aggregation with wild-collected adults that are being reintroduced to the wild under Permit 14344-2R.

Researchers will monitor the survival, growth, health, and habitat characteristics at the adult outplanting sites and an approximately 625-m^2 area surrounding the adult aggregation. At a minimum, divers will monitor the outplant sites annually over the life of the permit to characterize the habitat, measure white abalone observed, collect genetic samples from untagged individuals, visually assess the health of live animals (e.g., body shrinkage), and collect and measure empty shells. If time and resources allow, divers will revisit the sites every two months for the first six months and annually thereafter for the life of the permit. Divers will measure all white abalone observed and, as needed, collect genetic samples from untagged individuals, fecal samples, photographs, and empty shells. Divers will also collect dead and/or obviously unhealthy abalone for further analysis to determine the cause of death. If available, divers will place time-lapse cameras to monitor feeding, movement, and survival of the outplanted adults for a period of at least six months. The time-lapse cameras will take a picture every 10 minutes for a period of five to seven weeks. Divers will swap out cameras every five to seven weeks and monitor the abalone during these visits.

1.3.5 Marking methods

Juvenile and small adult white abalone may be tagged prior to outplanting by attaching an external tag to the shell and/or marked by notching the shell. External tagging with visual tags and PIT tags is already covered under Permit 14344-2R. However, notching the shell would be covered under Permit 18116. Notching the shell involves using a rotary tool to cut a notch about 1mm thick and 2-4mm deep into the growing edge of the shell. A minimum of two people wearing proper protective equipment is required, one to hold the abalone and one to use the rotary tool to notch the shell. Notching the shell takes about 5 - 10 minutes and individual abalone would not be kept out of water for more than 10 minutes.

1.3.6 Use of anesthetics

Anesthetics may be used to remove juvenile and small adult abalone from the tanks to closed containers (e.g., PVC tubes, mesh bags, critter keepers) for transport from the captive facility to the staging facility and/or outplanting site. To anesthetize the animals, researchers would expose them to a low concentration (up to 3%) of ethanol solution for a maximum of 10 minutes.

For larger adult white abalone, researchers may use different anesthetics, including ethanol, carbon dioxide (CO_2), Epsom salt ($MgSO_4$), magnesium chloride ($MgCl_2$), and phenoxyethanol. Researchers would use the minimum concentrations and exposure times that are deemed safe and effective at anesthetizing the adult abalone. See Section 1.3.8 *Permit Conditions - Conditions Relating to Field Outplanting and Monitoring* (Condition No. 8, pp. 22 -23), and the discussion in Section 2.5 *Effects of the Action* (pp. 46 - 47).

1.3.7 Post-outplant monitoring

Post-outplant monitoring would be conducted for each approach described above, to assess the survival and growth of outplanted abalone. Researchers do not expect to observe a measurable response until 5-8 years post-outplanting, as observed in experimental outplanting studies involving other abalone species (e.g., unpublished data by J. Bouma, Puget Sound Restoration Fund, and M. Ulrich, Washington Department of Fish and Wildlife, cited in permit application). Post-outplant monitoring would still be conducted to observe abalone behavior and survival, compare the different outplanting methods, and develop effective monitoring methods.

Monitoring activities would involve measuring the shell length of individual abalone and collecting genetic samples, fecal samples, empty shells, and dead and/or obviously unhealthy white abalone.

Researchers would use non-lethal methods and would not remove live abalone from the substrate in order to measure shell length and collect genetic and fecal samples. For example, to measure abalone, divers would leave animals in place and simply use a caliper or ruler to determine the shell length.

Genetic samples (epipodial clippings or swab samples) would be collected for species identification and to determine the origin of untagged individuals (outplant versus wild). Epipodial clippings involve using tweezers to grasp the end of one of the epipodial tentacles on the sides or posterior of the animal and cutting the tentacle 1-2 millimeters from its base (Hamm and Burton 2000). Swab samples involve swabbing the surface of the abalone’s soft tissue (e.g., from the respiratory pore) with a soft-tipped swab. Samples would be placed in a vial filled with preservative solution (e.g., 70% or higher concentration of ethanol) and sent to facilities conducting genetic analysis, including CDFW, the Scripps Institute of Oceanography, the Southwest Fisheries Science Center (SWFSC) in La Jolla, CA, and the Center for Scientific Research and Higher Education of Ensenada, Baja California (CICESE).

Fecal samples would be collected for analysis to determine whether the individual is infected with the pathogen that causes withering syndrome (*Candidatus* Xenohaliotis californiensis, or CaXC). Divers would insert a nylon-tipped swab between the epipodium and mantle, along the gills, to collect fecal material near the anus. Samples would be sent to facilities conducting the analyses, including the University of Washington, CDFW, and CICESE.

Divers would collect empty shells for measurement, species identification, origin assignment (outplanted versus wild), potential sources of mortality, research, and outreach and education purposes. Researchers expect to collect up to 500 shells per year. The shells would be archived at authorized facilities.

Divers would also collect dead and/or obviously unhealthy white abalone for further analysis to determine why and how the abalone died. Dead abalone are those that are unresponsive and not attached to the substrate. 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. Researchers expect to collect up to 1,000 dead and/or obviously unhealthy white abalone over the life of the permit. The individuals would be collected and sent to trained personnel at the CDFW Shellfish Health Lab to determine the cause of death.

1.3.8 Permit conditions

The proposed permit would include general and specific conditions to be followed by researchers when conducting permitted research and enhancement activities. These conditions would minimize the potential adverse effects of the activities on outplanted and wild white abalone. The proposed permit conditions include the following:

General Conditions

1. The permit holder must ensure that white abalone 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 this permit.
2. The permit holder must handle white abalone with extreme care. When white abalone are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water at appropriate temperatures.
3. The permit holder must obtain approval from NMFS before changing outplanting/monitoring locations or research protocols.
4. The permit holder must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. The permit holder must submit a written report detailing why the authorized take level was

exceeded or is likely to be exceeded.

5. The permit holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

6. The permit holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

7. 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.

8. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

9. The permit holder must obtain all other Federal, state, and local permits/authorizations needed for the research activities.

10. If the permit holder violates any permit condition, they will be subject to any 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 and Conditions for Suspension of Permit Activities

1. Researchers may conduct activities authorized by this permit through December 31, 2024. 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 six to nine months before the permit expires in order to be considered for a renewal without a break in coverage.

2. Unspecified mortality has been authorized for outplanted white abalone due to natural causes and authorized research. These mortalities must be included in the annual report. In the event of an unusual mortality event (mortality due to unique circumstances; *e.g.* disease outbreak, equipment failure during transport), outplanting activities must be immediately suspended, an increased monitoring frequency may be requested, and all relevant protocols must be reviewed, and, if necessary, revised to NMFS' satisfaction. The Permit Holder must notify the NMFS contact listed on the first page of this permit within two days of the event. The Permit Holder must also submit a written incident report. The Permit Holder, in consultation with NMFS, must re-evaluate the techniques that were used and those techniques must be revised accordingly to prevent further injury or death. NMFS may amend this Permit in order to allow outplanting activities to continue.

3. If authorized take or mortality is exceeded, the researchers must cease outplanting 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. 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 this permit.

Conditions Related to Field Outplanting and Monitoring

1. Co-investigators must coordinate permitted activities with the Principal Investigator before conducting fieldwork.
2. To the maximum extent practical, co-investigators must coordinate permitted activities with the activities of other co-investigators on the permit conducting the same or similar activities on the species, in the same locations, and/or at the same times of year to avoid unnecessary disturbance of animals.
3. The Permit Holder must submit a field outplanting plan to NMFS at least four weeks before outplanting is to occur. The field outplanting plan must include:
    a. The dive plan;
    b. The date(s) or range of dates when diving will occur;
    c. Cruise location and description, including: habitat quality, food availability, and the presence and number of wild white abalone and other abalone species;
    d. Vessel description;
    e. Names of participants and their roles, including: divers, NMFS diver(s), and topside support;
    f. A description of the planned field outplanting activities, including the life stage(s) to be outplanted, the estimated number, whether the animals are captive-bred or wild-origin, and the outplanting methods to be used (e.g., BARTs, SAFEs, hand-planting, larval pump and net tent);
    g. A description of lessons learned from previous outplanting activities conducted under the permit and how these lessons have been applied to the planned field planting activities (e.g., to minimize stress, injury, and mortality to white abalone; to improve logistics);
    h. A description of the presence of white abalone and other abalone species at the outplanting site(s), justification for the number of white abalone to be outplanted and why that number is appropriate for each site, and measures to minimize negative impacts on wild white abalone and other abalone species at each site;
    i. A description of how the animals will be selected for outplanting (e.g, health, size, life stage);
        i. For adults: explain why the animal or animals are eligible for outplanting, including health, genetic composition, and spawning success;
    j. A description of how the animals will be prepared for outplanting, including tagging, health assessments, and maximization of genetic diversity;
    k. The facilities involved (e.g., current holding facilities, staging facilities);
    l. A description of how the white abalone will be transported (see Appendix A of the Final White Abalone Recovery Plan, NMFS 2008); and
    m. A proposed monitoring plan and timeline (up to two pages).

4. The Permit Holder must submit a field outplanting report to NMFS not more than 90 days following the field outplanting activities. The field outplanting report must include:

   a. Date(s) and general location of the field outplanting, including depth range and the area covered;

   b. Names of participants and their roles, including: divers, NMFS diver(s), and topside support;

   c. A description of habitat within the field outplanting site, including any white abalone or other abalone species, substrate, rugosity, macroalgal community, macroinvertebrate and fish communities, presence of pathogens (if known), predator abundance, and any predator removal conducted;

   d. A description of the outplanting activities, including: The life stage(s) of white abalone, the outplanting method(s) used, the number per life stage and method, and:

      i. For larval outplanting: The estimated number outplanted per tent, the estimated number retained in the larval pumps, and genetics;

      ii. For juveniles and small adults: The number outplanted per module, the type and number of modules used, size range (shell length), tagging methods used, health assessment results, and genetics;

      iii. For adults: The number outplanted per site, the origin (captive-bred or wild-origin), size range (shell length), tagging methods used, health assessment results, genetics, proximity to other white abalone or other abalone species, and whether time lapse cameras were deployed;

   e. The general location of outplanted animals within the habitat and the proximity to other white abalone or other abalone species. Note any other observed individual abalone, their species, and their proximity to one another, and any predators observed;

   f. A summary of holding conditions at the staging facility(ies) and during transport; and

   g. A summary of any deviations from the approved field outplanting plan, as well as any effects on the outplanted animals, effects on wild white abalone and other abalone species at the site(s), effects on the habitat, logistical issues, additional comments regarding the field outplanting, and recommendations for improving future field planting efforts (e.g., to minimize stress, injury, and mortality to white abalone; to improve logistics).

5. The Permit Holder must submit an annual monitoring data summary to NMFS at the conclusion of each year for which the permit is valid, as part of the annual report due by March 31st for the previous reporting year. The annual monitoring data summary must include:

   a. Date(s) and general location of the monitoring activities, including depth range and the area covered;

   b. Names of participants and their roles, including: divers, NMFS diver(s), and topside support;

c. A description of habitat quality within the monitoring site;

d. A description of monitoring methods;

e. A summary of live wild white abalone observed at the sites before and after outplanting, including: the life stage(s) and number per life stage, shell length, health, samples collected (fecal, genetic), habitat, proximity to other white abalone or other abalone species, and proximity to outplant site/module;

f. A summary of live white abalone observed, including: the life stage(s) and number per life stage, shell length, tags, health, samples collected (fecal, genetic), habitat, proximity to other white abalone or other abalone species, and proximity to outplant site/module;

g. A summary of dead and/or obviously unhealthy white abalone or shells observed, including: the number, shell length, visual tags, habitat, whether collected or left in place, and any signs of predation;

h. A summary of fecal samples, genetic samples, shells, and dead and/or obviously unhealthy abalone collected and their disposition (e.g., where the samples, shells, and specimens were sent);

i. A summary of results from fecal and genetic analyses, as available;

j. A summary of results from analyses of shells and dead and/or obviously unhealthy abalone, as available; and

k. A summary of any deviations from the monitoring plan, as well as any effects on the outplanted white abalone, effects on wild white abalone and other abalone species, effects on the habitat, logistical issues, additional comments regarding the field monitoring activities, and recommendations for improving future field outplanting and monitoring efforts (e.g., to reduce stress, injury, and mortality to white abalone; to improve logistics).

6. The Permit Holder must allow a NMFS diver (i.e., a NOAA employee or contractor that is a certified NOAA diver) to participate on field outplanting and monitoring cruises to provide expertise, to assist in outplanting and monitoring activities, to transport samples to NMFS SWFSC, and to act as a liaison to NMFS management on the status of the outplanting and monitoring operations.

7. Shell notching: To mark individual abalone, researchers may cut a notch into the growing edge of the shell. Researchers must avoid cutting the soft tissue of the abalone. Researchers must keep the abalone moist and abalone may not be kept out of the water for more than 10 minutes.

8. Use of anesthetics: Researchers may use anesthetics to remove abalone from tanks or other holding containers, to relax the abalone and minimize injury. To minimize stress to the abalone, researchers must limit the concentration of the anesthetics and exposure time to the minimum needed to relax the abalone and remove them from the substrate.

   a. For juvenile abalone: Exposure to low concentrations of ethanol (e.g., less than 3%) for a short period of time (e.g., 5-10 minutes) has been effective for sedating mass numbers of small juvenile abalone.

b. For larger abalone: Researchers may evaluate the effectiveness of anesthetics on larger abalone to develop best practices. Researchers may use the following anesthetics and must limit the concentration and exposure time to the maximum levels identified below:

   i. Carbon dioxide (11.3% CO_2, 88.7% O_2): flow rate of 12 L per minute for up to 10 minutes

   ii. Ethanol (non-denatured): 3% (30 mL/L) for up to 10 minutes

   iii. Epsom salt ($MgSO^4$): 22% (220 g/L) for up to 10 minutes

   iv. Phenoxyethanol: 1% (10 mL/L) for up to 5 minutes

9. 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 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.

10. Fecal sampling: Fecal samples may be collected using an in-situ sampling method that involves inserting a flexible nylon swab between the epipodium and mantle, along the gills, to collect fecal material near the anus. Animals may not be removed from the substrate.

11. Collection of dead and/or obviously unhealthy white abalone: White abalone may be collected for further analysis if they are determined to be dead and/or obviously unhealthy (according to Moore 2019[4]).

   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 meeting this description are expected to die within days and may be collected to determine the cause of death.

12. The Permit Holder must maintain a summary of the number and genetics of individuals outplanted and monitored by location, life stage, and method, and share these data with the NMFS Permits Team and the co-investigators on the permit.

Number and Kind(s) of Protected Species, Location(s) and Manner of Taking

1. The take table in the permit application outlines the number of white abalone that may be

[4] Moore. 2019. White Abalone Standard Operating Procedure: Processing Unhealthy or Dying White Abalone Encountered During Outplant Monitoring Surveys. California Department of Fish and Wildlife, Shellfish Health Lab. 4 pages.

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 and audio recordings collected under this permit in printed materials (including commercial or scientific publications) and presentations, provided a statement indicating that the activity was conducted pursuant to Permit No. 18116 accompanies the images and recordings. 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. Researchers must comply with the following conditions related to the manner of taking:

   a. Researchers must conduct appropriate health screening of the white abalone prior to release to the wild.

   b. Researchers should 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.

6. Biological Samples:

   a) The Permit Holder is responsible for all of the biological samples collected from ESA-listed species. Such samples are subject to the Terms and Conditions of this Permit. A unique number shall identify all samples obtained. All specimen materials collected or obtained under this authority shall be maintained according to accepted curatorial standards. After completion of initial research goals, any remaining samples shall be maintained by the Permit Holder or deposited into a bona fide scientific collection that meets minimum standards of collection, curation, and data cataloging as established by the scientific community.

   b) The transfer of any biological samples from the Permit Holder to researchers other than those specifically identified in the application requires written approval from NMFS. Any such transfer will be subject to such conditions, as NMFS deems appropriate.

7. Researchers must comply with the following conditions related to methods of capture, supervision, care, and transportation, as well as general protocols outlined in the appendices to the White Abalone Recovery Plan.[5]

   a. Researchers and approved facilities listed on this Permit are authorized to transfer, receive, import, and export tissue samples, parts, and whole specimens of wild-origin white abalone or captive-origin progeny (e.g., embryos, larvae, juveniles, adults) for scientific research and enhancement activities. The ability to exchange samples, parts, and dead specimens will facilitate collaboration among white abalone researchers in the U.S. and Mexico and enhance research in both areas. The Permit Holder must:

      - Maintain a record of all dead specimens, parts, and tissue samples received from and transported to other facilities, including the purpose of the transfer; what is being transferred (dead specimens, parts, tissue samples); origin (wild, captive, location); individual identifiers (e.g., tag numbers, cohort); transport methods; and final destination and disposition. Researchers under the permit may receive dead specimens, parts, and tissue samples.
      - Summarize these records in the annual report to NMFS.
      - Notify NMFS prior to importing/exporting dead specimens, parts, or tissue samples to/from approved co-investigators and approved facilities in Mexico.

8. This permit does not authorize takes of any protected species other than white abalone, including those species under the jurisdiction of the USFWS. Should other protected species be encountered during the research activities authorized under this permit, researchers should exercise caution and remain a safe distance from the animal(s) to avoid take, including harassment.

9. The Permit Holder is responsible for all costs incurred by research and/or enhancement activities including determination of cause of death.

Reports

1. 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 March 31st for the previous reporting year. Falsifying annual reports or permit records is a violation of this permit. Annual reports must describe the following:

   a. A summary of field-outplanting activities to date, including the number outplanted per life stage, outplanting method, and general location; the captive breeding and staging facilities involved; health and genetic assessment results; habitat observations; outplanting operations (e.g., transport conditions, field planting operations); and recommendations for improving future field planting efforts (e.g., to minimize stress, injury, and mortality to white abalone; to improve logistics).

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[5] NMFS. 2008. Final white abalone recovery plan (*Haliotis sorenseni*). Prepared by the White Abalone Recovery Team for NOAA NMFS Office of Protected Resources Division. 133 pp.

b. A summary of field monitoring activities and results to date, including a description of field monitoring operations; effects on wild white abalone and other abalone species; number of white abalone observed live/dead per life stage, outplanting method, and general location; shell length data; health assessment results; and genetic analysis results.

c. A summary of biological samples, parts, and specimens collected and transferred among facilities.

d. A summary of progress toward developing a central repository for biological samples and toward developing a forum for sharing data and public outreach and education materials with the project partners.

2. The permit holder and researchers under the permit must develop a central tracking system (e.g., database, spreadsheet) for the following information collected as part of the permit activities, to inform future analyses and implementation of the proposed field activities. The permit holder must provide access to the tracking system to NMFS and the co-investigators, and provide a summary of the information in the annual reports.

   a. Larval outplanting efforts and survival, growth, and health. The tracking system for outplanting should include the following information: captive facility, staging facility, number of larvae per family line, outplant location, date, and depth. The tracking system for monitoring should include the following information: number observed, shell length, habitat, location, date, depth, samples collected (tissue, fecal), health, growth, and survival over time.

   b. Juvenile and small adult outplanting efforts and survival, growth, and health. The tracking system for outplanting should include the following information: captive facility, staging facility, number of juveniles and/or small adults per family line, shell length, tag number, outplant location, date, depth, method, and density. The tracking system for monitoring should include the following information: number observed, shell length, tag number, habitat, location, date, depth, samples collected (tissue, fecal), health, growth, and survival over time.

   c. Survival, growth, and health of captive-bred and wild-origin adults outplanted. The tracking system should include the following information: origin (captive-bred or wild), collection location and date (for wild-collected broodstock), holding facility, staging facility, outplanting location and depth, outplanting date, tag number, size, weight, gonad index, sex, samples collected (tissue, fecal), health, growth, and survival over time.

   d. Survival and health of wild white abalone (and other abalone species) observed during field outplanting and monitoring. The tracking system should include the following information: date, location, and depth for each observation; habitat; samples collected (tissue, fecal); health; and survival over time.

   e. Biological samples collected and analyzed. The tracking system should include the following information for each sample: collection date and location; name of collector; reason for collection; description of specimen (whole animal, epipodial sample, shell); life stage, origin (wild or captive), sex, size, weight, and tag number for the individual; and a summary of analysis results.

f. Tracking observations of disease and parasites and necropsy results. The tracking system should include the following information: results of pre-outplanting health assessments and post-outplanting health monitoring for each outplanting effort, and necropsy results, including the following information for each specimen: date of death, origin (wild or captive), size, weight, age (if known), symptoms, description of specimen (preservation method, tissues), and cause of death.

3. A final report must be submitted to the NMFS within 90 days after expiration of the permit (March 31, 2025), or, if the research concludes prior to permit expiration, within 90 days of completion of the research.

4. 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.

1.3.9 Interrelated and interdependent actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have not independent utility apart from the action under consideration (50 CFR 402.02). We have not identified any actions that are interrelated with or interdependent to the proposed action.

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 provides 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 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.

We determined that the proposed action overlaps with the occupied range of endangered white abalone and black abalone, and with designated critical habitat for black abalone. We conclude that the proposed action is likely to adversely affect endangered white abalone and analyze the effects on white abalone below. NMFS has not designated critical habitat for the species. We also conclude that the proposed action is not likely to adversely affect black abalone or black abalone critical habitat. That determination is documented in the "Not Likely to Adversely Affect" Determinations section (2.12).

2.1 Analytical Approach

This biological opinion consists of a jeopardy analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species:

- Identify the rangewide status of the species expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species.
- Reach a conclusion about whether species are jeopardized.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species

This opinion examines the status of white abalone that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that white abalone face, based on parameters considered in documents such the recovery plan, status reviews, and listing decision. 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' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

2.2.1 Range-wide status of white abalone

White abalone are marine snails with one shell, typically three to five open respiratory pores, an anterior head, and a large muscular foot fringed by sensory structures called epipodia (Cox 1962). Abalone use their foot muscle to move and to anchor themselves on rocky surfaces. White abalone can reach 200 to 254 mm in shell length (SL) but more commonly range from 127 to 203 mm in the U.S. and around 170 mm in Mexican waters (Hobday and Tegner 2000). White abalone life expectancy is about 35 to 40 years (Tutschulte 1976, Andrews et al. 2013).

Geographic distribution, habitat, and population structure

White abalone occur on the North American West Coast along offshore islands and banks (particularly Santa Catalina and San Clemente Islands) and along the mainland coast from Point

Conception, California, south to Punta Abreojos, Baja California, Mexico (Bartsch 1940, Cox 1960, 1962, Leighton 1972). Adults occupy open, low relief rocky reefs or boulder habitat surrounded by sand (Hobday and Tegner 2000). Because suitable habitat is patchy, the distribution of white abalone is also patchy (NMFS 2008). White abalone are the deepest living abalone species on the North American West Coast, occupying depths from 5-60m (Cox 1960). Current remnant populations are most common between 30 and 60 meters in depth, and recent surveys by Butler et al. (2006) and Stierhoff et al. (2012) found the highest densities at depths of 40-50 m. Several factors may have contributed to white abalone being more commonly found in deeper waters. These include: the distribution of optimal water temperatures and food availability (Hobday and Tegner 2000); competition with other abalone species that occur in shallower waters, such as pink abalone (Tutschulte 1976); and greater risk of sea otter predation at shallower depths (Tutschulte 1976). The deeper depth distribution of remaining wild populations may also result from past abalone harvest activities that depleted populations at shallower depths.

Understanding whether white abalone consist of one population or discrete sub-populations is important for evaluating the status of the species as well as for informing field planting efforts for species recovery. However, we have little information on the population structure of white abalone in the wild. Gruenthal and Burton's (2005) analysis of white abalone indicated that wild populations still have significant genetic variation, but could not evaluate population structure, because the 19 samples analyzed came from only one site. Additional samples need to be collected from throughout the species' geographic range. Under Permit 14344-2R, additional genetic samples have been collected and are being analyzed to evaluate genetic diversity.

Life history and reproduction

Abalone are broadcast spawners (i.e., individuals release their gametes into the water column and rely on external fertilization) and females and males must be in close proximity to one another to successfully reproduce. Spawning is highly synchronous (i.e., gametes are released at the same time) and believed to occur once a year from February to April (Tutschulte and Connell 1981).

Chemical cues (bioactive triggers) and/or physical cues (abrupt temperature changes, tidal rhythm, lunar periodicity) may stimulate spawning (Giese and Pearse 1977, Leighton 2000). The presence of the opposite sex also affects spawning synchronicity and can increase the volume of gametes released into the water column (Hooker and Morse 1985, McCormick 2000). Estimated fecundity (eggs released per year) of female white abalone ranges from about 3.7 million to 6.5 million eggs, based on gonad volume and oocyte density of animals collected off Catalina Island (Tutschulte and Connell 1981). Fecundity may increase with size and age (Tutschulte 1976, Tegner 1989, Leighton 2000). In captivity, females have spawned as many as 11 million eggs (pers. comm. with Kristin Aquilino, BML, on 10 March 2016).

About 24 hours after fertilization, the free-swimming larvae emerge from the embryo and swim in the plankton (Leighton 1989). This stage does not actively feed, but instead survives on its own yolk sac. The larval stage lasts about 3-10 days before the animals settle and metamorphose (McShane 1992). A chemical cue produced by crustose coralline algae induces abalone larvae to settle and metamorphose (Morse et al. 1979). Other environmental cues may also play a role in selection of a settlement site (Shepherd and Turner 1985, Slattery 1992, Daume et al. 1999).

Small juveniles feed on benthic diatoms, bacterial films, and other benthic microflora (Cox 1962). Juveniles occupy cryptic habitat (e.g., rock crevices, under rocks), and are difficult to see until they reach a size of about 75 to 100 mm (Cox 1962). Abalone greater than 100 mm are considered "emergent" as they leave sheltered habitats and move to more open habitat to forage on attached or drifting macroalgae (Tutschulte 1976). White abalone become sexually mature at approximately four to six years of age (about 88 to 134 mm SL) (Tutschulte and Connell 1981). Growth rates in the lab vary between juveniles and adults. When both were fed Macrocystis, juveniles (ages 0 to 4 years, or 11 to 114 mm SL) grew about 25 mm per year, whereas adults (ages 5 to 8 years, or 120 to 155 mm SL) grew about 10 mm per year (Tutschulte and Connell 1988).

Tutschulte and Connell (1976) observed adult white abalone in the wild and found that they remained on their homesites, feeding on drift algae that passed by or grazing on nearby attached algae. In general, juvenile abalone tend to be more cryptic and move more frequently and over larger distances, whereas adults become less cryptic as they increase in size and may have limited movements as they grow larger (Cox 1962, Shepherd 1973, Tutschulte 1976).

Population trends and status

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

In California, the modern commercial abalone fishery began in the late 1920's, but white abalone did not appear in the landings records until 1959 (Rogers-Bennett et al. 2002). Prior to that, white abalone landings may have been recorded as pink abalone (pers. comm. with Buzz Owens, abalone diver, cited in Rogers-Bennett et al. 2002). The commercial fishery landed an estimated 354,973 white abalone during the peak period of 1969-1978, and the recreational fishery landed an estimated 5,503 white abalone during the peak period of 1971-1978 (Rogers-Bennett et al. 2002). Severe declines in abalone landings across all species led CDFW to close the commercial and recreational fishery for abalone in 1996 (effective in 1997) south of San Francisco. Illegal harvest of white abalone remains a problem (Stierhoff et al. 2012), though we lack data to assess the extent of the problem.

In Mexico, white abalone were commercially harvested along with four other abalone species off Baja California. White abalone were increasingly targeted as red abalone catch declined (Shepherd et al. 1998). Very little species-specific landings data exist. Hobday and Tegner (2000) were only able to find data on numbers or weights of white abalone landed after about 1990. The estimated proportion of white abalone in the catch has varied from extremely small (less than 1%) to large (65%), depending on the year and location (Hobday and Tegner 2000).

Based on the limited information available, white abalone populations in Mexico have likely been declining since the 1970s and densities may have declined to a level where recruitment failure has already occurred in some areas (Hobday and Tegner 2000). As of June 2003, Mexico no longer issues permits to harvest white abalone (NMFS 2008). Since at least 2012, catch quotas for white abalone have not been authorized along the west coast of Baja California, Mexico (Carta Nacional Pesquera 2012). Recreational harvest of abalone is also prohibited in Mexico (pers. comm. with Miguel del Rio Portilla and Fabiola Lafarga de la Cruz, CICESE, 20 July 2017). Illegal harvest of undersized white abalone remains a problem in Mexico, but we have limited information on the problem's extent (NMFS 2008).

Fishery-independent abundance and density estimates also indicate severe declines in wild white abalone populations. For southern California, density estimates have declined by orders of magnitude from 0.23 abalone per m^2 in 1969-1972 (Tutschulte 1976) to about 0.002 abalone per m^2 in the early 1980s and 1990s (Davis et al. 1996) to between 0.0001 to 0.0003 abalone per m^2 in the late 1990s (Davis et al. 1998, Hobday et al. 2001, Lafferty et al. 2004). We note that Tutschulte's (1976) estimates were based on a few white abalone observed within four 10 m^2 quadrats, whereas subsequent estimates were based on data from SCUBA and submersible surveys. Depth-weighted mean density estimates are available for one offshore bank (2 abalone per ha for 2014) and one of the Channel Islands (0.62 abalone per hectare for 2012) (Catton et al. 2016) and are orders of magnitude lower than the density needed to meet the criteria for downlisting the species from endangered to threatened (2,000 abalone per hectare). For Mexico, only two fishery-independent surveys have been conducted in 1968-1970 and 1977-1978. Estimated densities in 1968-1970 ranged from 0.07 to 0.149 abalone per m^2, whereas no white abalone were found in 1977-1978 (Guzman del Proo 1992).

Abundance estimates for southern California indicate population numbers have declined by several orders of magnitude since the 1960s. Estimates for the late 1960s to early 1970s ranged from about 600,000 to 1.7 million white abalone (based on Tutschulte 1976 density estimates; Rogers-Bennett et al. 2002), whereas estimates for the 1990s were around 2,000 white abalone (Hobday et al. 2001). Hobday and Tegner (2000) estimated a total abundance of less than 2,600 white abalone in California and Mexico, about 0.1% of estimated pre-exploitation numbers.

More recent survey data indicate that the population is likely larger than previously estimated, based primarily on updated habitat data showing greater amounts of suitable habitat than previously thought. In 2002-2004, Butler et al. (2006) conducted ROV surveys off southern California at two offshore banks and one of the Channel Islands and found 258 individual white abalone, with the highest estimated density at one of the offshore banks in 2002 (approximately 0.002 abalone per m^2). Abundance estimates for each area were: 12,819 ±3584 (SE – standard error) in 2002 and 5,883 ±3324 (SE) in 2004 for one of the offshore banks; 7,366 ±5,340 (SE) in 2003 for one of the offshore banks; and 1,938 ±1,598 (SE) in 2004 for the island (Butler et al. 2006). Although these abundance estimates contain a high degree of error, they generally indicate population numbers are likely greater than estimated by Hobday and Tegner (2000).

Additional ROV surveys have been conducted at one of the offshore banks since 2002 and show continued decline in white abalone abundance and density over the period from 2002-2010 (Stierhoff et al. 2012). The total number of white abalone observed declined from 194 in 2002 to

39 in 2010; the total estimated abundance declined from 15,323 ±5,362 (SEM – standard error of the mean) in 2002 to 3,375 ±1,396 (SEM) in 2010 (Stierhoff et al. 2012). Over the period from 2002-2014, the abundance of white abalone at the offshore bank is estimated to have declined by 76% (Catton et al. 2016). The size distribution indicates that individuals are getting larger and older with little recruitment. Across all survey years, most (77-89%) of the white abalone observed were considered singletons (i.e., more than 2 m from other white abalone), with only 5-8% of the animals observed in groups of two and only one group of five observed in 2002 and one group of three observed in 2010 (Stierhoff et al. 2012). Thus, although numbers are likely higher than previously estimated, white abalone populations in the wild have experienced severe declines.

Field observations since 2013 indicate recruitment is occurring in the wild in southern California, but likely at a rate that is too low to sustain and rebuild the population without human intervention (e.g., captive propagation and field planting). In Section 2.3 (Environmental Baseline), we discuss the recent field observations and captive breeding efforts in more detail.

Impacts of disease

Withering syndrome is a disease caused by a Rickettsiales-like organism (CaXC) that infects the gut tissue of abalone and inhibits that animal's ability to digest food. As a result, the animal becomes lethargic and unable to hold onto the substrate as its foot muscle withers away. Animals typically die within a few weeks of exhibiting symptoms. Lab studies have shown that white abalone, in particular, are highly susceptible to withering syndrome (unpublished data by Friedman, cited in Crosson et al. 2014). The disease likely caused the die-off of a large number of captive-bred white abalone at CIMRI from 2002-2005 (NMFS 2011b). Since then, the captive propagation program has applied an antibiotic (oxytetracycline) treatment to remove the pathogen from infected animals (Moore 2015) and regular fecal monitoring to ensure animals remain infection-free (Moore and Marshman 2015). These measures have been effective at managing and minimizing disease outbreaks among captive white abalone populations.

Withering syndrome related mortalities have not yet been observed in wild white abalone populations. Given the presence of the pathogen in waters throughout Southern California (Moore et al. 2002), wild white abalone are likely infected with the pathogen that causes withering syndrome. Of the 12 wild white abalone collected in 2016-2017 to serve as broodstock for the captive propagation program, all but one were confirmed to be infected with the CaXC (Moore and Marshman 2018 unpublished data). Pathogen levels ranged widely among individuals and all appeared healthy despite prolonged warm water events in 2015 and 2016. The one abalone collected in 2019 has not yet been analyzed.

The susceptibility of white abalone to the disease warrants consideration when evaluating habitat quality and selecting sites for outplanting. To minimize disease risks, site evaluation and selection should consider the temperature regime as well as the health and density of other abalone in the area. Warmer water conditions associated with climate change impacts and El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) events may increase the spread and virulence of withering syndrome in the wild and in captive populations. Continued monitoring of wild populations is needed to evaluate disease risks in the wild. Disease management of captive populations must continue through treatment and health monitoring.

Climate change impacts

One factor affecting the range-wide status of white abalone, and aquatic habitat at large, is climate change. In particular, ocean acidification and elevated water temperatures could affect white abalone growth, development, and survival.

Ocean acidification could result in water quality conditions that reduce larval survival and shell growth and increase shell abnormalities (Crim et al. 2011). Ocean acidification could also affect the growth of crustose coralline algae, an important component of juvenile settlement habitat. However, studies show that effects of ocean acidification are highly species specific, because of differences between species in physiology, adaptability, and exposure to natural variation in ocean pH. White abalone may be able to adapt to ocean acidification because they already experience natural variability in ocean pH, including low pH levels (Feely et al. 2004, Feely et al. 2008, Feely et al. 2009, Hauri et al. 2009).

Increasing ocean water temperatures may occur due to global warming and short-term and longer-term oceanographic conditions (e.g., ENSO, PDO) and may have varying effects on white abalone. For example, elevated water temperatures may reduce food availability and quality by reducing macroalgal growth (Hobday et al. 2001, Tegner 1989, Tegner et al. 2001) and increase susceptibility to withering syndrome. Elevated water temperatures could also shift the distribution of white abalone to deeper waters or northward along the coast if temperatures within the current depth and latitudinal range increase above the optimal range. At the same time, warmer water temperatures may benefit white abalone larval survival if temperatures move toward the optimum temperature of 18°C (Leighton 1972).

Ocean acidification and increasing ocean water temperatures due to global warming or short-term and long-term oceanographic conditions (ENSO, PDO) are ongoing threats that will continue to influence the survival and health of wild white abalone populations. The nature and severity of the potential effects are uncertain due to varying predictions regarding ocean acidification and water temperature (especially at local scales), species-specific responses to changing conditions, and the relative lack of focused studies involving white abalone.

Impacts of other factors

Other natural factors such as predation, competition, and pollution could affect white abalone populations. Abalone have a number of predators (sea stars, crustaceans, octopus, fish, sea otters), but we lack data on predation pressure in the field and how much predation by non-human predators has contributed to the species' decline in the past and currently. Predation by sea otters may affect white abalone by limiting populations to small individuals and cryptic habitat (NMFS 2008). Although predation by sea otters is a potential threat to white abalone and white abalone recovery, studies show that other abalone species (red, flat, pinto, black) co-exist with sea otters along the Central California coast (Lowry and Pearse 1973, Cooper et al. 1977, Hines and Pearse 1982, Raimondi et al. 2015).

Competition with sea urchins or other abalone species for food and space may occur, because these species all feed on macroalgae and use similar habitats (rocky crevices). Despite this overlap in resource use, studies have shown urchins may benefit abalone by providing physical protection for small abalone (Tegner and Dayton 1977, Tegner and Butler 1985). Differences in the range and depth distribution of the abalone species may ameliorate any competition for resources, although Tutschulte (1976) suggested that competition with pink abalone (*Haliotis corrugata*) may have restricted the upper depth distribution of white abalone. At present, interactions with white abalone are likely minimal because densities of urchins and other abalone species are low in the areas where white abalone occur (Hobday and Tegner 2000).

Pollution may affect water quality, settlement habitat, and food resources for white abalone, but little is known about actual impacts in the past or present. For example, pollution may have caused the loss of kelp forests along the Palos Verdes Peninsula in the 1950s and 1960s (Tegner 1989, 1993), reducing food availability for abalone species.

Overall risk of extinction and recovery potential

Overall, white abalone populations in southern California face a high risk of extinction. White abalone abundance and density have declined substantially, resulting in low reproductive and recruitment success, such that the remaining animals in the wild do not appear to be replacing themselves. The little information we have about populations in Baja California also indicates severe declines and likely recruitment failure in wild populations. Increased monitoring efforts in southern California since 2010 have provided more observations of white abalone in the wild, in areas where white abalone were not observed in the previous 20 years, and indicate that some level of recruitment is occurring (Neuman et al. 2016, NMFS 2016b). However, existing monitoring efforts do not provide enough information to evaluate the level of population growth and productivity that is occurring.

At one offshore bank where we have white abalone trend data collected over several years, the continued decline in estimated abundance and density and the prevalence of “singleton” animals indicate that successful reproduction and recruitment are not happening at a broad enough scale to reverse declining trends. Surveys indicate suitable habitat remains intact and one study on genetics indicates a high degree of genetic variation remains in the population. Thus, the primary threat to the species is their current low densities and spatial distribution, where animals may be too far apart to reproduce successfully or at levels needed for recovery.

Recovering the species will involve: (1) protecting the remaining animals in the wild; (2) promoting natural reproduction at a level that can sustain the population, by increasing the abundance and density of white abalone in the wild; and (3) monitoring wild populations in California and Baja California to assess the species’ status throughout its range. The White Abalone Recovery Plan (NMFS 2008) provides a comprehensive guide to recovering the species and has identified captive propagation and field planting as critical recovery actions.

In Section 2.3 (Environmental Baseline), we describe the status of the captive white abalone propagation program, as well as surveys to monitor wild white abalone populations and pilot field planting studies using other abalone species. All of these efforts will provide valuable information to guide conservation efforts and contribute to white abalone recovery.

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: (1) coastal marine waters within the U.S. portion of the range of white abalone (Point Conception, California, to the U.S./Mexico border); and (2) facilities and laboratories throughout the range of white abalone and the U.S. West Coast where research activities would be conducted (e.g., staging facilities where white abalone would be placed in containers for transport to outplanting sites; facilities and laboratories 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.

Field outplanting and monitoring activities would occur in coastal marine waters within the U.S. portion of the range of white abalone, from Point Conception south to the U.S./Mexico border. Field activities would occur within habitats suitable for white abalone, characterized as rocky subtidal habitats at depths ranging from 5 to 60 m. Areas where white abalone are observed typically consist of soft sediment with patches of rocky outcrops and kelp forests, which supply drift algae for abalone to feed on.

Preparation of white abalone for outplanting would occur under Permit 14344-2R, at captive facilities throughout the range of white abalone and the U.S. West Coast. The transport of white abalone from the captive facilities to field outplanting sites would occur under Permit 18116; thus, the action area includes the captive facilities that would serve as staging facilities. These facilities include those within the range of white abalone that are under Permit 14344-2R: University of California Santa Barbara (UCSB), the Santa Barbara Museum of Natural History Sea Center (Sea Center), Cabrillo Marine Aquarium (CMA), The Bay Foundation's (TBF) Abalone Laboratory, Aquarium of the Pacific (AoP), and the NMFS Southwest Fisheries Science Center (SWFSC) La Jolla laboratory.

Research activities involving white abalone genetic samples, fecal samples, shells, other parts, and specimens would occur at facilities throughout the coast, including the BML, NMFS SWFSC La Jolla lab, Scripps Institute of Oceanography, and CICESE. Other facilities may be added to the permit if they meet the permit conditions.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Because the action area overlaps with the species' range, the description of the status of the species 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 white abalone within the action area. These factors and activities include past and ongoing wild white abalone broodstock collections, captive propagation activities, and research activities conducted under Permit 1346-01 and Permit 14344-2R, as well as past and ongoing monitoring of wild white abalone populations, continued disease impacts, historical overfishing and ongoing harvest impacts, and other factors and threats, including pollution, predation, competition, and climate change impacts. We also discuss ongoing outplanting activities conducted within the action area, using other abalone species.

2.4.1 Environmental Baseline for White Abalone

Impacts of historical overfishing and ongoing illegal harvest

Low population densities resulting from historical overfishing has been identified as the primary threat to white abalone in California. White abalone were subject to serial depletion by the commercial fishery in the early 1970s (Karpov et al. 2000). White abalone suffered the most dramatic declines of the five abalone species, potentially because they were the most highly valued species in the fishery and were naturally lower in abundance compared to the other species. During the main period of commercial harvest of white abalone (1969-1981), landings peaked in 1972, but declined to nearly zero by the early 1980s and remained low until the fishery was closed in 1996 (Karpov et al. 2000).

Harvest of white abalone has been prohibited in both California (since 1996) and Mexico (since 2003). Progress has been made to enforce regulations and protect white abalone from illegal harvest. Further coordination and assessment is needed to evaluate the threat of illegal harvest and the effectiveness of enforcement measures to address illegal harvest and trade.

Overall, overfishing has reduced local densities of white abalone. As the number of individuals decreased and the distance between individuals increased, the probability of successful reproduction and recruitment among the remaining individuals has likely declined. Although harvest of white abalone has been prohibited since 1996, the effects of historical harvest continue to affect wild populations. Wild white abalone populations continue to decline as animals grow old and die. Recent surveys have found evidence of successful reproduction and recruitment in the wild since the mid-2000s, indicating that some individuals remain reproductively viable (see next section on "Past and ongoing monitoring of wild populations"). However, this natural reproduction and recruitment may not be happening over a large or broad enough scale needed to recover the species. Human intervention is needed to boost recovery, e.g., increasing local abundance and densities through outplanting of captive bred animals and/or aggregation of animals to increase the probability of reproduction and recruitment.

Past and ongoing monitoring of wild populations

Survey data from the 1980s to present show continued declines in abundance with little to no recruitment, although some evidence of recruitment in the wild has been observed. Increased survey efforts along the mainland southern California coast since 2010 have resulted in observations of additional white abalone, at locations where they had not been observed for several years. These white abalone range in size from 136 to 190 mm SL, and may have recruited in the past 10-15 years, indicating a limited level of recruitment is occurring (Neuman et al. 2016).

The size of the animals observed in ROV surveys at one of the offshore banks between 2002-2014 also indicates an estimated age range of 3-16 years at the time of observation, indicating recruitment between 1995 to 2005 (Stierhoff 2015). These observations show that individuals in the wild have been able to reproduce and recruit successfully, though likely not at a broad enough scale or high enough rate to support recovery. We need more systematic survey efforts and analyses to monitor the abundance and density of wild populations and to estimate productivity in the wild. These efforts would inform our evaluation of the species' status, recovery, and population dynamics, and our definition of "singleton" animals that are reproductively isolated from other individuals.

Impacts of past broodstock collection activities

In 1999-2000, researchers collected 19 white abalone from one of the Channel Islands (Gruenthal and Burton 2005). This collection occurred prior to the listing of white abalone as endangered under the ESA in 2001 (66 FR 29046; 29 May 2001). All of these animals were taken to CIMRI and UCSB for holding. In 2004, NMFS issued Permit 1346-01 to Mr. Tom McCormick, allowing collection of additional broodstock from the wild. Under Permit 1346-01, researchers collected three white abalone from one of the Channel Islands. Overall, 22 white abalone adults were collected between 1999 and 2004. To date, all but one of these animals (collected in 2004) have died in captivity due to various causes, including collection-related injuries, disease, accidents (toxic chemical exposure, animals crawling out of the tanks), and unknown causes (unpublished data by Kristin Aquilino, BML, June 2014). Four individuals successfully spawned in captivity in 2001 and 2003 and produced thousands of progeny. A subset of these progeny have survived to adulthood and now serve as broodstock for the captive program, producing thousands of progeny between 2012 and 2018. The captive broodstock and their progeny will be used for outplanting and captive research activities.

In 2016, NMFS issued Permit 14344-2R to BML, allowing collection of additional broodstock from the wild. In 2016 through March 2019, 13 adult white abalone were collected from the wild off Southern California and brought into captivity to serve as broodstock for the captive propagation program. As of March 2019, four have died due to injury-related infections and nine newly collected wild broodstock remain at BML. In 2017, one wild-collected female spawned and in 2019, three wild-collected broodstock spawned (two females and one male), producing thousands of progeny and inserting new genetic diversity into the captive population.

Overall, past collection activities have removed 35 individuals and their reproductive potential from the wild population. However, Permit 1346-01 and Permit 14344-2R minimized the loss of reproductive potential by only allowing collection of white abalone that were likely to be reproductively isolated from other white abalone, based on specific collection criteria (e.g., distance from other white abalone). In addition, the collected animals are contributing their reproductive potential to the captive population (described below) and future outplanting efforts to restore populations in the wild.

Impacts of past and ongoing captive propagation and research activities

The white abalone captive propagation program began in 2000 at CIMRI, with the 19 wild broodstock collected in 1999 – 2000 off Catalina Island. After the species was listed as endangered in 2001, NMFS issued scientific research and enhancement Permit 1346 to Mr. Tom McCormick, authorizing the captive propagation program at CIMRI. Successful spawnings in 2001 and 2003 produced thousands of captive-bred white abalone. Between 2002 and 2005, a large number of the captive-bred animals at CIMRI died, most likely due to withering syndrome as well as an unknown shell disease. In May 2008, due to growing concerns about the reliability of a high quality water supply at CIMRI, all of the remaining white abalone at CIMRI (four wild-collected broodstock and 30 captive-bred progeny) were transferred to BML at UC Davis.

In 2011, NMFS issued Permit 14344 to BML, authorizing captive propagation and research on white abalone. In 2016, NMFS issued a modified Permit 14344-2R to BML, allowing collection of additional wild broodstock for the captive propagation program. Currently, the captive propagation program consists of BML and several partner facilities in southern California: UCSB, Sea Center, CMA, AoP, TBF's Abalone Laboratory, and the NMFS SWFSC La Jolla lab. The current captive broodstock consists of one wild-collected adult from 2004 (collected under Permit 1346-01), 13 wild-collected adults from collections in 2016 - 2019 (under Permit 14344-2R), and several captive-bred abalone produced in the 2001 and 2003 spawning events.

In 2012 and 2013, BML and its partner facilities in southern California successfully spawned white abalone in captivity, but produced only a small number of animals (9 in 2012 and 123 in 2013). Since then, the success of the captive propagation program has increased significantly, resulting in the production of thousands of progeny in 2016 - 2018. In April 2019, wild-collected and captive-bred broodstock at BML produced over 20 million fertilized eggs, more than in previous years (pers comm with Kristin Aquilino, BML, 16 April 2019). The number of juveniles produced from this spawning event will depend on settlement and survival over the next year.

White abalone of all life stages have been transported between BML and the southern California facilities several times with high survival. For example, transport of larvae by vehicle from southern California to BML is a routine part of the spawning protocol. In 2016, larvae were successfully shipped overnight from BML to CMA and the SWFSC La Jolla Lab for settlement and grow-out (BML 2017). In 2015, BML successfully transported 200 white abalone juveniles from the 2014 cohort to four southern California facilities (pers. comm. with Kristin Aquilino, BML, on 8 September 2015), with only two mortalities within the first two months (pers. comm. with John Hyde, SWFSC, on 29 December 2015 and with Kiersten Darrow, CMA, on 3 January 2016). Juveniles have been transported from BML to southern California facilities multiple times since then. Finally, all of the wild-collected adult white abalone broodstock were successfully transported from temporary holding facilities in southern California to BML by vehicle, with no observed adverse effects from transport activities (BML 2018, 2019).

Researchers regularly monitor the health of all captive animals and apply disease treatments or shell waxing when needed. Researchers have observed normal rates of natural mortality at the larval rearing and post-settlement stages, which can be as high as 100% mortality. To date, the maximum survival of captive-bred white abalone from the larval to one-year old stage has been 0.5% (unpublished data by Kristin Aquilino, BML, on 20 January 2016). Researchers have also observed normal rates of natural mortality for juveniles and adults (about 5% per year; NMFS 2011b). The one exception is the die-off of all captive broodstock (n = 15) at UCSB in 2015, likely due to warm water temperatures that may have led to development of withering syndrome (pers. comm. with Scott Simon, UCSB, on 8 Sept. 2015).

Overall, the captive propagation program has been progressing, with improved success in recent years and increased production and survival of progeny. Current needs include increasing: (a) the number of potential spawners (i.e., broodstock); (b) the genetic diversity of the captive population; and (c) the program's overall capacity to settle and grow out large numbers of white abalone. The collection of additional wild broodstock and the successful spawning of one of those new broodstock in 2017 and 2019 has inserted new genetic diversity into the captive population. In addition, collaboration with other partner facilities has increased the program's overall capacity. The proposed permit would also help to alleviate the program's capacity limitations by allowing the outplanting of larval, juvenile, and adult white abalone, which would open up space at the facilities for settlement and grow out.

Impacts of past and ongoing abalone outplanting activities

NMFS has been collaborating with partners to evaluate the feasibility and effectiveness of different outplanting strategies to maximize survival. Experimental studies are being conducted using other abalone species, to work out factors such as the optimal size, density, or seasons at which to outplant animals, the effectiveness of different outplanting modules at increasing survival, and the best tagging techniques to identify outplanted vs wild-origin individuals. For example, CDFW has and continues to conduct pilot red abalone outplanting studies at BARTs, using the proposed PVC tube method for delivering the juvenile abalone to the BARTs (Kawana et al. 2016, Rogers-Bennett et al. 2016). NMFS and the AoP have tested out the SAFE modules in an exhibit at the Aquarium, using captive-bred juvenile white abalone. NMFS is currently working with partners to test the SAFEs in the field, using red abalone as surrogates. The results will inform experimental studies and future large-scale outplanting efforts involving white abalone.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

We first describe the general types of activities proposed under Permit 18116 and the effects of these activities on abalone (see Section 2.5.1 Effects of the Proposed Research and Enhancement Activities on Abalone). We then evaluate the specific effects of the proposed activities under Permit 18116 on white abalone (see Section 2.5.2 Effects of the Proposed Permit on White Abalone).

2.5.1 Effects of the Proposed Permit Activities and Conditions on White Abalone

The proposed research and enhancement activities under Permit 18116 would affect and take endangered white abalone. We use the "exposure-response-risk" approach to analyze the effects of the action on white abalone. This approach involves first evaluating the exposure of individual white abalone to the effects of the action. Next, we evaluate how individual white abalone are likely to respond to those effects. We then evaluate how we expect those responses to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success). Finally, we evaluate the risk to white 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.

Permit 18116 would authorize research and enhancement activities that involve direct take of white abalone. Table 1 summarizes the take requested in the permit application. In the following sections, we describe the activities that involve take and, for each activity, the exposure of individuals to that take and its effects. We also evaluate how white abalone are likely to respond and the potential lethal, sub-lethal, and behavioral responses that might reduce the fitness of individuals. We then analyze the potential population and species level effects of the research and enhancement activities under the proposed permit.

Table 1. Summary of the take of white abalone requested in the permit application. Activities that involve take of white abalone include the outplanting of captive-bred adults, juveniles, and larvae (rows 1-3) and the monitoring of both wild and captive-bred white abalone. All activities would be conducted in marine waters off Southern California (from Point Conception to the U.S.-Mexico border) at any time of year.

Life Stage	**Origin**	**Take Activity**	**Take (number of individuals)**	**Unintentional Mortality[a]**
Adult	Captive	Field Planting; Tagging; Monitor; Tissue Sample; Fecal Sample; Mortality; Transfer/transport (live animals)	2,500[b]	2,500
Juveniles/ small adults	Captive	Field Planting; Marking; Monitor; Tissue Sample; Fecal Sample; Mortality; Transfer/transport (live animals)	110,000[c]	110,000
Larval	Captive	Field Planting; Monitor; Mortality; Transfer/transport (live animals)	50 million[d]	50 million
Adult, juvenile	Wild	Monitor; Tissue Sample; Fecal Sample; Mortality	1,000[e]	2
Adult, juvenile	Wild, Captive	Removal from wild (dead and obviously unhealthy abalone)	1,000[f]	1,000[f]
Adult, juvenile	Wild, Captive	Removal from wild (shells)	500[g]	N/A

[a] Unintentional mortality estimated for each proposed activity. Although not expected, the estimates consider the possibility that all of the captive-bred adults, juveniles, and larvae may die when outplanted to the wild, and that up to two wild white abalone may die as a result of monitoring activities.

[b] Field planting and monitoring of captive-bred adults > 60 mm in shell length, maintained at captive facilities under Permit 14344-2R and under any subsequent permit renewals or modifications.

[c] Field planting and monitoring of captive-bred juveniles and small adults, maintained at captive facilities under Permit 14344-2R and under any subsequent permit renewals or modifications.

[d] Field planting and monitoring of captive-bred larvae, maintained at captive facilities under Permit 14344-2R and under any subsequent permit renewals or modifications.

[e] Estimated number of wild white abalone that may be encountered during outplant monitoring activities, including wild-origin broodstock that are reintroduced to the wild under Permit 14344-2R, issued to the UC Davis Bodega Marine Lab (BML), and any subsequent permit renewals or modifications.

[f] Estimated number of dead and obviously unhealthy white abalone that may be permanently removed from the wild for further analysis of the cause of death.

[g] Estimated number of empty white abalone shells that may be permanently removed from the wild for further analysis and outreach and educational purposes.

Experimental larval outplanting

The proposed permit would allow researchers to outplant captive-bred white abalone larvae to the wild. Outplanting can occur at any time of the year, but most likely during the spawning season between February and July. Researchers estimate outplanting up to 50 million larvae per year.

Larval outplanting would generally only occur when a spawning event produces more larvae than the captive propagation program has room for at the existing facilities. Rather than disposing the larvae, the proposed permit would allow the larvae to be outplanted and contribute to white abalone populations in the wild. This is a beneficial action in that outplanting these animals would very likely increase white abalone abundance and enhance species productivity, and even if all the captive-bred larvae that are outplanted fail to survive, that loss would not pose any sort of demographic threat to the natural wild population.

Larval outplanting would involve several activities that involve take of white abalone. First, transport from the captive facilities to the field outplanting sites by vehicle and vessel may result in stress, injury, or mortality to larvae. Researchers would minimize injury or mortality during transport by placing the larvae in large, aerated plastic bags that are then placed in coolers to maintain optimal water temperatures. As described in Section 2.4.1 above, larvae have been successfully transported between North Central California and Southern California. We expect handling and transport to result in minor stress to the larvae and any injury and mortality to be limited to a small portion of the larvae.

Second, deployment of larvae to the field site may cause stress, injury, or mortality to larvae. To maximize survival, researchers would use PVC pump modules to deploy the larvae into a plankton net tent, which would retain the larvae in areas of suitable settlement habitat. However, some portion of the larvae may be injured or killed during this process. Preliminary results from pump testing suggest that >75% of the larvae inserted into the pump are successfully deployed into the plankton net. In addition, the post-deployment shape and mobility of larvae appeared normal when viewed under a microscope, suggesting that the slow and steady deployment of larvae from the PVC pump did not significantly affect larval quality (A. Reynolds, T. Ford, D. Witting, M. Neuman, S. Wang, 2016, unpublished data). Researchers would be able to measure the proportion of larvae that remain in the pumps after each deployment, to estimate the number of larvae that are killed during deployment.

We expect that a large proportion, or potentially all, of the larvae that are outplanted could die before reaching the settlement or one-year old stage due to high natural mortality at these early life stages. For the white abalone captive propagation program, the survival rate from the larval stage to one year of age ranges from 0.002 to 0.5 percent (unpublished data presented by Kristin Aquilino, BML, on January 20, 2016). Researchers would monitor the outplant sites every twelve months over the life of the permit to evaluate white abalone survival, growth, and habitat characteristics. A measurable response may not be observable, however, until 5-8 years post-outplant, based on results from other outplanting studies (Bouma and Ulrich, unpublished data).

In summary, researchers plan to potentially outplant an estimated 50 million larvae per year over the life of the permit. We expect most outplanting activities (transport, deployment at field sites) to cause temporary, short-lived stress. The proposed transport methods have been used to distribute white abalone larvae among captive facilities throughout California, with high survival rates. We expect that up to 25% of the larvae (up to 12.5 million if 50 million are outplanted) may die during deployment through the PVC pump modules, based on preliminary testing in the lab. In addition, we expect that a large proportion, or potentially all, of the larvae that are outplanted could die before reaching the settlement or one-year old stage, due to high natural mortality at the early life stages. Consequently, for our analysis we assumed all captive-bred larvae that are outplanted could be lost. Measures to maximize survival include deployment of larvae into plankton net tents to retain the larvae in areas of suitable settlement habitat. Under the "Population and Species Level Effects" section, we evaluate how larval outplanting activities may affect white abalone at the population and species level.

Experimental juvenile and small adult outplanting

The proposed permit would allow researchers to outplant captive-bred white abalone juveniles and small adults to the wild. Outplanting can occur at any time of the year. Based on the number of juveniles and small adults available at this time, researchers estimate conducting up to four outplantings per 12-month period at each geographic location, with up to 110,000 juveniles and small adults outplanted per year.

The ability to outplant juvenile and small adult white abalone would serve multiple purposes for white abalone recovery. The primary purpose of the captive propagation program is to produce white abalone for outplanting, to increase numbers in the wild and support the development of self-sustaining populations. Outplanting abalone at the juvenile and small adult stage would allow researchers to maximize survival during the early life stages, while also balancing the space and costs needed to grow abalone to a larger size. Introducing captive-bred abalone to the wild at the juvenile and small adult stage also allows the abalone to develop with natural cues that researchers may or may not be able to mimic in captive facilities. The juvenile and small adult stages are large enough to monitor visually, so that researchers would be better able to track the survival and growth of the abalone over time as a measure of outplanting success. This is a beneficial action in that outplanting these animals would very likely increase white abalone abundance and enhance species productivity, and even if all the captive-bred juvenile and small adults that are outplanted fail to survive, that loss would not pose any sort of demographic threat to the natural wild population.

Outplanting activities would involve several activities that involve take of white abalone. First, captive-bred juvenile and small adult white abalone may be tagged prior to outplanting, to visually distinguish outplanted individuals from wild-origin abalone. External tagging, such as with a visual numbered tag or PIT tag glue to the shell, has already been analyzed and covered under Permit 14344-2R. The proposed permit would also allow researchers to mark juvenile and small adult white abalone by notching the shell. Individual abalone are likely to experience stress due to handling. Researchers will avoid injuring the soft tissue and minimize the time the abalone are out of the water to less than 10 minutes. Shell notching has been conducted on other abalone species (e.g., black abalone) with no observed injuries or long-term negative effects on the individual abalone's health. We expect shell notching to result in minor, temporary stress to the white abalone, with no long-term effects on the abalone's health.

Second, handling and transport from captive facilities to the outplanting sites by vehicle and vessel may result in stress, injury, and mortality to abalone. As described in Section 2.4.1 above, juvenile white abalone are routinely transported between facilities throughout California, with low rates of injury and mortality. Researchers would minimize stress, injury, and mortality by implementing best practices, including relevant components of the abalone transport methods discussed in Appendix A (Broodstock Collection and Holding Protocol) of the White Abalone Recovery Plan (NMFS 2008). These best practices include placing the abalone in closed containers that permit water exchange (e.g., a PVC tube with perforations, mesh bag, critter keeper) and maintaining proper aeration and water temperatures throughout transport. We expect minor stress to the abalone from handling and transport, and that injury and mortality would be limited to a few individuals.

Third, outplanting in the field would involve handling the abalone and may result in stress to the abalone. We expect the stress to be minor, temporary, and not much more than the stress experienced when the abalone are handled for health check-ups at the facilities. Researchers under Permit 14344-2R have noted low rates of injury and mortality following regular health check-ups at the facilities (BML 2019). Several measures would be implemented to minimize stress and the risk of injury to individual abalone during outplanting. The abalone would be held at temperatures similar to those at the field-planting site, to minimize the change in temperature experienced during outplanting. Divers would carefully remove the abalone from the closed containers, taking care not to injure the soft tissue of the animals. Those transported in PVC tubes would be allowed to crawl out on their own, to further minimize injury.

We expect that a large proportion, or potentially all, of the juveniles and small adults that are outplanted could die due to natural mortality associated with predation or other factors (e.g., disease, competition for food, ocean conditions). Protective shelters or modules for transport and field planting may reduce predation and improve survival, especially during the first few days after release to the wild (NMFS 2008). Researchers would implement several measures to maximize survival of newly outplanted abalone. First, researchers would outplant the abalone to fixed, semi-protected modules (BARTs and SAFEs). These modules provide refugia from predators and a place for the abalone to acclimate to ocean conditions before venturing out into the natural habitat. Second, some abalone would be outplanted to the BARTs in PVC tubes that allow for delayed release of abalone from the tubes at night, when predation risk is lower. Finally, divers may collect predators observed (e.g., octopus, sea stars, whelks) and relocate them at least 0.5 km away from the outplant site. Researchers would monitor the outplant sites at regular intervals (at least quarterly for SAFEs and every six months for BARTS) to evaluate white abalone survival, growth, and habitat characteristics. A measurable response may not be observable, however, until 5-8 years post-outplant, based on results from other outplanting studies (Bouma and Ulrich, unpublished data).

The placement of the BARTs and SAFEs may affect the habitat within the sites; however, we expect impacts on the habitat to be minor. The modules would be anchored to the ocean floor by being filled with substrates (BARTs) or by attaching them to a concrete base (SAFEs). Many of the BARTs are already in place; however, BARTs may be moved or new ones placed at the sites. As much as possible, divers would avoid placing BARTs and SAFEs directly on rocky reef. In addition, the area covered by each BART (approximately 36” x 28”) and SAFE (approximately 14” x 10”) is a small portion of the overall area within each site, further minimizing the impacts on habitat.

In summary, we expect to outplant an estimated 110,000 captive-bred juvenile and small adult white abalone per year over the life of the permit. We expect most outplanting activities (transport, placement in modules) to cause temporary, short-lived stress. Outplanted abalone may take a period of time to acclimate to conditions in the wild, during which growth and reproductive development may be reduced. We expect a portion, or potentially all, of the outplanted abalone to die due to stress, injuries, or other factors (e.g., predation, disease, unfavorable oceanic conditions) in the wild. Consequently, for our analysis we assumed all captive-bred juveniles and small adults that are outplanted could be lost. Measures to maximize survival include implementing best practices for transport; using modules (BARTs, SAFEs) to provide shelter from predators and time to acclimate to ocean conditions; and relocating predators from the outplant sites. Under the “Population and Species Level Effects” section, we evaluate how juvenile and small adult outplanting activities may affect white abalone at the population and species level.

Experimental adult outplanting

The proposed permit would allow researchers to outplant up to 2500 adult ($\geq$ 60 mm SL) captive-bred white abalone over the life of the permit. Outplanting may occur at any time of year and may be conducted in coordination with the reintroduction of wild-origin white abalone broodstock (under Permit 14344-2R).

The ability to outplant adults rather than keep them in captivity would contribute to white abalone recovery by maximizing the reproductive potential of larger adults, as well as opening up space in captive facilities for future progeny. Researchers would select adult white abalone for outplanting based on the individual’s health, spawning success in captivity, and potential to contribute to the genetic diversity of the captive population. For example, an adult abalone that has spawned successfully and whose genetic composition is already well represented in the captive population may be a good candidate for outplanting. On the other hand, an adult abalone that has not spawned in captivity despite several spawning attempts may also be a good candidate for outplanting. In both cases, the potential contribution of the individual to the captive population is low. Outplanting would allow researchers to place these individuals in the wild, in aggregation with one another and/or with other wild white abalone, to increase the potential for natural reproduction in the wild.

Outplanting activities would involve several activities that involve take of white abalone. First, transport from captive facilities to the outplanting sites by vehicle and vessel may result in stress, injury, and/or mortality to the adults. As discussed in Section 2.4.1 above, we expect stress, injury, and mortality to be minimal, based on past transport activities. Researchers would minimize stress, injury, and mortality to the abalone by implementing best practices, including relevant components of the abalone transport methods discussed in Appendix A (Broodstock

Collection and Holding Protocol) of the White Abalone Recovery Plan (NMFS 2008). These best practices include using proper tools (abalone irons; thin, blunt-edged spatulas) to carefully remove abalone from the tanks; placing adults in mesh bags and into coolers filled with seawater; and maintaining proper aeration and water temperatures throughout transport.

Second, outplanting in the field would involve handling each abalone individually and may result in stress to the animals. We expect the stress to be minor, temporary, and not much more than the stress experienced when the adults are handled for spawning events or health check-ups at the facilities. Researchers under Permit 14344-2R have noted that adults are healthy following being handled for a spawning event or health check-up (BML 2019). The abalone would be held at temperatures similar to those at the field planting site and hand-planted to create aggregations at densities greater than the critical density threshold needed for successful reproduction and recruitment (0.15 to $1m^2$; Babcock and Keesing 1999; Miner et al. 2006, Neuman et al. 2010).

Although not expected, potentially all of the adult white abalone that are outplanted could die shortly after release to the wild. We expect that some of the adult white abalone that are outplanted could die due to natural mortality (e.g., predation, disease, ocean conditions). The large size of the adults would help to minimize predation, and divers would also place individuals in appropriate habitat, with sufficient refuge. In Washington, wild pinto abalone were collected to serve as broodstock and subsequently re-introduced to the wild after spending a few years in captivity. Overall, 81 wild-origin pinto abalone were reintroduced to the wild and experienced mortality rates ranging from about 20% to 40% after one and a half years (WDFW 2014). These should be considered minimum mortality rates because more animals may have died, but the shells were not found. Several factors could have contributed to the high mortality rates observed, including the age of the abalone, domestication in captivity, injury during handling, predation, and unfavorable oceanic conditions (WDFW 2014). Although all of the captive-bred adults may die once outplanted, the WDFW study indicates that up to 40% mortality (up to 1,000 adults) may be a more reasonable estimate. We evaluate the effects of these mortalities on white abalone at the population and species level in the “Population and Species Level Effects” section.

In summary, we expect to outplant up to 2,500 adult captive-bred white abalone over the life of the permit. We expect most outplanting activities (transport, placement in the wild) to cause temporary, short-lived stress. Outplanted abalone may take a period of time to acclimate to conditions in the wild, during which growth and reproductive development may be reduced. Although we consider the potential for all of the outplanted adults to die when outplanted, a more reasonable estimate is that up to about 40% of the outplanted adults may die due to stress, injuries, or other factors (e.g., increased susceptibility to predation, disease, unfavorable oceanic conditions) in the wild. Under the “Population and Species Level Effects” section, we evaluate how outplanting adults may affect white abalone at the population and species level.

Anesthetics

The proposed permit would allow researchers to use the following anesthetics to remove juvenile and adult white abalone from the tanks in preparation for outplanting: ethanol, carbon dioxide, Epsom salt, and phenoxyethanol. The purpose for using these anesthetics is to minimize injuries to the abalone when removing them from the substrate. In general, the use of anesthetics over mechanical removal results in fewer injuries to abalone; however, use of anesthetics could also result in greater measurable physiologic effects than mechanical removal (Edwards et al. 2000, Chacon et al. 2003; Hooper et al. 2011, 2014). Except for ethanol, no specific studies using these anesthetics on white abalone have been conducted. We summarize the studies below.

Carbon dioxide is a commonly used, effective, and safe method of anesthesia of abalone but is less used than other methods in commercial culture due to the cost and volume of CO_2 gas mix needed. White (1996) provides dosages, rate of anesthesia, and rate of recovery for size classes up to 90 mm of *Haliotis midae* using a gas mixture of 11.3% CO_2 and 88.7% O_2. For the three size classes (5-15mm, 20-50mm, 60-90mm) the dosages of 4L/min, 4L/min, and 12L/min, respectively, were the most effective doses for sedation in 3-5 min at 18°C with no observed mortality. White (1996) showed a strong effect of temperature on response to anesthesia with CO_2, likely due to changes in metabolic rate. The concentrations given here should be used primarily as a guide for other species, which may be adapted to and held at different temperatures than those presented by White (1996) and White et al. (1996). No specific studies have been done using CO_2 on white abalone.

Ethanol is a commonly used anesthetic for invertebrates including abalone (Edwards et al. 2000, Aprilia et al. 2018; Hsu & Gwo 2017; Gilbertson & Wyatt 2016). Edwards et al. (2000) found that 3% ethanol was an effective anesthetic for *H. laevigata* and *H. rubra* at 17°C and that it lowered VO_2 for the first hour after sedation. Aprilia et al. (2018) tested 1, 2, and 3% ethanol solutions on 15-25 mm *H. squamata* and found higher concentrations of ethanol sedated animals faster but the highest concentration (3%) resulted in a significantly higher mortality than was observed for 1% and 2% solutions. Ethanol (non-denatured) mixed with seawater has been routinely used at the SWFSC and BML to sedate juvenile abalone and has proven a safe and effective method in red, white, green, pink and black abalone. For 5-25mm abalone, 25-90mm, and >90mm, 1%, 2% and 3% solutions of ethanol in seawater, respectively, are sufficient to sedate animals in 4-10 minutes with no observable mortality (J. Hyde, SWFSC, and K. Aquilino, BML, unpublished data).

Magnesium salts, both $MgSO_4$ and $MgCl_2$, act similarly and are common anesthetics for invertebrates and used widely in abalone culture. Magnesium sulfate (Epsom salt) is the more commonly used of the two given its availability, low cost, and effectiveness. White et al. (1996) provide dosages, rate of anesthesia, and rate of recovery for size classes up to 90 mm of *H. midae*. For the three size classes (5-15mm, 20-50mm, 60-90mm) the dosages of 4%, 14%, and 22%, respectively, were the most effective doses for sedation in 5-8 min at 18°C with no observed mortality. White (1996) showed a strong effect of temperature on response to anesthesia with $MgSO_4$, likely due to changes in metabolic rate. As such, the concentrations given here should be used primarily as a guide for other species that may be adapted to and held at different temperatures than those presented by White (1996) and White et al. (1996). No specific studies have been done using $MgSO_4$ on white abalone.

Phenoxyethanol is a commonly used anesthetic in fish and invertebrates and has been used commonly in abalone culture. Though most studies using this anesthetic in abalone have shown no mortality (e.g. White et al. 1996, Edwards et al. 2000, Chacon et al. 2003, Mercer et al. 2014), there is evidence to suggest that this anesthetic is not suitable for long-term use (White 1996). It appears that abalone develop a tolerance after repeated use that may result in mortality, likely due to the overdose from the high dosage eventually required to sedate. However, this should not preclude the use of this anesthetic, as it is an effective and apparently safe anesthetic when used on abalone that have not been previously exposed to the anesthetic. Chacon et al. (2003) noted that abalone treated with phenoxyethanol exhibited higher VO_2 (1.5 times the control) for up to two hours after treatment which may explain the faster recovery from this anesthetic. White et al. (1996) provide dosages, rate of anesthesia, and rate of recovery for size classes up to 90 mm of H. midae. For the three size classes (5-15mm, 20-50mm, 60-90mm) the dosages of 0.5%, 2%, and 3%, respectively, were the most effective doses for sedation in 1-2 min at 18°C with no observed mortality. Phenoxyethanol is not very soluble in seawater but if mixed 1:1 with ethanol the solubility is greatly increased (J. Hyde unpublished data). No specific studies have been done using phenoxyethanol on white abalone.

Based on the studies described above, we expect the use of CO_2, ethanol, Epsom salt, and Phenoxyethanol to result in stress to the abalone. However, when use is limited to the proposed maximum concentrations and exposure times (see Section 1.3.8 for the proposed permit conditions), we expect stress to be minor and temporary, with no long-term adverse effects on individuals.

Post-outplant monitoring

The proposed permit would allow researchers to conduct post-outplant monitoring activities that involve take of white abalone. Post-outplant monitoring activities include counting individuals, measuring shell length, collecting genetic tissue samples, collecting fecal samples, and collecting empty shells. Researchers routinely conduct these activities to monitor the health and growth of wild and captive abalone.

We expect monitoring activities to cause minor, temporary stress to individuals, with little to no long-term effects. Abalone will not be removed from the substrate. Touching the animals may cause them to clamp down more tightly onto the substrate. Rarely, an abalone may become more active and move, which could expose it to greater risk of predation. More often, this results in the abalone seeking shelter and better protection. 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 minor effects on individuals are greatly outweighed by the information on growth, health, and origin (outplanted or wild) obtained from taking these measurements and samples.

Intentional Lethal Take

The proposed permit would allow researchers to collect dead and obviously unhealthy white abalone for further analysis to determine the cause of death. The abalone collected can include both wild-origin and captive-bred individuals. 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 1.3.7, Post-outplant Monitoring). 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.

Population and Species Level Effects

We evaluate how the effects of the proposed outplanting and monitoring activities at the individual level may affect white 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 activities within the context of the species' status and recovery needs. The wild white abalone population is at high risk of extinction, with populations remaining at low densities and continuing to decline in some areas, despite prohibitions on fisheries harvest since 1996 (Butler et al. 2006, Stierhoff et al. 2012). We estimate that the wild population consists of at least 4,000 adults, based on the most recent estimates for one of the Channel Islands (approximately 500 individuals) and an offshore bank (approximately 3,500 individuals; pers. comm. with Kevin Stierhoff, SWFSC, on 16 July 2015). Individuals in the wild are likely too far apart to support successful fertilization at levels measured for other abalone species (Babcock and Keesing 1999, Butler et al. 2006, Stierhoff et al. 2012). However, field observations since 2013 indicate recruitment is occurring in some areas off Southern California (Neuman et al. 2015, Stierhoff 2015). Although natural recruitment is likely limited and happening too slowly to sustain the species against ongoing and future threats over the long-term, these observations indicate that we have much to learn about the wild population and what constitutes a reproductively viable population. The White Abalone Recovery Plan (NMFS 2008) identifies captive propagation and field planting as the primary actions needed to enhance wild populations and restore the species.

Field Outplanting Activities

Outplanting activities would reduce the total abundance and, potentially, the genetic diversity of the captive population. The captive program would also have fewer animals for future spawnings and research activities. However, when done strategically as proposed under the permit, removing abalone for outplanting can benefit the captive population by creating more space for future progeny, new broodstock, and increased genetic diversity. Researchers would identify the number of abalone needed for research, display, and other purposes at the captive facilities and balance that with the number of abalone needed for outplanting. Overall, we expect the potential benefits of outplanting to outweigh the potential risks to the captive population.

Outplanting activities may cause stress, injury, and mortality to the abalone as they are removed from a captive setting and placed in the wild. All of the outplanted animals may die before they are able to reproduce and contribute to wild populations. We expect mortality to be greatest for larvae and to decrease for juvenile through adult life stages. The proposed outplanting methods include measures to minimize stress, injury, and mortality to outplanted abalone (e.g., established transport methods, net tents for larvae, BARTs and SAFEs, predator relocation, suitable habitat selection). Potential benefits to the outplanted abalone include increased growth and reproductive development due to exposure to natural cues and conditions in the wild, and increased reproductive potential and genetic diversity in the wild. We consider any survival and reproduction by outplanted animals to be a net benefit to the wild population and to species recovery. Overall, we expect these potential benefits to outweigh the risks of outplanting to the population and species as a whole.

Outplanting activities may affect the wild white abalone population by increasing the risk of disease, predation, and competition for food and space, as well as changes to the habitat. Outplanting can also alter the genetic diversity of the wild population. To minimize the risk of transmitting pathogens or parasites to the wild, researchers would assess the health of the abalone prior to outplanting and only outplant healthy animals. In some cases, healthy abalone that are infected with the CaXC may be outplanted if the pathogen is already present at the field site.

Outplanting may cause increased competition for food and space with other white abalone. However, food and space do not appear to be limiting factors for the wild population at this time, given the low numbers and density of white abalone in the wild. We do not expect the outplanted abalone to have a measurable effect on food resources or habitat availability at the field planting sites, because we expect the abalone to use a small amount of food resources and space compared to what is available at the sites. Researchers would consider the availability of food and space when selecting outplant sites and the number of abalone to outplant. Other habitat effects include changes in the algal community as the abalone establish their territory and graze on attached algae. We expect these changes to make the habitat more suitable for white abalone in the future. For example, these changes may promote the growth of crustose coralline algae, improving the habitat for larval settlement and recruitment.

Predation risk may increase for a short period after outplanting. Mitigation measures include selecting sites with complex habitat (to provide refuge from predators) and temporarily moving potential predators (e.g., sea stars, octopus) from the area. Researchers would also maximize the genetic diversity of the outplanted abalone within a site. One of the purposes of the proposed outplanting is to evaluate how families with different genetic backgrounds fare in the wild over time. Complementary laboratory studies would be conducted (under ESA Permit 14344-2R) to evaluate how genetics affect survival and growth in different ocean conditions, for application in selecting animals for outplanting.

In summary, we expect that the potential risks to the wild population would be adequately addressed by health and disease assessments prior to outplanting; selection of field planting sites with adequate food resources, space, and complexity; and careful consideration of the genetic diversity and number of abalone to be outplanted to each site. We also expect outplanting to result in several benefits to the wild population. Outplanting has the potential to increase the local densities, reproductive potential, and genetic diversity of wild white abalone populations. Given the low numbers of white abalone in the wild at this time, we expect any increase in local populations due to outplanting to contribute to the development of self-sustaining populations and the species' overall recovery. We expect that the ability to outplant large numbers of white abalone under the proposed permit would also benefit species recovery by spreading efforts over a wide range of sites, habitats, and local conditions, and increasing the chances that some outplants would survive and reproduce. Overall, we expect the potential benefits of outplanting to outweigh the potential risks to wild white abalone populations, given the measures in place to minimize the risks and maximize the benefits to species recovery, and a net benefit to viability at the population and species level.

Post-Outplant Monitoring Activities

We expect post-monitoring activities to cause minor stress, but not to injure or kill white abalone. Although the likelihood is low, up to two juvenile and/or adult wild white abalone may die per year because of these monitoring activities. Based on the estimate that the wild population consists of at least 4,000 white abalone, mortality of two animals would represent the loss of 0.05% of the wild white abalone population in California. Actual mortality would likely be less than two individuals. Overall, we do not expect the loss of two animals to affect viability at the population or species level.

Monitoring would also include collecting empty shells and up to 1,000 dead and obviously unhealthy white abalone for further analysis. We do not expect any adverse effects to the populations from removing empty shells, because the individual abalone have already died. Collecting and killing up to 1000 white abalone (outplanted and/or wild) would be a much more substantial loss to the population. However, these animals would already be dead or expected to die within a few days whether or not they were collected. Collecting dead and/or obviously unhealthy white abalone can benefit wild populations by removing potentially diseased animals from the population, limiting the spread of disease to other individuals. In addition, understanding the cause of death would contribute to our understanding of the health of the populations, as well as help with early detection of disease outbreaks.

Summary

Overall, the outplanting and post-outplant monitoring activities to be conducted under the proposed permit may result in stress, injury, and/or mortality to outplanted white abalone and any wild white abalone at the outplanting sites. However, we do not expect these activities to result in adverse consequences to white abalone populations or the species as a whole. Successful outplanting of white abalone would benefit the species by increasing local densities, genetic diversity, and reproductive potential of wild populations. The survival and reproduction of these outplanted abalone over time would contribute to the development of self-sustaining populations and species recovery in Southern California.

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). 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).

We also expect the other threats and factors described in the environmental baseline would continue to affect white abalone populations. Collection of wild broodstock will continue under Permit 14344-2R, to increase the genetic diversity and number of spawners for the captive propagation program. Collections will be limited to individuals that are likely to be reproductively isolated from other white abalone. Reintroduction of wild-collected broodstock may also be conducted under Permit 14344-2R. Researchers may coordinate efforts to reintroduce wild broodstock in aggregation with the outplanted captive-bred adults, enhancing the genetic diversity and reproductive potential of the resulting aggregations. Monitoring of wild populations will also continue under Permit 14344-2R, providing valuable information on the status of wild white abalone populations to inform future broodstock collection efforts as well as outplanting efforts (e.g., site selection, understanding of health and genetic diversity of wild population) under the proposed permit. In addition, pilot outplanting efforts using other abalone species will continue throughout the Southern California Coast. The information learned from these efforts will inform and improve outplanting efforts under the proposed permit.

To identify potential cumulative effects, we contacted local CDFW personnel, cited information in our records, and conducted an online search of state and local agencies' websites with jurisdiction in the action area. These include the CDFW's Marine Aquaculture (https://www.wildlife.ca.gov/Conservation/Marine/ABMP/Aquaculture) and Shellfish Health Laboratory (https://www.wildlife.ca.gov/Conservation/Laboratories/Shellfish-Health) websites.

We did not identify additional state or private activities that are reasonably certain to occur within the action area, do not involve Federal activities, and could result in cumulative effects on white abalone. We do not know of or expect major changes in State regulations or requirements for facilities that hold abalone or for field planting and monitoring of abalone along the California coast. Oil spills and the introduction of other pathogens and parasites could affect both wild and captive populations, but we do not consider these activities 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 the species 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 (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

2.7.1 White Abalone

White abalone populations have declined significantly throughout their range and face a high risk of extinction, primarily due to overfishing and the resulting low local densities. Little information is available to track population abundance and trends over time, except for a few locations off southern California. The data that are available indicate populations in southern California have declined by several orders of magnitude since the 1960s and remain at low abundance and density. Although harvest of white abalone has been prohibited since 1996, the effects of historical harvest continue to affect the wild population. Other factors such as poaching, disease, ocean acidification, and elevated water temperatures pose potential threats to the wild population. Surveys indicate suitable habitat remains intact and available for the species and the one study on genetics indicates a high degree of genetic variation remains in the population. Thus, the primary threat to the species is their current low densities and spatial distribution, where animals may be too far apart to reproduce successfully or at levels needed for recovery. Field observations since 2010 indicate successful reproduction and recruitment has occurred in the wild over the past 10 years. However, natural production may not be happening at the rate or scale needed to reverse declining trends.

Recovering white abalone will require protecting the remaining wild populations, increasing the abundance and density of white abalone in the wild to promote natural reproduction, and monitoring throughout their range to understand and track the species' status in California and Mexico. The White Abalone Recovery Plan (NMFS 2008) highlights captive propagation and field planting as the main recovery actions needed to increase the abundance and density of white abalone in the wild. Since the early 2000's, researchers have been developing the captive propagation program for white abalone, with increasing success and production from 2012 through 2019. At the same time, outreach and education efforts throughout the coast have raised public awareness of abalone conservation issues. Researchers are exploring different field planting strategies to optimize survival and monitoring, using other abalone species. The lessons learned from these studies will directly inform field planting efforts for white abalone, to optimize efforts and increase the likelihood that field planted animals will survive and reproduce.

Permit 18116 would allow researchers to outplant captive-bred larval, juvenile, and adult white abalone at locations throughout the Southern California coast. Permit 18116 would also allow researchers to monitor outplanted and wild white abalone at the field planting sites.

Permit 18116 would authorize extensive take of white abalone for outplanting. Researchers would outplant millions of larvae, hundreds of thousands of juveniles and small adults, and up to 2,500 adults over the life of the permit. We expect the abalone to experience stress, injury, and mortality due to outplanting and monitoring activities, as well as due to natural mortality once placed in the wild. Researchers would minimize stress, injury, and mortality by implementing best practices to transport abalone to the field planting sites; using net tents and modules to maximize survival of outplanted abalone; and applying well-established protocols for monitoring the survival, growth, and health of the abalone overtime. Monitoring would involve non-lethal methods, as well as the collection of dead and/or obviously unhealthy white abalone for further analysis. Collection would involve killing those individuals, but abalone would only be collected if they are already dead, or considered obviously unhealthy and likely to die within a few days. Researchers would minimize potential risks to the existing wild population by assessing the health of the abalone prior to outplanting; maximizing the genetic diversity of outplanted abalone at each site; selecting habitats with adequate food resources, space, and complexity to support white abalone; and considering the habitat's capacity in deciding the number of abalone to outplant to a site. We conclude that these measures sufficiently minimize the potential risks of the proposed outplanting and monitoring activities to the captive, outplanted, and wild population.

Overall, we do not expect that the proposed outplanting and monitoring activities will cause long-term harm to the captive, outplanted, or wild population. Instead, we expect the proposed outplanting and monitoring activities to benefit white abalone populations in captivity and in the wild. Outplanting would free up space at the captive facilities to grow out future progeny, as well as provide an option in years when larval production exceeds the capacity of the captive facilities. Outplanting would provide individual abalone an opportunity for increased growth, reproductive development, and reproductive success in the wild. Outplanting would also potentially increase the local densities, genetic diversity, and reproductive potential of wild populations, supporting the development of healthy, self-sustaining populations. Monitoring would allow us to assess the survival, growth, health, and genetic diversity of the outplanted and wild population over time.

In conclusion, we have considered the status of the species, the environmental baseline, and the cumulative effects along with the effects of the action, and do not expect the research and enhancement activities under the proposed permit to reduce fitness of white abalone at the population or species level. The proposed permit would authorize extensive take of white abalone as part of outplanting and monitoring activities. One of the risks of outplanting is the potential for most or all of the outplanted abalone to die due to injury, predation, disease, and exposure to ocean conditions. Outplanting also poses potential risks of disease, competition, and reduced genetic diversity for wild white abalone. We conclude, however, that the proposed permit provides appropriate measures to minimize harm to the wild, outplanted, and captive populations, including measures to minimize stress, injury, and mortality due to outplanting and monitoring activities; health and disease assessments prior to outplanting; selection of field planting sites with sufficient food resources, space, and complexity; and careful planning and consideration of the captive program's needs and the habitat's capacity in determining the number of abalone to outplant to a site. Overall, the proposed permit would support critical recovery actions (field planting and monitoring of white abalone) and adequately considers and minimizes the risks, such that the potential benefits of the proposed activities would largely offset the potential adverse effects.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of white abalone. No critical habitat has been designated or proposed for this species; therefore, no effects on critical habitat were analyzed.

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 an ITS.

All of the take authorized under the permit is direct take, including the mortality that results as a consequence of the permitted research and monitoring. Nonetheless, one of the purposes of an incidental take statement is to set reinitiation of consultation triggers, by laying 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. We fulfill that purpose here by describing the amounts of take in the effects section above and summarized in Table 1, which limits both the amount and extent of take the permit holder would be allowed in a given year. We also incorporated this concept in the second paragraph of the re-initiation 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).

Below are the conservation recommendations for the proposed action:

(1) The permit holder and researchers under the permit should consider developing a central repository for biological samples collected and analyzed. The specimens in the repository should be linked to a central database providing metadata on the specimens.

(2) The permit holder and researchers under the permit should consider developing a forum for sharing data (e.g., results of experimental studies) and public outreach and education materials with one another, to inform all the project partners.

(3) The permit holder and researcher under the permit should consider the feasibility and effectiveness of installing signage near the BARTs and SAFEs to deter others from harming, destroying, or taking the modules and/or abalone.

To keep NMFS informed of actions that minimize or avoid adverse effects or that benefit listed species or their habitats, we request that the permit holder notify us of the implementation of any conservation recommendations. The proposed permit would require the permit holder to summarize their progress on these conservation measures in the annual reports.

2.11 Reinitiation of Consultation

This concludes formal consultation for NMFS' proposal to issue Permit 18116 to the NMFS WCR PRD to take white abalone for research and enhancement purposes pursuant to the provisions of Section 10(a)(1)(A) of the ESA.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of 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 agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this 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 WCR PRD's determination that an action "is not likely to adversely affect" listed species or critical habitat is based on a finding that the effects are expected to be discountable, insignificant, or completely beneficial. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are contemporaneous positive effects without any adverse effects on the species or their critical habitat.

As stated in Section 2, the action area overlaps with the range of endangered black abalone and designated black abalone critical habitat in southern California. Proposed activities that may affect these black abalone and their critical habitat include field outplanting and post-outplant monitoring activities.

In most instances, we would not expect field activities to take place in black abalone habitat because the range of white abalone (5-60m depth) has minimal overlap with that of black abalone (0 to 6 m depth). Field planting sites would most likely be in habitats deeper than 6 m. In the unlikely case that that field activities occur at shallow field sites and a black abalone is observed, the researchers would not touch or disturb the animal(s), but will simply count how many there are and note their approximate size, habitat, and distance to the nearest abalone of the same or different species. Because we do not expect researchers to do anything other than note and count black abalone (even if they should be encountered), we conclude that the potential effects of the proposed action on black abalone are insignificant.

Designated black abalone critical habitat may occur in the action area. When conducting habitat and monitoring surveys, researchers would search cracks, crevices, and under movable substrates, with minimal disturbance to the habitat. The proposed activities would not affect the habitat in a measurable way and any potential effects would therefore be insignificant.

Therefore, we concur with NMFS WCR PRD's conclusion that the proposed actions under Permit 18116 - singly and in combination - may affect but are not likely to adversely affect black abalone or their designated critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." 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) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

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) and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

Because we do not expect adverse effects on habitat, we also do not anticipate adverse effects on EFH. As the biological opinion and "not likely to adversely affect" determination above state, the proposed research and enhancement actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon and groundfish 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.

NMFS WCR PRD 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.

4.1 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 the NMFS WCR PRD. Other interested users could include the Principal Investigator on the proposed permit (Melissa Neuman, NMFS WCR PRD), co-investigators listed on the permit application, and abalone researchers. The format and naming adheres to conventional standards for style.

4.2 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.

4.3 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 and EFH consultation 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 MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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