National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological and Conference Opinion

Agency:	Permits, Conservation, and Education Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service
Activity Considered:	Biological and Conference Opinion on the proposal to issue permit No. 14400 to the Channel Islands National Park (Responsible Party: Dr. Daniel Richards) for studies on black abalone (*Haliotis cracherodii*) in California, pursuant to section 10(a)(1)(A) of the Endangered Species Act of 1973
Consultation Conducted by:	Endangered Species Division of the Office of Protected Resources, NOAA's National Marine Fisheries Service
Approved by:	
Date:	DEC 0 6 2010

Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1536(a)(2)) requires that each federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or its designated critical habitat, that agency is required to consult with either NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the listed resources that may be affected. For the action described in this document, the action agency is the NMFS Office of Protected Resources, Permits, Conservation, and Education Division. The consulting agency is the NMFS Office of Protected Resources, Endangered Species Division.

This document represents the NMFS' biological and conference opinion (Opinion) of the effects of the proposed permit on endangered black abalone (*Haliotis cracherodii*) and on areas proposed for designation as black abalone critical habitat. This Opinion has been prepared in accordance with Section 7 of the ESA. This Opinion is based on our review of the Permits, Conservation, and Education Division's draft Environmental Assessment (EA), draft permit No. 14400, the Channel Islands National Park's permit application, the black abalone listing decision and supporting documents, scientific and technical reports from government agencies, peer-reviewed literature, biological opinions on similar research activities, and other sources of information.

Consultation history

The NMFS' Permits, Conservation, and Education Division (Permits Division) requested consultation with the NMFS' Endangered Species Division on the proposal to issue a scientific research permit authorizing studies of black abalone. Issuance of the permit constitutes a federal action that may affect marine species listed under the ESA.

On 7 July 2009, the Permits Division received an application from Dr. Daniel Richards, Channel Islands National Park, National Park Service (NPS), Ventura, California, for a permit to "take"[1] endangered black abalone as part of an ongoing program to monitor black abalone population status and trends along the California coast.

Between August and September 2009, the Permits Division processed the permit application and solicited public comments on the permit application via a notice published in the Federal Register (74 FR 43679, 27 August 2009). No public comments were received on the permit application.

On 8 July 2010, the Permits Division provided the Endangered Species Division with a draft of the proposed scientific research permit No. 14400 that would authorize the take of black abalone in the course of the proposed research activities as described in the permit application. During July and August 2010, the Endangered Species Division requested and received additional information from the Permits Division and the Applicant on the proposed permit, the proposed research activities, and the effects of the proposed research activities, and the Permits Division provided the Endangered Species Division with a draft Environmental Assessment.

On 3 August 2010, the Endangered Species Division determined the information provided was sufficient to initiate formal consultation on the Permits Division's proposal to issue Permit No. 14400 to the Channel Islands National Park. During the consultation, the Endangered Species Division recommended that the researchers notify NMFS in the event of a mass mortality of black abalone and clean all field gear between sites to avoid the transfer of disease or non-indigenous species between survey sites. The researchers agreed to these conservation recommendations and the Permits Division incorporated them into the proposed permit.

This Opinion considers the effects of the research activities to be authorized under the proposed permit on listed resources, namely endangered black abalone in the wild.

Description of the proposed action

The Permits Division proposes to issue a permit under the authority of section 10(a)(1)(A) of the ESA to the Channel Islands National Park (Responsible Party: Dr. Daniel Richards), to authorize research activities for wild black abalone, as described in the permit application and summarized below. The proposed permit would authorize the research activities for a period of five years from the date of issuance of the permit.

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

Proposed research activities

The black abalone research activities proposed by the applicant would consist of three main components:

(1) monitoring surveys to obtain black abalone population counts and size frequency measurements;
(2) tagging studies to determine the growth, movement, habitat selection, and survivorship of individual black abalone; and
(3) collection of dead or dying black abalone for pathology and histology studies.

All of the activities would be conducted by trained field biologists within the Multi-Agency Rocky Intertidal Network who are listed under the proposed permit. In the following sections, we describe each component of the proposed research activities in detail and identify those aspects that are likely to have direct or indirect effects on listed resources or on the physical, chemical, and biotic environment.

Black abalone monitoring surveys

The Minerals Management Service (renamed the Bureau of Ocean Energy Management, Regulation and Enforcement, or "Bureau of Ocean Energy", in June 2010) has coordinated with several federal, state, and local agencies to form the Multi-Agency Rocky Intertidal Network (MARINe). MARINe partners use standardized methods to monitor rocky intertidal populations throughout the U.S. West Coast, including at over 80 survey sites throughout California (www.marine.gov). Black abalone populations throughout the Central and Southern California coasts have been monitored by MARINe partners (including the Channel Islands National Park) since the 1980s. These long-term monitoring surveys have provided valuable data on the status and trends of black abalone populations throughout the California coast. Under the proposed permit, black abalone monitoring surveys would continue to be conducted at the MARINe sites established throughout coastal California. Black abalone have actually been observed at 33 of the sites, including 13 sites along the Central California coast from Point Arena to San Diego, 11 sites on the Northern Channel Islands, and 9 sites on San Nicolas Island.

Monitoring surveys would be conducted during low tides when black abalone are exposed to air. Non-destructive search methods would be used (i.e., no boulders would be rolled, nor rocks broken or organisms removed from the habitat). Counts would be conducted using two methods: (1) timed counts; and (2) fixed plot counts. In timed counts, researchers would search for all abalone in an area over a set amount of time. The duration of timed counts would typically be 30 minutes, although longer searches would be conducted at sites where numerous abalone are observed, to get a more complete search of the reef. In fixed plot counts, researchers would search for all abalone within a fixed area on the reef. Plots would be marked with stainless steel bolts which are drilled and attached to rock with epoxy (a thermosetting resin) at the corners of the plot. Plots would be outlined by wrapping a line or measuring tape around the bolts. At most sites, steel bolts to mark the plots have already been installed and no new installations would be expected. Plot sizes would range from one square meter to tens of square meters.

In both timed counts and fixed plot counts, each black abalone encountered would be recorded and the greatest shell length would be measured using adjustable calipers or rulers. Non-lethal take of black abalone (i.e., touching the animal's shell or mantle) could occur while counting or measuring abalone. Contact and time spent with each individual abalone would be minimized. The abalone would not be removed from the rock, but would be measured by placing the calipers on the shell, taking care not to touch the mantle tissue. Rulers could also be used to estimate shell length without touching the animal. The abalone shell could be temporarily marked using a lumber crayon to indicate it was previously measured. The health of the abalone would be assessed visually by observing whether the mantle is visible below the shell or whether the abalone appears active by moving or clamping down on the rock in response to the person's presence or to a light touch. The total time needed to measure the shell length and assess the health of each abalone would be less than one minute. Actual contact with abalone would last only a few seconds.

While conducting the surveys, researchers would avoid stepping on vulnerable species, such as mussels, and would wear soft-soled shoes to minimize crushing of organisms on the reefs. Researchers would also approach monitoring sites slowly and quietly to minimize disturbance to pinnipeds and seabirds at or near the sites. At each site where black abalone are found, monitoring surveys would typically be conducted twice per year. At some sites, temperature loggers could be installed on the rocky substrate using epoxy and the data downloaded once or twice per year.

Tagging studies

Since 2006, over 300 black abalone have been tagged and monitored at three sites on the Northern Channel Islands and one site on San Nicolas Island. Under the proposed permit, tagging efforts would increase at these four sites, with the goal of tagging up to 100 black abalone per year for a total of up to 500 black abalone tagged over the 5-year permit period. The actual number of black abalone tagged per year would depend on the number of black abalone encountered.

Non-lethal take of black abalone (i.e., touching the shell or mantle) would occur when applying tags to the shell and measuring shell length. Tagging would be conducted at the same time as the fixed-plot or timed counts, or a separate search from the fixed-plot or timed counts would be conducted to find exposed black abalone with shells accessible for tagging. Abalone would be tagged with either one or both of two kinds of tags: Passive Integrated Transponder (PIT) tags (Biomark model TX1411SST), which are read with a hand-held tag reader, and small visual tags (usually a numbered plastic fish tag). Placing two tags on each abalone allows measurement of tag loss and increases the likelihood of identifying the abalone in the future. The tags would be applied to the shell using Z-spar epoxy, a two-part marine epoxy that is relatively easy to use, holds up well in the marine environment, and has been successfully used in black abalone tagging studies conducted since 2006 at the Channel Islands and in earlier tagging studies (*Douros 1987*).

To apply the tags, researchers would first measure and record the abalone's greatest shell length and then gently and carefully clean the shell using a small brush or cloth to remove diatoms or algae. To apply the PIT tag, the tag would be placed on the shell and the epoxy placed on top to attach the tag to the shell. The resulting epoxy would be limpet-

shaped, approximately 2 cm wide and 0.5 cm high. To attach the visual tag, a smaller amount of epoxy (approximately 1 – 1.5 cm wide and 1 – 2 mm high) would be pressed onto the shell and the visual tag pressed onto the surface of the epoxy. The epoxy would be placed near the ridge of the whorl, where the shell is rough and the epoxy may stick well, taking care to avoid covering the respiratory pores and shell edges. Researchers would smooth the edges of the epoxy to reduce tag loss and to minimize drag on the shell. The epoxy is not believed to cause undue drag on the shell because it is smaller and smoother than typical barnacles found encrusting on abalone shells. Contact and time spent with each individual abalone would be minimized. The total time required to measure each abalone and apply the tags would be less than five minutes. Tagged abalone would be monitored and re-measured at each of the sites up to three additional times per year (but typically only once or twice per year). Since 2006, about 30% to 50% of tagged abalone have been found and re-measured each year. Abalone would not be handled or removed and contact with the mantle tissue would be avoided during tagging and measuring activities.

Collection of dead or dying abalone

Under the proposed permit, researchers would be authorized to collect up to ten dead or obviously dying black abalone per year, to be used for pathology and histology studies and to inform early identification of disease or toxin outbreaks. During field surveys, researchers would assess the health of each black abalone observed. Black abalone would be collected if they are dead or exhibiting signs of the disease called withering syndrome. Symptoms include the inability to hold onto the substrate or to resist any pressure, extreme lethargy, and a withered or shrunken and discolored foot muscle. Each animal would be placed in individual plastic bags, properly labeled, and immediately frozen or preserved as instructed by pathologists. Whole animals or tissue samples would be shipped to laboratories that have the appropriate permits to conduct the analyses. Based on the number of dead black abalone encountered in the field over the last several years, researchers expect to encounter up to ten dead or dying black abalone per year, although a mass mortality event could occur due to withering syndrome.

Expected take under the proposed permit

The research activities described above will result in the take of juvenile and adult black abalone of both sexes. The research activities are not expected to result in the take of other ESA-listed species. Table 1 summarizes the maximum take of black abalone (numbers of animals and numbers of takes per animal) that would be allowed under the proposed permit per year during specified activities.

Table 1. Summary of the permitted take of black abalone under the proposed permit, including the research procedures resulting in take, the type of take (i.e., take action), the number of animals and number of takes per animal per year, and the life stages and sexes of individuals allowed to be taken.

Procedures	Take Action	Number of animals per year	Takes per animal per year	Life Stage	Sex
Count/survey; measure shell length, observation, monitoring (including monitoring of tagged individuals)	Harass/ Sampling	5,300	Four	Adult and juvenile	Male and female
Mark (e.g., with an external PIT tag and/or visual tag); count/survey; measure shell length	Harass/ Sampling	100	One	Adult and juvenile	Male and female
Collection and transfer/transport of dead or dying black abalone for analysis	Removal from wild (permanent)	10	One	Adult and juvenile	Male and female

Permit Conditions

The proposed permit lists general and specific conditions to be followed when conducting permitted research activities. The permit application also contains measures to be implemented by researchers under the permit to minimize effects to listed resources. These conditions and measures are intended to minimize the potential adverse effects of the research activities on black abalone and other listed resources within the action area. The proposed permit conditions and measures include the following:

- Researchers will suspend permitted activities if authorized take is exceeded or in the event of a serious injury or mortality of black abalone or any other ESA-listed species. The Permit Holder will contact the Chief of the Permits Division by phone within two business days and submit a written incident report within two weeks. Research may recommence upon review of that information and authorization by the Chief of the Permits Division.
- All biological samples collected from ESA-listed species or obtained under the permit shall be identified by a unique number and maintained according to accepted curatorial standards. The Permit Holder is responsible for all biological samples collected or obtained under the permit, including the maintenance of such samples after completion of initial research goals.
- Written approval from the NMFS Office of Protected Resources and compliance with appropriate conditions is required for the transfer of biological samples from the Permit Holder to researchers other than those specifically identified in the permit application.
- Commercial culture and sale of black abalone, including of parts, is forbidden.
- If ESA-listed species other than black abalone are encountered during permitted activities, then researchers must exercise caution and remain a safe distance from the animals to avoid take.
- If a mass mortality of black abalone is detected, the permit holder should notify NMFS of the location(s) and potential cause(s) of the mass mortality as soon as possible.

- 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.
- Annual reports must be submitted to the Chief, Permits Division at the conclusion of each year (due date: by the 30th of November) for which the permit is valid, including the actual number of animals taken, the effects of the permitted activities on animals, measures taken to minimize those effects and the effectiveness of those measures, preliminary findings, and other information as described in the permit.
- A final report must be submitted to the Chief, Permits Division within 180 days after expiration of the permit, or, if the research concludes prior to permit expiration, within 180 days of completion of the research.
- The Permit Holder must provide written notification of planned field work to the Assistant Regional Administrator, Protected Resources Division, Southwest Region, at least two weeks prior to initiation of a field trip or season, including: the intended field study locations and/or survey routes, estimated dates of research, and number and roles of participants (e.g., Principal Investigator, Co-Investigator, research assistant).
- To the maximum extent practical, the Permit Holder must coordinate permitted activities with the activities of other Permit Holders conducting the same or similar activities on the species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals.
- The Permit Holder must cooperate with NMFS' request to review activities conducted pursuant to the proposed permit by allowing an employee of NOAA or a person designated by the Director, NMFS Office of Protected Resources, to observe the permitted activities, and by providing all documents or other information relating to the permitted activities.

Approach to the assessment

The NMFS approaches its Section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *Action area* for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *Exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *Response analyses*).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent

our *Risk analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

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

We measure risks to listed individuals using the individual's "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our *Response analyses*) are likely to have consequences for the individual's fitness.

When individual listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (*Stearns 1992*). Reductions in at least one of these variables (or one of the variables we derive from them) is a necessary condition for reductions in a population's viability, which is itself a necessary condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (*Brandon 1978; Mills and Beatty 1979; Stearns 1992; Anderson 2000*). As a result, if we conclude that listed plants or animals are not likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a necessary condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always sufficient to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analysis, we use the population's base condition (established in the *Status of listed resources* and *Environmental baseline* sections of this Opinion) as our point of reference. If we

conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always sufficient to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of listed resources* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence consists of:

- monitoring reports submitted by past and present permit holders
- reports from the NMFS Science Centers
- reports prepared by natural resource agencies in States and other countries
- reports from non-governmental organizations involved in marine conservation issues
- the information provided by the NMFS Permits Division when it initiates formal consultation
- the general scientific literature

We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies.

During the consultation, we conducted electronic searches of the general scientific literature. We supplemented these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically tried to identify data or other information that supports a particular conclusion as well as data that do not support that conclusion. When data were equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely (i.e., Type II error).

Action area

The action area for this consultation consists of the MARINe rocky intertidal survey sites along the California coast that are within the range of black abalone, from Point Arena in Northern California (Mendocino County) to the Cabrillo National Monument in Southern California (San Diego County), and including the Farallon Islands, Año Nuevo Island, and the eight Channel Islands. The number of sites at which black abalone have been found, and at which the research activities as proposed in the permit application would occur, include 13 sites along the Central California coast from Point Arena to San Diego, 11 sites on the Northern Channel Islands, and 9 sites on San Nicolas Island. Research activities could be conducted any time of the year when there are low tides, but would typically be conducted during the fall through spring months when the best daytime low

tides occur. Sites would typically be monitored once or twice per year, with the four tagging sites monitored up to four times per year.

Status of listed resources

In this step of the assessment, we identify the listed resources that are likely to occur within the action area and that may be exposed to the effects of the proposed research activities. We also summarize relevant information regarding the status of those listed resources in order to establish the environmental baseline and assess the effects of the proposed action on those listed resources.

We have determined that the action being considered in this Opinion may affect the following species under NMFS' jurisdiction that are protected under the ESA. The common and scientific names and ESA status of each species that may be affected are listed below:

Black abalone	*Haliotis cracherodii*	Endangered
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened
Steller sea lion (Eastern Distinct Population Segment)	*Eumetopias jubatus*	Threatened

In addition, the proposed action may affect designated critical habitat for the Steller sea lion and areas proposed for designation as critical habitat for black abalone. NMFS plans to make a determination on the final black abalone critical habitat designation in July 2011.

Listed resources not considered further in this Opinion

To refine the scope of this Opinion, we used two criteria (risk factors) to determine whether any endangered or threatened species or designated critical habitat are not likely to be adversely affected by the human disturbance associated with the proposed action. The first criterion was *exposure*: if we conclude that particular listed species or designated critical habitat are not likely to be exposed to human disturbance, then we must also conclude that those listed species or designated critical habitat are not likely to be adversely affected by the proposed action. The second criterion is *susceptibility* upon exposure: if we conclude that particular listed species or designated critical habitat may be exposed to the human disturbance, but may not be affected by those activities – either because of the circumstances associated with the exposure or the intensity of the exposure – then we must also conclude that those species or critical habitat are not likely to be adversely affected by the proposed action. This section summarizes the results of our evaluations.

We conclude that Steller sea lions and Guadalupe fur seals may occur in the action area, but are not likely to be exposed to human disturbance associated with the proposed research activities. Steller sea lions are generally observed at haulout and rookery sites along the California coast (as far south as Point Conception) from April through October (*NMFS 2007; pers. comm. with Monica DeAngelis, NMFS, on 10 August 2010*). Because the proposed research activities would typically be conducted in the fall through spring

months, Steller sea lions are not likely to be encountered at or near the monitoring sites during the proposed research activities. Guadalupe fur seals are considered rare in California waters, with a few sightings on San Miguel Island (*Melin and DeLong 1999*) and San Nicolas Island (*Stewart and Yochem 1984*). Guadalupe fur seals generally occur within the action area during summer months and are also not likely to be at or near the monitoring sites during the proposed research activities. If a protected pinniped is observed at or near the monitoring sites, researchers would suspend their activities at the site and immediately vacate the area to avoid disturbing the animals. We conclude that Steller sea lions and Guadalupe fur seals are not likely to be adversely affected by the proposed action, based on the permit conditions and measures (as described above), the manner in which the research activities would be conducted, and the fact that the proposed research targets black abalone and not pinnipeds.

Designated critical habitat for Steller sea lions occurs within the action area. Critical habitat for Steller sea lions includes (58 FR 45269, 27 August 1993; 50 CFR § 226.12): (a) all major rookeries, haulouts, and associated terrestrial, air, and aquatic zones in Alaska; (b) three special aquatic foraging areas in Alaska; and (c) all major rookeries and associated air and aquatic zones in California and Oregon. The physical and biological habitat features essential to conservation include rookeries and haulouts and associated terrestrial, air, and aquatic zones, as well as foraging areas and the prey resources within them. These features support Steller sea lion reproduction, foraging, rest, and refuge. The designated critical habitat areas in Alaska and Oregon do not occur within the action area, but the designated critical habitat areas in California (i.e., major Steller sea lion rookeries on Año Nuevo Island, Southeast Farallon Island, Sugarloaf Island, and Cape Mendocino) do occur within the action area and would be exposed to human disturbance associated with the proposed research activities. Any potential effects to this critical habitat would be insignificant, however, because the proposed research activities would not cause significant changes to the habitat or disrupt the ability of Steller sea lions to use these areas for reproduction, foraging, rest, and refuge. We conclude that the proposed research activities will not adversely affect the conservation value of designated critical habitat for Steller sea lions.

In summary, Guadalupe fur seals, Steller sea lions, and designated critical habitat for Steller sea lions may occur in the action area, but are either not likely to be exposed to the proposed research activities or are not likely to be adversely affected. Therefore, these listed resources will not be considered further in this Opinion.

Areas proposed for designation as critical habitat for black abalone also occur within the action area and may be affected by the proposed action. The proposed designation includes rocky intertidal habitat (from the mean higher high water line onshore to the six meter depth contour offshore, determined relative to the mean lower low water line) along the California coast from the Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as rocky intertidal habitat on the Farallon Islands, Año Nuevo Island, and the Channel Islands (75 FR 59900; 28 September 2010). The physical and biological habitat features essential to conservation include: suitable rocky substrate from mean higher high water to six meters depth; abundant food resources (e.g., diatom films, crustose coralline algae, and sources of detrital macroalgae); juvenile settlement habitat (e.g., rocky intertidal substrates with crustose coralline algae and crevices or cryptic

biogenic structures); suitable water quality (e.g., suitable temperature, salinity, and pH levels); and suitable nearshore circulation patterns to retain eggs, sperm, fertilized eggs, and ready-to-settle larvae for successful fertilization and settlement in suitable habitat. The areas proposed for designation as black abalone critical habitat would be exposed to physical disturbance associated with the proposed research activities. Any potential effects to the proposed critical habitat would be insignificant, however, because the proposed research activities would not cause significant changes to the physical or biological features of the habitat. Researchers would use non-destructive search methods to survey abalone and would take care to minimize trampling effects. The installation of bolts (to mark survey plots) or of temperature loggers would affect rocky substrate, but the effects would be minor and would not reduce the value of the habitat for black abalone. After reviewing the current status of the areas, the effects of the proposed research activities, and the cumulative effects, it is NMFS' conference opinion that the proposed research activities are not likely to destroy or adversely modify proposed black abalone critical habitat. Therefore, the areas proposed for designation as black abalone critical habitat will not be considered further in this Opinion.

Status of species considered in this Opinion

The species narrative that follows focuses on attributes of life history and distribution that influence the manner and likelihood that black abalone may be exposed to the proposed action, as well as the potential response and risk when exposure occurs. Consequently, the species' narrative is a summary of a larger body of information on black abalone biology, life history, distribution, and status. A summary of black abalone status and trends throughout its range is presented to provide a foundation for the analysis of the species as a whole and as a point of reference for determining whether the proposed action's direct or indirect effects are likely to increase the species' probability of becoming extinct (i.e., the jeopardy determination).

Black abalone

Distribution, biology, and life history

Black abalone are marine gastropods characterized by a soft body, a univalve shell with typically five to nine open respiratory pores, a mantle which secretes the shell, an anterior head, and a large muscular foot (*Cox 1960*). The species occupies rocky intertidal habitats and uses the large muscular foot for movement as well as to clamp down onto hard substrates to avoid being dislodged by wave action. Black abalone are most commonly observed in coastal and offshore island rocky intertidal habitats with complex surfaces and deep crevices that provide shelter for juvenile recruitment and adult survival *(Leighton 1959; Cox 1960; Leighton and Boolootian 1963; Douros 1985, 1987; Miller and Lawrenz-Miller 1993; VanBlaricom et al. 1993; Haaker et al. 1995; Leighton 2005).* The species occupies a broad lateral range from the upper intertidal to six meters depth, with most individuals found in the middle and lower intertidal. Thus, black abalone are able to withstand extreme variations in temperature, salinity, moisture, and wave action. Black abalone are usually strongly aggregated with some individuals stacking two or three on top of each other (*Cox 1960; Leighton 2005*).

The final listing decision for black abalone defined the current occupied range to extend from Crescent City (Del Norte County, California) to Cape San Lucas, Baja California, Mexico *(74 FR 1937, 14 January 2009).* Some literature references describe the range to extend as far north as Coos Bay, Oregon (*Oldroyd 1927; Cox 1960*), but their presence in Oregon is questionable. Observations of black abalone in Coos Bay in the 1930s (upon which the range extension into Oregon is based) were most likely due to an attempt by citizens to introduce black abalone to the Oregon coast (*pers. comm. with Paul Reimers, Oregon Department of Fish and Wildlife, on 28 March 1975*). The northernmost documented record of black abalone in California is from Crescent City, based on museum specimens (*Geiger 2004*). Black abalone are considered rare north of San Francisco (*Morris et al. 1980*) and south of Punta Eugenia *(pers. comm. with Pete Raimondi, UC Santa Cruz, cited in VanBlaricom et al. 2009).*

Black abalone are broadcast spawners, meaning their gametes are released into the water and fertilization occurs externally. Reproductive maturity is reached at a size of about 50 mm in female black abalone and about 40 mm in male black abalone (*Leighton 1959; Ault 1985*). The peak spawning season varies across the geographic range, but generally occurs between spring and early autumn (*Leighton 1959; Leighton and Boolootian 1963; Webber and Giese 1969; Leighton 2005*). Male black abalone, but no females, have been observed to spawn during winter *(unpublished observations by Glenn VanBlaricom, U.S. Geological Survey (USGS), cited in VanBlaricom et al. 2009).* Because temporal and spatial synchrony of spawning is necessary to maximize fertilization success, a critical adult density threshold is believed to be required for successful recruitment. At three long-term monitoring sites in California, recruitment failure was found to occur when adult black abalone density declined to an estimated 0.25 to 0.46 m^{-2} (*Neuman et al. In press*). Thus, the estimated average minimum adult density below which local recruitment failure occurred at these sites was 0.34 m^{-2} (*Neuman et al. In press*).

Larvae remain in the plankton for about three to ten days before settlement and metamorphosis (*McShane 1992*). Evaluations of population structure in black abalone using genetic approaches have consistently suggested limited larval dispersal distances and low connectivity among populations (*Hamm and Burton 2000; Chambers et al. 2006; Gruenthal and Burton 2008*). Larval settlement habitat consists of hard substrates with crustose coralline algal cover (*Morse et al. 1979; Morse and Morse 1984; Douros 1985; Trapido-Rosenthal and Morse 1986; Morse 1990*, *1992*). Young abalone are usually relatively cryptic, making detection and monitoring of recruitment events difficult until abalone reach a certain size and move into more open habitats.

Growth rates in black abalone vary by season and by location. In general, black abalone grow to about 20 mm in their first year (*Leighton 2005*) and grow about 10 to 20 mm per year until they reach a size of about 100 mm (at about 4 to 8 years in age), after which growth is less predictable, varying according to local conditions and shell erosion rates (*Leighton and Boolootian 1963; Leighton 2005; VanBlaricom and Monti In preparation, cited in VanBlaricom et al. 2009*). Adults typically range in size from 100 to 170 mm in shell length (*Blecha et al. 1992; Haaker et al. 1995*), with maximum recorded shell lengths of 213 mm (*Wagner and Abbott 1990*) and 215 mm (*Ault 1985*).

Observations and results from tagging studies indicate that adult black abalone are capable of moving substantial distances (on the order of tens to hundreds of feet) over

short time spans, but, in general, move very little (*Cox 1960; unpublished observations by Glenn VanBlaricom, USGS, and by Daniel Richards, NPS, cited in VanBlaricom et al. 2009*). In some studies, tagged abalone have been observed in the same location over two years (*Cox 1960*). Black abalone are more active at night than during the day (*Bergen 1971; Leighton 2005*). Tagging studies indicate that smaller abalone (less than 65 mm in shell length) move more frequently than larger abalone (greater than 100 mm in shell length) (*Bergen 1971; Blecha et al. 1992*).

Juvenile black abalone feed on benthic microflora that grow on rocky surfaces, whereas adult black abalone feed primarily on a variety of marine macroalgal species (*Leighton 1959; Cox 1960; Leighton and Boolootian 1963; Bergen 1971*). Adult black abalone most commonly feed by entrapping drift plant fragments, but may also feed on attached living plants (*VanBlaricom 2003; Leighton 2005*). A substantial portion of the adult diet is composed of drift *Macrocystis pyrifera* and *Egregia menziesii* in Southern California (*Leighton 1959; Leighton and Boolootian 1963; Douros 1987*) and of drift *Nereocystis leutkeana* in Northern California (*Webber and Giese 1969; Hines and Pearse 1982*).

Little is known about mortality rates and sources of mortality in larval and newly recruited juvenile abalone (*Shepherd and Breen 1992, cited in VanBlaricom et al. 2009*). Small, cryptic black abalone (less than 40 to 50 mm in shell length) and large adult abalone (greater than 40 to 50 mm in shell length) are subject to mortality from predation, illegal harvest by humans, physical disturbances (e.g., substratum movement or disruption, sediment deposition, etc.), variation in food supply, pollution, and disease (i.e., withering syndrome) (*Shepherd 1973; Ault 1985; Shepherd and Breen 1992, cited in VanBlaricom et al. 2009*). These sources of mortality and their effects on black abalone populations are described in more detail in the *Status and Trends* section below.

Status and trends

Black abalone were determined to be in danger of extinction throughout all or a significant portion of its range based on significant declines in population abundance throughout the Southern and South-Central California coasts. The main factors contributing to these declines were historical overfishing and mass mortalities caused by the disease called withering syndrome. The primary threat to the species is the continued spread of withering syndrome to the remaining unaffected populations along the North-central and Northern California coast. This section summarizes the available data on black abalone population abundance, trends, and status.

Abundance data for black abalone are available from fishery-dependent sources (i.e., commercial and recreational fisheries landings data) and fishery-independent sources (i.e., long-term monitoring studies along the California coast and recent monitoring studies in California and Mexico). The minimum estimated baseline abundance of black abalone in California prior to the recent population declines is 3.54 million abalone (*Rogers-Bennett et al. 2002*). Rogers-Bennett *et al.* (*2002*) based their estimate on commercial and recreational fishery landings from the peak period of 1972 to 1981, assuming that the population abundance was at least as large as the number of black abalone taken in the fishery. This estimate may be much greater than the historical baseline abundance, however, because black abalone populations during this period were

unusually high, especially on the Channel Islands where two important predators (i.e., indigenous peoples and sea otters) had been removed (*VanBlaricom et al. 2009*).

Commercial landings data for California show significant declines of approximately 93% in black abalone harvest from the 1970s to early 1990s (*Tissot 2007*). Commercial landings in California increased rapidly in the early 1970s with an average annual harvest of 290 metric tons (mt), but declined to an average annual harvest of 175 mt in the 1980s and 14 mt in the 1990s until the fishery was closed in 1993 by the California Department of Fish and Game (*Tissot 2007*). Black abalone populations on the Channel Islands made up most of the harvest in California. In Mexico, the little data available indicate a similar decline in commercial harvest from a high of 28 mt in 1990 to less than one mt in 1998 (*Hobday and Tegner 2000*). Fisheries may still occur in Mexico, but limited information is available to determine the relative threat of this fishery to the population and the overall species' decline.

Data from long-term fishery-independent monitoring studies of black abalone populations in California (from Laguna Beach to as far north as Año Nuevo Island) also show severe declines in black abalone abundance throughout Southern and South-Central California. At some sites, populations have declined by more than 99% primarily due to withering syndrome. At the Channel Islands, black abalone occurred in relatively high densities (some greater than 100 abalone per m^2) in the 1980s (*Douros 1987; Leighton 2005; Tissot 2007*), with the highest recorded density of 235 abalone per m^2 at San Nicolas Island (*VanBlaricom et al. 1993*). In the late 1980s to 1990s, black abalone populations on the Channel Islands suffered mass mortalities associated with withering syndrome. Populations on Anacapa, Santa Rosa, and Santa Barbara Islands declined from average densities of 20 to 50 per m^2 in 1985 to less than 10 per m^2 in 1989 (*Richards and Davis 1993*). On Santa Cruz Island, average densities declined from 42 to 58 per m^2 in 1987 to less than one per m^2 in 1992 *(Tissot 1995)*. On San Nicolas Island, average densities ranged from 4 to 30 per m^2 from 1981 to 1992 (*VanBlaricom et al. 1993*) but declined to less than one per m^2 from 1992 to 1996 at all but one site (*VanBlaricom et al. 2009*). Along the California mainland coast, withering syndrome was first detected at Diablo Canyon in 1988, but mortalities appeared to be restricted to the cove (*Steinbeck et al. 1992*). Beginning in 1992, declines in black abalone abundance due to withering syndrome were detected near Government Point (Santa Barbara County) and have spread progressively northward as far as Point Piedras Blancas (San Luis Obispo County) (*Altstatt et al. 1996; Raimondi et al. 2002; Miner et al. 2006; VanBlaricom et al. 2009*). In all cases, the appearance of abalone exhibiting symptoms of withering syndrome has been followed by mass mortalities and rapid, dramatic declines (usually by greater than 90%) at long-term monitoring sites at the Channel Islands and along the Southern to South-Central California coast (*Tissot 2007*).

Thus, as a result of withering syndrome and historical overfishing, most populations of black abalone at long-term monitoring sites in California from Cayucos south to Laguna Beach have declined to levels below the estimated average minimum adult density (0.34 per m^2) required for successful recruitment (*Neuman et al. In press*). Most populations affected by the disease remain at very low densities compared to pre-disease levels, or have gone locally extinct (*Tissot 2007*). In addition, evidence suggests that withering syndrome is spreading northward along the mainland California coast (*Raimondi et al.*

2002; Miner et al. 2006). This progression is likely to be exacerbated by warmer water temperatures. Among the areas affected by withering syndrome, recruitment has been observed at only two sites, one on San Nicolas Island *(unpublished data by Glenn VanBlaricom, USGS, cited in VanBlaricom et al. 2009)* and one on Santa Cruz Island *(unpublished data by Daniel Richards, NPS, cited in VanBlaricom et al. 2009)*.

Populations in areas that have not yet been affected by withering syndrome have declined slowly (i.e., at the North-Central California monitoring sites) or have remained steady (i.e., at the Northern California monitoring sites) (*Raimondi et al. 2002; Miner et al. 2006; pers. comm. with Pete Raimondi, UCSC, cited in VanBlaricom et al. 2009*). Studies conducted in Monterey County in 2002 indicate that, in the absence of the disease, black abalone populations can remain stable and experience regular recruitment despite low adult densities, including densities below the estimated average minimum adult density of 0.34 per m^2 that is believed to be required for successful recruitment (overall mean density in Monterey County sites = 0.39 per m^2; range of means = 0.01 to 0.77 per m^2) (*Micheli et al. 2008*).

Relatively little data are available for black abalone populations in Mexico. Three fishery-independent surveys for black abalone were conducted in 2002, 2004, and 2005 on the mainland coast and offshore islands of Baja California, Mexico. Black abalone populations were at low densities and were largely composed of small individuals less than 120 mm in shell length (*Sierra-Rodriguez et al. 2006, cited in VanBlaricom et al. 2009*). In 2005, fresh shells were found at a few sites on the northern Baja California coast, indicating that black abalone populations along that coast are still being affected by withering syndrome *(unpublished data by Pete Raimondi, UCSC, cited in VanBlaricom et al. 2009)*. Evidence of recent recruitment has been observed in northern Baja California, based on the large proportion of small black abalone (less than 50 mm in shell length) found at study sites *(unpublished data by Pete Raimondi, UCSC, cited in VanBlaricom et al. 2009).*

In summary, the available data from both fishery-dependent and fishery-independent sources show significant declines of 90% to 99% in black abalone populations throughout southern California south of Cayucos. In most areas south of and including Cayucos, the adult density has declined to less than the estimated average minimum adult density (0.34 per m^2) below which recruitment failure appears to occur (*Tissot 2007; Neuman et al. In press*). These declines are primarily due to mass mortalities associated with withering syndrome, although historical overfishing and other threats have contributed to the declines. Although populations at two sites on the Channel Islands have shown signs of recovery, populations in all other areas that have been affected by withering syndrome remain at or near extirpation and have not experienced recruitment (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). The Black Abalone Status Review Team estimated a 96% likelihood that black abalone would become functionally extinct within the next 30 years based on the effects of the disease alone (*VanBlaricom et al. 2009*). Populations north of Point Piedras Blancas have not yet been affected by withering syndrome and remain at low, but stable, densities sustained by regular recruitment events. However, the continued northward progression of withering syndrome along the mainland California coast poses an imminent threat to these populations. In addition, natural recovery of Southern California populations via

recruitment from the remaining stable populations is likely to be very slow given the poor connectivity and short larval dispersal distances of the species (*Tegner 1992; VanBlaricom et al. 2009*). For these reasons, black abalone were determined to be in danger of extinction and listed as endangered under the Federal ESA.

Environmental baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, 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 that are contemporaneous with the consultation in process *(50 CFR §402.02)*. The *Environmental baseline* for this Opinion includes the effects of several activities affecting the survival and recovery of the endangered black abalone in the action area. The *Environmental baseline* focuses primarily on past and present impacts to these species.

The following discussion summarizes the natural and human phenomena in the action area that may affect the likelihood these species will survive and recover in the wild. These include withering syndrome, historical overfishing and ongoing illegal harvest, habitat degradation and climate change, predation, and pollution, as well as ongoing conservation.

General description of the action area

The action area consists of the MARINe rocky intertidal survey sites along the coast of California from Point Arena in Northern California (Del Norte County) to the Cabrillo National Monument in Southern California (San Diego County), including the Farallon Islands, Año Nuevo Island, and the eight Channel Islands. The rocky intertidal communities within this action area are dominated by algae and invertebrates. Several species of marine mammals and seabirds also occupy these habitats and adjacent areas. Ongoing surveys are being conducted at these sites under the MARINe program to monitor rocky intertidal resources, including black abalone. In general, the monitoring sites are not subject to high levels of human disturbance given their location away from human population centers and limited accessibility. However, other activities in addition to the ongoing MARINe surveys may occur in the areas and affect the rocky intertidal habitats, such as: recreational use (e.g., tidepooling); other research activities; coastal development and in-water construction activities (e.g., coastal armoring, pier or jetty construction, and other onshore or nearshore construction projects); sand replenishment or beach nourishment; side-casting; discharge of thermal effluent (e.g., from coastal power plants, desalination plants); and oil and chemical spills and clean-up activities.

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

Black abalone populations throughout most of the action area face high levels of risk in each of four demographic risk criteria: abundance, growth rate and productivity, spatial structure and connectivity, and diversity (*VanBlaricom et al. 2009*). Populations at the majority of long-term monitoring sites, including all sites in Southern California, have declined in abundance by more than 80% and are at critically low population abundance and density levels (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). Many populations are at or below the estimated average minimum adult density needed for successful recruitment, with recruitment failure and declining population trends at all monitored sites south of Cayucos except for two sites on the Channel Islands (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). Loss of genetic diversity has likely resulted, putting the species at further risk by reducing their ability to respond to disease and environmental change. Poor connectivity among populations may also hinder recovery by making re-colonization of extirpated populations, as well as the spread of any existing genetic resistance to the disease, unlikely in the foreseeable future (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). The continued spread of withering syndrome, and other threats to the species as described below, may further exacerbate these demographic risks. Long-term black abalone monitoring studies have provided critical information to assess the effects of withering syndrome and the status and trends of populations pre- and post-disease. The continuation of such studies is necessary to inform future management decisions and recovery efforts.

Withering syndrome

Withering syndrome is the primary ongoing threat to black abalone populations in the action area. First detected on Santa Cruz Island in 1986 (*Haaker et al. 1992*), the disease has spread throughout all of the Channel Islands and the Southern California coast as far north as Rancho Marino, south of Point Piedras Blancas in San Luis Obispo County (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). As described in the *Status of listed resources* section, the disease has resulted in mass mortalities of black abalone throughout Southern California and continues to threaten populations as it moves progressively northward along the mainland California coast. Most populations affected by withering syndrome have been extirpated or remain at low densities and have not exhibited successful recruitment.

The causative agent for withering syndrome is believed to be a Rickettsia-like prokaryote (RLP) called *Candidatus Xenohaliotis californiensis* (*Friedman et al. 1997a; Friedman et al. 2002*). The bacteria invades the digestive cells, disrupting the ability of the abalone to assimilate food (*Friedman et al. 1997a*), resulting in pedal atrophy and a diminished ability to maintain a grip on rocky substrata (*Lafferty and Kuris 1993*). Epipodial and mantle discoloration and a lack of response to tactile stimulation are also observed (*Haaker et al. 1992; Richards and Davis 1993*). Abalone may be exposed to the RLP agent and not exhibit symptoms for about eight months, but once symptoms develop, the animals succumb to death rapidly, generally within six weeks of developing symptoms (*Friedman et al. 1997a; Friedman et al. 2000; Friedman et al. 2002*). Abalone may die of the disease itself or may be more easily preyed upon due to its weakened grip on the substrate. Transfer of the pathogen from animal to animal is fecal to oral on a local scale. The transmission of the disease on a larger spatial scale is unknown. Small abalone from less than 40 to 50 mm in shell length to large adult abalone are susceptible to withering

syndrome (*VanBlaricom et al. 2009*). The pathogen is endemic to all coastal marine waters of Central (*Friedman and Finley 2003*) and Southern California (*Moore et al. 2002*) south of San Francisco, and has also been found at Southeast Farallon Island (*pers. comm. with Jim Moore, Bodega Bay Marine Laboratory, cited in VanBlaricom et al. 2009*).

Elevated sea surface temperatures have been correlated with increased virulence of withering syndrome and accelerated rates of disease-induced mortality (*Friedman et al. 1997b; Raimondi et al. 2002; Harley and Rogers-Bennett 2004; Vilchis et al. 2005*). Captive animals have been successfully treated with injections of the antibiotic oxytetracycline, but such treatment for wild populations is impractical (*Friedman et al. 2000; Friedman et al. 2003*). Evidence of recovery at two Channel Island sites indicates the potential for disease resistance, which is being investigated at the University of Washington (*VanBlaricom et al. 2009*).

Historical overfishing and ongoing illegal harvest

Black abalone have been subject to human exploitation since indigenous peoples harvested abalone for their meat and shells 10,500 years ago (*Erlandson et al. 1996*). In more recent history, black abalone were harvested as part of an intertidal abalone fishery in California beginning in the 1850s, which peaked in 1879 (*Cox 1962*) but eventually closed in 1913 due to concerns regarding overfishing (*Bonnot 1930*). Commercial and recreational dive fisheries for abalone developed from 1913 to 1928, but black abalone were not intensively harvested until after other more marketable species were depleted and were not documented until 1940. In the 1980s and early 1990s, black abalone populations experienced severe declines likely due to overexploitation and withering syndrome. As a result, both the commercial and recreational fisheries for black abalone were closed in 1993 (*Tissot 2007*). Rogers-Bennett *et al*. (*2002*) estimated that approximately 3.5 million black abalone were harvested during the peak decade of black abalone commercial fishing from 1972 to 1982, with an additional 6,729 black abalone harvested in the recreational fishery during that period. The commercial data demonstrate a trend of serial depletion of abalone species in California and indicate that excessive commercial harvest was a contributing factor to the depletion of black abalone and other California abalone populations (*Karpov et al. 2000*).

Although black abalone harvest is prohibited throughout California, poaching remains an important source of mortality for black abalone. The virtual absence of black abalone in rocky intertidal habitats that are highly accessible and near highly populated areas in California is an indication of the impact of poaching. Since 1993, there have been several black abalone poaching cases documented by the California Department of Fish and Game along the California mainland coast, particularly in the northern portion of the range *(unpublished data from Ian Taniguchi, California Department of Fish and Game, cited in VanBlaricom* et al. *2009)*. Poaching cases have involved the removal of tens to hundreds of black abalone across all size categories. However, the relative impact of poaching-related mortality to black abalone is poorly understood.

Other factors

Elevated water temperatures resulting from anthropogenic sources of thermal effluent and from long- and short-term climate change (e.g., El Niño-Southern Oscillation) may

accelerate the rate of disease transmission and withering syndrome-induced mortality for black abalone. In addition, activities that lead to substrate destruction or increased erosion and sedimentation (e.g., coastal and in-water development, in-water cable installation and repairs, nearshore military operations, recreational use of rocky intertidal areas) may affect black abalone habitat. Due to the narrow geographic scope and infrequent occurrence of such activities, however, the level of impact is highly uncertain.

Other threats to black abalone within the action area include: entrainment or impingement of larvae and juveniles at water intake structures; environmental pollutants and toxins; reduced food quality and quantity (e.g., as a result of El Niño events); ocean acidification; interspecies competition; non-anthropogenic predatory pressure; and non-anthropogenic physical disturbance of the habitat (e.g., movement of boulders due to large storms). The relative impact of these threats to black abalone is highly uncertain depending on the location and severity of the threat. For example, entrainment and impingement risks to larval and juvenile black abalone are uncertain, but likely relatively low because larvae and juveniles are spatially and temporally restricted (*McShane 1992; Hamm and Burton 2000; Chambers et al. 2005*). Non-anthropogenic predation may pose a risk to populations that have already experienced severe declines and may limit the effectiveness of recovery efforts by interacting with other limiting factors. Few studies have examined the effects of ocean acidification on marine gastropods, but indicate the potential for reduced growth and survivorship (*Shirayama and Thornton 2005*). The relative risk of environmental pollutants and toxins is likely to be low given the limited geographic scope and uncertain effects on black abalone, but single events (e.g., oil and chemical spills) can result in large impacts to populations depending on where they occur. One such case was the discharge of toxic levels of copper in the cooling water effluent from a nuclear power plant near Diablo Canyon which led to abalone mortalities (*Martin et al. 1977, cited in VanBlaricom et al. 2009*). Although the impacts are uncertain, these threats may exacerbate the demographic risks to black abalone within the action area, particularly for populations that have already experienced declines due to overfishing and disease.

At the same, ongoing efforts to protect and recover abalone populations throughout California may benefit black abalone and its habitat. The California Department of Fish and Game's (CDFG) Abalone Recovery and Management Plan (ARMP) was adopted in December 2005 and provides a framework for the recovery of abalone populations in Southern California and the management of the abalone fishery in Northern California, as well as future abalone fisheries. The state of California's actions to implement the ARMP would likely benefit black abalone by raising awareness of abalone and focusing efforts on abalone conservation and management throughout California.

Effects of the action

Pursuant to Section 7(a)(2) of the ESA, federal agencies are required to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed permit by the Permits Division would expose endangered black abalone to actions that constitute "take." In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of listed species being

exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the assessment* section of this Opinion, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, and lifetime reproductive success), the assessment would consider the risk posed to the viability of the population. The purpose of this assessment is to determine if it is reasonable to expect the proposed studies to have effects on the endangered black abalone that could appreciably reduce the species' likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level, and therefore species-level, consequences. The proposed permit would authorize non-lethal "takes" of listed species during research activities.

All three components of the proposed research (i.e., the monitoring surveys, tagging studies, and biological collection) would involve take of wild black abalone. We examined the monitoring and tagging aspects of the research program to identify the nature of possible interactions with black abalone (i.e., the exposure of particular life stages to monitoring and tagging activities) and the probable response of exposed black abalone to monitoring and tagging activities. We examined whether and to what degree the proposed monitoring and tagging activities would be expected to pose a risk of harm, injury, or mortality to black abalone and reduce individual survival and growth of individuals. If the effects of the proposed research activities are likely to reduce the survival and growth of individual black abalone, we then assess whether and to what degree the proposed research activities pose a risk to the viability of the populations those individuals represent, and to black abalone as a species. In addition, we examine whether and to what degree the removal of dead or obviously dying black abalone poses a risk to the individuals that would be removed, the populations they would be removed from, and to black abalone as a species. Table 1 in the *Description of the Proposed Action* section of this Opinion summarizes the number of black abalone that may be taken per year over the duration of the permit and the estimated number of takes per animal.

Long-term monitoring surveys and tagging studies on black abalone similar to those that would be conducted under the proposed permit have been conducted since the 1980s. Thus, we relied on the best available scientific and commercial data from these studies to inform our assessment and to address the questions stated above.

Exposure analysis

The Permits Division proposes to issue a permit to the Channel Islands National Park to authorize the monitoring (counting), measuring, and tagging of male and female endangered black abalone, and the collection of dead or dying black abalone. Up to 5,300 black abalone could be counted and their shell length measured per year, for the duration of the 5-year permit. This number includes the estimated number of black abalone that could be counted and measured during regular monitoring surveys (n = 4500, based on the numbers of black abalone observed in recent years and accounting for potential increases in population abundance) and the estimated maximum number of

tagged black abalone that could be counted and measured at the four tagging sites (n = 800 in year five of the permit). Researchers could monitor and measure black abalone at the survey sites up to four times per year, but would likely conduct only one or two surveys per year at most sites.

Given increased numbers of black abalone observed at the tagging sites and planned increases in tagging efforts, up to 100 black abalone could be annually tagged with one or both of two kinds of tags (PIT tags and small visual tags), as well as being counted and measured. The total time required to measure an abalone and apply the tags would be less than five minutes. Tags are expected to remain attached for the life of the individual, as long as the epoxy remains in place. Researchers would attempt to re-locate and measure tagged abalone up to three times per year. Additionally, the permit would authorize the annual collection of up to ten dead or dying abalone.

Response analysis

As discussed in the *Approach to the assessment* section of this Opinion, our response analyses determine how black abalone are likely to respond upon being exposed to the monitoring, measuring, tagging, and collection that would be authorized by the proposed permit. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences.

Monitoring

The applicant proposes to use non-destructive search methods (i.e., abalone are not removed from the substrate, nor are rocks rolled or broken apart) to count and measure black abalone at each site. Surveys may be conducted at each site up to four times per year, but at most sites (other than the four tagging sites, as described in the next section), researchers would expect to conduct surveys only once or twice per year. Direct effects on black abalone associated with monitoring activities are expected to result from touching the shell or mantle of black abalone when searching for, counting, and measuring individuals, and marking the shell to indicate an individual has been counted or measured. Contact with the abalone shell or mantle would only be for a few seconds. Researchers would be careful to avoid contact with living tissues, such as the mantle. Take of juvenile and adult black abalone of both sexes would occur. The life stage can be determined by the shell length measurements, but the proportion of females to males taken would not be determined because that would require removing individuals from the rock to examine the gonads. Black abalone are expected to respond by temporarily clamping down more tightly onto the substrate. Rarely, an abalone may become more active and move, which could expose it to greater risk by predators or being dislodged by waves, but more often would result in the abalone seeking shelter and better protection. Juvenile abalone (less than 40 mm in shell length) are more likely than adult abalone to become more mobile if disturbed. These responses may result in mild stress to the individual abalone, but would not be expected to result in harm, injury, or mortality.

It is possible that individual black abalone may be stepped on during survey activities. Depending on the amount of pressure exerted on the individual, the individual may be

killed, injured, or simply clamp down more tightly onto the substrate. The likelihood of stepping on a black abalone is very low and the likelihood of death as a result is even lower, however, because researchers generally wear soft shoes and are very careful where they step on the reef.

Indirect effects via effects on black abalone habitat may result from the installation of bolts (to mark fixed plots) or temperature loggers to the substrate, or from trampling of the habitat during the surveys. Installation of bolts and temperature loggers involve drilling bolts into the substrate, or attaching bolts or temperature loggers to the substrate using epoxy. At most sites, bolts and temperature loggers have already been installed and no additional installation is expected. Given the small area required for installation of the bolts and equipment (e.g., one square inch to a few square inches), the effects on black abalone habitat are expected to be low. Human trampling has been shown to result in reduced species richness and diversity, as well as an increased proportion of bare rock, on rocky intertidal reefs (*Van De Werfhorst and Pearse 2007*). Specifically, sessile invertebrates like mussels and barnacles may be crushed (*Smith and Murray 2005*) and the algal community may shift from one dominated by foliose species to one dominated by low profile species (*Brosnan and Crumrine 1994, cited in Van De Werfhorst and Pearse 2007*). Trampling effects resulting from monitoring activities are expected to be minimal, however, given the low frequency and duration of monitoring surveys. Researchers would minimize effects on the habitat by wearing soft-soled shoes and avoiding walking on vulnerable species such as mussels.

Based on this analysis of the effects, monitoring activities are not expected to harm, injure, or kill wild black abalone. Thus, we conclude that the take of black abalone in the course of the proposed monitoring activities will not reduce the survival, growth, or reproductive success of individual black abalone.

Tagging

Direct effects on black abalone associated with tagging activities are expected to result from touching the shell to apply the tags and touching the shell or mantle when searching for and measuring individuals. Take of juvenile and adult black abalone of both sexes would occur, although the proportion of females and males would not be determined because abalone would not be removed from the substrate. An initial survey would be conducted to tag black abalone at the four proposed tagging sites. Up to three additional surveys would be conducted per year to find and re-measure tagged abalone. Cleaning the shell and applying the tag would take less than five minutes. Measuring the abalone would take a few seconds. Although tagging activities involve a greater level of disturbance to individual abalone than monitoring activities, individual black abalone are expected to respond similarly by clamping down more tightly onto the substrate. Abalone are more likely to become active and move after being tagged than if they were just measured. As stated above, this could expose the individuals to greater risk by predators or being dislodged by waves, but more often results in the abalone seeking shelter and better protection. The presence of the tags on the shell is not likely to affect the individual abalone's ability to move and fit into crevices, given that the epoxy is comparable in size to barnacles that sometimes encrust on abalone shells. To further ensure that tagging does not negatively affect the abalone's health or ability to move, the applicant specifies that care should be taken to smooth out the epoxy and to avoid

covering the abalone's respiratory pores. We expect that tagging activities and the additional monitoring activities to find and re-measure tagged individuals would result in a low level of disturbance that would not be likely to harm, injure, or kill black abalone.

Indirect effects on black abalone may result from trampling of the rocky intertidal reefs during the initial and additional monitoring surveys. As described above, human trampling may affect the abundance, diversity, and distribution of invertebrate and algal species on the reefs. Although tagging activities would involve up to three additional surveys per year at each of the four tagging sites, we do not expect this increase in the frequency of surveys to substantially increase the trampling effects on the reefs to a level where the invertebrate and algal community would be affected.

Tagging activities, including the additional monitoring activities associated with tagging, are not expected to harm, injure, or kill wild black abalone, based on the above analysis of the effects. Thus, we conclude that the take of black abalone in the course of the proposed tagging studies will not reduce the survival, growth, or reproductive success of individual black abalone.

Collection and removal

Collection and removal of dead black abalone from the survey sites would not be expected to result in direct or indirect effects on black abalone. The individuals would already be dead and their removal would not affect black abalone habitat. If the abalone died due to withering syndrome, removal may benefit other abalone at the site by reducing the potential for further spread of the disease. Collection and removal of dying black abalone for laboratory studies would result in mortality of the individual abalone that are collected. However, these individuals would have died due to withering syndrome whether or not they were collected. Removal of these individuals may benefit other abalone at the site by reducing the potential for further spread of the withering syndrome pathogen. To reduce the likelihood that a healthy abalone may be collected and killed, the applicant provided specific criteria that will be used by researchers to identify black abalone that are obviously dying of withering syndrome.

The collection and removal of dead black abalone from the wild is not expected to result in harm, injury, or mortality to individual wild black abalone. The collection of dying black abalone is expected to result in the mortality of those individuals that are collected, but the individuals would be expected to die of the disease whether or not they are collected.

Cumulative effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. 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. According to the Consultation Handbook (USFWS and NMFS 1998), the "reasonably certain to occur" clause may include such indicators of actions such as approval of an action by state, tribal, or local agencies or government; indications that granting authorities for the action are imminent; project sponsor's assurance that actions will proceed, etc. Although speculative non-federal actions are not factored into the analysis, "reasonably certain to

occur" does not require a guarantee that an action will occur. Therefore, a degree of uncertainty is acceptable when characterizing cumulative effects.

A future state action that is reasonably certain to occur in the action area and that may affect black abalone is the redesign of California's marine protected areas (MPA) under California's Marine Life Protection Act (MLPA). The state of California approved and signed the MLPA in 1999, directing the state to reevaluate and redesign its system of MPAs as a coherent network to protect and conserve marine life and habitats. The state is currently engaged in the MLPA planning process to evaluate and redesign MPAs along the California coast. This process has been completed for the North-Central coast (Point Arena to Pigeon Point) and Central coast (Pigeon Point to Point Conception) regions and is currently underway for the North coast (California/Oregon border to Point Arena) and the South coast (Point Conception to the California/Mexico border) regions. The MLPA process would likely result in additional protections for black abalone and its habitat by providing for more effective management measures and enforcement in MPAs. Thus, implementation of the MLPA would not be expected to result in cumulatively adverse effects on black abalone and its habitat.

Other than the MLPA planning process, no future non-federal actions are expected to occur. Based on this analysis, we do not expect this action to result in cumulatively adverse effects on black abalone.

Integration and synthesis of effects

As explained in the *Approach to the assessment* section of this Opinion, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (*Brandon 1978; Mills and Beatty 1979; Stearns 1992; Anderson 2000*). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment.

The evidence available demonstrates that black abalone face a high risk of becoming extinct in the foreseeable future. Black abalone populations have been locally extirpated or dramatically reduced throughout a large portion of the species' range, primarily due to historical overfishing and mass mortalities caused by withering syndrome. In areas affected by withering syndrome, the populations remain small and are subject to demographic risks such as Allee effects, loss of genetic diversity, and poor connectivity among populations. Most populations at monitored sites south of Cayucos are at or below the estimated average minimum adult density that appears to be needed for successful recruitment and are experiencing recruitment failure and decreasing population trends, except for two sites on the Channel Islands. Withering syndrome is likely to spread northward to the remaining unaffected populations and would be expected to cause mass mortalities of black abalone. Other threats, such as poaching and increased sea surface temperatures, would continue to affect black abalone and may further exacerbate the demographic risks faced by the species. However, ongoing conservation efforts such as implementation of California's ARMP would likely provide

benefits to the species by increasing public awareness of abalone conservation issues and enhancing management and protections. The redesign of California's MPAs under the MLPA process would also likely provide benefits to black abalone by improving the effectiveness of management and enforcement measures within MPAs.

Long-term black abalone monitoring studies have provided critical information for assessing the status and trends of populations before and after the onset of withering syndrome and would continue to provide critical information to inform management and recovery of black abalone. The proposed black abalone monitoring and tagging studies to be conducted from Point Arena to San Diego, California, under the proposed permit would involve non-lethal take of wild black abalone, but will not result in harm, injury, or mortality to individual black abalone. Because no individual is expected to experience a fitness reduction, no fitness consequence would be experienced at a population or species level due to the proposed monitoring and tagging activities. The proposed collection and removal of dead or obviously dying black abalone (due to withering syndrome) would result in mortality of the individuals that are removed, but those individuals would have died of the disease regardless of whether they were collected or not. Thus, the collection and removal of dead or dying black abalone will not reduce the viability of black abalone at the population or species level. Overall, the research activities to be conducted under the proposed permit would not result in a reduction in fitness at the population or species level, but would provide fundamental information on the ecology and status of black abalone to develop effective management and recovery strategies.

Conclusion

NMFS has reviewed the best available scientific and commercial information, the current status of black abalone, the environmental baseline for the action area, the effects of the proposed research activities under the proposed permit, and the knowledge to be gained from the proposed research. Based on this analysis, it is NMFS' biological and conference opinion that the issuance of permit No. 14400 to the Channel Islands National Park and the conduct of the scientific research activities it authorizes, as proposed, are not likely to jeopardize the continued existence of endangered black abalone in the wild and are not likely to destroy or adversely modify areas proposed for designation as critical habitat for black abalone.

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 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 NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not the purpose of the agency action is not considered to be prohibited

taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

NMFS does not expect the proposed research activities to result in incidental take of any ESA-listed species. Endangered black abalone that are harassed, harmed, captured or injured by the proposed action would be taken as part of the purpose of the action. Therefore no incidental take of black abalone is anticipated.

Conservation recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

(1) In addition to the existing MARINe database for black abalone monitoring data, the permit holder and researchers under the permit should consider developing a central database for the black abalone tagging data and the data on biological samples collected.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

Reinitiation notice

This concludes formal consultation and conference on NMFS' proposal to issue a permit to the Channel Islands National Park to take black abalone for research purposes pursuant to the provisions of section 10 of the ESA. As provided in 50 CFR § 402.16, 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 take 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 to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

You may ask NMFS to confirm the conference opinion as a biological opinion issued through formal consultation if critical habitat for black abalone is designated. The request must be in writing. If NMFS reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, NMFS will confirm the conference opinion as the biological opinion on the project and no further section 7 consultation will be necessary.

After the designation of critical habitat for black abalone and any subsequent adoption of this conference opinion, the Federal agency shall request reinitiation of consultation if:

(1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect the species or critical habitat in a manner or to an extent not considered in this conference opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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