Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion

Action Agency:	National Marine Fisheries Service, Office of Habitat Conservation
Federal Action:	Management of grant funding activities associated with coral sexual propagation and distribution of coral settlement materials in Saipan, Commonwealth of Northern Mariana Islands
Consulting Agency:	National Marine Fisheries Service, Pacific Islands Regional Office, Protected Resources Division
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Approved By: [signature]

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1 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species or its designated critical habitat, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the United States Fish and Wildlife Service (FWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species or their designated critical habitat, and NMFS or the FWS concur with that conclusion (50 CFR 402.14(b)(1)).

Section 7(a)(4) of the ESA requires that each Federal agency confer with NMFS on any agency action that is likely to jeopardize the continued existence of any proposed species, or likely to result in the destruction or adverse modification of proposed critical habitat as per 50 CFR §402.10(d). NMFS may request to conference if, after a review of available information, it determines that a conference is required for a particular action (50 CFR §402.10(b)). If requested by the Federal agency and deemed appropriate by NMFS, the conference may be conducted in accordance with the same procedures as a formal consultation (50 CFR §402.10(d)). A conference opinion may be adopted as a biological opinion when the species is listed or critical habitat is designated.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, in accordance with the ESA Subsection 7(b)(3)(A), NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures. NMFS, by regulation has determined that an ITS must be prepared when take is "reasonably certain to occur" as a result of the Proposed Action. 50 C.F.R. 402.14(g)(7). An ITS provided with a conference opinion does not become effective unless NMFS adopts the conference opinion once the listing is final or proposed critical habitat is designated as final.

For the actions described in this document, the Action Agency is NMFS' Office of Habitat Conservation (OHC). NMFS OHC proposes to fund, via a National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) grant, activities associated with a coral gamete collection and restoration research project in Saipan, Commonwealth of Northern Mariana Islands (CNMI). The consulting agency for this Proposed Action is the NMFS Pacific Islands Regional Office (PIRO) Protected Resources Division (PRD). This document represents NMFS PIRO PRD biological opinion and conference on the effects of the Proposed Action on endangered and threatened species and critical habitat that is proposed to be designated for those species. This biological and conference opinion has been prepared in accordance with the requirements of section 7 of the ESA, the implementing regulations (50 CFR 402), agency policy, and guidance and considers and is based on information contained in NMFS OHC's biological evaluation, NMFS and FWS recovery plans and status reviews for the species under consideration and other sources of information as cited herein.

Updates to the regulations governing interagency consultations (50 CFR part 402) became effective on October 28, 2019 [84 FR 44976]. This consultation was completed under the new regulations, which were designed to improve clarity and consistency, streamline consultations, and codify existing practice. As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice."

2 CONSULTATION HISTORY

The proposed federal action addressed by this biological and conference opinion is NMFS OHC funding, via a CRCP grant a coral gamete collection and restoration research project in Saipan, CNMI, to include activities such as coral fragment and gamete collection, coral larval rearing, coral juvenile out-planting, and testing of coral settlement materials.

On August 3, 2020, NMFS OHC submitted to NMFS PIRO PRD, via e-mail, a biological evaluation (NMFS 2020a) analyzing the effects of the proposed project titled "Sowing the seeds of success: testing novel approaches to improve the efficiency of coral reef restoration using sexually propagated corals (Ruth Gates grant application)", on the following species listed as endangered or threatened: *Acropora globiceps, Acropora retusa,* and *Seriatopora aculeata* corals, and Central West Pacific green and Hawksbill sea turtles. NMFS OHC also submitted a copy of a project narrative and data management plan for the project (JAMS 2020).

On September 1, 2020, NMFS PIRO PRD requested clarification via e-mail from NMFS OHC on the nature of the consultation request as the NMFS OHC August 3, 2020 submission did not clarify that it was a written request to initiate formal consultation as per the requirement identified in 50 CFR 402.14(c)(1). NMFS OHC responded on the same day confirming that their request was to initiate formal consultation for their determination that their action is likely to adversely affect ESA listed *A. globiceps* coral.

On September 4, 2020, NMFS PIRO PRD followed up to request additional information from NMFS OHC via e-mail as the information provided in the August 3, 2020 submission did not meet the initiation criteria as outlined in 50 CFR 402.14(c)(1). NMFS PIRO PRD considered that the description of the proposed action, specifically the location of the action to include all related activities (402.14(c)(1)(i)(C)); the specific components of the action and how they would be carried out (402.14(c)(1)(i)(D)); and a description of the effects of the action on *A. globiceps* and other affected species determinations (402.14(c)(1)(iv)), were incomplete. NMFS PIRO PRD specifically requested clarification on where vessel transit would occur; whether fragments would need to be taken from *A. globiceps* parent colonies prior to gamete collection; whether gametes would be collected from *A. globiceps* colonies occurring on natural reefs, or only from *A. globiceps* fragments currently being cultivated in an existing coral nursery; and some specifics for vessel and land-based activities associated with the project.

On September 17, 2020, NMFS OHC provided NMFS PIRO PRD the requested additional information via email. NMFS PIRO PRD initiated the formal consultation on the same day.

On December 4, 2020, NMFS PIRO PRD asked NMFS OHC, via e-mail, to consider conferencing on the effects of the proposed action on the November 27, 2020, proposal to designate critical habitat for the 7 listed Indo-Pacific corals (85 FR 76262), of which critical habitat was proposed in the *Action Area* for the 3 listed coral species found in the CNMI: *A. globiceps*, *Acropora retusa (A. retusa)* and *Seriatopora aculeata (S. aculeata*). On December 9, 2020 NMFS OHC requested to conference on the effects to the proposed coral critical habitat in the *Action Area* for the listed corals including *A. globiceps*.

3 DESCRIPTION OF THE PROPOSED ACTION

NMFS OHC (Action Agency) proposes to fund, via the NOAA CRCP Ruth Gates Restoration Innovation Grants Program, Johnston Applied Marine Sciences (JAMS) to undertake a coral gamete collection and restoration research project in Saipan, CNMI, titled "*Sowing the seeds of success: testing novel approaches to improve the efficiency of coral reef restoration using sexually propagated corals*." The coral restoration research project will include activities such as coral fragment and gamete collection, coral larval rearing, coral juvenile out-planting, and testing of coral settlement materials.

The purpose of the Proposed Action is to enable the funding awardee, JAMS, through collaboration with various partners, to develop active intervention strategies in the CNMI to maintain coral populations and increase ecosystem resilience. The described objectives of the coral restoration project are to: 1) develop and test novel settlement substrates designed to improve the efficiency of outplanting, or seeding, of sexually propagated juveniles at scale; 2) build local capacity in the CNMI to implement coral sexual propagation methods as part of a broader restoration strategy; and 3) test an existing island-wide resilience assessment as a framework for increasing larval outplant survivorship.

The coral restoration project is expected to last three years and was slated to begin on November 1, 2020 with the coordination and planning with partners (in-water work is expected to occur only after this consultation has been completed). The project involves collection of coral gametes (eggs and sperm) from parent coral colonies of various coral species (ESA listed and non-listed) from reefs across Saipan; placing then holding these gametes in small land-based seawater settlement tanks and/or larger ocean-based pool(s) in Saipan Lagoon to promote fertilization and development of planktonic larvae called planulae (fertilized larvae) on two different types of settlement substrates/units; and outplanting these settlement units supporting settled juvenile corals on test reefs around Saipan. Table 1 provides a schedule of the planned project activities during the 3-year project.

Table 1. Schedule of the project activities during the 3-year project.

Project Milestones/Activities	Year 1	Year 2	Year 3
Conduct initial spawning observation dives	✓		
Collect coral gametes	✓	✓	✓
Set up small scale land-based seawater system for larval culturing and settlement	✓		
Set up ocean pool(s) for large scale larval culturing and settlement		✓	✓
Culture coral larvae and outplant settlement units	✓	✓	✓

The project involves three main types of activities that have the potential to impact ESA-listed resources: 1) coral fragment and gamete collection from coral colonies located at reefs around Saipan; 2) deployment of settling pools in Saipan Lagoon; and 3) outplanting of settlement units at various reef test sites. These activities are described in more detail in the following sections.

3.1 Coral Fragment and Gamete Collection

Coral gametes (eggs and sperms) will be collected from parent coral colonies of various coral species, including one ESA listed coral species *A. globiceps*. The final coral species list has yet to be determined but will include a subset of the following species: staghorn *Acropora* spp. (e.g. *Acropora pulchra, A. aspera, A. muricata*), *A. globiceps*, *A. tenuis, A. surculosa, and A. abrotanoides, Leptoria phrygia and Goniastrea spp*. To capture as much of the local genetic diversity as possible, coral gametes will be collected from parent colonies from several sites around Saipan representing both lagoon and forereef species. Final sites will be selected based on ease of access, species composition (at least several large colonies of target species), and prior spawning observations.

Coral gamete collections will be conducted each summer of the 3-year project and may involve different species each year depending on spawning windows and collection locations (see Table 1). Approximately three (possibly four) coral species will be targeted each season, and will include *A. globiceps*. Gametes from *A. globiceps* will be collected from "wild" colonies, i.e. those located on natural reefs, and from *A. globiceps* fragments previously harvested and cultured as part of the existing Saipan Coral Nursery Pilot Project (coral nursery) in Saipan Lagoon (see NMFS 2019 biological opinion for this action; NMFS 2019).

For branching corals, including *A. globiceps*, collection sites will be visited approximately two weeks prior to the expected coral spawning dates to determine if the colonies are gravid and will release gametes. To determine if colonies are gravid, small branches/fragments less than 4 centimeters in size will be broken off from individual colonies. This practice of determining if corals are gravid greatly enhances the chances of successfully collecting gametes given limited project resources such as divers and boats. It is estimated that up to 60 small (< 4 centimeters) fragments will be taken from wild *A. globiceps* colonies over the course of the 3-year project. All fragments will be added to the coral nursery after checking for mature gametes.

Once it has been determined which parent colonies are gravid, gametes will be collected from these colonies using standard 'tent' collectors (e.g. see Edwards, 2010). Collection tents are made of fine mesh screen with leaded line secured around the base to weight the bottom of the tent down to substrate. The top of the tent collectors have a funnel and a collection jar to contain the positively buoyant gametes as they float up. These types of collection tents are stated to have been used extensively in the Caribbean on ESA listed corals with no negative impacts (NMFS 2020a). Different size tents will be used for different coral species and morphologies. The tents used for *A. globiceps* will be approximately 0.5 meter diameter at the base, large enough that they completely surround the colony with little-to-no contact at the base, and approximately 0.5 meters - 1 meter high. The tents will be temporarily (a few hours) placed over coral colonies and monitored by divers at all times to prevent excess movement or abrasion of the colonies. It is estimated that gamete collection from approximately 10 wild *A. globiceps* colonies will be targeted each year, in addition to targeting colonies growing in the nursery[1] (NMFS 2020a).

The total volume of gametes that will be collected will vary by colony, but the approach collects only a fraction of the gametes produced from any given colony, allowing a large portion of gametes to also enter the water column. The total volume of *A. globiceps* gametes that will be collected as part of this project across all sites and from approximately 10 *A. globiceps* colonies per year is estimated to be approximately 1 liter (NMFS 2020a).

3.2 Deployment of Settling Pools

Collected coral gametes will be placed and held in small land-based seawater settlement tanks and/or larger ocean-based settling pools to promote fertilization of gametes and the development and settlement of planulae on two types of settlement substrates/units. In the first year of the project, all of the collected gametes and larval culturing through to settlement will take place in land-based tanks. In year 2 and year 3, gametes may be kept in land-based tanks overnight to increase fertilization rates, then deployed to ocean-based settling pools.

The land-based tanks will be temporary, modular seawater systems with either recirculating or stagnant water. They will be set up at existing JAMS or CNMI operated facilities and will not require any new construction. The larger ocean-based settling pools will involve construction and deployment of two floating mesocosm pools, also referred to as Coral Rearing In-Situ Basins (CRIBs), at the existing coral nursery in Saipan Lagoon (Figure 1a). The size of the pools are anticipated to be 2.4 meter long x 3.7 meter wide x 1.8 meter deep, and will be deployed for approximately three months each summer of project year 2 and year 3.

[1] The anticipated "take" of *A. globiceps* under current permits for the nursery is 300 colonies: to date, fragments of 11 parent colonies have been collected. Effects to fragments previously collected and present in the coral nursery are not analyzed in this biological and conference opinion as they are covered by a previous NMFS biological opinion (NMFS 2019).

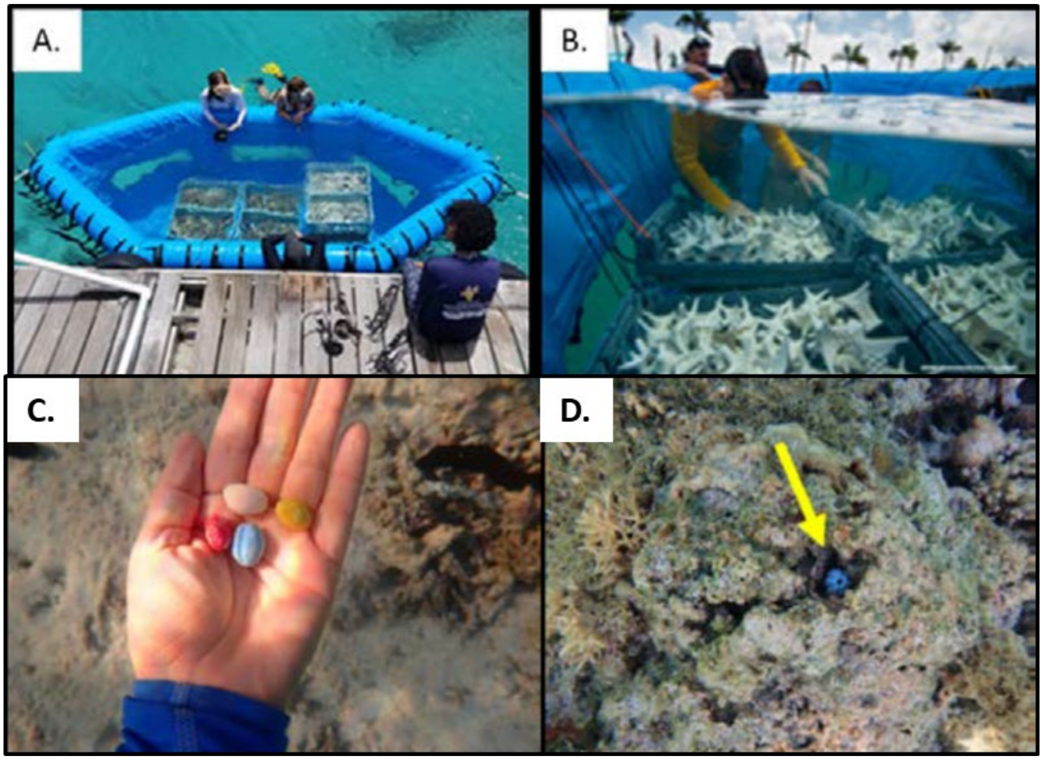

Figure 1 (a) Example of deployed settlement pool; (b) example of tetrapod settlement units; (c) example of bead settlement units; and (d) example of beads outplanted on a reef.

The pools will be anchored in sandy habitat using either concrete blocks or the helix style sand anchors that are already in use at the coral nursery. The helix anchors can easily be installed and removed within minutes, have a very small footprint with strong holding power, and do not cause any damage to the sand habitat. The pool and anchors will only be deployed over bare sand habitat to avoid shading or other damage to sensitive habitats and species. It is anticipated that only one central anchor per pool will be needed (for up to two pools). No drilling or hammering is anticipated to be necessary during anchoring.

Signage will be placed on the pools to educate and deter unwanted human interactions. In the event of a major storm, JAMS will bring the pools to either nearby Mañagaha Island or Saipan and secure them on land. If planktonic larvae are in the pool at the time, the larvae (as many as possible) will be attempted to be collected and moved to temporary shore-based holding tanks/aquaria. If the larvae have already settled, the substrates will either be brought to shore and held in temporary tanks or be transferred to closed baskets and secured on the sand substrate at the nursery location using concrete blocks and/or helix anchors. A final storm plan building off of the draft language provided in the *Storm Mitigation Plan* section below will be developed in collaboration with local management partners prior to commencing spawning operations.

3.3 Outplanting of Settlement Units

Two types of settlement units will be placed in the holding tanks/pools for the coral planula to settle on: 8 centimeter - 10 centimeter sized self-stabilizing SECORE tetrapods (tetrapods) that are a traditional design; and 1 centimeter – 1.5 centimeters larval seed beads (beads) that are a novel design (Figure 1b and 1c). The material to be used has yet to be determined, but will consist only of the most trusted and safe products available on the market that do not leach toxins into the marine environment. Once larvae have settled onto tetrapods and beads within tanks, the settlement units will be placed in secure bins and baskets on cinder blocks on the sand at the coral nursery to give the new corals time to grow. They will thereafter be outplanted at selected reefs around Saipan to test settlement unit stability and coral settlement and growth success of both designs within the CNMI. Settlement units will not be retreived at the end of the experiment as they are expected to become incorporated into the reef framework. In total, approximately 5,150 tetrapods and approximately 75,000 beads will be deployed during the 3-year project duration as per the schedule and distribution plan outlined in Table 2.

Table 2. Schedule and distribution plan for the two types of settlement units during the 3-year project.

	Tetrapods	**Beads**
Year 1 (pre-gamete collection)	N/A	50 beads, in 10 replicate 1-m radius circular plots, across 4 reef sites
Year 1 (post-gamete collection)	5 units/m^2, in 10 replicate 1-m radius circular plots, at 1 reef site	50 units/m^2, in 10 replicate 1-m radius circular plots, at 1 reef site
Year 2	5 units/m^2, in 60 replicate 1-m radius plots, across 4 reef sites 4 units/m^2, in 2 replicate 20 m x10 m reef sites	50 units/m^2, in 60 replicate 1-m radius plots, across 4 reef sites 50 units/m^2, in 2 replicate 20 m x 10 m reef sites
Year 3	1 unit/m^2, in a 1 acre area (~4000 m^2), at 1 reef site	40 units/m^2, in a 1 acre area (~4000 m^2), at 1 reef site

In year 1, prior to the spawning season, beads without larvae will be distributed to assess reef retention. Fifty beads will be distributed over 1-meter radius circular reef plots and tracked through time. Ten replicate plots will be established at a minimum of four reef sites (two lagoonal and two forereef) representing different structural complexities. In five of the plots at each site, the beads will be dispersed evenly across the plot by dropping them on the reef from ~ 50 centimeter above the substrate. For the other three plots, beads will be actively placed into holes and grooves on the reef (see Figure 1d). The time it takes to complete the dispersal using both methods will be recorded.

The distribution of beads within plots will be mapped the day of dispersal and weekly thereafter for at least four weeks. The beads will be mapped and tracked using high-resolution photomosaics and 3D models generated using photogrammetry. The 3D models will also be used to quantify structural complexity for each plot. The proportion of beads that remain stable in the reef framework will be assessed in relation to reef rugosity, benthic cover, and other environmental characteristics. Test beads may be colored using non-toxic pigment or paint to increase visual detection and image analysis, if necessary. A small informative sign will be deployed near each plot as a precaution so that recreational divers do not inadvertently remove the beads thinking they are trash or debris. Should pigmented beads be used, the pigment should only be highly visible for a couple of weeks until the beads are colonized with crustose coralline algae and other organisms. Natural colored ceramic beads will be used for all larval settlement.

In year 1, post-spawning season and gamete collection, and after larval settlement has occurred on the two different types of settlement units within the ocean-based settling pools, the settlement units will be distributed to compare the performance of the more traditional tetrapods to the novel beads. Tetrapods and beads will be distributed at a density of 5 per square meter and 50 per square meter respectively, across 20 paired 1-m radius circular plots (10 plots per unit type) at one reef site. The year 1 total distribution across all plots is 157 tetrapods and 7,850 beads.

In year 2, tetrapods and beads with settled larvae will be spread at the same concentration as in year 1, across another 60 replicate 1-m radius plots each across four reef sites as part of the resilience output survivorship tests. In addition, two larger 20 meter x 10 meter sized demonstration plots will be set up with tetrapods distributed at a density of 4 per square meter for a total of 1,600 units, and beads distributed at a density of 50 per square meter for a total of 20,000 units. The year 2 total distribution across all plots is 2,542 tetrapods and 29,420 beads.

In year 3, tetrapods and beads and will be deployed in slightly lower densities across two larger 1-acre (~ 4000 square meters) sized demonstration plots. If the beads have performed well in previous tests it is possible that the tetrapods would not be used at this stage of the study. However, assuming both settlement units are used the maximum amount to be deployed would be 4,000 tetrapods, and 160,000 beads across the two large plots.

Plots will not be reused at any point during this project to help minimize the risk of cumulative impacts. The density, shape, size and ceramic material used to create the tetrapods and beads closely match pebbles, broken coral fragments, and other loose benthic materials found naturally on reefs. A study of retention and movement (Chamberland et al. 2017) showed that 50% of traditional tetrapods did not move at all over the first six months post-deployment. After one year, 76% of tetrapods could be recovered within 3 meters of their original deployment location and 86% of those were firmly attached to the reef. On average, tetrapods dispersed approximately 32 centimeters over 6 months and dispersal declined as structural complexity increased.

3.4 Vessel Transit, Diver Activities and Monitoring

Coral fragment and coral gamete collection, settling pool deployment, larval culturing, settlement unit outplanting, and monitoring of plots will be conducted by trained local managers, students, and volunteers. The transport of coral, materials, equipment and divers amongst project sites will occur via locally available outboard boats typically 5 meters to 9 meters in length. Monitoring of outplant sites will be conducted either on snorkel or SCUBA, depending on depth. Permanent markers for monitoring will be installed at the outplant sites, one in the center of each radial plot. The markers will likely be stainless steel eyebolts with a small float attached. Eyebolts will only be installed in non-living hard substrates. There may be drilling or hammering associated with the installation of markers, which would be expected to be on the order of a couple of minutes per plot. During monitoring surveys, transect lines and scale markers (30 centimeters x 5 centimeters plastic and metal bars) will come into contact with the substrate.

Throughout these activities divers will ensure that no contact is made with sensitive living organisms, especially ESA listed species including corals.

3.5 Best Management Practices

The following BMPs will be implemented by the funding awardee and project partners during the execution of this project to minimize interactions with listed species:

1. Anchors, tools or equipment will not be placed on any organism unless contact with the organism is a necessary component of the project (e.g., installation of gamete collectors, collection of coral fragments, and outplanting activities). Divers will avoid contact with organisms wherever possible. Anchors and spuds will be placed in soft-sediment only. Where applicable, divers will check boat anchor deployment and shift anchors to ensure they are not a threat to corals or seagrass.
2. All vessels will operate at 'no wake/idle' speeds at all times while in water depths where the draft of the vessel provides less than a 2 meter (6 foot) clearance. All vessels will follow deep-water routes (e.g. marked channels) whenever possible. If operating in shallow water, all vessels will use a dedicated lookout to assist the pilot with avoiding large coral colonies.
3. Scientific instruments, markers, and signs, whether attached to the substrate or mounted to a cinderblock, will only be attached to sandy bottoms or non-living hard substrates. Attachments and tethers will be as short as possible to avoid potential entanglement hazards. They will be checked regularly and removed after data collection is completed.
4. Anchors will only be deployed in sandy substrate using hand tools, such as a drive rod or turning bar, to minimize bottom disturbance which requires no holes, no digging and no concrete.
5. Constant vigilance will be kept for the presence of ESA- or Marine Mammal Protection Act (MMPA)-listed marine species during all aspects of the project, particularly in-water activities such as boat operations, diving, and deployment of anchors and mooring lines.
6. The project manager will designate an appropriate number of trained and/or experienced observers to survey the areas adjacent to the Proposed Action for listed species before and during in-water project activities.
7. All work will be postponed or halted when a non-coral listed species is in the area of the proposed work, and will only begin/resume after the animals have voluntarily departed the area.
8. Before entering the water, all divers will be made aware of ESA-listed corals, and the requirement to avoid contact with those organisms while performing their duties, except as allowed as part of the Proposed Action (i.e. coral fragment and gamete collection). This will include taking measures to avoid kicking the reef with fins, and to secure dive and survey equipment in a manner that will prevent that equipment from being drug across the substrate.
9. Special attention will be given to verify that no listed animals are in the area where equipment or material is expected to contact the substrate before that equipment/material

may enter the water. This includes the requirement to limit anchoring to sandy areas well away from coral.

10. All objects will be lowered to the bottom (or installed) in a controlled manner. This can include the use of buoyancy controls such as lift bags, or the use of cranes, winches or other equipment that affect positive control over the rate of descent.
11. In-water tethers, as well as mooring lines for vessels and marker buoys will be kept to the minimum lengths necessary, and shall remain deployed only as long as needed to properly accomplish the required task.
12. When piloting vessels, vessel operators will alter course to remain at least 100 m from whales and at least 50 m from other marine mammals and sea turtles. Vessel operators shall reduce vessel speed to 10 knots or less when piloting vessels at or within the ranges described above from marine mammals and sea turtles. Operators shall be particularly vigilant to watch for turtles at or near the surface in areas of known or suspected turtle activity, and if practicable, reduce vessel speed to 5 knots or less.
13. If, despite efforts to maintain the distances and speeds described above, a marine mammal or turtle approaches the vessel, the engine will be put in neutral until the animal is at least 50 feet away and then the vessel will slowly move away to the prescribed distance.
14. Marine mammals and sea turtles will not be encircled or trapped between multiple vessels or between vessels and the shore.
15. No attempts to feed, touch, ride, or otherwise intentionally interact with any non-coral ESA-listed marine species will be made.
16. Coral fragments will be collected from no more than 60 *A. globiceps* colonies, and it will be ensured that the funding awardee, and any project managers/principle investigators responsible for implementing fragment collection activities associated with this project, irrespective of their employment arrangement or affiliation (e.g. employee, contractor, partner, volunteer etc.), are aware of, and adhere to this number.
17. Healing and survival of *A. globiceps* parent colonies from which fragments will be taken will be maximized through continued proper use of fragment collection techniques and methods, including ensuring that:
    a. The divers involved with taking fragments from parent colonies are properly trained for the task;
    b. The width of fragments/branches taken from parent colonies are minimized, to the greatest extent practicable, to limit lesion size on parent colonies;
    c. Fragments are taken from parent colonies in good condition (with healthy coloration and high tissue cover, without bleaching, without disease, without existing lesions, without boring sponges etc.), that are not subject to environmental stress above the baseline (e.g. sedimentation or thermal stress), and that fragments are no larger in size than approximately 10% of the parent colony (see Schopmeyer et al. 2017).

18. A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires or materials unintentionally entering the water column.
19. Appropriate materials to contain and clean potential spills will be stored at the work site and be readily available.
20. All project-related materials and equipment placed in the water will be free of pollutants.
21. Fueling of land-based vehicles and equipment will take place at least 50 feet away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
22. During in-water operations, divers will use minimal and/or less harmful (containing oxybenzone and other chemicals that may disrupt coral reproduction, cause coral bleaching, and damage coral DNA), sunscreen and will use clothing for sun protection wherever possible.
23. All dive equipment, materials and instruments will be examined and rinsed with fresh water prior to use or deployment to ensure no organisms are being introduced or transported between the collection areas.
24. All structures such as settling pools and anchor blocks will be removed when no longer in use.
25. Signs will be deployed on the settlement pools and at the demonstration plots to educate the public and minimize risk of entanglement, trampling or other damage to project materials.
26. The project team will monitor cumulative impacts at the collection sites, deployment sites and within the nursery itself.
27. All action-related take of *A. globiceps* corals, and any other ESA-listed species, will be recorded and reported to NMFS PIRO PRD as soon as practicable, but on no less than on an annual basis if take has occurred.

3.6 Storm Mitigation Plan

Located within "typhoon alley," tropical storms and typhoons frequently impact the CNMI and surrounding waters. While the location of the nursery within the Saipan lagoon provides some protection from wave energy, the funding awardee and project partners will take several precautions to minimize potential storm impacts to the structures, corals, surrounding habitat and ESA-listed species.

In the western Pacific, tropical cyclones can occur at any time during the year, but the vast majority of storms occur from July to November. Thus, a trip will be made in late spring to prepare the nursery for the upcoming typhoon season. During this trip all structures, hardware, and ropes will be checked thoroughly and repaired if necessary.

Often, the time to prepare for an imminent storm is less than 48 hours, making any major ocean-based operations difficult to organize and execute. During this pre-storm window, the sea state and safety conditions deteriorate rapidly. Thus, any actions planned to prepare the nursery in response to an active storm threat need to be able to be conducted quickly, safely, and on short notice. The CNMI uses an alert system that ranges from a Condition Level 4, which is the lowest alert level and indicates a possible threat of destructive winds within 72 hours, to a Condition Level 1, which indicates that destructive winds are expected within 12 hours. The project's storm response plan will be triggered by a Condition Level 3 (destructive winds are possible within 48 hours) when the storm is forecast to be a Category 1 or stronger typhoon (> 74 mph maximum sustained winds) when it passes over or near Saipan.

When these conditions are met, JAMS will bring the pools to either Mañagaha Island or Saipan and secure them on land. If planktonic larvae are in the pool at the time, project partners will attempt to collect as many of the larvae as possible and move them to temporary shore-based holding tanks/aquaria. If the larvae had already settled, the substrates will either be brought to shore and held in temporary tanks or be transferred to closed baskets and secured on the sand substrate at the nursery location using concrete blocks and/or helix anchors. As the nursery is located within the protected lagoon, only about 2 kilometers from the nearest marina, project partners believe this plan can be implemented quickly and safely.

Once the storm has passed, divers will visit the nursery as soon as it is feasible to do so safely. On this initial post-storm visit, the boat will be stocked with all of the supplies needed to make basic repairs to the nursery. Divers will check all structures for damages and make any necessary repairs and reattach or stabilize any loose materials. In the case of major damages where the structures are damaged beyond repair but still present at the site, project partners will remove and/or secure structures and corals as necessary until further repairs can be made. In the case that the structures or pieces of the structures come loose from their anchors and auxiliary lines, project partners will make every effort to find and retrieve them. Should the structures cause damage to wild corals or coral reef habitat, project partners will document all damages with photos and collect data on the number and species of corals and area of habitat impacted. Corals fragmented or dislodged by structures from the nursery site will either be brought to the nursery or reattached to the substrate at the impacted site. The damaged site will also be prioritized for future outplanting and restoration, pending discussions and approval by local managers and stakeholders.

4 APPROACH TO THE ASSESSMENT

4.1 Overview of NMFS Assessment Framework

Biological opinions address two central questions: (1) has a Federal agency insured that an action it proposes to authorize, fund, or carry out is not likely to jeopardize the continued existence of endangered or threatened species; and (2) has a Federal agency insured that an action it proposes to authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat that has been designated for such species. Every section of a biological opinion from its opening page and its conclusion and all of the information, evidence, reasoning, and analyses presented in between is designed to help answer these two questions. What follows summarizes how NMFS' generally answers these two questions; that is followed by a description of how this biological opinion will apply this general approach to the Proposed Action.

Before we introduce the assessment methodology, we want to define the word "effect." An *effect* is a *change or departure* from a *prior state or condition* of a *system caused* by an *action or* *exposure* (see Figure 2). An "effect" is defined by the ESA regulations to include a "consequence to listed species or critical habitat that is caused by the proposed action," and may include "the consequences of other activities that are caused by the proposed action." 50 CFR 402.02. A consequence is "caused by the proposed action" if "it would not occur but for the proposed action and it is reasonably certain to occur." 50 CFR 402.02; 402.17. A conclusion of "reasonably certain to occur" must be based on "clear and substantial information, using the best scientific and commercial data available." 50 CFR 402.17. This definition of "effect" is neutral: it applies to activities that benefit endangered and threatened species as well as to activities that harm them. Whether the effect is positive (beneficial) or negative (adverse), an "effect" represents a change or departure from a prior condition (**a** in Figure 2); in consultations, the prior global condition of species and designated critical habitat is summarized in the *Status of the Species* narratives while their prior condition in a particular geographic area (the *Action Area*) is summarized in the *Environmental Baseline* section of this opinion. Extending this baseline condition over time to form a *future without the project* condition (line **b** in Figure 2); this is alternatively called a counterfactual because it describes the world as it might exist if a particular action did not occur. Although consultations do not address it explicitly, the future without project is implicit in almost every effects analysis.

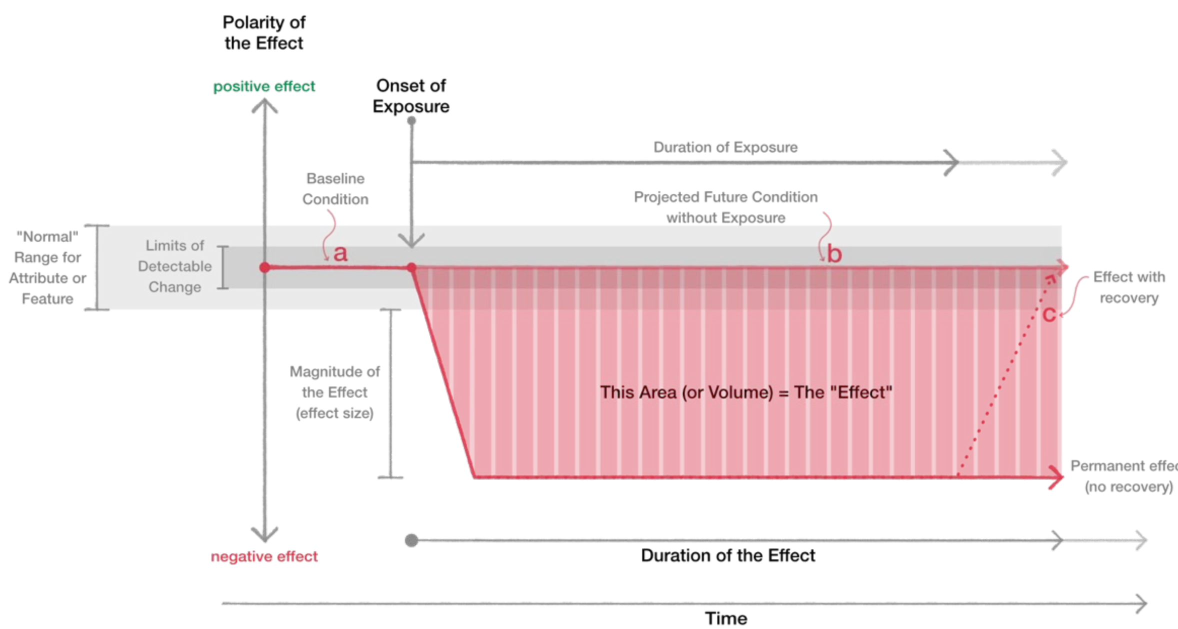

Figure 2. A schematic of the various elements encompassed by the word "effect." The vertical bars in the figure depict a series of annual "effects" (negative changes from a pre-existing or "baseline" condition) that are summed over time to estimate the action's full effect. See text for a more complete explanation of this figure.

As Figure 2 illustrates, effects have several attributes: *polarity* (positive, negative, or both), *magnitude* (how much a Proposed Action causes individuals, populations, species, and habitat to depart from their prior state or condition) and *duration* (how long any departure persists). The last of these attributes—*duration*—implies the possibility of recovery which has the additional attributes *recovery rate* (how quickly recovery occurs over time; the slope of line **c** in Figure 2) and *degree of recovery* (complete or partial). For instance, the recovery rate allows us to estimate how long it would take for a coral reef and associated benthic communities to recover.

As described in the following narratives, biological opinions apply this concept of effects to endangered and threatened species and designated critical habitat. Jeopardy analyses are designed to identify probable departures from the prior state or condition of individual members of listed species, populations of those individuals, and the species themselves. Destruction or adverse modification analyses are designed to identify departures in the area, quantity, quality, and availability of the physical and biological features that represent habitat for these species.

4.1.1 Jeopardy Analyses

The section 7 regulations define "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, *to reduce appreciably* the *likelihood of both the survival and recovery* of a listed species in the wild by reducing the *reproduction, numbers, or distribution* of that species" (50 CFR 402.02, emphasis added). This definition requires our assessments to address four primary variables:

1. Reproduction
2. Numbers
3. Distribution
4. The probability that the Proposed Action will cause one or more of these variables to change in a way that represents an appreciable reduction in a species' likelihood of surviving and recovering in the wild.

Reproduction leads this list because it is "the most important determinant of population dynamics and growth" (Carey and Roach 2020). *Reproduction* encompasses the reproductive ecology of endangered and threatened species; specifically, the abundance of adults in their populations, the fertility or maternity of those adults, the number of live young adults produce over their reproductive lifespans, how they rear their young (if they do), and the influence of habitat on their reproductive success, among others. Reducing one or more of these components of a population's reproductive ecology can alter its dynamics so reproduction is a central consideration of jeopardy analyses.

The second of these variables—*numbers*—receives the most attention in the majority of risk assessments and that is true for jeopardy analyses as well. Numbers or abundance usually represent the total number of individuals that comprise the species, a population, or a sub-population; it can also refer to the number of breeding adults or the number of individuals that become adults. For species faced with extinction or endangerment several numbers matter: the number of populations that comprise the species, the number of individuals in those populations, the proportion of reproductively active adults in those populations, the proportion of sub-adults that can be expected to recruit into the adult population in any time interval, the proportion of younger individuals that can be expected to become sub-adults, the proportion of individuals in the different genders (where applicable) in the different populations, and the number of individuals that move between populations over time (immigration and emigration). Reducing these numbers or proportions can alter the dynamics of wild populations in ways that can reinforce their tendency to decline, their rate of decline, or both. Conversely, increasing these numbers or proportions can help reverse a wild population's tendency to decline or cause the population to increase in abundance.

The third of these variables—*distribution*— refers to the number and geographic arrangement of the populations that comprise a species. Jeopardy analyses must focus on populations because the fate of species is determined by the fate of the populations that comprise them: species become extinct with the death of the last individual of the last population. For that reason, jeopardy analyses focus on changes in the *number of populations*, which provides the strongest evidence of a species' extinction risks or its probability of recovery. Jeopardy analyses also focus on changes in the spatial *distribution of the populations* that comprise a species because such changes provide insight into how a species is responding to long-term changes in its environment (for example, to climate change). The spatial distribution of a species' populations also determines, among other things, whether the same natural and anthropogenic stressors and whether some populations occur in protected areas or are at least protected from stressors that afflict other populations affect all of a species' populations.

To assess whether reductions in a species' reproduction, numbers, or distribution that are caused by an action measurably reduce the species' likelihood of surviving and recovering in the wild, NMFS' first assesses the status of the endangered or threatened species that may be affected by an action. That is the primary purpose of the narratives in the *Status of Listed Resources* sections of biological opinions. Those sections of biological opinions also present descriptions of the number of populations that comprise the species and their geographic distribution. Then NMFS' assessments focus on the status of those populations in a particular *Action Area* based on how prior activities in the *Action Area* have affected them. The *Environmental Baseline* sections of biological opinions contain these analyses; the baseline condition of the populations and individuals in an *Action Area* determines their probable responses to future actions.

To assess the effects of actions considered in biological opinions, NMFS' consultations use an *exposure–response–risk* assessment framework. The assessments that result from this framework begin by identifying the physical, chemical, or biotic aspects of Proposed Actions that are known or are likely to have individual, interactive, or cumulative direct and indirect effects on the environment (we use the term "potential stressors" for these aspects of an action). As part of this step, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time. The area that results from this step of our analyses is the *Action Area* for a consultation.

After they identify the *Action Area* for a consultation, jeopardy analyses then identify the listed species and designated critical habitat (collectively, "listed resources"; critical habitat is discussed further below) that are likely to occur in that *Action Area*. If we conclude that one or more species is likely to occur in an *Action Area* when the action would occur, jeopardy analyses try to estimate the number of individuals that are likely to be exposed to stressors caused by the action: the intensity, duration, and frequency of any exposure (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 the individuals of listed species that 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 individuals are likely to respond given their exposure (these represent our *response analyses*). Our individual-level assessments conclude with an estimate of the probable consequences of these responses for the "fitness" of the individuals exposed to the action. Specifically, we estimate the probability that exposed individuals will experience changes in their growth, development, longevity, and the number of living young they produce over their lifetime. These estimates consider life history tradeoffs, which occur because individuals must allocate finite resources to growth, maintenance and surviving or producing offspring; energy that is diverted to recover from disease or injury is not available for reproduction.

If we conclude that an action can be expected to reduce the fitness of at least some individuals of threatened or endangered species, our jeopardy analyses then estimate the consequences of those changes on the viability of the population(s) those individuals represent. This step of our jeopardy analyses considers the abundance of the populations whose individuals are exposed to an action; their prior pattern of growth and decline over time in the face of other stressors; the proportion of individuals in different ages and stages; gender ratios; whether the populations are "open" or "closed" (how much they are influenced by immigration and emigration); and their ecology (for example, whether they mature early or late, whether they produce many young or a small number of them, etc.). Because the fate of species is determined by the fate of the populations that comprise them, this is a critical step in our jeopardy analyses.

The final step of our analyses assesses the probability of changes in the number of populations that comprise the species, the spatial distribution of those populations, and their expected patterns of growth and decline over time. In this step of our jeopardy analyses, we consider population-level changes based on our knowledge of the patterns that have led to the decline, collapse, or extinction of populations and species in the past as well as patterns that have led to their recovery from extinction. These patterns inform our jeopardy determinations.

4.1.2 Destruction or Adverse Modification Analysis

The section 7 regulations define "destruction or adverse modification" as "a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR 402.02). This definition focuses on how federal actions affect the quantity and quality of the physical or biological features in the designated critical habitat for a listed species and, especially in the case of unoccupied habitat, on any impacts to the critical habitat itself.

NMFS' assessments of the potential effects of actions on designated or proposed critical habitat specifically focus on alterations of the quantity or quality of the physical or biological features that comprise the habitat or alterations that preclude or significantly delay the capacity of habitat to develop those features over time. NMFS uses the same exposure–response–risk assessment framework for designated critical habitat that it uses for jeopardy analyses. To properly conduct this analysis the starting point must be the Status of Critical Habitat Rangewide if known, and the Baseline Condition of the Critical Habitat in the action area.

Status and Baseline of Critical Habitat – Some features of critical habitat can be variable over time based on season, weather, or cyclic changes. If the quantity, quality, or availability of the essential features of the area of designated critical habitat are stressed, diminished, or absent as a baseline condition, the exposure to effects of an action can have a much more significant response than if the features are plentiful and robust. The status and baseline help identify the ecology of the habitat at the time of exposure and what features are likely to be exposed.

Exposure -If designated critical habitat occurs in the action area for a consultation, we identify the physical or biological features of critical habitat that are likely to be exposed to an action's effects. We evaluate the timing, intensity, duration, and frequency of the likely exposure to the identified stressors.

Response - To determine how those features are likely to respond to that exposure, we again examine the scientific and commercial data available to determine whether and how those features are likely to respond.

In the next step of our assessment, we combine: 1) information about the contribution of essential features of critical habitat that give the designated area value for the conservation and recovery of listed species; with 2) the critical habitat's value to conservation of the listed species in the action area, given the physical, chemical, biotic, and ecological processes that produce and maintain those essential features in an action area; we then 3) evaluate the changes in these features due to the exposure and response, including the timing and duration of the changes and the amount of the feature/s so changed to determine the risk that these changes cause a reduction in conservation value.

Risk - NMFS' destruction or adverse modification analyses are based on whether any reductions in the value of designated critical habitat in an action area increases the risk that the proposed action is likely to be sufficient to adversely modify or destroy the critical habitat, meaning that its conservation value is appreciably reduced.

In the final step of our assessment, we combine information about the essential features of critical habitat that are likely to experience changes in quantity, quality, and availability given exposure to an action, with information on the physical, chemical, biotic, and ecological processes that produce and maintain those constituent elements in the action area. We use the conservation value of the entire designated critical habitat (as described in the *Status of the Species* and *Designated Critical Habitat* subsections of biological opinions) as our point of reference for this comparison, and evaluate the role of the features affected and the duration of the features affected are so influential on the ability of the habitat to sustain individuals or populations that the conservation value (recovery value) at designation scale is modified adversely or destroyed.

4.2 Application of this Approach in this Consultation

NMFS PIRO PRD has identified several potential stressors associated with the Proposed Action that may affect the environment. The environment is considered all areas to be affected directly or indirectly by the Proposed Action and not merely the immediate area involved in the action (50 CFR 402.02). The term *stressor* means any physical, chemical, or biological entity that can induce an adverse response. The stressors identified, and addressed in this consultation include:

- Direct physical impacts;
- Entanglement;
- Introduction of invasive species;

- Introduction of wastes and other pollutants;
- Vessel collisions;
- Noise;
- Increased turbidity; and
- Benthic disturbance and change in habitat.

Our section 7 consultation considers the number of endangered or threatened marine animals that might be exposed to each of these different stressors, the nature of those exposures, the animal's probable responses upon being exposed, and the risks those responses might pose to individual animals, the populations those individuals represent and the species those populations comprise. In total, 5 listed species occur, or have the potential to occur within the *Action Area* that may be affected by the Proposed Action identified for this consultation (Table 3).

4.2.1 Action Area

The *Action Area* means all areas to be affected directly or indirectly by the Proposed Action, in which the effects of the action can be meaningfully detected, measured, and evaluated (50 CFR 402.02). The *Action Area* for this project is the entire sea floor and water column from the shoreline out to approximately 0.8 kilometers seaward of the reef slope around the island of Saipan (Figure 3 inset map). The *Action Area* boundary is defined not only by the locations where project activities will occur (such as the existing coral nursery site within the no-take marine preserve Mañagaha Marine Conservation Area in Saipan Lagoon; the various collection and outplanting reef sites around Saipan; and the vessel corridors/routes between the harbor and projects sites), but also the geographic extent of the effects of the stressors as listed above (e.g. areas affected by noise, areas affected by discharge of waste and other pollutants from vessels). This *Action Area* includes various habitats such as unconsolidated soft sediment, small fringing reefs, backreefs, patch reefs, staghorn thickets, coral bommies, seagrass meadows, nearshore fore reefs/reef slopes, and the overlaying water column.

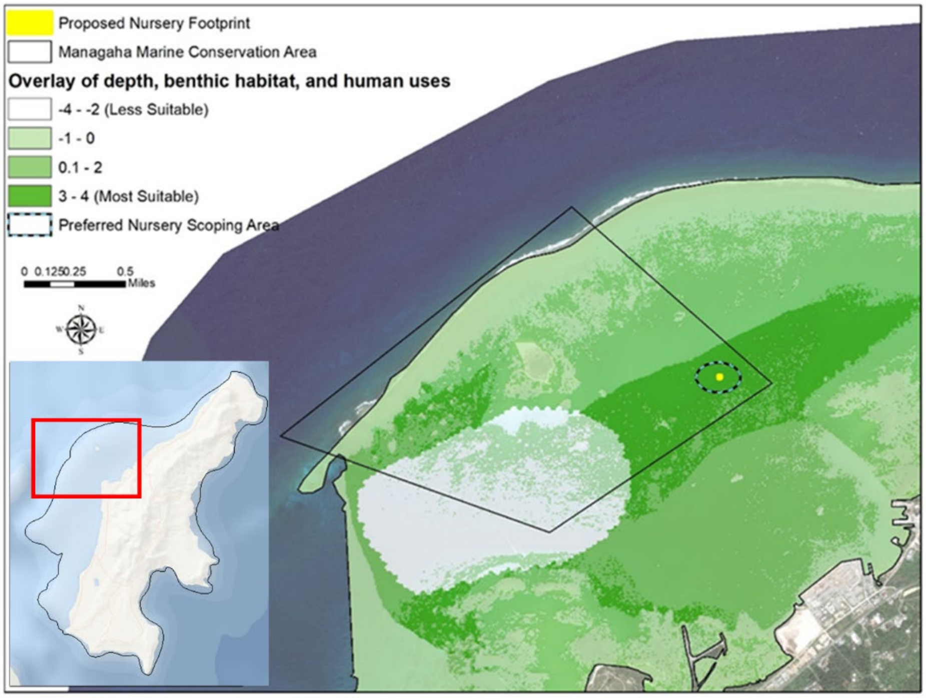

Figure 3. Proposed location for the settling pools at the Saipan Coral Nursery Pilot Project (SCNPP) in Saipan Lagoon. "Suitable" habitat in the legend consists of habitat that is a combination of the habitat that is deepest, least exposed to human use, and has the most area of unconsolidated sediment. The inset shows Saipan Island; the Action Area is the area within a boundary (black line) approximately 0.8 km seaward of the reef slope around the island.

4.2.2 Approach to Evaluating Effects

After identifying the *Action Area* for this consultation, we identified those activities and associated stressors that are likely to co-occur with: (a) individuals of endangered or threatened species or areas designated or proposed as critical habitat for threatened or endangered species; (b) species that are food for endangered or threatened species; or (c) species that prey on or compete with endangered or threatened species. The latter step represents our exposure analyses, which are designed to identify:

- the exposure pathway (the course the stressor takes from the source to the listed resource or its prey);
- the exposed listed resource (what life history forms or stages of listed species are exposed; the number of individuals that are exposed; which populations the individuals represent); and
- the timing, duration, frequency, and severity of exposure.

We categorized species by taxonomic groups (sea turtles, corals etc.), and reviewed whether there were any unique characteristics to their potential exposure. We then evaluated the likelihood that each species would be exposed to the stressors described above. We also evaluated the likelihood that proposed critical habitat and its essential features would be exposed to the stressors. For the listed species and critical habitat where we concluded that that there is a low likelihood of exposure or that the potential for an adverse response is unlikely to result in adverse effects, we do not include them further in our exposure or response analyses. The basis for these determinations is presented in Appendix A. As a result, we focused our attention on the primary threat, and characterizing the effects of those interactions on listed resources.

For the purpose of analyzing impacts to listed corals, we define the "individual" as the physiological colony, whether sexually or asexually produced as outlined in the Individual Delineation section of the final coral listing rule 79 FR 53852. This is based on most Indo-Pacific reef-building corals, including the listed species, being both modular and colonial organisms: A larva will settle and develop into a single unit (the primary polyp), which then produces genetically-identical units (secondary polyps) of itself. Such colonial organisms are "modular", in that they consist of identical modules, in this case polyps. The primary and secondary polyps are connected seamlessly through both tissue and skeleton into a colony. Colony growth is achieved mainly through the addition of more polyps, and both the total number of polyps in a colony and colony growth, are indeterminate. Likewise, the colony structure is not strictly defined, providing plasticity in colony shape. The colony can continue to exist even if numerous polyps die, the colony is broken apart, or otherwise damaged. Colonies are also founded by asexually-produced fragments of pre-existing colonies that break off to form a new colony. Colonies that are broken apart, i.e. fragments which are clones, can fuse back together (NMFS 2020b).

When a fragment is removed from a parent colony, it could be considered that there are two individuals. However, for the purpose of this consultation, we consider that any fragments that will be placed in the nursery and subject to human handling are unlikely to contribute measurably to the wild population and the species as a whole. We therefore focus our analysis on the effects of the action to the wild population, in this case the parent colonies that have fragments broken off from them.

We do not include larvae in our definition of the individual for listed corals species (see Individual Delineation section of the final rule, p. 53876). The reproductive biology of coral species results in prolific larval production and high natural mortality (Goreau et al. 1981). In addition, in the 2011 status review and 2014 final rule, threats to all reef-building corals globally are identified and rated from High to Negligible; of the 19 threats identified in the status review, and the top nine of those analyzed in the final rule, none include mortality of larvae by physical contact, such as cavitation or explosives, or acoustic effects.

In evaluating what constitutes an adverse effect to listed corals, we do not hold the same assumption for individuals of listed invertebrate corals as for individuals of listed vertebrate species, which is that physical contact of equipment or humans with an individual constitutes an adverse effect due to high potential for harm or harassment. This is because: (1) all corals are simple, sessile invertebrate animals that rely on their stinging nematocysts for defense, rather than predator avoidance via flight response; and, (2) colony growth is achieved mainly through the addition of more polyps, and colony growth is indeterminate. For corals, contact of colonies by equipment or humans may not be sufficient to reduce the performance of an individual colony, unless the contact does damage or destroys more than a minor proportion of the colony's polyps (NMFS 2020b). This is because the colony has the capacity to repair at least minor areas of damaged or destroyed polyps without reducing the performance of the individual colony (Jayewardene 2010), as long as the colony is not stressed for other reasons, such as high seawater temperatures or coral disease. Thus the effects of an action that includes some contact of equipment or humans with colonies of listed corals may not rise to the level of adverse effects.

Once we identify the individuals of listed species that are likely to be exposed to an action's effects and the nature of that exposure, we examine the best available data to determine whether and how those individuals are likely to respond given their exposure. We thereafter determine whether the Proposed Action directly or indirectly reduces appreciably the likelihood of both the survival and recovery of a listed species in the wild by evaluating whether the main threats reduce the reproduction, numbers, or distribution of the species to each colony as individuals within a local population, within a regional, and global population.

4.2.3 Climate Change

Climate is determined by the long-term pattern of oceanic and atmospheric conditions at a location. Climate is described by statistics, such as means and extremes of temperature, precipitation, and other variables, and by the intensity, frequency, and duration of weather events. Currently, our planet's global surface temperature is rising. This change is correlated with human activities that increase the amount of greenhouse gases (carbon dioxide, methane, nitrous oxide, and others, of which carbon dioxide makes up approximately 80% of the total) in the atmosphere (NOAA 2020). Since the beginning of the industrial era (starting in the mid-19th century) the release of carbon dioxide (CO_2) from industrial and agricultural activities has resulted in atmospheric CO_2 concentrations that have increased from approximately 280 ppm in 1850 to 410 ppm in 2018. The resulting warming of the earth has been unequivocal, and each of the last three decades has been successively warmer than any preceding decade since 1850 (IPCC 2013; IPCC 2018). According to the Intergovernmental Panel on Climate Change (IPCC), the global mean surface temperature has increased by nearly 1° Celsius since 1850, and is currently increasing at 0.2° Celsius per decade due to past and ongoing greenhouse gas emissions (IPCC 2013).

Marine stressors induced by climate change include elevated water temperatures (hereafter referred to as ocean warming); altered oceanic chemistry (herein referred to as ocean acidification); and rising sea level. In addition to these stressors, other global changes include higher than normal king tides and increases in storm intensities. These stressors are affecting marine ecosystems across the globe, and are contributing to a degradation in the health of coral reef ecosystems (Carpenter et al. 2008; Birkeland 2019; Smith 2019). As a global phenomenon, impacts are also occurring in Saipan and in the *Action Area* (NMFS 2020a).

Future climate will depend on warming caused by past anthropogenic emissions, future anthropogenic emissions and natural climate variability. As atmospheric greenhouse gas concentrations increase, less of the sun's heat can be radiated back into space, causing the earth to absorb more heat. The increased heat forces changes on the earth's climate system, and thus is referred to as "radiative forcing." The IPCC developed four Representative Concentration Pathways (RCPs) to reflect potential increases in radiative forcing of 2.6 Watts per square meter, 4.5 Watts per square meter, 6.0 Watts per square meter, and 8.5 Watts per square meter of the earth's surface. These result from atmospheric CO_2 concentrations of 421 (RCP 2.6), 538 (RCP 4.5), 670 (RCP 6.0), and 936 ppm (RCP 8.5) in 2100. The four pathways were developed with the intent of providing different potential climate change projections to guide policy discussions.

Taken together, the four pathways project wide ranges of increases in global mean surface temperatures, ocean warming, ocean acidification, sea level rise, and other changes globally throughout the 21st century (IPCC 2013). NMFS' policy (NMFS 2016a) is to use climate indicator values projected under the IPCC's RCP 8.5 when data are available, or best available science that is as consistent as possible with RCP 8.5. The best available current information supports the NMFS policy that RCP 8.5 is the most representative pathway (IPCC 2013; IPCC 2018).

We address the effects of climate change in multiple sections of this assessment: *Status of Listed Resources*, *Environmental Baseline*, *Cumulative Effects* and *Integration and Synthesis of Effects*. We review existing studies and information on climate change and the local patterns of change to characterize the *Environmental Baseline* and *Action Area* changes to environmental conditions that would likely occur under RCP 8.5, and where available we use changing climatic parameters (magnitude, distribution, and rate of changes) information to inform our assessment. In our exposure analyses, we consider whether changes in climate related phenomena will alter the timing, location, or intensity of exposure to the action. In our response analyses we try to ask whether and to what degree a species' responses to anthropogenic stressors would change as they are forced to cope with higher background levels of stress cause by climate-related phenomena.

4.2.4 Evidence Available for this Consultation

We used the following procedure to ensure that this consultation complies with NMFS' requirement to consider and use the best scientific and commercial data available. We started with the data and other information contained in the NMFS OHC's 2020 *Biological Evaluation & Essential Fish Habitat Assessment – Sowing the seeds of success: testing novel approaches to improve the efficiency of coral reef restoration using sexually propagated corals (Ruth Gates grant application)* (NMFS 2020a), NMFS' proposed rule to designated critical habitat for seven Indo-Pacific corals (85 FR 76262), relevant Letter of Concurrences and biological opinions (e.g. NMFS 2019), available recovery plans for affected species, NMFS' final ruling to list 20 coral species as threatened under the ESA (79 FR 53851), status of corals reports, manuals, and taxonomic listings (Veron 2000; Veron 2014; Wallace 1999), coral resilience studies in Saipan (Maynard et al. 2012; Maynard et al 2015; Maynard et al 2018), and coral nursery restoration guides and documents (Johnson et al. 2011; Nedimyer 2011; RRN 2020).

We supplemented this information by conducting electronic searches of literature published in English or with English abstracts to cross search multiple databases for relevant scientific journals, open access resources, proceedings, and web sites. Particular databases we searched for this consultation included in the Science Direct, PubMed, Google Scholar, and Google. We recognize this is not an exhaustive list of all resources that were referenced. For our literature searches, we used paired combinations of the keywords: *Acropora*, gamete collection, coral lesions, lesion healing, coral tissue regeneration, regeneration rates, coral breakage, coral breakage survival, Saipan and coral, coral resilience, coral disease, climate change, greenhouse gas emissions, and many others to search these electronic databases.

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

When two sources of data and other information were comparable in terms of quality, we relied on the data source that would provide the benefit of the doubt to the species. That is, we relied on the data or other information that would minimize our chances of falsely concluding "no effect."

5 STATUS OF LISTED RESOURCES

The ESA-listed species and any designated or proposed critical habitat that potentially occur within the *Action Area* within the Mariana Islands that may be affected by the Proposed Action are provided in Table 3. NMFS PIRO PRD has determined that the Proposed Action is likely to adversely affect one of these ESA-listed species, the coral *A. globiceps*.

Table 3. ESA listed species and their designated or proposed critical habitat within the Mariana Islands that potentially occur within the *Action Area* that may be affected by the Proposed Action.

ESA Species	Listing Status	Listing Date and Federal Register Notice	Critical Habitat Date and Federal Register Notice (if applicable)	Effect Determination
MARINE INVERTEBRATES				
Acropora globiceps **Coral**	Threatened	09/10/2014 79 FR 53852	11/27/2020 85 FR 76262 Proposed	Likely to Adversely Affect Not Likely to Adversely Affect (NLAA) Proposed Critical Habitat
Acropora retusa **Coral**	Threatened	09/10/2014 79 FR 53851	11/27/2020 85 FR 76262 Proposed	NLAA NLAA Proposed Critical Habitat
Seriatopora aculeata **Coral**	Threatened	09/10/2014 79 FR 53851	11/27/2020 85 FR 76262 Proposed	NLAA NLAA Proposed Critical Habitat

ESA Species	Listing Status	Listing Date and Federal Register Notice	Critical Habitat Date and Federal Register Notice (if applicable)	Effect Determination
SEA TURTLES				
Chelonia mydas **Central West Pacific Green sea turtle**	Endangered	04/06/2016 81 FR 20057	N/A	NLAA
Eretmochelys imbricata **Hawksbill sea turtle**	Endangered	06/02/1970 35 FR 8491	09/02/1998 63 FR 46693 Not in action area	NLAA

5.1 Critical Habitat

The ESA defines critical habitat as "(i) the specific areas within the geographic area occupied by the species, at the time it is listed … on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed … upon a determination by the Secretary that such areas are essential for the conservation of the species" (16 USC §1532 [5][A]).

Critical habitat has not been designated within the *Action Area* for any of the species analyzed in this document (see Table 3). However, on November 27, 2020, NMFS announced a proposed rule in the Federal Register (85 FR 76262) to designate critical habitat for seven of the fifteen threatened Indo-Pacific corals*, A. globiceps, A. retusa, S. aculeata, Acropora jacquelineae, Acropora speciosa, Euphyllia paradivisa,* and *Isopora crateriformis*. Critical habitat is proposed for most of the geographic area occupied by these seven listed corals in US Pacific Islands waters and includes a total of 17 specific occupied units, or areas, containing physical features essential to the conservation of the coral species. The areas/units generally consist of individual islands or atolls and nearby shoals or banks. Seven of the units/areas occur in CNMI (Rota, Aguijan, Tinian, Saipan, Anatahan, Pagan, and Maug Islands). One of the units/areas in the CNMI, the Saipan and Garapan Bank, occurs throughout the *Action Area*.

The Saipan and Garapan Bank unit/area is described as all waters 0-40 meters depth around Saipan and Garapan Bank, except for the areas specified below. The proposed coral critical habitat consists of substrate and water column habitat characteristics essential for the reproduction, recruitment, growth, and maturation of the listed corals. Sites that support the normal function of all life stages of the corals are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column. Several attributes of these sites determine the quality of the area and influence the value of the associated feature to the conservation of the species:

(1) Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae;

(2) Reefscape (all the visible features of an area of reef) with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae;

(3) Marine water with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function; and

(4) Marine water with levels of anthropogenically-introduced (from humans) chemical contaminants that do not preclude or inhibit any demographic function.

Critical habitat does not include the following particular areas where they overlap with the 0-40 meter depth around Saipan and Garapan Bank:

(1) National security based exclusion of six Navy anchorage berths within the Saipan Military Prepositioned Squadron Anchorages (L-62- circle with radius approximately 366 meters around center point 15°11′4.9194″ N 145°39′41.7594″ E; L-32 - circle with radius approximately 366 meters around center point 15°12′13.6794″ N 145°41′33.3594″ E; L-44 - circle with radius approximately 366 meters around center point 15°11′40.1994″ N 145°40′37.5594″ E; L-47 - circle with radius approximately 366 meters around center point 15°11′27.2394″ N 145°41′30.1194″ E); L-19 - circle with radius approximately 366 meters around center point 15°12′53.64″ N 145°40′53.3994″ E; and M-16 - circle with radius approximately 488 meters around center point 15°12′36″ N 145°39′34.9194″ E);

(2) Areas where the essential feature does not occur;

(3) All managed areas that may contain natural hard substrate but do not provide the quality of substrate essential for the conservation of threatened corals. Managed areas that do not provide the quality of substrate essential for the conservation of the seven Indo-Pacific corals are defined as particular areas whose consistently disturbed nature renders them poor habitat for coral growth and survival over time. These managed areas include specific areas where the substrate has been disturbed by planned management authorized by local, territorial, state, or Federal governmental entities at the time of critical habitat designation, and will continue to be periodically disturbed by such management. Examples include, but are not necessarily limited to, dredged navigation channels, shipping basins, vessel berths, and active anchorages;

(4) Artificial substrates including but not limited to: Fixed and floating structures, such as aids-to-navigation (AToNs), seawalls, wharves, boat ramps, fishpond walls, pipes, submarine cables, wrecks, mooring balls, docks, aquaculture cages;

(5) The Commonwealth Ports Authority harbors, basins, and navigation channels, their seawall breakwaters; all other channels, turning basins, berthing areas that are periodically dredged or maintained, and a 25 m radius of substrate around each of the AToN bases;

(6) Artificial substrates, including but not limited to the 15 USCG-managed fixed AToNs; Territory-managed boat ramps at Smiling Cove (Garapan); Sugar Dock (Chalan Kanoa); Tanapag; Fishing Base (Garapan) and Lower Base (Tanapag); and all other

ATоNs, seawalls, wharves, docks, boat ramps, moorings, pipes, wrecks, and other artificial structure.

Given that the duration of the proposed action (3-years) may overlap with a final designation of the proposed coral critical habitat, NMFS PIRO PRD is with this consultation conferencing with NMFS OHC on the effects of the proposed action on the proposed critical habitat in the *Action Area* to gain efficiencies in the process, and avoid disruption of the proposed action if the critical habitat is designated.

5.2 Listed Resources Not Considered Further

As described in the *Approach to the Assessment* section of this biological and conference opinion, NMFS uses two criteria to identify those endangered or threatened species and critical habitat that are not likely to be adversely affected by the Proposed Action. The first criterion was exposure or some reasonable expectation of a co-occurrence between one or more potential stressors associated with Proposed Action and a particular listed species or critical habitat. If we concluded that a listed species or critical habitat is not likely to be exposed to the Proposed Action, we also concluded that the species or critical habitat is not likely to be adversely affected by those activities. The second criterion is the probability of a response given exposure, which considers susceptibility: species that may be exposed to vessel noise from vessels operating near them, for example, but are likely to be unaffected by the noise the vessel makes (at noise levels they are likely exposed to) are also not likely to be adversely affected by the Proposed Action.

Based on the exposure and response analyses that we developed during the course of this consultation, and described in Appendix A of this biological and conference opinion, NMFS PIRO PRD has determined that the following threatened and endangered species are not likely to be adversely affected by the Proposed Action: two (2) species of corals, *A. retusa* and *S. aculeata;* and two (2) species of turtles, the Central West Pacific green sea turtle and Hawksbill turtle. NMFS PIRO PRD has also determined that the Proposed Action is not likely to adversely affect the proposed coral critical habitat that occurs in the *Action Area*.

The Action Agency concluded that 11 other species, as provided in the NMFS OHC biological evaluation, that are primarily pelagic, or species that previously occurred or suspected to occur in the *Action Area* but that are not likely to be in the *Action Area*, will not be affected by this action.

5.3 Introduction to the Status of Listed Species

The rest of this section of NMFS PIRO PRD biological and conference opinion consists of narrative for the threatened *A. globiceps* coral that occurs in the *Action Area* and that may be adversely affected by the Proposed Action. We present a summary of information on the distribution and abundance of this species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether the action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

5.3.1 *Acropora globiceps*

Distribution

A. globiceps is a species of coral that most commonly occurs on upper reef slopes in shallower than 8 meters of depth. It is also sometimes found on reef flats and in backreef pools, and has been recorded as deep as 20 (Fenner 2020a; NMFS 2020b).

A. globiceps has been reported from the central Indo-Pacific, the oceanic west Pacific, and the central Pacific (Richards et al. 2014; NMFS 2020b). It is common and relatively widespread in the north-south direction, but somewhat restricted in the east-west direction and has a narrow depth range (Richards 2009). The Corals of the World website (http://www.coralsoftheworld.org) shows that *A. globiceps* is either confirmed or strongly predicted in 26 of 133 Indo-Pacific ecoregions, from the Coral Triangle to French Polynesia. In addition, *A. globiceps* has been confirmed in the Marshall Islands, Vanuatu, the Society Islands (Fenner 2020b), Johnston Atoll, the Northwestern Hawaiian Islands, and is strongly predicted to occur in western Kiribati (NMFS 2020b). Thus, *A. globiceps'* geographical range is considered to consist of the 32 ecoregions as shown in Figure 4 (NMFS 2020b).

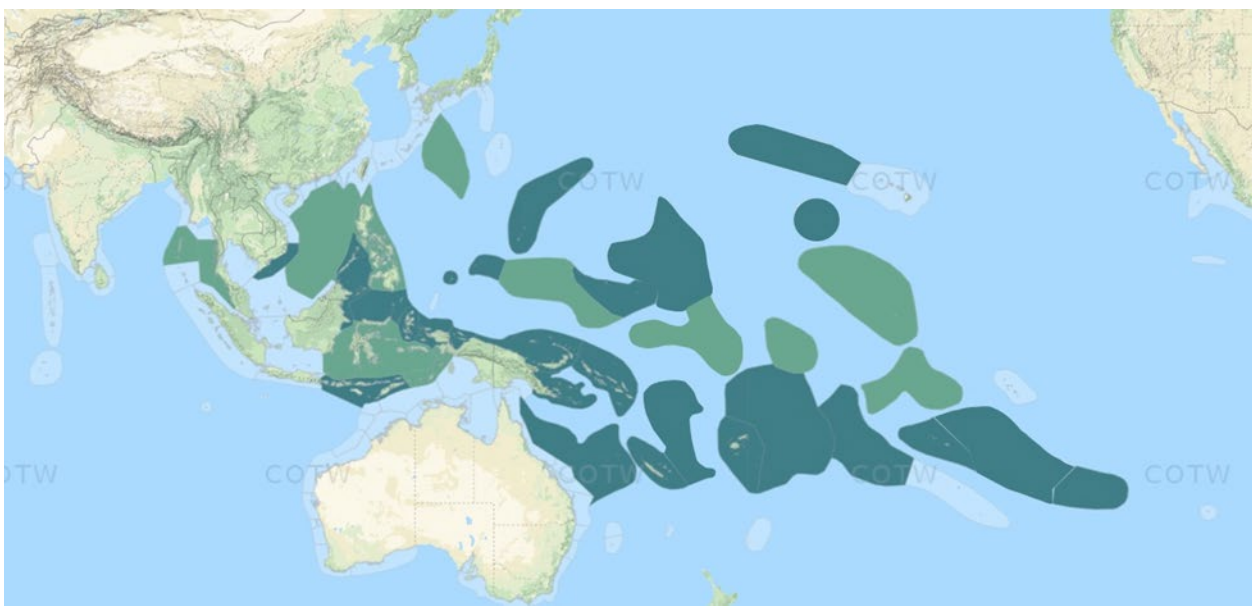

Figure 4. Range of *A. globiceps*, modified from the map on the Corals of the World website (http://www.coralsoftheworld.org/ accessed Sep-20) and Fenner (2020b). Dark green indicates ecoregions with confirmed observations of *A. globiceps* by recognized experts, and light green indicates ecoregions where it is strongly predicted to occur by recognized experts.

In CNMI, *A. globiceps* has been recorded throughout the southern islands, including on Saipan, Tinian, Aguijan, and Rota (Maynard et al. 2015; Maynard et al. 2018; Fenner 2020b). The islands of northern CNMI are uninhabited and rarely surveyed, however, *A. globiceps* has been reported from Anatahan, Pagan, and Maug (NMFS 2020b). In addition, *A. globiceps* has been reported from Farallon de Medinilla (Carilli et al. 2020), an islet between the southern and northern islands. These confirmed reports of *A. globiceps* on eight of CNMI's 15 islands, from the southernmost (Rota) to one of the northernmost (Maug) suggest that the species is found throughout CNMI.

Abundance

The relative abundance of *A. globiceps,* i.e. how common it is relative to other reef-building corals, is described as ‘‘uncommon’’ overall, but depending on the location can range from rare to common (NMFS 2020b). A rough qualitative minimum estimate of the total number of *A. globiceps* colonies that currently exist throughout its range (i.e. absolute abundance) is likely at least tens of millions of colonies (79 FR 53851).

In the CNMI, surveys conducted by NOAA’s Coral Reef Ecosystem Program (CREP) during the 2017 Marianas Pacific Reef Assessment and Monitoring Program (MARAMP) cruise indicated that Saipan has the highest abundance of *A. globiceps* of all of the Mariana Islands (CREP 2017). CREP estimated that there were approximately 3,000,000 *A. globiceps* colonies in Saipan between 0 and 30 meters depth in 2017, of which about half were juvenile colonies < 5 centimeters in diameter. However, significant coral bleaching occurred after these surveys were undertaken, and the *A. globiceps* population along with most other branching *Acropora* species in Saipan were reduced by an estimated 90% (NMFS 2020a). Accounting for an estimated 90% loss and assuming no recovery of colonies since, the estimated number of *A. globiceps* in Saipan is now approximately 300,000 colonies.

Threats to the Species

One-third of reef building corals face elevated extinction risk from climate change and local impacts (Sheppard et al 2008). While there is very little information on threats to the species specific to *A. globiceps,* it is highly susceptible to the main and global-scale threats identified for reef building corals, of which the most important are global climate change induced ocean warming and ocean acidification (79 FR 53851; NMFS 2020b). *A. globiceps* is also vulnerable to sea-level rise and coral disease (79 FR 53851; NMFS 2020b), and to several localized threats with potential widespread impact such as sedimentation, nutrient enrichment, and fishing. Many other localized threats (e.g., physical damage from storms or ship groundings, invasive species or predator outbreaks, collection and trade) also negatively affect corals including *A. globiceps,* often acutely and dramatically, but generally at relatively small local scales.

Ocean warming is responsible for coral bleaching events around the world that have led to significant coral mortalities (Bruno et al. 2007). Coral in the genus *Acropora*, including *A. globiceps,* are among the most susceptible corals to bleaching (Marshall and Baird 2000; McClanahan et. al., 2005; McClanahan et al. 2007; Carpenter et al. 2008;;). It is likely that ocean warming will have detrimental effects on every life history stage of reef corals including *A. globiceps*, by causing impaired fertilization, developmental abnormalities, mortality, and impaired settlement success of larval phases (Negri et al. 2007; Randall and Szmant 2009).

Ocean acidification impacts corals and likely also *Acropora* species, including *A. globiceps*, by reducing calcification rates, increasing erosion, and affecting reproduction and settlement (Marubini et al. 2003; Reneger and Riegel, 2005; Schneider and Erez, 2006; Anthony et al., 2008; Crawley et al. 2010; Albright et al. 2010). Reduced calcification rates may cause corals to grow slower; corals to grow at the same rate but with a reduction in skeletal density; or corals may divert energy from other processes (such as reproduction) to maintain the same growth rate (Hoegh-Guldberg et al. 2007). Reduced skeletal density may make corals more fragile, which would impede reef growth and decrease the ability of corals to recover from habitat damage resulting from disturbances such as hurricanes, vessel groundings, and anchoring (Brainard et al. 2011). Although research has been inconclusive, acidification may impact development and physiology, fertilization and settlement success of coral larvae (Portner et al. 2004, Albright et al. 2008) and net reef calcification (Albright et al. 2018).

Available information indicates that species of the *Acropora* genus are moderately to highly susceptible to disease (Aronson and Precht 2001; Bruckner and Hill 2009).

Status and Trends

An extensive body of literature documents broad declines in live coral cover over the past 50 to 100 years and shifts to reef communities dominated by hardier coral species or algae (Pandolfi et al. 2003; Birkeland 2004; Fenner 2012; Sale and Szmant 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. A precise quantification of *A. globiceps* is not possible due to the limited species-specific information, but given that *A. globiceps* occurs in many areas affected by these broad changes, and that it has susceptibility to both global and local threats, it is also likely to have declined in abundance over the past 50 to 100 years. Carpenter et al. (2008) extrapolated species abundance trend estimates from total live coral cover trends and habitat types and for *A. globiceps*, the overall decline in abundance (i.e. "Percent Population Reduction") was estimated at 35 percent, and the decline in abundance before the 1998 bleaching event (i.e. "Back-cast Percent Population Reduction") was estimated at 14 percent (Carpenter et al. 2008).

Unfortunately, an analysis of historical population trends for *A. globiceps* in the CNMI is hampered by difficulties and inconsistencies with in-situ species field identification. For example, only two colonies of *A. globiceps* appear in the CNMI long-term marine monitoring program's coral demographic database from 2003-2014 (BECQ-DCRM unpub. data), whereas species with similar morphologies (*A. humilis* and *A. gemmifera*) were common. It was only after the proposed listing that NOAA began to develop guides (e.g. Fenner 2016) and conduct trainings for field identification of the listed corals. Identification has since become more consistent among local and federal biologists and several reports indicate that *A. globiceps* is relatively common throughout the region (Tetra Tech Inc. 2014; Maynard et al. 2015).

Nearly all anthropogenic threats to Indo-Pacific reef-building corals, including *A. globiceps*, are projected to worsen in the foreseeable future (79 FR 53851). Since the frequency of disturbance resulting from these threats is predicted to increase, especially under conditions projected for the 21st century in response to climate change, the time available for coral recovery between events is expected to continue to decrease in the foreseeable future. Because of expected reduced recovery times, mean coral cover in the Indo-Pacific including for *A. globiceps* is predicted to decrease. Given the above trends, overall resilience of reef building corals, including *A. globiceps* is projected to decrease in the foreseeable future (NMFS 2020b).

Conservation

Records confirm that *A. globiceps* occurs in many countries' Exclusive Economic Zone (EEZ) including the following jurisdictions: Australia, Federated States of Micronesia, Fiji, French Pacific Island Territories, Indonesia, Japan, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Pitcairn Islands, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and Vietnam (79 FR

53851). The scope of regulatory mechanisms in the countries where the species is found varies in terms of whether they are, and if so the extent to which those regulatory mechanisms are applied. The most common regulations in place for this species are related to reef fishing, area management for protection and conservation, and collection laws (79 FR 53851). These conservation measures all generally occur at a localized scale.

Numerous international and multinational agreements and conventions on coral reef conservation are also aimed at reducing localized threats. Likewise, numerous nongovernmental organizations (NGO) support coral research, monitoring, restoration and protection, thereby addressing such threats in various ways.

6 ENVIRONMENTAL BASELINE

By regulation, the *Environmental Baseline* refers to the condition of the listed species or its designated critical habitat in the *Action Area*, without the consequences to the listed species or designated critical habitat caused by the Proposed Action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the *Action Area*, the anticipated impacts of all proposed Federal projects in the *Action Area* that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The Consultation Handbook further clarifies that the environmental baseline is “an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the *Action Area*” (FWS and NMFS 1998). The purpose of describing the environmental baseline in this manner in a biological opinion is to provide context for effects of the Proposed Action on listed species.

The Proposed Action will take place in Saipan, the second largest island in the Mariana Islands. Saipan is the largest (120 square kilometers) (Ballendorf and Foster 2020) and most populous (48,220) (U.S. Census Bureau 2020) island in CNMI. Saipan is surrounded by coral reefs, with fringing reefs along the north, east, and south and a barrier reef stretching nearly 25 kilometers along the west coast, forming a 32 square kilometer m semi-enclosed, shallow (1 meter -10 meters) lagoonal system, referred to as Saipan Lagoon.

The climate of Saipan is classified as tropical with average yearly temperatures on Saipan ranging between 26 and 28 ° Celsius and annual precipitation averaging about 1,8 meters (Ballendorf and Foster 2020). A monsoon season influences the western North Pacific from July until January that can bring strong southwest winds and rough seas to the western shoreline. The rest of the year the conditions are that of a trade wind regime with winds and seas predominantly from the east. In addition, Saipan is influenced by the western North Pacific tropical cyclone season extending from about mid-May through mid-December in each year (Lander 2004).

The *Action Area* includes the entire sea floor and water column from the shoreline out to approximately 0.8 kilometers seaward of the reef slope around the island of Saipan (Figure 3 inset map). The conditions, physical properties, and health of the reefs and waters in the *Action Area* vary among sites: dynamic conditions occur on the east side of the island where prevailing winds and storms batter the coast and reef; while the relatively shallow Saipan Lagoon including the Mañagaha Marine Conservation Area on the western side of the island is calm, largely protected from winds and waves.

Two relevant consultations have been completed by NMFS PIRO PRD in the *Action Area* since the listing of *A. globiceps* in 2014, of which none were considered to jeopardize or adversely affect ESA listed species including *A. globiceps*. In 2019 NMFS Habitat Conservation Division consulted with NMFS PIRO PRD for the effects of building and operating a coral nursery for growing and reproducing coral colonies including ESA listed *A. globiceps* colonies. The coral nursery is located in the northeast portion of the Mañagaha Marine Conservation Area in Saipan Lagoon. NMFS PIRO PRD concluded in a biological opinion (PIRO-2018-10501; I-PI-18-1716-AG) dated March 25, 2019, that the action would not jeopardize the continued existence of *A. globiceps* species (NMFS 2019). In that opinion, NMFS PIRO PRD estimated that the action would result in at least 30, and up to 300 parent colonies on reef slopes throughout Saipan being wounded due to fragments being broken off to supply the nursery (NMFS 2019). To date, fragments of 11 parent colonies have been collected under the current permits for the nursery. In 2020 the U.S. Army Corps of the Engineers' consulted with NMFS PIRO PRD for the effects of permitting the construction of a separate and additional coral culture facility adjacent to the existing pilot coral nursery in the Mañagaha Marine Conservation Area in Saipan Lagoon. This action did not include culturing of any ESA-listed corals including *A. globiceps*. NMFS PIRO PRD concluded that the construction and operations were not likely to adversely affect any ESA-listed species, including *A. globiceps* (PIRO-2020-01631; I-PI-20-1838-AG).

The majority of Saipan's human population, infrastructure, and commerce are located along the west coast of the island, immediately adjacent to the Saipan Lagoon. Long-term biological monitoring and habitat mapping indicate that seagrass and coral reef habitats in the lagoon have declined in size and quality over the last several decades (Houk and van Woesik 2008; Houk and Camacho 2010; Kendall et al. 2017) largely due to poor water quality associated with coastal development and land use. Adding to these threats, Saipan has seen a boom in new coastal development over the last five years that may have additional negative impacts to the nearshore marine environment (NMFS 2020a).

A portion of Saipan Lagoon immediately to the south of the Mañagaha Marine Conservation Area has been dredged and altered for a shipping lane and for mooring. The lagoon is also heavily used for recreational and commercial in-water activities such as snorkeling, diving, fishing, and boating (NMFS 2020a). Disturbances associated with these activities such as vessel groundings and anchoring frequently impact corals in Saipan Lagoon (NMFS 2020a). The lagoonal waters near Mañagaha Island are especially heavily used by tourists, tour operators, boaters and other recreationalists. Mañagaha Island, while uninhabited, is a popular tourist spot that sees over 300,000 visitors a year. Coral reef habitat within and nearby the designated swimming zone is impacted by direct damage and decreased water quality from snorkelers and swimmers. Additionally, reef fish are an integral part of the culture and diet of the people of the CNMI and are therefore a primary target of both commercial and subsistence fishers (NMFS 2020a). The Saipan Lagoon is particularly heavily fished because it is shallow, calm, and easily accessible year-round (PCRP 2017). Direct damage to corals due to fishing practices and overharvesting of herbivorous reef fish may also reduce the overall resilience of coral reef ecosystems.

Forereefs and reef slopes around Saipan are subject to various levels of stress from land-based pollution, fishing, and other recreational and commercial activities depending on watershed characteristics and accessibility (Maynard et al. 2015). Maynard et al. (2012) surveyed and scored the conditions of 35 sites around Saipan, noting coral diversity, recruitment, bleaching resistance, herbivore biomass, macroalgae cover, coral disease, and anthropogenic physical impacts (e.g., anchor or human-caused damage). The authors also noted variables such as temperature variability, nutrient input, sedimentation, the level of fishing pressure, and wave exposure at each site. Each site was ranked with a score of high, medium, or low resilience potential, or indicators that the reef can withstand or recover from bleaching or catastrophic events. Of the 35 sites surveyed in 2012, 23 were ranked as having high resilience.

Shortly after the 2012 resilience survey, the original rankings were challenged by mass coral bleaching events on an almost annual basis that affected coral reefs throughout the Mariana Islands including Saipan. In 2015 after repeating the survey, Maynard et al. (2015) ranked only 4 of the 35 sites as having high resilience, downgrading many of the sites previously ranked in 2012. In 2018 additional surveys were conducted following yet another bleaching event in 2017 aimed at assessing coral resistance and recovery in CNMI (Maynard et al 2018). The resilience ranking resulting from the 2018 surveys indicated that out of 29 sites, 5 had high resilience, 8 medium-high, 12 medium-low, and 4 low.

The anthropogenic climate change stressors that are affecting marine and coral reef ecosystems across the globe are, as noted above, also occurring in Saipan and the *Action Area,* and are impacting corals including listed *A. globiceps* corals. The CNMI has experienced extensive and unprecedented thermal stress and coral bleaching events over the last several years. Since 2012, reefs in CNMI have experienced bleaching events in 2013, 2014, 2016 and 2017, and two typhoons (Soudelor in 2015 and Yutu in 2018). The first of these major bleaching events occurred in 2013 when bleaching was observed in 85% of coral taxa on Saipan and Guam (Reynolds et al. 2014). This was followed in 2014 by a second mass bleaching event that impacted the entire archipelago (Heron et al. 2016). These consecutive annual bleaching events resulted in over 90% loss of staghorn *Acropora* spp. corals in Saipan Lagoon (BECQ-DCRM, Long-Term Monitoring Program, unpub. data) and high mortality of shallow water coral communities throughout the island chain (Heron et al. 2016; NOAA Coral Reef Ecosystem Program (CREP) unpub. data). In 2015, the Marianas experienced El Niño Southern Oscillation (ENSO)-related extreme low tides that exposed reef flats for prolonged periods during the dry season as well as a direct hit from the Category 4 Typhoon Soudelor. In 2016, mild bleaching occurred throughout the region (Raymundo 2017). In 2017, the most severe mass bleaching event on record occurred across the region: on Saipan, nearly all coral taxa were impacted down to at least 20 meters depth (BECQDCRM unpub. data) and preliminary data indicated that 90% of *Acropora* spp. corals and 70% of *Pocillopora* spp. corals died on shallow (<10 meters) reefs (NMFS 2020a).

In summary, known human-induced stressors to *A. globiceps* in Saipan and the *Action Area*, include climate change induced ocean thermal stress and bleaching, land-based sources of pollution, and direct damage and habitat degradation through storms and recreational and commercial activities. Overharvesting of reef fish may also contribute to reduced resilience of coral reef ecosystems in the *Action Area*.

7 EFFECTS OF THE ACTION

In *Effects of the Action* sections of biological opinions, NMFS PIRO PRD presents the results of its assessment of the probable effects of federal actions on threatened and endangered species and designated critical habitat that are the subject of a consultation. As we described in the *Approach to the Assessment* section of this biological opinion, we organize our effects' analyses using a stressor identification - exposure – response – risk assessment framework.

The *Integration and Synthesis* section of this opinion follows the *Effects of the Action* section, and integrates information we presented in the *Status of Listed Resources* and *Environmental Baseline* sections of this biological and conference opinion with the results of our exposure and response analyses to estimate the probable risks the Proposed Action poses to threaten the *A. globiceps* species.

Because NMFS PIRO PRD has previously concluded that the Proposed Action is not likely to adversely affect several listed species, these listed resources are not considered in the analyses that follow. Species and proposed critical habitat not likely to be adversely affected by the Proposed Action are discussed in the *Status of Listed Resources Not Considered Further* section of this biological and conference opinion, and in Appendix A.

7.1 Potential Stressors

NMFS PIRO PRD has identified that the potential stressors associated with the Proposed Action that may affect the environment and define the *Action Area*, as listed in the *Application of this Approach in this Consultation* section, may induce an adverse response from threatened and endangered species and their critical habitat.

7.2 Exposure Analyses

This section analyzes the Proposed Action's potential for exposing *A. globiceps* to each of the stressors listed in the *Application of this Approach in this Consultation* section as referenced in the *Potential Stressors* section above.

7.2.1 Direct physical impacts

Direct physical contact with *A. globiceps* will occur when divers break off fragments from individual parent colonies to determine if they are gravid prior to gamete collection. Depending on the severity of the break, the size, and condition of the colony, the resulting effects to the coral colonies could vary from injuries fully healing within days or weeks with little to no effect on the colonies, to the colonies becoming stressed for a period of time, to at the extreme, colonies dying (Brainard et al. 2011). It is estimated that up to 60 < 4 centimeter sized fragments would be taken from wild parent *A. globiceps* colonies from several sites around Saipan over the course of the 3-year project (NMFS 2020a).

Direct physical contact with *A. globiceps* will also occur from handling of *A. globiceps* gametes and larvae during collection of coral spawn and culturing of larvae in settlement tanks. Only a fraction of the gametes produced from any given colony will be collected during a spawning event with most gametes entering the water column. The gametes collected will be placed in settlement tanks, of which a proportion are expected to join to form the free-floating, or planktonic, larvae called planulae. A portion of the planulae may settle onto the provided settlement units. The total volume of *A. globiceps* gametes that will be collected as part of this project across all sites from approximately 10 *A. globiceps* colonies per year (for a total of up to 30 *A. globiceps* colonies for the project) is estimated to be approximately 1 liter (NMFS 2020a).

Additionally, direct physical contact with *A. globiceps* may occur from placement of gamete collection tents over the parent/donor colonies; installation of anchors on the seafloor to secure the settling pools; placement of cinder blocks on seafloor for temporary holding of settlement units; placement of settlement units at reef sites; drilling or hammering of markers at outplant sites; divers inadvertently handling or coming in contact with corals during in-water activities; vessel anchoring across sites; and vessel groundings. Depending on the nature of contact, this can result in abrasion, breakage, dislodgement and/or crushing of exposed *A. globiceps* coral colonies. However, a range of BMPs will be employed to minimize direct contact with *A. globiceps* colonies from project related activities (BMPs 1, 3-6, 8-10 and 21) including deploying settling pool anchors only into sandy substrate devoid of live coral; placing boat anchors only in soft bottom areas with divers checking and adjusting anchors once deployed; and divers ensuring that no contact is made with listed corals while performing work.

A. globiceps exposure to direct contact from project associated vessel grounding is expected to be discountable due to experienced boat drivers being able to navigate around shallow coral reef, in combination with the relatively small size of the vessels leaving small footprints on reef in the event of a grounding, and the low probability of *A. globiceps* presence within an eventual grounding scar.

It is expected that the gamete collection tents placed around parent colonies will be large enough that they completely surround the colony with little-to-no contact with coral tissue at the base. In addition, tents will be monitored by divers at all times and removed if currents or surge cause excess movement or abrasion of the colonies. Settlement units outplanted will be dispersed in a manner to avoid contact with *A. globiceps* live coral tissue. After deployment of settlement units, it is expected that these will not move, or move only minimally based on previous studies of tetrapod retention and given expected high reef rugosity at sites: a study by Chamberland et al. 2017 showed that on average, tetrapods dispersed approximately 32 centimeters over 6 months and dispersal declined as structural complexity increased.

In conclusion, over the course of the 3-year project, it is expected that *A. globiceps* exposure to direct physical contact would occur as per the following: 60 *A. globiceps* colonies from several sites around Saipan will be subject to lesions from collection of fragments; a total volume of approximately 1 liter of *A. globiceps* gametes from approximately 30 *A. globiceps* colonies will be subject to handling from collection of coral spawn; and given the implementation of BMPs few to no *A. globiceps* coral colonies will be exposed to abrasion, breakage, dislodgement and/or crushing from all other project related activities combined.

7.2.2 Entanglement

Entanglement of *A. globiceps* with lines and other materials associated with the deployment of settlement pools and vessel anchor lines is unlikely to occur since corals are sessile benthic organisms, and only present in the water column in their larval stage. *A. globiceps* coral larvae are currently not defined as an "individual" (79 FR 53851), and the reproductive biology of coral results in prolific larval production and high natural mortality (Brainard et al. 2011). Therefore, the likelihood of the Proposed Action causing entanglement of *A. globiceps* is extremely unlikely, and therefore discountable.

7.2.3 Introduction of invasive species

Introduction of invasive species to the marine environment may occur via vessels, materials, equipment, divers and transfer of coral fragments amongst locations during all phases of project activities. Introduced invasive species have the potential to increase exposure of corals to diseases, predation and competition, and to disrupt the natural ecosystem on which they depend (Brainard et al. 2011).

However, all operations will take place on Saipan, eliminating the potential for long distance transmission of invasive and nuisance species. All dive equipment, materials and instruments will be examined and rinsed with fresh water prior to use or deployment to ensure no organisms are being introduced or transported between the collection areas (BMP 20). *Chaetomorpha sp*. have become a problem on the east side of Saipan in Laolao Bay, smothering the reef flat and shallow spur and groove reefs in that area, stressing and killing coral colonies in some cases. Particular attention and extra care (expected to involve implementing specific protocols relevant to this species) will be taken to avoid transporting the filamentous algae should parent colonies be collected within that region. Given the above, the likelihood of *A. globiceps* being exposed to the introduction of invasive species is considered extremely unlikely, and therefore discountable.

7.2.4 Introduction of wastes and other pollutants

Waste, discharge and other pollutants may be introduced to the marine environment from vessels, equipment and divers during all phases of project activities in the form of hydrocarbon-based chemical spills, inadvertent disposal of debris/trash, and leaching of toxins from materials used for settlement units and/or sunscreens used by divers. Exposure of corals to toxic substances may cause reduced growth, reproductive impairment, bleaching, or in some severe cases, death. Oil spills occurring near or at peak reproductive season (e.g., summer) could adversely affect reproductive effort because coral gametes and eggs are present, potentially bringing them into direct contact with floating oil. Debris can abrade and smother corals. Sunscreens containing oxybenzone and other chemicals may disrupt coral reproduction, cause coral bleaching, and damage coral DNA (Brainard et al. 2011; Downs et al 2013; Downs et al 2015).

However, local and federal regulations prohibiting intentional discharge of pollutants and plastics into the marine environment, and the implementation of BMPs to control contamination (BMPs 16-19) will limit hydrocarbon-based chemical spills and disposal of trash. Any spills of fuel, lubricants and oil that occur are expected to be of minor volume, float i.e. not sink to the bottom where adult corals occur, and evaporate and disperse quickly. During in-water operations, divers will use minimal and/or less harmful sunscreen, and will use clothing for sun protection wherever possible. The project's Principle Investigator (s) will consult with counterparts in the Caribbean to ensure that the most trusted and safe materials available are used for settlement units. Given the above information, the likelihood of *A. globiceps* exposure to waste, discharge and other pollutants is considered extremely unlikely, and therefore discountable.

7.2.5 Vessel collisions

Vessel collisions with *A. globiceps* in the water column is unlikely to occur. Corals are sessile benthic organisms that will only occur in the water column during their coral larval phase. Non-larval *A. globiceps* exposure to vessel grounding is addressed in the above *Direct physical* *impacts* section. *A. globiceps* coral larvae are currently not defined as an "individual" (79 FR 53851), and the reproductive biology of coral results in prolific larval production and high natural mortality (Brainard et al. 2011). Therefore, the effects from vessel collision with *A. globiceps* from the Proposed Action is extremely unlikely, and therefore discountable.

7.2.6 Noise

Noise may be generated from potential drilling or hammering associated with marking settlement unit outplant sites, and from vessel outboard motors during vessel transit across the *Action Area*. The noise from potential drilling or hammering is anticipated to be very short-lived on the order of a couple of minutes per plot over the course of the project. While there are studies that indicate that coral larvae can detect and move towards reef sounds (Vermeij et al 2010), and that this process can be disrupted by man-made noise generated by boat activity (Lecchini et al. 2018), there is no evidence that we are aware of that coral colonies can "hear" sound. Therefore, the effect of noise on *A. globiceps* is extremely unlikely, and therefore discountable.

7.2.7 Increased turbidity

Increased turbidity exposure of *A. globiceps* may occur from attachment of structures on the sandy seafloor at the coral nursery site, and vessel anchor deployment and retrieval across the *Action Area*. Elevated turbidity can reduce light penetration through the water column potentially reducing photosynthesis of the coral algal endosymbiont (zooxanthellae), and can increase sediment settling onto corals resulting in varying effects including benign energy expenditure to shed the sediment, reduced reproduction, slowed growth, and in severe cases, death (reviewed in Brainard et al. 2011).

However, the disturbance of sand is expected to be limited to a few occurrences for a matter of minutes at a time at the nursery site during the 3 year project duration, and infrequently for vessel anchoring during all phases of activities. The substrate that will generally be disturbed across project sites is expected to predominantly consist of larger grained sandy substrate that will settle out of the water column relatively quickly. Therefore, turbidity generated is expected to be temporary and confined to the immediate vicinity (< 3 meters) of the source of disturbance. Given that listed *A. globiceps* corals do not grow in sandy substrate and are not expected to occur within these sandy bottom disturbance footprints, the likelihood of *A. globiceps* being exposed to increased turbidity caused by the action is considered extremely unlikely, and therefore discountable.

7.2.8 Benthic disturbance and change in habitat

Benthic disturbance and change in habitat will occur as a result of the placement of anchors and concrete blocks in the sandy habitat at the coral nursery, and potentially from outplanting of settlement units and associated markers across reef sites. Benthic disturbance and change in habitat can reduce the quality and quantity of hard substrate needed for corals to settle and grow, and can negatively impact the reef frameworks upon which ESA-listed corals depend on (Brainard et al. 2011).

However, *A. globiceps* are not found within the predominantly sandy bottom at the coral nursery, and since hard substrate is necessary for corals to settle, it is unideal habitat for listed corals. The settlement units are small (tetrapods 8 - 10 centimeters, and beads 1 – 1.5 centimeters in size) and will be distributed in relatively low densities in small plots relative to the overall reef area.

The markers are even smaller. The units and markers are expected to be deployed so as to not abrade or displace live coral tissue, will be barely visible on the reef, and will provide beneficial substrate for coral settlement within the reef habitat. Given the lack of presence of *A. globiceps* at the coral nursery, the avoidance of placing settlement units and markers on top of live coral tissue, and their small size, the level of exposure of *A. globiceps* to the disturbance and change in habitat stressor is expected to be extremely unlikely, and therefore discountable.

7.3 Response Analyses

As discussed in the *Approach to the Assessment* section of this biological and conference opinion, response analyses determine how listed resources are likely to respond after being exposed to an Action's effects on the environment or directly on listed species themselves. Our assessment analyzes the responses that might result in reducing the fitness of *A. globiceps*. We consider and weigh evidence of adverse consequences, beneficial consequences, or the absence of such consequences. Where exposure to a stressor is considered discountable, the *A. globiceps* species response to the stressor is not discussed.

7.3.1 Direct physical impacts

As introduced in our *Approach to Evaluating Effects* section, physical contact of equipment or humans with an individual coral does not necessarily constitute an adverse effect. This is due to two key biological characteristics:

1 All corals are simple, sessile invertebrate animals that rely on their stinging nematocysts for defense, rather than predator avoidance via flight response. So whereas it is logical to assume that physical contact with a vertebrate individual results in stress that constitutes harm and/or harassment, the same does not apply to corals because they have no flight response.

2 Most reef-building corals, including all the listed species, are colonial organisms, such that a single larva settles and develops into the primary polyp, which then multiplies into a colony of hundreds to thousands of genetically-identical polyps that are seamlessly connected through tissue and skeleton. Colony growth is achieved mainly through the addition of more polyps, and colony growth is indeterminate. The colony can continue to exist even if numerous polyps die, or if the colony is broken apart or otherwise damaged. The individual of these listed species is defined as the colony, not the polyp, in the final coral listing rule (79 FR 53852). Thus, affecting some polyps of a colony does not necessarily constitute harm to the individual.

Breaking off fragments from *A. globiceps* colonies to determine if the colonies are gravid prior to gamete collection will result in wounds, or lesions for both the coral fragment and parent colony. Up to 60 wild parent *A. globiceps* colonies across several sites around Saipan over the course of the 3-year project will be inflicted with lesions.

Lesions often heal naturally, may do so quickly with little to no effect on the colonies (Jayewardene 2010), but can result in the affected coral colony being subject to reduced fitness in three ways. First, coral tissue regeneration requires energy so that resources may be diverted from growth and reproduction (e.g., Kobayashi 1984; Rinkevich and Loya 1989; Meesters et al 1994; Van Veghel and Bak 1994; Lirman 2000). Secondly, colony health and survival may be compromised because open lesions provide sites for the entry of pathogens and bioeroders and space for the settlement of other organisms such as algae, sponges, and other corals (Bak et al 1977). Third, injuries reduce the coral's surface area available for feeding, photosynthesis and reproduction (e.g. Jackson and Palumbi 1979; Wahle 1983; Hughes and Jackson 1985), which may alter colony survivorship (e.g. Hughes and Jackson 1985; Babcock 1991; Hall and Hughes 1996). Severe injuries to colonies can lead to death, especially if the colony is simultaneously exposed to other stressors such as warm sea temperatures, and bleaching (e.g. Meesters and Bak 1993).

The ability for lesions to heal ultimately depends on the species of coral, colony growth form, the surrounding environment, colony interactions with other organisms on the reef, and the size and shape of the lesion (Meesters et al 1997). *A. globiceps* colonies are typically small (about 12 centimeters in diameter) and round, with finger-like branches growing upward. Branches are uniform in size and shape, roughly finger length, with almost no side branches. The size and appearance of branches depends on degree of exposure to wave action, but are always short, closely compacted, with dome-shaped ends (NMFS 2020b). *A. globiceps* lives on reef flats, but also upper reef slopes often exposed to surf. A coral with these characteristics likely experiences natural breakage. To survive in such conditions, *A. globiceps* like many of the *Acroporid* species that are digitate, branching, or table- or plate-like, have likely adapted to breakage and are more likely to heal readily.

A study by Hall (1997) on 18 branching *Acropora* colonies noted that all lesions in the study healed within 74 days, while some began vertical branch extension from the lesion. In Saipan, 10 out of 11 *A. globiceps* parent colonies with lesions from which fragments were taken in 2019 as part of the Saipan coral nursery pilot project, healed successfully within 2-4 months post collection (McKagan personal communication 2020). Regenerated tissue across lesions included symbionts, and formed new apical polyps. The lesion on the one parent colony that did not heal successfully is believed to have been adversely affected by boring sponges that were documented on the colony when the initial fragmentation occurred. Monitoring of a lesion on a single fragment of *A. globiceps* in the coral nursery in the summer of 2020 indicated that tissue regenerated across the lesion within a single week. In general, the *A. globiceps* fragments taken from wild colonies in 2019 and currently cultured in the coral nursery are estimated to have increased 6 to 10 times in overall mass over the course of 9 months (McKagan personal communication 2020). Based on the above information, we expect that the small lesions (1-3 centimeter diameter) created on *A. globiceps* parent colonies by collection of the less than 4 centimeter sized fragments will heal with temporary and minimal effects to colony reproduction and growth. However, it is possible that parent colonies may become stressed from the damage, in particular if simultaneously exposed to other environmental stressors such as ocean warming, which may reduce their fitness and possibly lead to death. While this is not expected, it is possible that fragment collection may result in the loss of up to all 60 *A. globiceps* colonies from which fragment will be collected.

The direct handling of *A. globiceps* gametes and larvae is not expected to constitute harm to *A. globiceps* coral individuals. Corals, including *A. globiceps* release a very large number (thousands, even millions) of eggs and sperm into the water during spawning events (Szmant 1986, Soong and Lang 1992). Upon the release of gametes, successful fertilization is dependent on the random chance that an egg and a sperm from colonies of separate genets (i.e., two colonies that are not clones of each other) will “find” each other in the water column. If fertilization occurs, embryonic development culminates with the development of the planktonic larvae called planulae. Planulae experience considerable mortality (up to 90% or more) from predation or other factors prior to settlement and metamorphosis as they are carried by water currents during their dispersal (Goreau et al. 1981).

The number of gametes that *A. globiceps* colonies release during spawning events in Saipan is unknown. However, it is likely similar to *Acropora* species in the Caribbean: an elkhorn coral colony at puberty will produce approximately 1 million eggs, and a staghorn coral colony at puberty (with branches approximately 0.25 centimeters to 1.5 centimeters in diameter) will produce approximately 70,000 eggs per branch (NMFS 2011). The collection of a total volume of 1 liter of gametes from approximately 30 *A. globiceps* colonies across different reef sites, and over the course of the 3 year project is expected to result in the removal of only a tiny fraction of gametes from the total number of *A. globiceps* gametes released. Because collected gametes will be cultured in settlement tanks protected from certain stressors such as predation, there is potentially an increased probability for fertilization, larval survival, settlement and growth into coral colonies compared to the wild. It is therefore conceivable that gamete collection may result in an increase in reproductive output, though immeasurable, of *A. globiceps*.

The likelihood of *A. globiceps* corals being exposed to direct contact with equipment, materials and/or divers associated with project activities other than from the breaking off of *A. globiceps* fragments and handling of gametes is considered small. Any direct contact that might occur would most likely result from placement of gamete collection tents over *A. globiceps* colonies, and would likely result in minor surface-level abrasion to live coral tissue involving the loss of a few polyps. Most reef-building corals, including *A. globiceps*, achieve colony growth mainly through the addition of more polyps, with colony growth being indeterminate. Therefore, minor abrasions involving loss of a few coral polyps on a colony is expected to have insignificant effects on *A. globiceps*.

7.4 Cumulative Effects

"Cumulative effects", as defined in the ESA implementing regulations, are limited to the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the *Action Area* considered in this opinion (50 CFR 402.02). 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.

Cumulative effects on *A. globiceps* may occur as a result of climate change driven ocean warming and ocean acidification, land-based pollution, continued recreational activities at reef slopes, vessel groundings, non-federal fishing, and other actions described in the Environmental Baseline that are reasonably certain to continue in the *Action Area*. Human population and coastal development can increase anthropogenic stress in nearshore aquatic habitat and coral reefs. The CNMI does not currently have a master plan (for development), and no major island changes are expected for Saipan that will drastically degrade or improve reef conditions. The human population in Saipan peaked at 62,392 in 2000 (U.S. Census, 2003), but after new immigration and labor laws, the population decreased and is now estimated at 48,220 (U.S. Census Bureau 2020). Tourism is a major source of income to CNMI and Saipan; recently the island has added several large resorts near the coast. With the exception of climate change related effects, we expect cumulative effects to be similar to human-caused effects currently occurring in the *Action Area* as described in the *Environmental Baseline* section.

Global anthropogenic climate change is expected to continue and to therefore continue to impact corals across the globe and the Indo-Pacific, including *A. globiceps* in CNMI and in the *Action*

Area. Substantial warming-induced mass bleaching of Indo-Pacific reef coral communities is projected to rapidly increase in frequency, intensity, and magnitude in the foreseeable future (Brainard et al. 2011; Smith 2019). Under RCP 8.5, the average year for the onset of twice- per-decade severe bleaching is 2032, and only ten years later for annual severe bleaching (Heron et al. 2017). The resulting bleaching may cause mortality of the affected colonies.

The effects of ocean acidification on Indo-Pacific reef-building coral communities including those in CNMI and the *Action Area* are projected to steadily increase and broaden in the foreseeable future by reducing coral calcification, increasing reef erosion, impacting coral reproduction, reducing reef coral diversity, and simplifying coral reef communities. By the middle of this century, ocean acidity could lower calcium carbonate saturation to the point where the reefs may begin to dissolve (Brainard et al. 2011; Smith 2019). Coral reef taxa, including *A. globiceps,* may not have the ability to effectively acclimatize to such rapidly occurring ocean acidification (Comeau et al. 2019).

Global sea level continues to rise at a rate of about one-eighth of an inch per year (NOAA 2020). Sea-level projected under RCP 8.5 will far exceed recent sea-level rise rates both globally and in the Indo-Pacific. While the effects of sea-level rise to date on Indo-Pacific reef-building corals are complex, with trends unclear, potential effects include potential reef submergence if reef accretion cannot keep up, degradation of water quality in nearshore habitats such as reef flats by increased coastal erosion, and compounding the effects of other simultaneous threats such as warming-induced bleaching and ocean acidification (Smith 2019). These effects may affect also *A. globiceps* in the *Action Area.*

However, NMFS PIRO PRD expects that lesion healing and the recovery of *A. globiceps* colonies would be relatively fast after fragment collection and project activities have ended. While climate change effects are predicted to increase into the future, the potential synergistic impacts of this global stressor, combined with effects of other local stressors and the effects of the Proposed Action, are not expected to be significant for the *A. globiceps* corals considered in this opinion.

8 INTEGRATION AND SYNTHESIS OF EFFECTS

The purpose of this opinion is to determine if the Proposed Action is likely to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. The purpose is also to determine if the Proposed Action is likely to result in destruction or adverse modification of proposed critical habitat.

The jeopardy analysis considers the effects of the action within the context of the "Status of Listed Resources" together with the "Environmental Baseline" and the "Cumulative Effects", as described in the "Approach to the Assessment section." We determine if mortality of individuals of listed species resulting from the Proposed Action is sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In order to make that determination, we use a population's base condition (established in the *Status of Listed Resources* and

Environmental Baseline sections of this opinion) as context for the overall effects of the action on affected populations. Finally, our opinion determines if changes in population viability, based on the *Effects of the Action* and the *Cumulative Effects* sections, are likely to be sufficient to reduce viability of the species those populations comprise.

The destruction or adverse modification analysis considers if the action results in an alteration of the quantity or quality of the essential physical or biological features of proposed designated critical habitat, and if the effect of the alteration is to appreciably diminish the value of critical habitat as a whole for the conservation of the species. We use the same exposure–response–risk assessment framework for designated critical habitat that we use for jeopardy analyses. We consider the effects of the action within the context of Status and Baseline of Critical Habitat; we identify the exposure of physical or biological features of critical habitat to the action's effects evaluating the timing, intensity, duration, and frequency of the likely exposure to the identified stressors; and determine the response, evaluating whether and how those features are likely to respond to that exposure.

The following discussion summarizes the probability of risk the Proposed Action poses to the listed resources identified in the *Status of Listed Resources* section.

8.1 Acropora globiceps

As discussed in the *Approach to Evaluating Effects* section we defined the *A. globiceps* physiological colony as the "individual" rather than the coral polyp or coral larvae. We consider effects to each colony as individuals within a local population, within a regional, and global population. Also as discussed in the *Approach to Evaluating Effects* section we focus our analysis on the effects of the action to the wild population, in this case the parent colonies that have fragments broken off from them and not the fragments that will be placed in the nursery, subject to human handling, and therefore unlikely to contribute measurably to the wild population and the species as a whole.

The applicant proposes to extract up to no more than 60 less than 4 centimeter sized fragments from 60 parent colonies from various locations throughout Saipan over the course of 3 years. These parent colonies are naturally occurring individuals within Saipan's wild population of *A. globiceps*.

A. globiceps is a branching coral, and like most species in the *Acropora* genus, is characterized by fast growth in good conditions to outcompete other coral species within the reef. Branching species are generally naturally prone to breakage. Digits or fragments of *Acropora* species are often eaten by some species of parrotfishes (Bellwood and Choat 2000). Corals with these natural stressors are likely to be resilient from occasional fragment breakage and resulting lesions. Similar species within the *Acropora* genus show remarkable survival, recovery, and regrowth after breakage (Hall 1997), and sometimes mass breakage due to hurricanes (Lirman 2000).

Based on the observations of fast lesion healing of fragment of *A. globiceps* collected and grown in the existing Saipan coral nursery (McKagan personal communication 2020), we expect most if not all parent colonies to recover and survive from collection of fragments and resulting lesions. However, for our determination, we considered the effect of 100% mortality of all parent colonies as a worst case scenario. Based on surveys conducted in 2017, NOAA CREP estimated that there were ~3,000,000 *A. globiceps* colonies in Saipan (CREP 2017). Given that significant coral bleaching occurred in 2017 after these surveys were undertaken resulting in an estimated 90% loss of *Acropora* spp. corals, the estimated number of *A. globiceps* in Saipan is now approximately 300,000 colonies (assuming no recovery of colonies since). It is estimated that there are tens of millions of *A. globiceps* colonies throughout its range worldwide (79 FR 53851). If all 60 parent colonies died after the removal of fragments, which is unlikely, it would reduce the population by 0.02% on Saipan, a very small fraction of the global population of *A. globiceps*.

The action is not likely lead to an appreciable reduction in the size of the local population because according to Kendall and Poti (2014) and (2015), currents throughout the Mariana Archipelago travel throughout all of the islands. Although the prevailing current appears to be westward and northward, currents generated from the northern islands are variable in current directions and eddies, which may promote larval retention for the Mariana Archipelago. Saipan appears to be both source and sink for larval recruitment, and should contribute as a source to replenish other areas, and be replenished by distant colonies as local colonies die. The authors, however, also caution that current patterns may change with climate change (Kendall et al. 2016).

NMFS PIRO PRD believes that the magnitude and intensity of the impact from the directed take of fragments from *A. globiceps* would be mitigated by the following factors: 1) the small number of colonies from which specimen material would be collected compared to the estimated abundance of the species (60 out of approximately 300,000 colonies in Saipan); and 2) and the small size of the fragments and resulting minor lesions on parent colonies (< 4 centimeter sized fragments constituting less than 10% of the size of the colony).

A recovery plan does not currently exist for *A. globiceps*. However, as stated in the final listing (79 FR 53851) and supported by NMFS initial re-assessment of threats as part of a status review (NMFS 2020b), global climate change via ocean warming and ocean acidification poses the greatest extinction risk for reef building corals, including *A. globiceps*. Local-scale human induced direct physical damage (e.g., from vessel groundings, anchors, divers/snorkelers) is considered to be a threat of negligible to low importance to the listed corals (Brainard et al. 2011). The removal of < 4 centimeter sized fragments from 60 colonies, spread across reefs over the course of 3 years, is of little significance even compared to other forms of direct physical damage such as from vessel groundings, anchors, and divers/snorkelers. We therefore determine that this effect bears little to no importance on the potential of the species to recovery.

Impacts from the Proposed Action are expected to result in minor lesions to a relatively small number of *A. globiceps* parent colonies that will heal quickly, with resulting minimal and temporary cost to reproduction and growth of the colonies. We expect that colony survival would not be affected by the proposed activities, and that they would have the same probability of survival with or without the proposed action. We do not expect the Proposed Action to affect the ability of the overall population to grow and to successfully reproduce. We do not expect the Proposed Action to have any effect on the overall size or distribution of the population. We do not expect the Proposed Action to negatively affect the species ability to meet their lifecycle requirements, or to reduce the species' likelihood of surviving and recovering in the wild.

The ultimate goal of the Proposed Action is to develop active intervention strategies in the CNMI to maintain coral populations, including ESA-listed species such as *A. globiceps,* and increase ecosystem resilience. The immediate objectives are to develop and test novel settlement substrates designed to improve the efficiency of outplanting, or seeding, of sexually propagated coral juveniles at scale; build local capacity in the CNMI to implement coral sexual propagation methods as part of a broader restoration strategy; and test an existing island-wide resilience assessment as a framework for increasing larval outplant survivorship. Including the listed *A. globiceps* in the project will help contribute knowledge of *A. globiceps* colony survival exposed to small lesions (i.e. after fragments are taken); *A. globiceps* small fragment survival and growth in the coral nursery; practicability of *A. globiceps* gamete collection; *A. globiceps* parent colony fertility prior to spawning; *A. globiceps* gamete development through to planula settlement and juvenile growth on novel settlement substrates; and growth and survival of sexually propagated *A. globiceps* juveniles outplanted on to reefs. This knowledge may contribute to understanding the practicability of outplanting, or seeding, of *A. globiceps* juveniles at scale on a reef to maintain and recover *A. globiceps* populations in CMNI. The inclusion of *A. globiceps* in the study will also result in greater familiarity and recognition amongst local managers, students, and volunteers with the ESA listed *A. globiceps,* which may inspire them to promote the avoidance of damage to individuals of this species, and including this species in conservation projects during the course of efforts they engage in outside of the Proposed Action.

The outplanting of sexually propagated juveniles, and potentially eventually nursery cultured fragments broken off from parent colonies, may supplement the existing local population, replace clusters of *A. globiceps* that may have been killed by mass bleaching, storms, or other catastrophic event, or reintroduce areas that have been extirpated. These future actions including outplanting have not been fully developed yet, and depending on the success of the nursery and other factors like funding may not occur. If, however, outplanting occurs in the future, it will likely benefit the species.

8.2 Proposed Coral Critical Habitat

All possible effects of the Proposed Action on proposed coral critical habitat's hard substrate and associated water column occurring in the *Action Area*, including essential features (1), (2), (3) and (4) as described in the *Critical Habitat* section, are extremely unlikely to occur or insignificant as explained in Appendix A of this biological and conference opinion. Therefore, we do not expect an alteration of the quantity or quality of the essential physical or biological features of proposed designated critical habitat, and do not expect any diminished value of critical habitat as a whole for the conservation of the species.

9 CONCLUSION

The purpose of this biological and conference opinion is to determine if the Proposed Action is likely to jeopardize the continued existence of listed species (i.e., jeopardy determination) or result in destruction or adverse modification of proposed critical habitat. "Jeopardize the continued existence of" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02).

After reviewing the current status of *A. globiceps*, the environmental baseline for the *Action Area*, the effects of the Proposed Action, and the cumulative effects, it is NMFS PIRO PRD opinion that the Proposed Action is not likely to jeopardize the continued existence of this species.

Based on the exposure and response analyses that we developed during the course of this consultation, it is NMFS PIRO PRD opinion that the Proposed Action is not likely to adversely affect the critical habitat proposed to be designated for *A. globiceps*, *A. retusa* and *S. aculeata* in the *Action Area*, and therefore will not result in destruction or adverse modification of proposed critical habitat.

10 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and protective regulations pursuant to section 4(d) of the ESA generally prohibit the take of endangered and threatened species without a special exemption. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS).

As discussed in the accompanying biological and conference opinion, only 60 parent *A. globiceps* colonies throughout Saipan will be subject to injury (i.e., through small lesions from breaking off < 4 centimeter fragments from 60 individual colonies) as a part of the intended purpose of the Proposed Action. Because the Proposed Action will result in the directed take of *A. globiceps* only, and NMFS PIRO PRD does not expect that the Proposed Action will incidentally take any threatened or endangered species, an incidental take statement is not provided and the reinitiation trigger set out in 50 CFR 402. 16(1) is not applicable. However, if the directed take amount analyzed in this opinion is exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in 50 CFR 402.16(2) and/or (3) will have been met.

As noted in the *Description of the Proposed Action* section of this opinion, all action-related take of *A. globiceps* corals, and any other ESA-listed species, will be recorded and reported to NMFS PIRO PRD as soon as practicable, but on no less than on an annual basis if take has occurred.

10.1 Conservation Recommendations

The following conservation recommendation is a discretionary agency activity provided to minimize or avoid adverse effects of a Proposed Action on ESA listed species, to help implement recovery plans, or develop information:

NMFS OHC should support and encourage the awardee, JAMS, together with the various collaborative partners, to document and report to NMFS PIRO PRD the effectiveness of the project in meeting its objectives to: 1) develop and test novel settlement substrates designed to improve the efficiency of outplanting, or seeding, of sexually propagated juveniles at scale; 2) build local capacity in the CNMI to implement coral sexual propagation methods as part of a broader restoration strategy; and 3) test an existing island-wide resilience assessment as a framework for increasing larval outplant survivorship. Of specific interest to NMFS PIRO PRD are the project findings related to the practicability of seeding sexually propagated *A. globiceps* juveniles on natural reef habitats at scale, and ultimately how this may contribute to *A. globiceps* species survival and recovery.

10.2 Reinitiation Notice

This concludes formal consultation on the NMFS OHC proposed management of a CRCP grant funding activities associated with coral sexual propagation and distribution of settlement materials in Saipan, Commonwealth of Northern Mariana Islands. 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 for any species is exceeded;
2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;
3. The agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

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12 APPENDIX A: LISTED RESOURCES NOT CONSIDERED FURTHER

As addressed in the *Listed Resources Not Considered Further* section of this biological and conference opinion, NMFS PIRO PRD has determined that the Proposed Action is not likely to adversely affect the following threatened and endangered species: two (2) species of turtles, the Central West Pacific green sea turtle and Hawksbill turtle; and two (2) species of corals, *A. retusa* and *S. aculeata*. NMFS PIRO PRD has also determined that the Proposed Action is not likely to adversely affect critical habitat proposed to be designated for *A. globiceps*, *A. retusa* and *S. aculeata* in the *Action Area*. The reasons for NMFS's determinations are detailed below.

12.1 Listed Resources Exposure to Stressors

This section analyzes the Proposed Action's potential for exposing the Central West Pacific green sea turtle, Hawksbill turtle, *A. retusa* coral, *S. aculeata* coral, and proposed coral critical habitat to each of the stressors listed in the *Application of this Approach in this Consultation* section in the Opinion.

12.1.1 Sea Turtles

Direct physical impact

Direct Physical Contact with green sea turtles and hawksbill turtles could occur with equipment and materials during installation of settlement pools, anchors and concrete blocks in the coral nursery; with vessel anchors during deployment and retrieval; and with divers during all phases of project activities. Direct physical contact can cause injury and in severe cases, death of an animal (NMFS and USFWS 1998). However, turtles are highly mobile with capacity to swim away from activities, and multiple BMPs will be implemented to avoid proximity to, and contact with turtles (BMPs 1, 5-7, 9-10, and 12-15). Therefore, the likelihood of direct physical contact with green and hawksbill sea turtles is extremely unlikely to occur, and therefore discountable.

Entanglement

Entanglement of green and hawksbill sea turtles may occur with lines anchoring the settlement pools at the coral nursery; with vessel anchor lines when anchoring across the *Action Area*; and with marine debris inadvertently released from the project. Entanglement can cause physical damage to a turtle by partially severing limbs or fins, creating penetrating injuries, which can lead to death (NMFS and USFWS 1998; Seminoff et al. 2015). However, the settlement pools will be well anchored to the substrate using attachments and tethers that are as short as possible and taut, will be checked regularly, and will be on site only for about 2 to 3 months of each of the three project years. In the event of a strong storm event, the pools will secured on land prior to the event to prevent them from breaking loose. Vessels used are expected to be at anchor only for short periods of time with the anchor line kept at as short as possible. Marine debris is not expected to be released from activities. Given the above, and the implementation of BMPs to avoid entanglement (BMPs 3, 5 and 11), the likelihood of green and hawksbill sea turtles becoming entangled due to the Proposed Action is extremely unlikely to occur, and therefore discountable.

Introduction of invasive species

Introduction of invasive species in the *Action Area* may occur via vessels, equipment, divers and transfer of corals between project sites during all phases of project activities. Introduced invasive species have the potential to disrupt the natural ecosystems (Brainard et al. 2011) upon which green and hawksbill sea turtles depend on for food and habitat. However, the proposed activities will take place solely on Saipan, which reduces the potential for long-distance transport of invasive and nuisance species. In addition, all dive equipment, materials and instruments will be examined and rinsed with fresh water prior to use or deployment to ensure no organisms are being introduced or transported amongst project sites (BMP 20). An algae, *Chaetomorpha sp*. has become a problem on the east side of Saipan in Laolao Bay, smothering the reef flat and shallow spur and groove reefs in that area, stressing and killing coral colonies in some cases. Extra care will be taken to avoid transporting the filamentous algae should coral fragments be collected within that area. Therefore, the likelihood of introduction of invasive species caused by the Proposed Action and its effects on green and hawksbill sea turtles is considered extremely unlikely to occur, and therefore discountable.

Introduction of wastes and other pollutants

Waste, discharge and other pollutants may be introduced to the marine environment from vessels, materials, equipment and divers during all phases of project activities in the form of hydrocarbon-based chemical spills, inadvertent disposal of debris/trash, and leaching of toxins from materials used for settlement units and/or sunscreens used by divers. Environmental contamination can cause sea turtles to avoid an affected area; compromise their immunity and fertility; result in serious injury or in severe cases, death; and harm the communities that they feed on or shelter in (NMFS and USFWS 1998; NMFS and USFWS 2013). However, local and federal regulations prohibiting intentional discharge of pollutants and plastics into the marine environment, and the implementation of BMPs to control contamination (BMPs 16-19) will limit hydrocarbon-based chemical spills and disposal of trash. Any spills of fuel, lubricants and oil that occur are expected to be of minor volume, and will disperse quickly. During in-water operations, divers will use minimal and/or less harmful sunscreen, and will use clothing for sun protection wherever possible. The project's Principle Investigator (s) will consult with counterparts in the Caribbean to ensure that the most trusted and safe materials available are used for settlement units. Given the above information, the likelihood of green and hawksbill sea turtle exposure to waste, discharge and other pollutants is considered extremely unlikely to occur, and therefore discountable.

Vessel collisions

Vessel collisions with the green and hawksbill sea turtles, which are air-breathers, may occur from vessel transit among project sites during all phases of the project activities. Vessel collisions have the potential to injure or kill turtles (NMFS and USFWS 1998, 2013; Schoeman et al 2020). In Hawaii, the majority of vessel strikes (between 1982 and 2018) have involved green turtles, although vessel strike injuries have been identified for other species including hawksbill sea turtles (Kelly 2020; Brunson et al. in review). Green turtles are at higher risk of vessel strike compared to hawksbills turtles likely due to their higher abundance and density in nearshore shallow reef habitats and likely due to surface basking behavior, which increases their time at the surface (Kelly 2020). NMFS (2008) estimated 37.5 vessel strikes of sea turtles per year from an estimated 577,872 trips from vessels of all sizes in Hawaii, which translates to an estimated 0.04% probability of a turtle vessel strike (NMFS 2019).

The probabilities of an ESA-listed sea turtle vessel strike are likely much lower than this in the *Action Area* since there are fewer ESA-listed sea turtles and fewer vessels in Saipan compared to Hawaii. The sea turtles appear to display a stronger flight response in Saipan than in Hawaii (NMFS 2019), and the vessels that will be used for the project are relatively small. In addition, the vessel transits will be infrequent and relatively short in duration adding minimal appreciable change in vessel traffic in the *Action Area*. Limited sensory research has been conducted on sea turtle behavior relative to approaching vessels; however, a study from Australia found the proportion of green turtles that fled to avoid an approaching vessel increased significantly as vessel speed decreased (Hazel et al. 2007). Given the above information, and that BMPs (BMPs 2, 5, 7, 12 - 14) will be employed that will include slower speeds in shallow waters and the use of lookouts, the likelihood of vessels colliding with green and hawksbill sea turtles due to the Proposed Action is considered to be extremely unlikely to occur, and therefore discountable.

Noise

Noise exposure for green and hawksbill sea turtles may occur from vessel outboard motors during vessel transit across the *Action Area*, and from potential drilling or hammering of site markers at outplant sites. Man-made sounds can affect exposed sea turtles in several ways such as: non-auditory damage to gas-filled organs; hearing loss expressed in permanent threshold shift or temporary threshold shift hearing loss; behavioral responses; and reduced hearing by masking (i.e. the presence of one sound affecting the perception of another sound) (Popper et al. 2014). While the specific level of sound generated by the Applicant's vessels is unknown, sound generated by boat traffic is generally low frequency, which can travel long distances underwater (DOSITS 2020), and falls within the suspected hearing range of sea turtles. The sound will likely be below the estimated source levels for large commercial vessels that can range from < 150 dB to over 190 dB (re 1 μPa at 1m) (Popper et al. 2014), and not expected to exceed 160 - 166 dBRMS re 1 μPa, a threshold considered to cause harm to turtles (NMFS 2002; Popper et al. 2014). Vessel activity is not uncommon throughout Saipan and especially within Saipan Lagoon (NMFS 2019). Since vessels used by the Applicant will be small, transit infrequently and for short durations, the elevated noise levels generated are anticipated to be low, and barely above baseline levels. The noise from potential drilling or hammering of markers at outplant sites is anticipated to be very short-lived on the order of a couple of minutes per plot over the course of the project. Noise generated is expected to be well below the 160 - 166 dBRMS re 1 μPa threshold considered to cause harm to turtles. Given that BMPs will be implemented to maintain slow speeds of vessels and a distance between activities and turtles (BMPs 2, 5 - 9, and 12 - 14), the level of exposure of green and hawksbill sea turtles to noise is expected to be very low.

Increased turbidity

Increased turbidity exposure for green and hawksbill sea turtles may occur from disturbance of the sandy seafloor during installation of anchors and concrete blocks at the nursery site, and vessel anchor deployment and retrieval across the *Action Area*. Elevated turbidity in waters can reduce a turtle's ability to detect predators (Oliver et al. 2000), and sedimentation effects on communities such as coral reef and seagrass can negatively impact turtles' food sources (NMFS and USFWS 1998). However, anchors will only be deployed using hand tools, such as a drive rod or turning bar, with no holes, no digging and no concrete required resulting in minimal disturbance of sediment. In addition, the duration of the activities causing disturbance of sand is expected to be limited to minutes at the nursery site, and for vessel anchoring. Thus turbidity will be temporary and confined to the immediate vicinity of the source of disturbance. Given that sea turtles are highly motile and capable of avoiding turbid areas, and the Applicant will use monitoring and boating BMPs to maintain distance between activities and any observed turtles (BMPs 2, 4-9, and 12-15), the likelihood of green and hawksbill sea turtles being exposed to increased turbidity is extremely unlikely to occur, and therefore discountable.

Benthic disturbance and change in habitat

Benthic disturbance and change in habitat will occur as a result of the placement of the anchors and concrete blocks in the sandy habitat, and deployment of settling pools at the coral nursery where green and hawksbill sea turtles may currently pass through. Benthic disturbance and change in habitat can alter sea turtle foraging and resting behaviors (NMFS and USFWS 1998, 2013). However, there will only be a few anchors and blocks installed, each with a very small footprint, and confined to a small area. The seafloor at the nursery consists primarily of sand. It is unlikely favored turtle habitat because it is not optimal for foraging due to a lack of macroalgae or seagrass, and not optimal for resting or refuge because of the lack of structure and cover. The site is not unique and does not provide any type, quantity, or quality of habitat that cannot be found nearby within Saipan lagoon. Given the above information, the level of exposure of green and hawksbill sea turtles to the disturbance and change in habitat stressor is expected to be very low.

Conclusion

Green and hawksbill sea turtles are extremely unlikely to be exposed to direct physical contact; entanglement; introduction of invasive species; introduction of wastes and other pollutants; vessel collisions; and increased turbidity; and these effects are therefore all considered discountable. Because green and hawksbill sea turtle's exposure to noise, and benthic disturbance and change in habitat is not considered discountable, the significances of responses to such exposure are presented below in the Listed Resources Response to Stressors section.

12.1.2 Corals

Direct physical impact

Direct physical contact with *A. retusa* and *S. aculeata* corals could occur from placement of gamete collection tents over parent/donor coral colonies; installation of anchors on the seafloor to secure the settling pools; placement of cinder blocks on seafloor for temporary holding of settlement units; placement of settlement units at reef sites; drilling or hammering of markers into bottom at outplant sites; divers inadvertently handling or coming in contact with hard substrate during in-water activities; vessel anchoring across sites; and vessel groundings. Direct physical contact can abrade, fragment, dislodge and crush corals resulting in a range of impacts from minor tissue loss to death of a colony (Brainard et al. 2011). However, *A. retusa* and *S. aculeata* colonies are relatively rare in the *Action Area* and a range of BMPs will be employed (BMPs 1-5, and 8-10) to avoid any direct contact with listed corals. These include deploying anchors and blocks only in sandy substrate devoid of live coral; deploying boat anchors only in soft bottom areas with divers checking and adjusting anchors once deployed; and divers ensuring that no contact is made with listed corals while performing work. Experienced boat drivers are expected to navigate around shallow coral reef, and there is a low probability that *A. retusa* and

S. aculeata coral colonies would be present within an eventual grounding scar. Given the implementation of BMPs the likelihood *A. retusa* and *S. aculeata* corals being exposed to direct physical contact is considered to be extremely unlikely to occur, and therefore discountable.

Entanglement

Entanglement of *A. retusa* and *S. aculeata* with lines and other materials associated with the settlement pools at the coral nursery or vessel anchor lines will not occur since corals are sessile benthic organisms, and only present in the water column in their larval stage. *A. retusa* and *S. aculeata* coral larvae are currently not defined as an "individual" (79 FR 53851), and the reproductive biology of coral results in prolific larval production and high natural mortality (Brainard et al. 2011). Entanglement of *A. retusa* and *S. aculeata* may occur in the event of lines and other materials associated with the settlement pools at the coral nursery or vessel anchor lines breaking loose, draping and eventually becoming lodged around live or dead corals or other hard substrate structures. Depending on the nature of the entanglement from debris, this can abrade, fragment, dislodge and crush corals resulting in a range of impacts from minor tissue loss to death of a colony (Brainard et al. 2011). It can also reduce the quantity or quality of the hard substrate by damaging, altering and/or removing attributes such as crevices and holes, which can negatively impact the reef frameworks upon which the listed corals depend on. However, few lines will be used for the pools, and will be placed in the marine environment only for short durations. In the event of a strong storm event, the pools will be secured on land prior to the event to prevent them from breaking loose. Therefore, the likelihood of the Proposed Action causing entanglement of *A. retusa* and *S. aculeate*, or their habitat, is extremely unlikely, and therefore discountable.

Introduction of invasive species

Introduction of invasive species in the *Action Area* may occur via vessels, equipment, divers and transfer of corals among project sites during all phases of project activities. Introduced invasive species have the potential to increase exposure of corals to diseases, predation and competition, and to disrupt the natural ecosystem on which they depend (Brainard et al. 2011). As mentioned for the sea turtles above, the proposed activities will take place solely on Saipan and care will be taken to ensure no organisms are being introduced or transported amongst project sites (BMP 20), including the invasive *Chaetomorpha sp.* Given this, and that *A. retusa* and *S. aculeata* colonies are relatively rare in the *Action Area*, the likelihood of *A. retusa* and *S. aculeata* corals being exposed to the introduction of invasive species is considered extremely unlikely, and therefore discountable.

Introduction of wastes and other pollutants

Waste, discharge and other pollutants may be introduced to the marine environment from vessels, equipment and divers during all phases of project activities in the form of hydrocarbon-based chemical spills, inadvertent disposal of debris/trash, and leaching of toxins from materials used for settlement units and/or sunscreens used by divers. Exposure of corals to toxic substances may cause reduced growth, reproductive impairment, bleaching, or in some severe cases, death. Debris can abrade and smother corals. Sunscreens containing oxybenzone and other chemicals may disrupt coral reproduction, cause coral bleaching, and damage coral DNA (Brainard et al. 2011; Downs et al 2013; Downs et al 2015). However, as mentioned for the sea turtles above, various measures including BMPs (BMPs 16-19) will be implemented to limit hydrocarbon-based chemical spills, prevent disposal of trash/debris, and avoid toxins leaching from settlement unit materials and sunscreens. Any spills of fuel, lubricants and oil that occur are expected to be of minor volume, float i.e. not sink to the bottom where corals occur, and to evaporate and disperse quickly. Given the above information, and that *A. retusa* and *S. aculeata* corals are relatively rare in the *Action Area,* the likelihood of *A. retusa* and *S. aculeata* exposure to waste, discharge and other pollutants is considered extremely unlikely, and therefore discountable.

Vessel collisions

Vessel collisions with *A. retusa* and *S. aculeata* corals in the water column will not occur. Corals are sessile benthic organisms and not present in the water column except in their coral larval phase. Non-larval *A. retusa* and *S. aculeata* exposure to vessel grounding is addressed in the section *Direct physical impacts*. *A. retusa and S. aculeata* coral larvae are currently not defined as an "individual" (79 FR 53851), and the reproductive biology of coral results in prolific larval production and high natural mortality (Brainard et al. 2011). Therefore, the effects from vessel collision with the *A. retusa* and *S. aculeata* from the Proposed Action is extremely unlikely to occur, and therefore discountable.

Noise

Noise will be generated from vessel outboard motors during vessel transit across the *Action Area*, and from potential drilling or hammering of site markers at outplant sites. While there are studies that indicate that coral larvae can detect and move towards reef sounds (Vermeij et al 2010), and that this process can be disrupted by man-made noise generated by boat activity (Lecchini et al. 2018), there is no evidence that we are aware of that coral colonies can "hear" sound. Therefore, the effect of noise on *A. retusa* and *S. aculeata* is extremely unlikely to occur, and therefore discountable.

Increased turbidity

Increased turbidity exposure of *A. retusa* and *S. aculeata* may occur from disturbance of the sandy seafloor during installation of anchors and concrete blocks at the nursery site, and vessel anchor deployment and retrieval across the *Action Area*. Elevated turbidity can reduce light penetration through the water column potentially reducing photosynthesis of the coral algal endosymbiont (zooxanthellae), and can increase sediment settling onto corals resulting in varying effects including benign energy expenditure to shed the sediment, reduced reproduction, slowed growth, and in severe cases, death (reviewed in Brainard et al. 2011). However, the disturbance of sand is expected to be limited to a few occurrences for a matter of minutes at a time at the nursery site during the 3 year project duration, and infrequently for vessel anchoring during all phases of activities. The substrate that will generally be disturbed across project sites is expected to predominantly consist of larger grained sandy substrate that will settle out of the water column relatively quickly. Therefore, turbidity generated is expected to be temporary and confined to the immediate vicinity (> 3 m) of the source of disturbance. Given that listed *A. retusa* and *S. aculeata* corals do not grow in sandy substrate and are not expected to occur within these sandy bottom disturbance footprints, the likelihood of *A. retusa* and *S. aculeata* being exposed to increased turbidity caused by the action is considered extremely unlikely, and therefore discountable.

Benthic disturbance and change in habitat

Benthic disturbance and change in habitat will occur as a result of the installation of underwater structures on the seafloor at the coral nursery, and deployment of markers and settlement units at reef sites. Benthic disturbance and change in habitat can reduce the quality and quantity of hard substrate needed for corals to settle and grow, and can negatively impact the reef frameworks upon which ESA-listed corals depend on (Brainard et al. 2011). However, *A. retusa and S. aculeata corals* are not found within the predominantly sandy bottom at the coral nursery, and since hard substrate is necessary for corals to settle, it is unideal habitat for listed corals. The settlement units are small (tetrapods 8 cm - 10 cm, and beads 1 cm – 1.5 cm in size) and will be distributed in relatively low densities in small plots relative to the overall reef area. The markers are even smaller. They are expected to be deployed such not to abrade or displace live coral tissue, will be barely visible on the reef, and will provide beneficial substrate for coral settlement within the reef habitat. Given the lack of presence of *A. retusa* and *S. aculeata* at the coral nursery, avoidance of placing settlement units and markers on top of live coral tissue at reef sites, and the small size of settlement units placed on hard substrate, the level of exposure of *A. retusa* and *S. aculeata* to the disturbance and change in habitat stressor is considered extremely unlikely, and therefore discountable.

Conclusion

Listed *A. retusa* and *S. aculeata* corals are extremely unlikely to be exposed to direct physical contact; entanglement; introduction of invasive species; introduction of wastes and other pollutants; vessel collisions; noise; increased turbidity; and benthic disturbance and change in habitat. Because *A. retusa* and *S. aculeata* coral exposure to all stressors are considered discountable, no evaluation of response is required.

12.1.3 Critical Habitat

As noted in the *Critical Habitat* section, critical habitat is proposed to be designated within the *Action Area* for *A. globiceps*, *A. retusa* and *S. aculeata* corals within waters 0-40 meters depth around Saipan (except for the areas specified in the *Critical Habitat* section). Proposed coral critical habitat consists of substrate and water column habitat characteristics essential for the reproduction, recruitment, growth, and maturation of the listed corals. Sites that support the normal function of all life stages of the corals are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column. The four essential features of proposed coral critical habitat are:

1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae;
2. Reefscape (all the visible features of an area of reef) with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae;
3. Marine water with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function; and
4. Marine water with levels of anthropogenically-introduced (from humans) chemical contaminants that do not preclude or inhibit any demographic function.

Direct physical impact

Direct physical contact with proposed coral critical habitat's hard substrate, including essential features (1) and (2) as listed above, may occur from the same set of activities as described in the Corals *Direct physical impact* section above. Depending on the nature of contact, direct physical contact can reduce the quality and quantity of hard substrate needed for listed corals to settle and grow. However, the BMPs to be employed to avoid contact with listed corals and their habitat (BMPs 1-4 and 8-10), will minimize direct contact with critical habitat's hard substrate including essential features (1) and (2). Given the nature of the stressor, direct physical contact will have no effect on proposed critical habitat's water column, including essential features (3) and (4). Based on this information, the likelihood of proposed coral critical habitat being exposed to direct physical contact is considered extremely unlikely, and therefore discountable.

Entanglement

Entanglement with the proposed coral critical habitat's hard substrate, including essential features (1) and (2), may occur in the event of lines and other materials associated with the settlement pools at the coral nursery or vessel anchor lines breaking loose, draping and eventually becoming lodged around live or dead corals or other hard substrate structures. Depending on the nature of the entanglement, this can reduce the quantity or quality of the hard substrate by damaging, altering and/or removing attributes such as crevices and holes, which can negatively impact the reef frameworks upon which listed corals depend on. However, as described above for *A. retusa* and *S. aculeata* corals, few lines will be used for the pools, and will be placed in the marine environment only for short durations. In the event of a strong storm event, the pools will be secured on land prior to the event to prevent them from breaking loose. Given the nature of the stressor, entanglement will not affect proposed critical habitat's water column, including essential features (3) and (4). Based on the above, the likelihood of the proposed coral critical habitat being exposed to entanglement is considered extremely unlikely, and therefore discountable.

Introduction of invasive species

There is a potential for the introduction of invasive species from vessels, equipment, and divers associated with proposed activities to have an effect on proposed coral critical habitat's hard substrate, including essential features (1) and (2), during all phases of the project. Introduced invasive species, such as fleshy algae or sponges, have the potential to reduce the quantity or quality of the hard substrate, through occupation and dominance of the hard substrate, which can negatively impact the reef frameworks upon which listed corals depend on. However, as mentioned for the listed sea turtles and *A. retusa* and *S. aculeata* corals, the proposed activities will take place on Saipan solely, and care will be taken to ensure no organisms are being introduced or transported amongst project sites (BMP 20), including the invasive *Chaetomorpha sp*. Given the nature of the stressor, introduction of invasive species will not have any effects on proposed critical habitat's water column, including essential features (3) and (4). Based on this information, the likelihood of the proposed coral critical habitat being exposed to the introduction of invasive species is considered extremely unlikely, and therefore discountable.

Introduction of wastes and other pollutants

As mentioned above for sea turtles and corals, waste, discharge and other pollutants may be introduced to the marine environment from vessels, equipment and divers during all phases of project activities in the form of hydrocarbon-based chemicals, debris/trash, and toxins from materials used for settlement units and/or sunscreen. Similar to the analysis provided for *A. retusa* and *S. aculeata* corals, depending on the nature of the discharge/s, these may affect proposed critical habitat hard substrate, including essential features (1) and (2), and critical habitat's water column, including essential features (3) and (4). The quantity and quality of hard substrate needed for corals to settle and grow may be reduced through for example contaminants harming live coral tissue, nutrients promoting fleshy algal growth, and trash abrading and breaking coral skeletons. In addition, discharge may reduce water quality. However, as mentioned above for listed corals, various measures including BMPs will be implemented to limit discharges and their effects on organisms, hard substrate and water quality. Therefore, the likelihood of proposed coral critical habitat being exposed to waste, discharge and other pollutants is considered extremely unlikely, and therefore discountable.

Vessel collisions

Vessel collisions with proposed coral critical habitat hard substrate, including essential features (1) and (2), will not occur due to the lack of spatial overlap between hard substrate and vessel movement in the water column. Exposure of hard substrate including corals to vessel grounding is addressed in the *Direct physical impacts* section above. In addition, given the nature of the stressor, vessel collisions will have no effect on proposed critical habitat's water column, including essential features (3) and (4).

Noise

Noise exposure of proposed coral critical habitat's hard substrate, including essential features (1) and (2), will not occur as there is no evidence, as mentioned for corals above, that coral colonies, or hard substrate, can "hear" sound. The temporary and minor levels of sound generated from project activities as mentioned above, are not expected to be associated with pressure waves. In addition, given the nature of the stressor, noise will have no effect on proposed critical habitat's water column, including essential features (3) and (4).

Increased turbidity

Increased turbidity exposure of proposed coral critical habitat's hard substrate, including essential features (1) and (2), and critical habitat's water column, including essential features (3) and (4), is extremely unlikely to occur due to the lack of spatial overlap between hard substrate (and the overlaying water column) and any turbidity plume/s generated by the sediment disturbance activities associated with the proposed action. As mentioned for listed corals above, turbidity would be associated only with activities causing disturbance of sand, which is expected to be limited to a few occurrences for a matter of minutes at a time at the nursery site during the 3 year project duration, and infrequently for vessel anchoring across the *Action Area* during all phases of activities. Any turbidity generated is expected to be temporary and confined to the immediate vicinity (> 3 m) of the source of disturbance. Based on this analysis, the likelihood of proposed coral critical habitat being exposed to increased turbidity is considered extremely unlikely, and therefore discountable.

Benthic disturbance and change in habitat

Proposed coral critical habitat's hard substrate, including essential features (1) and (2) will be exposed to the benthic disturbance and change in habitat stressor as a result of the placement of settlement units and installation of plot markers on hard substrate at reef sites. Benthic disturbance and change in habitat can reduce the quality and quantity of the essential features listed above, and the hard substrate needed for the listed corals to settle and grow. Given the nature of the stressor, benthic disturbance and change in habitat will have no effect on proposed critical habitat's water column, including essential features (3) and (4). As per the analysis conducted for *A. retusa* and *S. aculeata* corals, the level of exposure of proposed coral critical habitat to the disturbance and change in habitat stressor is expected to be minor.

Conclusion

Proposed coral critical habitat's hard substrate and associated water column, including essential features (1), (2), (3) and (4) are extremely unlikely to be exposed to direct physical contact; entanglement; introduction of invasive species; introduction of wastes and other pollutants; vessel collisions; noise; and increased turbidity. Because coral critical habitat's hard substrate, including essential features (1) and (2), exposure to benthic disturbance and change in habitat is not considered discountable, the significance of responses to such exposure is presented below in the *Listed Resources Response to Stressors* section.

12.2 Listed Resources Response to Stressors

This section analyzes the significances of responses of green and hawksbill sea turtles and proposed coral critical habitat to noise and the benthic disturbance and change in habitat stressors. Where exposure to a stressor is considered to not occur or is discountable, the ESA-listed species or proposed coral critical habitat's response to the stressor is not discussed.

12.2.1 Sea Turtles

Noise

Noise generated from the vessel outboard motors will be of low frequency, and this, as well as sounds generated from potential drilling or hammering of site markers at outplant sites, will be of minimal level and duration. Sea turtles hear well underwater, but their greatest hearing sensitivity lies within the envelope of sound produced by seismic sources (Van der Wal et al 2016). While sea turtle sensory biology is not well understood, information exists supporting the claim that sea turtles rely more on visual cues than auditory ones to react to their environment (NMFS 2016b; NMFS 2018). A few studies have demonstrated that sea turtles have limited reactionary behavior to sound below a certain level of intensity, roughly between 120 dB and 160 dB (reviewed in Kelly 2020), and acoustic stimuli may provide important environmental cues for sea turtles (Piniak et al. 2016). If and when an ESA- listed sea turtle is exposed to noise from vessels in the *Action Area*, the turtle is expected to respond with no more than temporary and recoverable behavior, which may include avoidance or halting its activities briefly. Given the low consequence of the response of the ESA-listed sea turtles to noise generated from vessel activity, we expect the response of the green and hawksbill sea turtles to the effect of noise from the Proposed Action to be insignificant.

Benthic disturbance and change in habitat

Benthic disturbance and change in habitat due to the temporary installation of anchors, concrete blocks, and deployment of settling pools at the coral nursery site in Saipan Lagoon will be minor. Green and hawksbill sea turtles are currently not known to use the site for foraging or resting (NMFS 2019), and are not expected to change their foraging or resting behavior in the general area as a result of the minor alteration of habitat. Given the low consequence of the response to the stressor, we expect the response of green and hawksbill sea turtles to the effect of benthic disturbance and change in habitat from the Proposed Action to be insignificant.

Conclusion

The responses of green and hawksbill sea turtles to the effects of noise and benthic disturbance and change in habitat stressors resulting from the Proposed Action will be of low consequence, and therefore insignificant.

12.2.2 Critical Habitat

Benthic disturbance and change in habitat

Benthic disturbance and change in habitat resulting from the placement of coral settlement units and installation of plot markers on hard substrate at reef sites will be minor. Any associated change in habitat, specifically alternation of the quantity and quality of critical habitat's hard substrate, including essential features (1) and (2), is expected to be barely detectable: the small settlement units will mimic and be incorporated into the hard substrate reef landscape immediately given the number, the type of materials, size, shape and placement of the units on the reef, and the plot markers are expected to be covered with filamentous algae and/or crustose coralline algae within a matter of days. Given the low consequence of the response to the stressor, we expect the response of proposed coral critical habitat to the effect of benthic disturbance and change in habitat from the Proposed Action to be insignificant.