United States Department of the Interior
FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawaii 96850

In Reply Refer To:
01EPIF00-2015-F-0025
01EPIF00-2016-F-0185

Commander Jeffrey S. Powell
Director, Pacific Programs Office
Office of the Assistant Secretary of the Navy (OASN)
Energy, Installations and Environment (EI&E)
1000 Navy Pentagon
Washington, DC 20350-1000

Subject: Reinitiation of the 2015 Biological Opinion on the Department of the Navy's Relocation of U.S. Marine Corps from Okinawa to Guam and Associated Activities on Guam

Dear Commander Powell:

This document transmits the U.S. Fish and Wildlife Service's (Service[1]) Biological Opinion (BO) regarding effects on the 11 endangered or threatened species listed in **Table 1**, from the proposed action of relocating U.S. Marine Corps (USMC) personnel from Okinawa to Guam and related infrastructure construction and military training activities. The U.S. Department of the Navy (DON) is the designated lead Federal agency for this consultation. This BO is a partial reinitiation of the *Biological Opinion for the DON's Relocation of the U.S. Marine Corps from Okinawa to Guam* (2015 BO) (USFWS 2015a), finalized on July 31, 2015. On October 1, 2015, the Service listed 23 species located in Micronesia as endangered or threatened (80 FR 59424). Of these 23 species, 13 were found to occur adjacent to or within the proposed project areas (**Table 1**).

The action to relocate USMC personnel to Guam was first consulted on in January 2010 and a BO was signed on September 8, 2010 (2010 BO) (USFWS 2010). In October 2014, the DON requested reinitiation of the 2010 BO due to significant changes to the proposed action. The conclusion of that reinitiation resulted in the 2015 BO, which completely superseded the 2010 BO.

[1] A complete list of acronyms can be found in **Appendix A**.

This BO is a reinitiation of the 2015 BO for the Mariana fruit bat only and superceeds all information and analysis related to the Mariana fruit bat in the 2015 BO. Information and analysis in the 2015 BO for the Mariana crow (*Corvus kubaryi*), Guam Micronesian kingfisher (*Todiramphus cinnamominus cinnamominus*), Guam rail (*Gallirallus owstoni*), and *Serianthes nelsonii* remains binding. This BO also evaluates anticipated effects of the proposed action on 10 newly listed species that are known to occur within the project area and their terrestrial habitat. This BO was prepared in accordance with the requirements of section 7 of the Endangered Species Act (Act) of 1973 as amended (16 U.S.C. § 1531 *et seq*.).

**Table 1.** Endangered and threatened species addressed in this BO, their listing status in accordance with section 4 of the Act, and the effect determination made by DON.

| **Common Name** | **Scientific Name** | **Listing Status** |
|---|---|---|
| **May Affect, Likely to Adversely Affect Determination** | | |
| Mariana fruit bat | *Pteropus mariannus mariannus* | Threatened |
| Mariana eight spot butterfly | *Hypolimnas octocula marianensis* | Endangered |
| Humped tree snail | *Partula gibba* | Endangered |
| Guam tree snail | *Partula radiolata* | Endangered |
| Fragile tree snail | *Samoana fragilis* | Endangered |
| No Common Name (NCN) | *Bulbophyllum guamense* | Endangered |
| NCN | *Cycas micronesica* | Threatened |
| NCN | *Dendrobium guamense* | Threatened |
| NCN | *Heritiera longipetiolata* | Endangered |
| NCN | *Tabernaemontana rotensis* | Threatened |
| NCN | *Tuberolabium guamense* | Threatened |
| **May Affect, Not Likely to Adversely Affect Determination** | | |
| NCN | *Eugenia bryanii* | Endangered |
| NCN | *Maesa walkeri* | Threatened |
| NCN | *Nervilia jacksoniae* | Threatened |

On March 3, 2017, the DON also requested our concurrence with a determination that the proposed action may affect, but is not likely to adversely affect (MA,NLAA) the endangered plant, *E. bryanii* (DON 2017a). Subsequent email correspondence and discussions, that began on May 3, 2017 and concluded on May 17, 2017, resulted in the inclusion of the endangered plants, *M. walkeri* and *N. jacksoniae* to the DON's MA,NLAA concurrence request. Our review of these determinations and a concurrence with the DON's effect determinations for *E. bryanii, M. walkeri,* and *N. jacksoniae* is located in **Appendix B**.

This BO is based on information provided in your March 10, 2015 letter and Conference Assessment (DON 2015a), the subsequent Revised BA, email correspondences, discussions between the Service and DON, and information contained in our files. A complete administrative record for this consultation is in the Service's Pacific Islands Fish and Wildlife Office (PIFWO) in Honolulu, Hawaii.

**Consultation History**

March 10, 2015. The DON submitted a request for initiation of a Conference consultation on

seven federally proposed species (*B. guamense*, *C. micronesica*, *T. rotensis*, Mariana eight spot butterfly (*H. octocula marianensis*), humped tree snail (*P. gibba*), Guam tree snail (*P. radiolata*), and fragile tree snail (*S. fragilis*)) that may occur in the project action area. The DON determined that the proposed project MA,NLAA these federally proposed species. The DON conference assessment did not include *D. Guamense*, *P. malaspinae* and *T. guamense* in their analysis due to their initial review of these species and *no effect* determinations.

March 24, 2015. The Service informed the DON via a conference call that we did not concur with their no effect and MA,NLAA determinations on the proposed project's potential effects to federally proposed species within the action area.

March 25, 2015. The DON submitted proposed Conservation Recommendations to the Service, including: (1) DON's active participation in recovery committees for endangered or threatened species on Guam and DON's commitment to work with the Service to develop a re-introduction plan and supporting programmatic BO that ensures such re-introduction efforts are consistent with species recovery plans and the military mission on Guam; (2) developing a team to explore the establishment of potential conservation area(s) in the Mariana Islands as part of a broader consultation solution; (3) working with the Service, other Federal agencies, as appropriate, and Government of Guam to use their authorities to carry out programs for the conservation of threatened and endangered species; and, (4) incorporating habitat conservation areas and actions into the Joint Region Marianas (JRM) Integrated Natural Resource Management Plan (INRMP), because (a) INRMPs ensure military operations and natural resources conservation are integrated and consistent with stewardship and legal requirements; and, (b) INRMPs are planning documents that allow Department of Defense (DoD) installations to implement landscape-level management of their natural resources while coordinating with various stakeholders.

June 11, 2015. The Service and DON entered into an MOA (DON & USFWS 2015) to ensure that sufficient amounts of suitable survival and recovery habitat for the Guam Micronesian kingfisher would be conserved and managed within DoD lands in northern Guam.

July 31, 2015. The Service issued a BO (TAILS # 2015-F-0025) (2015 DON BO) to the DON for their Relocation of the Marine Corps from Okinawa to Guam and Associated Activities on Guam (USFWS 2015a). The Service's Pacific Northwest Regional Office notified the DON that work on the Conference Assessment for the proposed species would start in August and should be completed by November 30, 2015.

August 21, 2015. During a DoD/Service meeting in Hawaii, DoD provided the status of the Marine Corps Relocation project and how the schedule of the consultation related to the timelines of the action as one subset of multiple other military projects. September 3, 2015. The Service acknowledged receipt of the DON's March 10, 2015 letter and Conference Assessment dated February 26, 2015, requesting a Conference on the effects of the proposed project on the seven federally proposed species noted in their letter. The

Service noted the review of incoming documents was delayed because of PIFWO's substantial section 7 consultation workload. The Service also requested clarification on the DON's use of the term "maximum extent practicable" related to their proposed conservation measures (The Service noted that the "maximum extent practicable" standard applies to Section 10 permit actions and does not apply to Section 7 consultations; however, it was discussed during this process to characterize conservation measures); a re-evaluation of their species effects determinations; and, the status of surveys for the proposed species conducted within the project footprint, including areas to be used for training within the Naval Base Guam's Naval Munitions Site (NMS) that was discussed August 21, 2015.

September 15, 2015. The DON responded to the Service's September 3, 2015 letter acknowledging completed survey data for newly listed species and requested confirmation of any additional surveys available. The DON also requested formal Conference on the species included within their March 10, 2015 Conference Assessment.

September 22, 2015. The Service provides DON with a revised DoD consultation "stacking" schedule based on the discussions with DoD on August 21, 2015.

October 1, 2015. The final listing rule for 23 species was published in the Federal Register (80 FR 59424).

October 1 & 2, 2015. The DON and the Service held in-person meetings on Guam. DON provided an update on the implementation of the conservation measures detailed in the 2015 DON BO. The DON requested to reinitiate the consultation because of potential project effects to five of the newly listed species (Mariana eight spot butterfly, *B. guamense*, *C. micronesica*, *T. rotensis*, and *H. longipetiolata*). The DON provided a map of *B. guamense*, *T. rotensis*, *T. guamense*, *H. longipetiolata*, and *D. guamense* locations within the ungulate exclusion fence at Northwest Field (NWF), Andersen Air Force Base (AAFB). The Service requested the survey results, including the methods, for the newly listed plants within the action area and was told the surveys would not be completed for eight months. The Service indicated this information was needed to complete the status of the species in the action area and confirm the project effect determinations for the newly listed species. The DON stated they would submit a progress report for surveys (including methods and results) in northern Guam. The DON and the Service also discussed the information needs, the timeline for the reinitiated consultation, and the re-evaluation of the effect determinations per the Service's September 3, 2015 letter. The Service and DON discussed the likelihood and challenges for successfully translocating recovered host plants for the Mariana eight spot butterfly due to habitat restrictions.

October 2, 2015. The DON provided information via email on the status of the JRM's fiscal year 2014 project on the *C. micronesica* in Tinian as requested by the Service.

October 13, 2015. The DON requested that project activities for geotechnical borings be allowed to proceed within areas of Northwest Field (DON project P-715 area) and Finegayan

(DON project J-016 area). The DON submitted maps of the newly listed species within both areas for the Service's review.

October 14, 2015. The Service emailed the DON a reminder of the request for the survey results for the newly listed plants within the action area. The Service also stated an updated BA would not be required contingent upon the DON providing the missing information and clarifications requested in the Service's September 3, 2015 request letter.

October 14, 2015. The DON emailed a map of listed species locations within the ungulate eradication fence to the Service. In addition, the DON stated the final report for the newly listed species would not be completed for another eight months because the DON modified the cooperative agreement to add additional survey areas. However, the DON would submit a progress report.

October 26, 2015. The DON submitted a letter in response to the Service's September 3, 2015 letter requesting clarification. The letter confirmed the request for a section 7 consultation for the five newly listed species discussed at the October 1 and 2, 2015 meeting; a statement that the survey maps of recently completed surveys for the NWF area were provided to the Service on October 13, 2015; a statement that the proposed action would directly impact the Mariana eight spot butterfly, *T. rotensis*, and *H. longipetiolata*; a statement that no project impacts are anticipated for *B. guamense*, *C. micronesica*, humped tree snail, Guam tree snail, and fragile tree snail; a statement that no Marine Corps relocation related ground training would occur in the Naval Munitions Storage (NMS); and a list of best management practices (BMPs).

October 29, 2015. The DON and the Service discussed the October 26, 2015, letter stating that no project impacts were anticipated for *B. guamense*, *C. micronesica*, humped tree snail, Guam tree snail, and the fragile tree snail. The DON stated that the consultation should be formal for *B. guamense* and *C. micronesica* and informal for the three listed snails.

November 10, 2015. The DON provided the Service with the monthly status reports of plant surveys (October 2014 to August 2015) that were submitted to JRM. These surveys did not include sufficient data and maps to address the Service's request for the complete surveys.

November 20, 2015. DON met with University of Guam butterfly researchers/experts to discuss the recovery value and the feasibility or logistics of the proposed conservation measures for the Mariana eight spot butterfly. The Service staff was unable to attend at the last minute due to extreme weather events.

November 24, 2015, The DON submitted maps for the Service's review that included plant species of cultural importance (including newly listed speices and high value trees) within geotechnical boring project activity sites in the Northwest Field and Finegayan

December 1, 2015. The Service approved the request to initiate work on geotechnical borings within the P-175 area.

December 3, 2015. The Service emailed the DON requesting the DON's proposed conservation measures for the Mariana eight spot butterfly. The DON and the Service discussed re-scheduling the November 20, 2015 meeting since the majority of partners were unable to attend.

December 15, 2015. In a letter and enclosed map, the DON included the locations of *T. guamense* and *D. guamense* within the northern Finegayan area. The DON requested these two species be included in the section 7 consultation and concluded that the proposed action may affect, but was not likely to adversely affect *T. guamense* and *D. guamense*.

December 16, 2015. The DON and Service held a teleconference focused on the December 15, 2015 letter and the conservation measures proposed for the *T. guamense*, *D. guamense*, and the Mariana eight spot butterfly. December 17, 2015. The DON sent an email to the Service requesting the due date of the final consultation.

December 22, 2015. The DON and the Service agreed to a revision of the Guam Micronesian Kingfisher (GMK) Recovery Habitat Memorandum Of Agreement (MOA), which was originally signed on June 11, 2015. The modification identified a mutually agreed upon revised configuration for 5,234 acres of habitat for the recovery and survival of GMK in northern Guam.

January 11, 2016. The Service requested an update on geotechnical boring activities proceeding within the NWF (DON project P-715 area) and Finegayan areas (DON project J-016 area).

January 12, 2016. The Service requested the DON review the description of the proposed training activity at the NMS to ensure the accuracy of the proposed action.

January 21, 2016. In response to the Service's January 11, 2016 request for an update, the DON reported that the Route 3A geotechnical work was completed, and the geotechnical work within the LFTRC was currently in progress with biomonitors accompanying the geotech crew on site.

January 21, 2016. The DON and Service discussed the timeline for the completion of the formal consultation. The Service inquired about the status of the report on species surveys within the ungulate exclusion fencing at NWF. The Service advised the DON that if a BO is completed based on the information to date, formal consultation may need to be reinitiated if new information revealed effects not considered in the resulting BO. As a follow up to the December 16, 2015 meeting, the DON stated they would not salvage *T. guamense* and *D. guamense*.

January 26, 2016. The DON and the Service discussed finalization of the BO to include the newly listed species and agreed that the target due date would be the end of March 2016.

January 28, 2016. The DON and the Service discussed the language to describe a qualified biologist per implementation of conservation measures in the draft BO, status of the ungulate eradication fence relocation at NWF, review of the Consultation History section of the draft BO, and status of the informal consultation for the subject action. The DON stated that any salvage or translocation of *T. guamense* and *D. guamense* should be included as a conservation recommendation (i.e., not as a conservation measure) in the final BO.

January 31, 2016. The DON asked for a timeline to complete the draft BO and review the DON's comments and finalize the BO.

February 3, 2016. The Service stated that they would provide a signed BO within five business days after receiving DON's comments on the draft BO.

February 4, 2016. The DON sent a letter to the Service to confirm the timeline changes for completing the draft BO. The DON asked the Service to provide a draft BO by mid-March, followed by a review period, with an anticipated final BO due in mid-April. The letter also included new information identifying over 5,000 *T. guamense* and over 300 *D. guamense* at Finegayan that had to be incorporated into the effects analysis.

February 4-12, 2016. Emails were exchanged between the DON and the Service clarifying the number of *B. guamense*, *T. guamense*, and *D. guamense* individuals within the action area, the number of individuals that would be removed as a result of the proposed project activities, additional project details, and a reference for the information on environmental baseline conditions for *S. nelsonii*.

February 5, 2016. The Service acknowledged that sufficient information to reinitiate the subject formal consultation was received from the DON for the following species; Mariana eight spot butterfly, *B.guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense*. The Service stated that a draft BO would be completed on March 25, 2016 and a final BO would be completed by April 15, 2016. The Service also acknowledged an ongoing dialog about the increase in the population of the Mariana fruit bat and whether that might warrant a revision to the effects analysis in the July 31, 2015 BO.

February 6, 2016. The Service and DON discussed U.S. Marine Corps (USMC) training at the NMS. The DON stated that the Project Description would not include USMC training at the NM) and that no Marine relocation ground training was planned in the NMS area over the next 5 years. DON would re-initiate if the species were listed and there would be a potential to affect the species in the NMS.

February 17, 2016. The Service sent the DON a draft Consultation History section for review.

February 19, 2016. The Service emailed the DON requesting the inclusion of a conservation measure to salvage and relocate the listed orchids, specifically *T. guamense* that could not be avoided in the course of construction.

February 23, 2016. The DON emailed a report to the Service on the monitoring of Mariana fruit bat within the Habitat Management Unit (HMU) at (AAFB). The report documents observations in one area of up to 112 fruit bats within the HMU.

February 24, 2016. The Service requested information on the number of *T. rotensis* individuals that would be removed as a result of the action.

February 24, 2016. The DON sent a letter to the Service requesting to reinitiate consultation on Mariana fruit bat as part of the on-going Marine Relocation to Guam consultation.

February 24, 2016. The DON emailed a report entitled *Memorandum for File, Subject: Pre-Construction High Value Tree (HVT) Surveys of J-001B Utilities and Site Improvements Phase I, Naval Base Guam*. The initial surveys focused on plant species of cultural importance and included the following HVTs: *C. micronesica (*cycad*), Intsia bijuga* (ifit), *Elaeocarpus joga* (joga), *Artocarpus mariannensis* (seed breadfruit), and *Artocarpus altilis* (seedless breadfruit). Additional tree species observed include *Ficus prolixa* and *F. tinctoria* (banyan) and *Maytenus thompsonii.* The supplemental surveys focused on re-surveying the HVTs post-storm events. Incidental sightings of plant species that were listed on November 1, 2015 and host plants for the Mariana eight spot butterfly were also recorded during the supplemental surveys.

March 1, 2016. The DON provided the Service comments on the draft BO Consultation History.

March 2, 2016. The DON determined and provided the number of *T. rotensis* individuals that would be removed as a result of the action.

March 3, 2016. The Service asked DON to provide the report on the surveys for the Mariana eight spot butterfly that indicated this species occurs at the Mangilao golf course and Fadian Cove, as stated in the DON's conference assessment.

March 10, 2016. The DON sent an email to the Service stating that *T. guamense* and *D. guamense* would be salvaged within the action area to the maximum extent practicable.

March 14, 2016. The Service and the DON discussed by teleconference project activities that would adversely affect the Mariana eight spot butterfly and *T. guamense*. Clarification on the impacted area for the butterfly within the proposed Live-Fire Training Range Complex (LFTRC) and proposed conservation measures for these two listed species were also discussed. The Service stated their preliminary analysis on the project impacts of the DON's action indicated very serious deleterious consequences for *T. guamense* and Mariana eight spot butterfly. The Service indicated the seriousness of the concern could likely push back finalization of the draft BO scheduled for March 25. The Service asked if the DON could possibly avoid taking approximately 5,000 *T. guamense* plants from the Finegayan area. The Service also indicated that one firing range, as currently planned, would take one of nine known populations of Mariana eight spot butterflies, and asked if

the range could be altered to avoid the take. The DON stated it would seek clarification and evaluate possible options.

March 21, 2016. The DON indicated that the construction plans for the Finegayan area were not finalized, and they could not be specifically altered at the current time because neither the construction bids nor the geological analyses of the site suitability were completed. The DON maintained that construction would avoid the orchids to the "maximum extent practicable" and that they would re-insert the conservation measure to relocate individuals that could not be avoided. The Service made clear that the success of transplantation was unknown and had to be considered as such in the analyses, and offered that the effects would likely still be severe unless more plants could be avoided. The DON suggested that the host plants of the Mariana eight spot butterfly might not be in the impact zone of the live-fire training range, and offered to provide some more detailed maps to better indicate the location of the butterflies relative to the range.

March 22, 2016. The DON sent additional information on the number of individuals of *T. guamense* that occur within DoD land on Guam.

March 24, 2016. The DON sent the rare plant survey report, titled "Plant Surveys, Joint Region Marianas Interim Report" to the Service.

March 31, 2016. The DON reviewed and updated the draft conservation measures for the proposed project to include the Newly Listed Species: Mariana eight spot butterfly, *B. guamense, C. micronesica, D. guamense, H. longipetiolata, T. rotensis,* and *T. guamense*.

April 4, 2016. Service staff conducted site visits of the AAFB portion of north Finegayan area to assess general habitat and growth characteristics of *T. guamense* in the wild. The purpose of the visit was to look at the existing habitat that the orchids inhabited and document observations to assist in the effects analysis and development of conservation measures.

April 5, 2016. The DON and the Service discussed by phone the DON's current understanding of the number of *T. guamense* and the construction impact on the Mariana eight spot butterfly. The DON indicated they would only be able to avoid 838 *T. guamense* of the just over 5,000 in the Finegayan action area (of the over 7,000 then identified on Guam) and that they could still not identify exactly which 838 *T. guamense* individuals would be avoided. In addition, while the DON was confident about avoiding 300 individuals, they were less certain about their ability to avoid the other approximately 500 of the 838. The Service indicated that this would have a substantial effect on the orchid population. The Service also stated the location of the avoided *T. guamense* individuals would be important, since not all habitat is created equal, and stated concerns with fragmentation of the *T. guamense* population. The DON indicated it was not possible to move the firing range that was going to impact the Mariana eight spot butterfly habitat due to safety issues on other adjacent firing ranges. The Service requested Geographic Information System (GIS) shape files for the locations of both the butterflies and the orchids.

April 11, 2016. Service staff conducted site visits of the Finegayan area to assess general habitat and growth characteristics of *T. guamense* in the wild.

April 13, 2016. The DON and the Service discussed the status of the draft BO. The Service indicated they had received all needed information except for that anticipated from a field visit planned to the Finegayan action area. The DON confirmed that impact area around the firing range was still as mapped (i.e., including the demolition of six of the nine known host plant locations of the Mariana eight spot butterfly). The Service indicated again that the proposed action effects on *T. guamense* and the Mariana eight spot butterfly were sufficiently significant to potentially delay finalizing the BO and would likely require Service review above the Field Office level.

April 18, 2016. DON escorted the Service in the field to look at the clusters of orchids near the NE corner of Finagayan.

April 26–May 5, 2016. Through a series of calls, the Service and the DON discussed possible alternative minimization and conservation measures for *T. guamense* and the Mariana eight spot butterfly.

April 29, 2016. The DON emailed the Service with an adjustment (including map and description of the change to the proposed action) to the firing range construction that would allow the DON to avoid all nine known locations of the Mariana eight spot butterfly. The DON included a map with this email as well as a description of the change to the proposed action.

May 4, 2016. The DON emailed the Service proposing further adjustments to the Finegayan construction area which would avoid 3,485 *T. guamense* individuals and a commitment to transplant an additional 2,000 individuals with an estimated success rate of 50 percent for the translocations (i.e. 1,000 successfully translocated and surviving)

May 5, 2016. The Service requested a consolidated proposal that would describe these proposed changes to facilitate review so that the draft BO could be sent to the DON by the end of May.

May 11, 2016. The DON emailed a letter and attachments of the consolidated proposals for best management practices and conservation measures on *T. guamense* and the Mariana eight spot butterfly for the Marine Corps Relocation to Guam to the Service.

July 8, 2016. In-person meetings between DON and the Service discussed the status of the consultation analysis and release of the draft BO.

July 17, 2016. The Service provided the DON a preliminary working draft BO for review. The draft BO contained analysis of impacts to only two of 11 species contained in the scope of the consultation.

July 24-28, 2016. Three-day meeting in Portland between DoD-Service representatives to discuss next steps in the development of Marianas Archipelago Conservation Strategy (MACS) that supports Service conservation initiatives and the DoD mission in the Region, and the Conservation Recommendations in the July 2015 BO while also providing overarching benefits to affected jurisdictions.

August 3, 2016. Conference call between DON and Service to determine a meeting date and to discuss DON's questions regarding the preliminary draft BO.

August 23-24, 2016. Meeting in Hawaii between the Service and DON to discuss the preliminary work on the draft BO. The discussion centered on new known occurrences of *T. guamense*, edge effect analysis, and potential impacts to butterflies and the conservation measures that would address these impacts. Review of the conservation measures offered by DON was conducted and a discussion of "certainty of effectiveness" led to Service requesting DON to provide additional information.

October 28, 2016. Conference call between the DON and the Service to discuss summary points and action items from the August 23-24, 2016, meeting in Hawaii. Discussion topics included ungulate eradication fence at NWF, butterfly rearing data from Dr. Moore's (University of Guam) research, and a BO amendment for Mariana fruit bat. The Service requested a revised reinitiation package that would include all previously submitted information.

November 4, 2016. The DON provided Phase 1 Data submission (including the draft write up on *T. guamense*, maps, metadata, survey line transects) and references to the Service.

November 5, 2016. In person meeting on Guam with DON and Service to discuss forest enhancement concepts at Finegayan, NWF, and Andersen South

December 1, 2016. Teleconference discussion of *T. guamense* Phase I data submission, clarification of the definitions of primary and secondary limestone forests, and discussion of schedule of future calls and in-person meetings.

December 14, 2016. Teleconference discussion of the Service's review of the Phase 1 data submission and how the edge effect analysis would consider the new empirical data provided by the DON. The Service notified the DON that we were developing a white paper on their edge effect analysis for *T. guamense,* which would be provided to DON prior to the upcoming in-person meeting. The group identified topics for discussion at the January 2017 in-person meeting in Portland.

January 12, 2017. The DON provided a white paper to the Service titled “Psychotria Criteria Review and Evaluation” supporting the argument that federally endangered *Psychotria malaspinae* is not the species that is present within the planned footprint of the Live Fire Training Range Complex (LFTRC). According to the research, the species present within the planned footprint of the LFTR is *P. hombroniana.* The DON provided their revised final comments on the Service’s draft BO.

January 17-18, 2017. The DON and Service consultation team members met in Portland, Oregon. Topics discussed included the Service's preliminary analysis on edge effects (edge effects white paper), the DON's Phase 1 information submission concerning *T. guamense*, general comments on the working draft BO, format and scope of anticipated BO (amendment vs. full BO), fire management plan, exclusion of *P. malaspinae* from the consultation, corrections to the Intelligence, Surveillance, and Strike Capability Project (ISR-Strike) history and compliance as portrayed in the working draft BO, potential inclusion of a perimeter fence/ ungulate eradication around the LFTRC, the consultation schedule, and new species occurrence data for butterfly and host plants at Northwest Field.

January 24, 2017. The Service presented by teleconference the white paper on edge effect analysis based on occurrence data provided by DON. The DON expressed concern with the assumptions and purpose of the statistical analysis of the edge effect paper, pointing out that the data collected was not intended to be used as statistical analysis, and that only a very small subset of the data provided was used to support the Service analysis. In addition, conclusions on edge effect were being made solely on the manipulated distribution data, without taking into account any other factors of the environment and habitat. The DON recommended that the statistical analysis by DON represents only a view of occurrence distribution from existing edges and not a determination of edge effect. The Service took the DON's comments under advisement.

January 25, 2017. Conference call between the Service and DON to discuss edge effects; the Service stated that revisions to the edge effects papers are being considered, including adding more data and changing the title to a study on the distribution of species with regard to existing edge. The revised white paper would be provided to the DON when complete.

January 31, 2017. DON requested a waiver regarding implementation of Term & Condition #4 in the Relocation of the USMC from Okinawa to Guam and Associated Activities on Guam BO (2015-F-0025) since the subject fence would be addressed in the current consultation.

February 1, 2017. The DON and Service discussed butterfly related topics on a conference call. Topics included DON providing additional new host plant and butterfly occurrence data from Dr. Fiedler, University of Guam, to update butterfly and host plant occurrences since the Final Listing Rule was published. A review of conservation measures specifically related to the butterfly was discussed. The DON opened the discussion on potential Terms and Conditions for the butterfly. FWS suggested that all measures be included as Conservation Measures.

February 8, 2017. Conference call between the Service and DON during which the Service committed to providing a response by February 15, 2017 to the DON's letter requesting a waiver from the 2015 BO term and condition (2015-F-0025). Also discussed were the edge effect paper, the Mariana fruit bat amendment, the Makua BO for reference

regarding the fire management plan, and conclusion of the previously discussed ISR-Strike BO language.

February 21, 2017. The Service acknowledged (2017-TA- 0150) the DON's efforts to comply with Term and Condition #4 from the 2015 BO (2015-F-0025), and agreed to discuss DON's alternatives to the ISR-Strike fence location as part of the current consultation.

February 22, 2017. Conference call between the Service and DON to discuss any outstanding tasks and issues. The Service provided DON with the revised draft Edge Effect white paper, which focused only on *T. guamense*.

February 23, 2017. The DON and Service subject matter experts discussed the Mariana fruit bat amendment and clarified that the military relocation and the Habitat Management Unit (HMU) management are separate actions and require separate amendments, and clarified Fire Management Plan specifics.

March 3, 2017. The DON emailed a letter and enclosed BA requesting a re-initiation of formal section 7 consultation on the effects of the proposed project on the eleven federally listed species noted in their letter. The DON determined that the action may affect, but was not likely to adversely affect three species (*E. bryanii*, the fragile tree snail and the humped tree snail) and may affect, likely to adversely affect the remaining eight species (the Mariana eight spot butterfly, the Guam tree snail, *T. guamense*, *B. guamense*, *D. guamense*, *C. micronesica*, *T. rotensis*, and *H. longipetiolata*).

March 13-14, 2017. In person meeting between DON and the Service in Hawaii to review information presented in the March 3, 2017 BA. The Service informally identified some additional information needs from the BA.

March 24, 2017. The Services provided the DON a list of information and comments from the 2017 BA necessary to complete a BO.

April 5, 2017. DON and Service consultation call to discuss status updates.

April 11-13, 2017. DON and Service teleconferences to clarify questions in the BA especially related to the information needs identified in March 24, 2017 letter.

April 12, 2017. DON submitted responses to the information request and comments provided by the Service regarding the Marine Corps Relocation to Guam BA. DON also emailed GIS data, EndNote library, sample HACCP plan, Wildland Fire Plan for MCB Hawaii and COMNAVMAR INST 3500.4.

April 12, 2017. The Service acknowledged receipt of a complete consultation package with a consultation start date of March 3, 2017. The Service also acknowledged that the consultation will also include the Mariana fruit bat to address new information on the species status and DON's request for an amendment to the amount of take of Mariana fruit bat specified in the 2015 BO (2015-F-0025).

April 20, 2017. Service requested information on the draft Forest Enhancement Plan.

April 21, 2017. DON and Service teleconference to discuss monitoring plans and specific details for all out-planting vegetation restoration activities mentioned in the Revised BA.

April 25, 2017. In person meeting on Guam with DON, Service and species experts to discuss monitoring concepts for the Mariana eight spot butterfly and the three listed snail species, especially those recently observed at Andersen South.

April 27-28, 2017. DON and Service conducted in-person site-visits on Guam to examine the project footprint areas and listed species habitat, including: LFTRC; Andersen South; Haputo ERA; Finegayan; and, other listed species locations. The Service identified and made DON aware of a discrepancy with the GPS location of the mature *S. nelsonii* and proposed Multipurpose Machine Gun Range (MPMG) range. The Service also indicated to DON that the 5 year review on *S. nelsonii* was recently completed and that the status for the species in the wild on Rota declined by 73% from the 1992 baseline. The Service recommended that DON should re-consult due to the significant wild population decline. May 4, 2017. DON confirmed that any project activities would not be within 100 feet of the *S. nelsonii* tree since prior maps misidentified the exact location of the tree and identified construction within this 100ft boundary.

May 11, 2017. The DON provided information clarifying Table 6 in the BA, relating to the population of *B. guamense*.The Service requested information on Forest Enhancement site establishment, monitoring, and proposed success criteria.

May 12, 2017. The Service recommended to the DON that *M. walkeri* and *N. jacksoniae* be included in the consultation with an effect determination of MA,NLAA due to DON proposing actions that will avoid or minimize effects to these two listed species within the NMS.

May 16, 2017. DON provided the Service with their identified measures related to out-planting the listed plant species. A draft vegetation map of the forest enhancement areas used to develop more site specific enhancement plans/targets was also provided.

May 17, 2017. DON verbally agreed to include *M. walkeri* and *N. jacksoniae* as MANLAA in the current consultation since DON intends to identify the area with these two species as a "No Training Area" to restrict access to the areas with these two plants in order to avoid the potential for effect. DON also stated that they were not interested in adding *S. nelsonii* to the current BO. The Service also received information on Forest Enhancement site establishment, monitoring, and proposed success criteria.

June 2, 2017. The Service provided a draft BO to DON.

June 19, 2017. The DON provided written comments to the Service on the draft BO.

June 22, 2017. The DON and Service consultation team members met in Hawaii to discuss DON comments on the draft BO

July 14 and 17, 2017. Conference calls between the DON and the Service to discuss the revised draft Incidental Take Statement.

## BIOLOGICAL OPINION

### Description of the Proposed Action

The DON proposes to relocate USMC personnel from Okinawa, Japan to Guam; construct and operate a Main Cantonment area and separate Family Housing; construct and operate a LFTRC; and conduct military training activities on Guam. Project activities will occur on land administered by the (DoD). The proposed action includes activities described in the 2015 BO addressing effects to the species in **Table 1** (above).

Minor non-substantive clarifications and organizational changes have been made to the description of the proposed action included in this BO and therefore this section differs from the 2015 BO. The only component actions not included in this BO are five roadway and bridge work projects (USFWS 2015a, p. 35), as majority of these projects have been completed, or occur within previously developed areas of Guam such as residential and commercial areas (**Table 2**). Where appropriate, effects from completed roadway projects are included in the Environmental Baseline section. In addition, 50 individual road projects have been proposed but would occur in urban areas and would be the responsibility of the Government of Guam or the Federal Highway Administration (FHWA). Where appropriate, these projects are included in the Cumulative Effects section. Finally, new details from DON have been included to describe proposed conservation measures within the two Forest Enhancement Sites (North Finegayan and Finegayan) and ungulate fencing and eradication activities surrounding the LFTRC in the Northwest Field (NWF). The conservation measures specific to these areas amend the measures described in the 2015 BO (USFWS 2015a, p. 37-38).

**Table 2.** Five roadway and bridge work projects included in the 2015 BO that have since been completed or initiated.

| # | Description | Status |
|---|---|---|
| 1 | Route 1 and Route 8 intersection and improvement (Hagåtña) ("Guam Road Network" GRN1) – (Part of Hagåtña Bridge Replacement Project Scope) | Completed |
| 2 | Route 1 and Route 3 intersection and roadway improvements (Dededo) (GRN2) | Under Construction |
| 3 | Replacement of Hagåtña (Agaña) Bridge #1 with reinforced concrete (GRN3) | Completed |
| 4 | Route 11 roadway improvements from the port to Route 1, including pavement strengthening (GRN4) | Completed |
| 5 | Widening of the Route 1 and Route 11 intersection, adding a second left turn lane and pavement strengthening (GRN5) | Completed |

The proposed action is divided into ten components listed below and described in detail in subsequent sections. The locations for these project components are shown in **Figure 1 (**all Figures are located in **Appendix C)**.

1. Relocation of approximately 5,000 USMC personnel and 1,300 dependents from Japan to Guam;
2. Utilities and Site Improvement Activities within DON-administered lands;
3. Construction of the Main Cantonment at the Naval Base Guam Telecommunications Site (NBGTS), Finegayan;
4. Construction of Family Housing at AAFB;
5. Construction and Operation of the LFTRC at the NWF and the establishment of an associated Surface Danger Zone (SDZ);
6. Construction and Operation of a hand grenade range at Andersen South as part of the LFTRC;
7. Training Activities and Aircraft Operations within AAFB;
8. Training Activities and Aircraft Operations within Naval Base Guam;
9. Training Activities and Aircraft Operations within the Naval Munitions Site (NMS) Southern Land Navigation Area; and
10. Conservation Measures to avoid or minimize project impacts.

Relocation of U.S. Marine Corps Personnel and Dependents

In furtherance of an agreement with the Government of Japan, the DON plans to relocate 5,000 USMC personnel and 1,300 dependents from Okinawa to Guam. The most recent population estimate for Guam is approximately 174,000 residents (UN 2015). The proposed action would temporarily increase Guam's population by approximately 10,000 (DON 2015b, p. ES-4) or 7.1 percent by 2021 (UN 2015). This number will decrease to about 7,400 additional residents after construction is completed by 2032 (DON 2015b, p. ES-4) or a 4.6 percent overall increase (DON 2017a, p. 14). All construction projects and training activities listed under project components would be conducted in support of or as a result of USMC relocation to Guam.

An estimated maximum number of 1,227 workers from Guam and up to 3,227 workers from off-island would work on construction projects related to the proposed action (DON 2015b, p. 4-136). It is anticipated that the majority of off-island construction workers would be H-2B visa holders or temporary non-agricultural workers from the Philippines and other Pacific Islands. In 2011, construction of the Ukudu Workforce Village (Village) in urban Dos Amantes, Guam was completed. The Village is designed to be scalable in support of the proposed action. The Village's first phase includes accommodations for 2,000 tenants. At full capacity, the 252-acre complex would include a fire station, medical clinic, recreational spaces and other residential amenities necessary to house up to 14,000 temporary residents (Montvel-Cohen 2011). During the later years of construction (2025-2026), it is anticipated that more workers from Guam than from off-island would work on construction projects related to the proposed project (DON 2015b, p. 4-136).

Utilities and Site Improvements

The proposed action includes approximately 100 separate construction projects identified as Utilities and Site Improvements (U&SI) that would occur prior to large-scale vertical construction (**Figure 2**). These projects include clearing, grubbing, grading, earthwork (such as digging, trenching, drilling, boring and/or cut and fill), processing and stockpiling of green waste, erosion and sediment control, temporary construction fencing, perimeter or security fencing, landscaping and other activities to prepare the area for vertical construction. Additionally, the effort will likely require removal of unexploded ordnance (UXO) and munitions and explosives of concern (MEC), seismic fault, and geotechnical/geophysical and/or topographic surveys in preparation for vertical construction. Conservation measures including contractor education, inspection of construction equipment and supplies to ensure they are free of invasive species, and biological monitoring to ensure project impacts to listed species are minimized and impacts to their habitats do not occur outside of the designated project footprint, are described in more detail in the Conservation Measures section of this project description. U&SI activities include installation of electrical, water, and sanitary sewer systems. The following sections describe in detail all U&SI projects included in the proposed action.

Clearing, Grading, and Earthwork

Clearing and grubbing U&SI projects, conducted at specific project sites, include removal of vegetation, stripping limestone rock, and removal and stockpiling of reusable topsoil. U&SI projects would permanently convert 1,219 ac (493 ha) from limestone forest habitat, and 613 ac (248 ha) from herbaceous scrub forest to developed land (**Table 3**). Clearing and grubbing site work preparation would occur prior to mass grading of the site.

**Table 3.** Amount of vegetation type or substrate that would be permanently modified to support the construction of the cantonment, family housing, and LFTRC facilities, as well as utility system preparatory work to connect the facilities to existing or new electrical, water, and sanitary sewer systems.

| **Project Site** | **Existing Vegetation or Substrate** | | |
|---|---|---|---|
| | Limestone Forest[1] | Herbaceous Scrub | Developed/Barren Land |
| Finegayan, Main Cantonment | 683 ac (276 ha) | 115 ac (46 ha) | 394 ac (159 ha) |
| AAFB, Family Housing | 12 ac (5 ha) | 0.13 ac (0.05 ha) | 488 ac (197 ha) |
| LFTRC | 187 ac (76 ha) | 49 ac (20 ha) | 70 ac (28 ha) |
| AAFB, South | 212 ac (86 ha) | 80 ac (32 ha) | 115 ac (47 ha) |
| Naval Base Guam | 86 ac (35 ha) | 358 ac (145 ha) | 2, 106 ac (852 ha) |
| Water Wells and Sanitary Sewer Systems[2] | 39 ac (16 ha) | 11 ac (4 ha) | 48 ac (19 ha) |
| TOTAL | 1,219 ac (493 ha) | 613 ac (248 ha) | 3,221 ac (1,303 ha) |

[1]Includes both primary and secondary limestone forest habitat, characterized by limestone karst and native vegetation.

[2]Majoriity of electrical system infrastructure would be installed along existing roadways or occur within the Main Cantonment footprint (DON 2017a, p. 17).

Grading and earthwork U&SI projects include major earth moving of large contiguous areas (mass grading) and limited fine grading along the roadway corridors and drainage systems. The cut and fill quantities associated with this mass grading effort would provide for a building pad for future vertical construction, which anticipates further import of structural fill material. Grading for construction of the cantonment and family housing areas and associated infrastructure, comprising the Finegayan and AAFB components would include 3,732,871 $yd^3$ (2,853,984 $m^3$) of cut (excavation) and 2,958,469 $yd^3$ (2,261,911 $m^3$) of fill, resulting in a net of 774,402 $yd^3$ (92,072 $m^3$) of cut material available for use as needed (DON 2015b, p. 2-50). The cut and fill quantities also assume a two foot deep road pavement section, including compacted base and pavement surfacing.

Grading to provide a clear zone for perimeter security fencing is included. In accordance with USMC Order 5530.1A, a 15 ft. (4.6 m) wide gravel perimeter road would be constructed on the inside of all perimeter fence lines, and a 20 ft. clear zone would be provided on the outside of the perimeter fence line.

If soil testing and/or geotechnical recommendations indicate native material excavated on site is not suitable for reuse as fill material, then importation of fill material may be required. Contractors are required to obtain aggregate/soil from contractors/vendors who have local permits. Imported sand and other quarried products from abroad are subject to inspection by the Guam Department of Agriculture which issues an importation permit. All sand and aggregate material imported will be accompanied by official records indicating chemical composition, pest-free certification, treatment certificate, and certificate of origin. Treatment (disinfection) would be conducted at the point of origin.

Processing of Green Waste and Construction Debris

Green waste processing and demolition debris generated during construction will be handled by contractors at designated laydown areas, in accordance with the *Comprehensive Construction and Demolition and Solid Waste Management Plan* (DON 2010). Contractors will be required to process the generated green waste as part of their assigned contract requiring 100 percent diversion of the green waste into mulch (trees and stumps) and compost (leaves and grass), and 60 percent minimum diversion of construction and demolition debris waste into reusable material, including but not limited to, concrete crushing and reuse as base material. Green waste would be processed in accordance with Marine Corps Activity Guam (MCAG) management procedures to prevent and reduce the spread of the invasive coconut rhinoceros beetle (*Oryctes rhinoceros*) and little fire ant (*Wasmannia auropunctata*) (DON 2016). The DON subject matter experts will review the contractor's green waste processing and composting facility operations plan to ensure that it meets industry and regulatory standards. The contractor would be responsible for obtaining the solid waste facility permit issued by Guam Environmental Protection Agency (GEPA) prior to commencing activities. Construction and demolition debris and green waste that cannot be recycled or reused, as well as waste that is prohibited at Layon Landfill in Southern Guam, would be disposed of at the Naval Base Guam Landfill and other permitted private hard fill facilities (DON 2015b).

Removal of Unexploded Ordnance, Munitions and Explosives of Concern

Any earthwork or excavation for building foundations, roads, underground utilities, and other infrastructure could encounter unexploded military munitions in the form of UXO, discarded military munitions (DMM), and/or material potentially presenting an explosive hazard (MPPEH). To reduce the potential hazards related to the exposure to MEC, in accordance with DoD Directive 6055.9, Ammunition and Explosive Safety Standard (ESS) and Naval Ordnance Safety and Security Activity Instruction 8020.15D, ESS documentation would be prepared that outlines specific measures that would be implemented to ensure the safety of workers, the public and avoid adverse effects to natural/cultural resources. UXO that is identified during construction of facilities that requires open detonation in-place may require an emergency permit from GEPA. UXO that is safe to transport would be taken to the AAFB Hazardous Waste Management Facility – Explosive Ordnance Disposal (EOD) Permitted Facility to be safely detonated. Depending on the location and the nature of the UXO, it may be taken to either the AAFB permitted facility or to the NBG Magazine for detonation as part of an emergency response under the Military Munitions Rule.

Electrical and Communication Systems

The proposed action is estimated to require a minimum of 5.7 megawatts of electrical power annually, in addition to DON's existing power needs, with increases primarily occurring as a result of the Main Cantonment and family housing projects (DON 2015b, p. 3-19). Because no refurbishing/reconditioning of any combustion turbines would be required, a supplemental major stationary source impact concentration analysis was not performed. Various upgrades to existing substations would not exceed the existing facility footprint. In addition, a new substation equipped with two 15 megavolt ampere, 34.5 kV – 13.8 kV transformers would be constructed in the Main Cantonment area, south of the main gate. A new 34.5 kV transmission line from the Harmon Substation, connecting Finegayan to AAFB would be placed underground (**Figure 2**).

Proposed Information Technology/Communications (IT/COMM) systems would require inter-base connections between the proposed Main Cantonment, the proposed LFTRC, AAFB, Andersen South, and other existing bases. These hardwired connections would consist of up to eight 6-inch conduits buried approximately 3 ft (0.9 m) deep. Off-site conduits would be encased in concrete and would have lockable manholes for security. Because redundant off-island communication paths are needed, an additional connection to the Tata Communications Cable Termination Facility (in Piti, Guam) from AAFB may be required. Off-site conduits would follow existing roads and rights-of-way between the facilities.

AAFB Well Field and Associated Water System

In order to support the proposed action, approximately 11 new water supply wells are proposed to be installed at AAFB, as well as several well-refurbishment projects and upgrades to DON's existing water system. When complete, the proposed water well area would total an estimated 45.2 ac (18.3 ha), including up to 7.6 ac (3.1 ha) for the test wells and approximately 11 production wells (each 200 ft [61 m] in diameter), approximately 28 ac (11.3 ha) for the water

lines and access roads that would connect the wells, and approximately 9.6 ac (3.9 ha) for a well field water storage tank, pumps, and treatment system (**Figure 2**). The new potable water distribution pipes would be installed underground at least three feet (0.9 m) deep. The width of the trench to install the pipes would be about 1.5 ft (0.5 m) to 4 ft (1.2 m), for 6-inch (15.2 cm) to 24-inch (61 cm) pipelines. The specific number and locations of wells would be determined during well development and would consider updated water system information. The estimated long-term increase in potable water demand to the Guam Waterworks Authority (GWA) potable water system would peak during construction around year 2021 at 0.84 million gallons per day (Mgal/d) (3.18 million liters per day [ML/d]) as a result of the proposed action (DON 2015b, p. 4-111). This estimate does not include forecasted organic civilian growth.

Based on conservative estimates, it is anticipated that to locate one well of sufficient yield to support production, approximately three test wells would be required. The well field area can accommodate approximately 22 test wells, 11 production wells and associated equipment. However, the actual footprint of the wells and the access roads to each is not known at this time, but is anticipated not to exceed 90 ac (36.4 ha) of cleared vegetation (DON 2017a, p. 24).

Prior to the start of drilling, efforts would be made by the design contractor to minimize disturbance to the limestone forest by inspecting the area with a DON biologist and identifying previously disturbed areas to the extent possible, for use as water well sites (DON 2017a, p. 23). In addition, the following actions would be implemented:

- Where disturbed areas cannot be identified, for each well location, a 14-ft (4.3 m) path will be created for the drill rig, trucks/vehicles and other equipment to get to the test well locations.
- An approximately 100 ft by 100 ft (or 0.23 ac [0.1 ha]) work area will be required to set up the equipment at each test well location.
- For each test well, an 8-inch to 12-inch (21 cm to 30.5 cm) borehole will be drilled to a depth of approximately 500 ft to 600 ft (152 m to 183 m) below ground surface. A submersible pump will be placed at the bottom of the well, and pump test and water sampling conducted. Based on the results of the pump test and water sampling, the well will either be abandoned or identified as a potential production well. For test wells identified as a potential production well, GIS survey coordinates will be taken and a stake placed at the test well site.
- A production well consists of well casing (approximately 10-inch to 12-inch [25 cm to 30.5 cm] in diameter), screen, gravel pack, submersible well pump, pump motor housing, and surface/borehole seal. At each well station the following will be provided: well housing, discharge piping, and flow meter. Each well head will have electrical lines, water transmission pipes, and feeders to each well.
- Locations of the water transmission and feeder lines will follow already disturbed areas made during test well drilling (path made by the drill rig/vehicles/equipment). A 20 ft to 30 ft (6 m to 9.1 m) wide strip will be required for construction of the pipelines, and manholes, valves, bends, anchor blocks, etc. as well as backfill material. The main transmission lines, ranging from 8 inches to 16 inches (20.3 cm to 40.6 cm) in width, will connect the well field storage tank facility to feeder lines. The individual well feeder lines, approximately 6 inches (15.2 cm) in width, will connect the wells to the main transmission lines.

- In the well field storage tank facility area, there will be a booster pump, water treatment storage tank, electrical room, and central emergency backup generator and fuel storage tank. In addition to the 14 ft (4.3 m) wide path for cranes/vehicles/equipment, an approximately 550 ft x 650 ft area (8.2 ac) will be disturbed during construction of the water storage tank and associated facilities.
- Unless cuttings or excavation materials are deemed contaminated or unacceptable as fill material, cuttings will be placed back into a borehole or trench. Unacceptable fill material or excess cuttings/excavation material will be removed from the site.
- The DON will be responsible for tracking and ensuring that 90 ac (36.4 ha) of cleared area is not exceeded during water well pre-construction, construction, and operation. When 68 ac (27.5 ha) or 75 percent of the allowed disturbance area is reached, the construction contractor will stop work and re-evaluate to determine if 90 ac (36.4 ha) could be exceeded, upon which time the DON will notify USFWS (DON 2017a, p. 24).

During well testing, only those wells with good water quality and capacity will be identified as production well sites. Test wells deemed unsuitable will be filled and capped and left in place, restored or converted to monitoring wells for management of the Northern Guam Lens Aquifer (NGLA).

Total average daily water extraction from the NGLA from all sources (the DoD water system, the GWA water system, and a few private wells) is estimated to be 47.0 Mgal/d (177.9 ML/d) by year 2028 (USGS 2013). USGS developed a numerical groundwater model to estimate the regional effects to groundwater availability from various withdrawal and recharge scenarios that include the increased withdrawal due to the proposed action and all other known future DoD actions, as well as organic growth of the Guam civilian population. The results from the model assist water resource managers in planning, designing, and managing water systems that will produce a sustainable and reliable freshwater supply (USGS 2013). The results of the USGS study confirm the recharge rate of the NGLA used in a 1992 Government of Guam study, but indicate that increased withdrawal from the NGLA may result in higher levels of chloride concentrations as compared to the 2010 base year scenario (DON 2015b, p. 4-112). The model indicates that these chloride concentration spikes would be a localized phenomenon, in which simulated salinity levels (i.e., measured by chloride concentration) in three wells (two GWA and one DoD) in the Finegayan basin moved into the cautionary classification. However, by redistributing withdrawal rates among the extraction wells, it would be possible to meet the water demands and maintain acceptable salinities over all existing and proposed GWA and DoD wells (DON 2015b, p. 4-112).

Sanitary Sewer System

The proposed wastewater collection system for the Main Cantonment and Family Housing would connect to the existing GWA collection system along Route 3 and Route 9 (**Figure 2**). The proposed wastewater collection system would include a network of gravity mains, manholes; two wastewater pump stations, force mains, and refurbishment of existing wastewater pump stations. Upgrades to existing GWA pump stations would connect to GWA's Supervisory Control and Data Acquisition (SCADA) system at the central monitoring station in Mangilao, Guam.

Wastewater would be conveyed to the Northern District Wastewater Treatment Plant (WWTP) in Dededo for treatment and disposal.

DON anticipates a monthly maximum wastewater flow of up to 4.77 Mgal/d (17.8 ML/d) from Cantonment/Family Housing, USMC personnel and other DoD, or project-related contractors. These levels would represent a 36 percent increase from the baseline (DON 2015b, p. 4-114).

The Northern District WWTP currently requires upgrades to meet the National Pollutant Discharge Elimination System (NPDES) permit standards of secondary treatment and the Guam Water Quality Standards, including those for nutrients (DON 2015b, p. 4-115). Until the required upgrades are operational, additional projected wastewater flows from the proposed action and all other sources would be treated to only primary treatment standards before discharge into coastal waters that are located south of Tanguisson Point on the northern shoreline of Guam (EPA 2013). In order to bring the Northern District WWTP into compliance, in August 2016 DoD awarded GWA $55.3M for: 1) the GWA Interceptor Sewer Refurbishment; 2) the Northern District Wastewater Treatment Plant Upgrade; and 3) the Northern Guam Lens Aquifer Monitoring System Expansion and Rehabilitation (GWA 2017). Timelines for completion of these projects are unknown and would depend on a variety of factors.

Construction and Operation of the Main Cantonment at Finegayan

The proposed Main Cantonment development includes base operations and support facilities constructed within 1,213 ac (491 ha) at Finegayan (DON 2017a, p. 18). A security fence approximately 27,900 ft (8,504 m) in length will be constructed around the Main Cantonment perimeter. The components of the Main Cantonment and support facilities are listed below, followed by examples of buildings for each category.

- Command Core: Marine expeditionary brigade headquarters and command buildings.
- Unit Operations: 3rd Marine Expeditionary Brigade Command Element, 4th Marines; 9th Engineer Support Battalion; ground combat element infantry battalions; artillery battalion; combat logistics battalion; and combat engineer battalion, including explosive ordnance disposal.
- Base Operations: Base administration, fire station, public works, vehicle fueling, base auto shop, kennel, corrosion prevention and control, and security.
- Housing: Bachelor enlisted quarters (BEQ) and bachelor officer quarters (BOQ).
- Community Support: Dining facility, fitness center, recreation areas, education center, auditorium/theater, branch exchange, bank/credit union, food court/amusement center, medical/dental clinic, and post office.
- Training: Battle training center, individual combat skills course.

Unit Operations and Base Operations will have the most intensive land use equivalent or similar to activities found in light industrial zoned areas. Activities in the Command Core, BEQ/BOQ, Community Support, and Training areas will have activities that are equivalent to residential or commercial zoned areas. Individual projects for follow-on vertical work will be implemented in accordance with function-specific criteria pertaining to civil, architectural, structural, mechanical, electrical and other engineered features of work.

Construction and Operation of Family Housing at AAFB

The Family Housing facilities will be located on 510 ac (206.4 ha) of developed or disturbed land on AAFB. Family housing includes residences for accompanied permanent USMC personnel and their dependents, and support and recreational facilities. Unaccompanied USMC personnel would stay at the Main Cantonment during their shorter-term (approximately six month) assignment to Guam. The new housing density at AAFB would be 5.5 units per acre. The family housing area would be accessed by the existing family housing gate (the Santa Rosa Gate) at the northern end of Route 15, or from the AAFB Main Gate off Route 9. The existing family housing would be demolished and 912 family housing units would be constructed as replacements for the existing AAFB housing, in addition to the 535 family housing units required for USMC families. All of the 1,447 family housing units would be integrated into one large housing pool where all eligible personnel and families would reside.

Expansion of existing community support facilities, such as the child development center, youth center, and temporary lodging facility may be required. New facility construction may include a temporary lodging facility, a community center, and a family support center.

The existing capacity of utilities at AAFB is adequate for the Family Housing project. The increase in the number of housing units and facilities would be minimal compared to the current number of housing units and facilities. Additionally, the new facilities would implement energy and water efficient features meeting Leadership in Energy and Environmental Design (LEED) silver or greater standards, which would reduce utility requirements.

Construction and Operation of the LFTRC and Associated Surface Danger Zone

The proposed LFTRC at AAFB NWF would consist of five individual ranges, range support buildings, range towers, range access roads, and a perimeter fence, removal of portions of the Ritidian Ungulate Fence (USFWS 2006) and the establishment of a Surface Danger Zone (SDZ) over NWF and the existing Guam National Wildlife Refuge (GNWR) (**Figure 3**). Repairs to Route 3A would also be part of the project. The LFTRC would require construction of electrical, telecommunication, wastewater, and water lines or facilities configured to operate with the existing utility infrastructure of AAFB NWF (DON 2017a, p. 19). The individual ranges are described below:

- *Known Distance (KD) Rifle Range*. The KD Rifle Range would have 50 firing points for 5.56-millimeter (mm) weapons. The range would be 534 ft (163 m) wide and 1,500 ft (457 m) from the farthest firing line to the target line. The target line would be flush with the ground, and there would be level ground from the 600 ft (183 m) firing line to the target line. The range would include a 25 ft (8 m) tall impact berm behind the target line. The range footprint would encompass approximately 18.5 ac (7.5 ha). The berm will be vegetated in accordance with the DON's landscape guidelines.
- *KD Pistol Range*. The KD Pistol Range would provide 25 firing points for training with 9-mm and 0.45-caliber (cal) weapons. The range would be 123 ft (37.5 m) wide by 150 ft (46 m) long with level ground from the firing line to the target line. The range would

include a 12 ft (4 m) tall impact berm behind the target line and 12 ft (4 m) lateral berms. The range footprint would encompass approximately 0.4 ac (0.2 ha).

- *Non-Standard Small Arms (NSSA) Range*. The NSSA Range would provide 25 firing points, and be used for training with 5.56-mm weapons. The range would be 204 ft (62.3 m) wide by 328 ft (100 m) long with level ground from the 300 ft (91 m) firing line to the target line. There would be a 16 ft (5 m) tall impact berm behind the target line and 16 ft (5 m) lateral berms on each side. The NSSA range footprint would encompass approximately 1.5 ac (0.6 ha).
- *Modified Record of Fire (MRF) Range*. The MRF Range would have 16 firing points for use by 5.56-mm weapons. This live-fire range area would be 525 ft (160 m) wide by 657 ft (200 m) in length with a 25 ft (8 m) tall impact berm at the far end of the range. The range footprint would encompass approximately 7.9 ac (3.2 ha).
- *Multipurpose Machine Gun (MPMG) Range*. The MPMG Range would have eight stationary firing lanes to support training with 5.56-mm, 7.62-mm, and 0.50-cal weapons, as well as 40-mm inert training rounds (i.e., nonexplosive). The range would be 525 ft (160 m) wide at the firing line, expanding to 1,050 ft (320 m) wide at the far end of the range. The range would be 3,281 ft (1,000 m) long and would include a 25 ft (8 m) tall impact berm at the far end of the range. The MPMG range footprint would encompass approximately 59 ac (24 ha).

Specific support buildings in the LFTRC NWF would include three range observation towers, target-storage and maintenance shed, ammunition issue points, covered bleachers, portable toilets, safety signage and lighting, and parking.

The range footprints would be entirely cleared of vegetation and the ranges would be designed with perimeter berms to contain expended rounds of ammunition within the range footprint. The MPMG range would include more uneven terrain with some vegetation. The purpose of the MPMG range is to simulate a more natural environment. Vegetation on the ranges would be designed using the Guam Landscaping Guidelines (DON 2011) and use appropriate or non-invasive species in order to reduce potential impacts associated with non-native vegetation.

Lighting will be designed to meet minimum safety, sustainable, antiterrorism, and force protection requirements. “Night-adapted lights” will be installed in the briefing and bleacher areas at NWF. Night-adapted lighting includes bulbs in red or other spectrums that allow a person’s eyes to remain adapted to low light or night conditions while still providing enough light for work and safety. Illumination of the coastline or beach will be kept to an absolute minimum including the shielding of lights and directing lighting away from the forest or other wildlife habitat (see Conservation Measures section).

*LFTRC Construction Phase*

Development of the LFTRC is anticipated to occur in two phases: Phase-1 would include the construction of the smaller ranges and repair/improve Route 3A; and, Phase-2 would include the construction of the larger MPMG Range. Due to the uneven limestone rock substrate prevalent throughout the NWF, construction of the LFTRC would involve the use of heavy machinery including, but not limited to the following: tractors, cranes, scrapers, jackhammers, pile drivers,

excavators, dozers, backhoes, and crane clam shovels (DON 2015b, p. 3-26). Blasting or the use of dynamite material will not be authorized. Approximately 212 ac (86 ha) would be cleared as a result of the construction of the LFTRC (DON 2014). Construction timelines are subject to availability of funding (DON 2017a, p. 21). Grading requirements for construction of the ranges and associated infrastructure would include 2,047,295 cubic yards ($yd^3$) (1,565,270 cubic meters [$m^3$]) of cut and 1,932,392 $yd^3$ (1,477,420 $m^3$) of fill, resulting in a net of 114,903 $yd^3$ (87,850 $m^3$) of cut (DON 2017a, p. 21). However, any grading and other earthwork required during facility construction at any of the ranges would be implemented to balance cut and fill on-site to the extent possible. If off-site fill material were needed, it would be obtained from a permitted source.

*LFTRC Operational Phase*

Range use would depend on the number of personnel required to complete annual individual training events, the duration of each event, and the training capacity of each range. The live-fire operations at the LFTRC would occur between 7:00 a.m. and 7:00 p.m. for up to 39 weeks (273 days) per year, and night operations (estimated to occur two nights per week over 39 weeks per year) would occur between 7:00 p.m. and 10:00 p.m. or 6:00 a.m. to 7:00 a.m. Training at the LFTRC would typically occur during weekdays but periodic weekend use could also occur as needed. Night training is estimated to occur twice per week during the associated qualification periods and would require consecutive firing days.

When operational, an estimated 6,719,190 rounds of various ammunition types are expected to be expended at the LFTRC NWF annually, by USMC and non-USMC personnel (**Table 4**) (DON 2017a, p. 22). Each range would also be required to have an emergency response vehicle. The actual number of emergency response vehicles would vary depending on the proximity of individual active ranges to each other. Transportation to and from the range is generally not expected to occur during peak travel hours.

Noise levels from training at the LFTRC would be impulse noise with very intense sounds of short duration (e.g., the discharge of a weapon). Firing noise from single shots merged in bursts, machine gun burst, and concurrent firing of multiple weapons would result in short periods of intense firing followed by periods of silence. Live-fire operations may occur for hours at a time, for five days a week, or not occur for multiple weeks in a row. The most widely used metric for noise is the day-night average sound level (DNL). The DNL represents energy-averaged sound levels measured by summation and averaging of sound exposure level (SEL) values during a 24-hour period. Noise levels at the LFTRC are estimated using the A-weighted DNL (ADNL), which is used to describe noise from transportation sources (e.g., vehicles, aircraft) and from other continuous sources (e.g., generators). The noise levels at LFTRC are estimated within the immediate and adjacent areas and would range from 55 ADNL to greater than 85 ADNL, depending on the zone or area (DON 2014, p. 68).

All operations of the LFTRC would adhere to the Marine Corps Ground Range Certification and Recertification Program (Marine Corps Order 3550.9, June 2004), Range Safety (Marine Corps Order 3570.1C, February 2012) and policies and procedures for range and training area management (Marine Corps Order P3550.10, July 2005). The Marine Corps Range and Training

Area Management Program is used to track ordnance expenditures and training area usage in order to remain in compliance with mandated government reporting requirements and environmental and safety policies.

**Table 4**. Annual amount of ammunition estimated to be expended at the LFTRC, NWF.

| Range | Weapon | Ammunition Type | Estimated Annual Ammunition Usage | | |
|---|---|---|---|---|---|
| | | | Day | Night | Total |
| **USMC Usage** | | | | | |
| **KD Rifle Range** | M16/M4 | 5.56 mm | 1,533,300 | 322,800 | 1,856,100 |
| | M249 SAW | 5.56 mm | 59,200 | 39,664 | 98,864 |
| **KD Pistol Range** | M9 | 9 mm | 324,956 | 19,328 | 344,464 |
| **Non-standard Small Arms Range** | M16/M4 | 5.56 mm | 569,356 | 403,500 | 972,856 |
| | M249 SAW | 5.56 mm | 152,736 | 34,900 | 187,636 |
| **MRF Range** | M16/M4 | 5.56 mm | 304,920 | 62,820 | 367,740 |
| | M249 SAW | 5.56 mm | 59,200 | 17,760 | 76,960 |
| **MPMG Range** | M249 SAW | 5.56 mm | 377,104 | 0 | 377,104 |
| | M40/M110 | 7.62 mm | 13,824 | 4,104 | 17,928 |
| | M240 | 7.62 mm | 576,716 | 141,336 | 718,052 |
| | M107 | 0.50 cal | 3,520 | 0 | 3,520 |
| | M2 | 0.50 cal | 190,756 | 6,180 | 196,936 |
| | MK19 | 40 mm inert | 84,480 | 8,448 | 92,928 |
| | M-203/M-32 Grenade Launcher | 40 mm inert | 24,940 | 2,580 | 27,520 |
| **Total Estimated USMC Use =** | | | **4,275,008** | **1,063,420** | **5,338,608** |
| **Joint Use (non-USMC)** | | | | | |
| **Total Estimated Joint Use =** | | | **1,104,466** | **276,116** | **1,380,582** |
| ***Grand Total*** | | | | | |
| ***USMC + Joint Use*** | | | ***5,379,474*** | ***1,399,536*** | ***6,719,190*** |

*SAW = Squad Automatic Weapon.

*LFTRC Surface Danger Zone*

The proposed action includes the establishment of a SDZ within the NWF and the GNWR. The SDZ would delineate areas that fired ammunition fragments or ricochets may land, forming the outermost limit of the LFTRC. The DoD standard for risk acceptance on ranges is a 99.9999 percent level of containment, which means the probability of munitions (for inert ordnance) or a hazardous fragment (for live ordnance) escaping the SDZ is one in a million. The SDZ projects north and outward over the GNWR-administered fee simple land and submerged lands. The DON would demarcate the SDZ beyond the shoreline through navigation map updates to alert maritime traffic of the potential hazard. For the land-based perimeter of the SDZ, perimeter access roads (KD and MPMG), perimeter fencing, or signage would indicate its boundaries for personnel and public safety. Approximately 3,701 ac (1,498 ha) of lands and submerged lands are required to support the SDZ. This includes approximately 142 ac (57.5 ha) of the Ritidian

Point Unit (fee simple land) of the GNWR and 3,059 ac (1,238 ha) of the submerged lands of the Philippine Sea.

Although most of the SDZ area can be seen with binoculars from the observation towers at Ritidian Point at NWF, ground patrols within the GNWR would ensure that the area under the SDZ is cleared of people prior to the operations of the LFTRC. Patrols would be conducted on the beach prior to the operations of the LFTRC, which will operate daily up to 39 weeks per year. The purpose of the access is to ensure the water portion of the SDZ is clear of people. The Range Safety Specialist (RSS) would conduct a ground survey of three locations (**Figure 4**); however they may only access one or two of these locations to clear the water portion of the SDZ. The RSS will access the location by using an all-terrain vehicle (ATV) (2 or 4 passenger Gator-type vehicle). The RSS will get out of the ATV and move to an area where the water portion of the SDZ can be seen (not on the beach). The RSS will use a pair of binoculars to clear the water portion of the SDZ. The RSS will walk back to the ATV and drive out the same trail taken to get to the access locations. Once the SDZ has been cleared, the RSS would notify Range Control and depart the area. The ground survey would last approximately 20 minutes.

Training Activities and Aircraft Operations within Andersen South

The proposed action at Andersen South would include the following: construction and operation of a Hand Grenade (HG) Range as part of the LFTRC; construction and operation of military training in an Urban Terrain Training Area (a portion of which will be a modular unit and another will be reconstructed from the existing unit); a logistics and administration area; a convoy course; an advanced motor vehicles operators course; an aviation training landing zone; an aviation and maneuver area landing zone; Pioneer Road; other range roads; a perimeter fence; main, secondary, and range road gates at Andersen South (**Figure 1**).

*Construction and Operation of a Hand Grenade Range*

The HG Range would include an approximately 0.9 ac (0.4 ha) area developed as a hand grenade training complex for the M67 fragmentation grenade that will be connected to existing utility infrastructure where available. The following features would be developed within the hazard zone: a holding shelter for four persons, four throwing positions with grenade sumps, a range observation tower with ballistic glass, and a grenade "dudded" impact area. A grenade house would be collocated with the grenade throwing pits. A concrete munitions storage (i.e., magazine) surrounded on three sides by earthen berms would be used for the temporary storage of hand grenades during training events.

In addition to the live-fire area, there would be a 1.0 ac. (0.4 ha) non-live-fire training area developed adjacent to the range and outside of the HG Range SDZ. The training area would consist of a demonstration area with bleachers, an open practice throwing field with various targets and throwing positions, portable toilets, and a parking area. Inert practice grenades would be used at this training area to provide familiarization training prior to proceeding onto the live-fire area of the range (DON 2017a, p. 24-25).

*Other Activities at Andersen South*

Convoy operations, maneuver training for military operations in urban terrain, and general maneuver and air-ground operations would vary, but may occur up to five days per week, 45 weeks per year, day and night. Up to 250 to 300 USMC personnel would participate in maneuver training at Andersen South each week, for a total annual throughput of approximately 11,250 to 13,500 personnel. Convoy operations would typically consist of 7 to 10 vehicles (e.g., high mobility multipurpose wheeled vehicles) traveling in tandem along an established course. Military operations in urban terrain includes transporting units to Andersen South by helicopter or vehicle, maneuvering toward the military operations in the urban terrain complex on foot or by vehicle, and engaging in integrated training at the urban terrain complex. Military operations in urban terrain at the reconstructed training area (also referred to as the Urban Embassy Component) will consist of 24 or more, multi-story concrete structures to simulate at least four city blocks.

The modular military operations in urban terrain (also referred to as the Rural Military Operations in Urban Terrain) would consist of movable components that can be stacked and grouped into a number of configurations to present tactical situations to be overcome by training units. This modular military operations in urban terrain will consist of shipping containers that will be assembled on site to simulate a more rural village or set of suburban buildings located outside the core urban area. Forklifts or cranes would be used to reconfigure the modules of the military operations in urban terrain to add variety and diversity to training. The military operations in urban terrain complex would include live-fire ranges, including a breacher and shooting house that will be used for forced-entry training, and the HG Range and storage shed. These training areas would be suitable for units or organizations of up to 800 USMC personnel at a time, and will be used daily by 40 to 750 personnel. The military operations in urban terrain will operate day and night; night operations will comprise an estimated 15 percent of all operations. The military operations in urban terrain will be used by organizations based on Guam, transients, and visiting regional allied forces. Units using the military operations in urban terrain may bivouac in the vicinity, or arrive and depart daily.

Typically, dry runs and individual skills training would occur prior to the military operations in urban terrain exercises, which will involve fire teams (smallest unit of infantry, typically four or fewer individuals), and squad drills (a group of 8 to 12 individuals). Types of weapons that will be authorized for use at the military operations in urban terrain will include M16, M4, M249, and M240. Blanks, simulators, smoke grenades, diversionary devices (improvised explosive devices and booby traps that release smoke when activated), special effects small arms marking system (similar to paintball), and a multiple integrated laser engagement system (small laser receivers scattered over the uniform of an individual soldier, which detect when the soldier has been shined by another soldier's firearm laser) are used in place of ammunition and explosives that would be used in a real combat situation.

Tactical motor vehicle operator training is a continuous requirement for USMC units. The advanced motor vehicle operations course would consist of a route along which a series of obstacles would be placed for driver trainees to negotiate. This would include obstacles simulating terrain features such as narrow bridges, serpentine courses, brake modulation blocks,

river crossing, side slope, pot holes, curb and ditch crossing, humps (similar to moguls on a ski slope), and narrow urban driving. The obstacles are connected with unpaved roads. The capacity of the advanced motor vehicle operations course facility will range from 25 to 60 personnel and will be used for individual, section, squad, or platoon training. An estimated 20 drivers per week would train at the advanced motor vehicle operations course, primarily with high mobility multipurpose wheeled vehicles. At two drivers per vehicle, an estimated 10 high mobility multipurpose wheeled vehicles would use the course during training events.

Convoy training consists of simulated threats and tactical scenarios to train in various defensive techniques. This area of Andersen South is currently used by the Air Force for expeditionary airfield and military operations in urban terrain training, which has similarities to the maneuver area training. The convoy training course is 2.5 mi (4 km) and would use existing and new roadways (see Andersen South construction area, **Figure 1**) within areas identified for the maneuver training space. All existing roads would be open to motor vehicle use associated with maneuver area training; this will primarily be wheeled vehicles, but occasionally a tracked vehicle may be used in maneuver area training at Andersen South. The area will continue to support Air Force training, while also accommodating Marine Corps training requirements. Access to the site would be by vehicle or air lift. Air lifts would typically involve two to four CH-53 helicopters dropping off and picking up personnel twice a week.

Andersen South would support landing zones for aviation training and include helicopter support team training for ground units. Personnel will be trained in rappelling from the helicopter and procedures that will be used in inserting and extracting troops via helicopter at combat locations. The air operation events associated with this air-ground training will typically consist of a pass for orientation, followed by a downwind approach, hovering at 30 ft (9 m) above ground level for approximately one minute at a designated landing zone and a departure. Since the maneuver area aviation training operations will be a component of training to meet the aviation training requirements, they are also described as aviation training. Helicopter-insertion extraction activities include fast rope, rappelling, helocasting, and parachute operations. Helicopter insertion-extraction training operations would involve one pass for landing zone orientation, followed by an approach of the landing zone, hovering at approximately 30 ft (9 m) above ground level for approximately one minute, and then departing the landing zone. During each training event, approximately three helicopter insertion-extraction operations would be conducted at one or more closely located landing zones. Approximately 114 helicopter insertion-extraction events would occur at Andersen South per year. Confined area landing, external loads, and maneuver lift (see descriptions above) training would also occur on Andersen South at a frequency of 125, 63, and 720 events per year, respectively.

Shooting house operations, which are to be located in Andersen South, are conducted in an enclosed structure and provide training in close-quarter skills, like room clearing and hallway navigation. Live-fire training operations with the 5.56-mm rifle will be authorized within the facility.

<u>Training Activities and Aircraft Operations within AAFB</u>

The main base at AAFB comprises about 11,500 ac (4,654 ha). Mass grading for construction of the Air Combat Element facilities addressed under the 2010 BO, has been completed as of May 2017. There are two airfields on AAFB, the north ramp and the south ramp runways. The facilities constructed at AAFB north and south ramps will be used by 12 permanently stationed MV-22 Ospreys and will accommodate the loading of additional transient aircraft. These aircraft will be used to conduct training and operational flights, including the following components: field carrier landing practice, familiarization-instrument, Marine air-ground task force, tactical air operations center, and routine operations to occur in association with the Air Mobility Command and the Air Combat Element (ACE). A training event consists of one aircraft performing a take-off, a training evolution, and a landing. These aircraft training operations (**Table 5**) would occur at existing airfields.

**Table 5**. Anticipated total flight operations at AAFB resulting from previous projects with the addition of the proposed action (Czech and Kester 2008).

| **Aircraft Type** | **Anticipated Total Aircraft Operations per Year at Andersen Air Force Base** | | | |
|---|---|---|---|---|
| | Previously Addressed | Proposed Project | Total | % Increase |
| Helicopter | 19,029 | 19,489 | 38,518 | 102% |
| Jet/Propeller | 25,697 | 6,424 | 32,121 | 25% |

The ACE facilities would be used for aircraft operations, maintenance of MV-22 tilt rotor aircraft, and training and support functions. The ACE facilities would also be used for USMC air control group training. The USMC air control group training involves coordination of air command, control, and defense units and the tactical air operations center. Training entails the set-up and operation of air traffic control radar and radio frequency emitters and facilities consisting of shelters, a portable tower, and electrical power sources. Tactical air operations center training involves the establishment and dismantling of these facilities within a 96-hour period. Training includes use of various emitters and sensors which need to be de-conflicted with other electronic equipment operating in the area. The ACE bed-down facilities will operate 24 hours per day and seven days per week. Staffing levels will be contingent on surge and operational requirements of the ACE facilities. Traffic would include government-owned vehicles, personal-owned vehicles, and shuttle buses from the proposed Main Cantonment area.

Approximately 1,000 annual field carrier landing practice and 79 annual familiarization-instrument flight events are proposed for AAFB. Field carrier landing practice operations entail one or more aircraft flying at a low altitude in almost circular patterns and involves landing on a simulated aircraft carrier during the day and, using night-vision goggles, at night. Familiarization-instrument training, including autorotation and simulated engine-out approaches will occur on the improved airfields with the support of aircraft rescue and firefighting facilities. Rotary-wing aircraft operations will occur at the AAFB airfields and in various proposed training areas on Guam. Fixed-wing aircraft operations will occur only in the immediate airfield environment of AAFB. Aircraft would then leave this area to conduct activities within established training areas of the Mariana Islands Training and Testing (MITT) program or other locations as described under MITT (USFWS 2015b). Air traffic at the ACE bed-down and the

north ramp will include helicopter, vertical lift aircraft, fixed-wing, and unmanned aircraft arrivals and departures.

In addition, the new Air Embarkation Facility was completed in June 2015 to serve as the passenger terminal for AAFB and temporary cargo storage. Air embarkation and disembarkation refers to the loading and unloading of passengers or cargo to and from aircraft. The passenger facilities are comparable to those of a small airport: luggage handling, waiting area, and ticket and documentation area. Cargo is staged for loading to aircraft or disbursement to warehouses or individual commands. The Air Embarkation Facility will operate 24 hours per day and seven days per week.

Training Activities and Aircraft Operations within Naval Base Guam

Naval Base Guam (NBG) is located along the southern side of Apra Harbor on the western coast of Guam. Relocation of the USMC to Guam would result in frequent embarkation operations supporting amphibious transportation of Guam-based Marines and other transiting amphibious forces for potential contingency, humanitarian, and exercise operations in the Pacific theater. In-water ship berthing and embarkation areas, staging areas, an amphibious craft laydown area, a military working dog kennel, a medical and dental clinic, wash down facilities, brown tree snake (BTS) barriers, and quarantine areas will be developed and operated at NBG. In addition, a U.S. Coast Guard (USCG) berthing and crew support building will be relocated to an area that is not currently forested. The military working dog kennel relocated from its existing site to a new site on NBG, within an existing laydown area for base maintenance with existing access roads and utility tie-ins.

The Apra Branch Medical and Dental Clinic will be built on a previously disturbed area that is currently vacant. The Morale, Welfare, and Recreation area will be developed to provide food and beverage booths, seating for 500 people, 40 phone bank seats, 100 stalls for visitor and rental car parking, portable restrooms, laundry facilities, temporary lighting, and trash dumpsters.

All facilities will have security lights mounted on buildings or steel poles. Lighting along the wharves will consist of 1,000-watt high pressure sodium floodlights mounted on new or existing poles. Lighting will be shielded and aimed such that the majority of the illumination will be directed towards the wharf deck, extending over water approximately 100 ft (30.5 m). All actions related to development and improvement of waterfront facilities will occur in currently paved or landscaped areas. All utility distribution lines and ductwork will be located underground, generally within existing utility corridors.

The DON will develop permanent and temporary wash down, quarantine, and inspection sites at arrival areas at Apra Harbor (ship and amphibious vehicle loading and unloading) (USFWS 2015a, p. 31-33) as follows.

1. A wash down, quarantine, and inspection facility will be built at Apra Harbor within 600 ft (183 m) of Victor Wharf to reduce the risk of exposure to invasive species after leaving the clean, biosecure area. During construction, invasive species and debris will be removed from the site. Prior to operation, the biosecure area will be inspected

to ensure the area is free of invasive species. These facilities will provide for vehicle cargo quarantine, inspection, and storage. The areas will use BTS barriers and active trapping for BTS will occur. The facilities will include a pre-wash down area, vacuum equipment, wash racks (raised platforms with ramps at either end that facilitate cleaning and inspection of undercarriages), an inspection building, and fenced area that will meet the requirements for the use of inspection dogs and a cargo loading and inspection area. Specifically, these facilities will be built in a designated paved area with a wash down area and sufficient space for segregating "clean" from "dirty" equipment, cargo, and vehicles. The areas will be surrounded by BTS barriers following specifications received from the Service: The barriers will be 4.5 ft (1.4 m) tall; made from pre-cast concrete with an outward projecting lip to deter snakes; the barriers will have only two gates providing one-way flow of traffic through the site; each gate made from sliding chain-link with fabric barriers or comparable materials to prevent BTS ingress and egress.

2. When in Apra Harbor, the vehicles and equipment unloaded or loaded onto a ship will be inspected and receive a wash down on arrival and departure to prevent introduction of any pest or invasive species that may present a potential threat to agriculture, public health, or the natural resources of Guam or other Pacific Islands. All wash downs will be conducted and supervised by trained personnel in accordance with Armed Forces Pest Management Board, Technical Guide No. 31 (2017). Personnel from USDA may participate in inspections and BTS inspections will be conducted with involvement of USDA Animal and Plant Health Inspection Service (APHIS) personnel. Vehicles will be inspected (internally and externally) prior to passing into the biosecure area. The water used to wash vehicles will be captured and circulated through filters to prevent pests from spreading. All waste on board ships will continue to be steam sterilized prior to disposal in regulated landfills in accordance with base operating procedures.
3. Supplies for the USCG Cutters are delivered to the wharves from existing DON supply warehouses where all supplies and material have undergone required USDA inspections upon arrival and before being transferred out of the warehouse and onto a USCG ship. The USCG ships do not offload supplies onto Guam from other locations.
4. Truck traffic at the NBG wharf will be required to re-supply ships. Trucks may be from DON Supply or direct from commercial vendors. Equipment to move cargo will be brought to the wharf as needed. When an aircraft carrier is not berthed, the Port Operations building will be used for storage. All equipment and cargo will go through inspection procedures prior to being brought into "clean" areas or being loaded on to ships, regardless of vendor.
5. A wash down, quarantine, and inspection facility will also be built at the amphibious vehicle laydown area in Apra Harbor to reduce the risk of exposure to invasive species after leaving the clean, biosecure area. This facility will be adjacent to the shore so that amphibious craft can drive into the wash down, quarantine, and inspection facility. This facility will be built to the specifications described above for Victor Wharf with modifications to accommodate amphibious vehicles, specifically: the laydown area will have dedicated ramps for landing craft air cushion and amphibious assault vehicles in the quarantine area.

6. Typically, the Amphibious Task Force will arrive fully supplied to meet all training requirements or will be replenished as needed prior to training in the CNMI. If cargo is loaded or unloaded, inspection is required as described above for Victor Wharf. Cargo will be loaded and unloaded in the laydown area which will be of sufficient size to segregate "clean" from "dirty" cargos. If there is a training mission on Guam, the trucks will drive off the ships' stern ramps (and be inspected as described above). Other cargo may be offloaded by mobile crane. After inspection, cargo may be temporarily stored in a "clean" material handling equipment area at the waterfront.
7. For all facilities, the DON will attempt to include USDA APHIS at the earliest possible time to plan for BTS inspections. Planning for cargo storage will include considerations of the length of time for storage, risk of BTS or other invasive species, and origin and destination of cargo.

All amphibious (i.e., on water) training operations and conservation measures are assessed under the MITT BO (USFWS 2015b). Though new facilities would be constructed due to the proposed project, no additional amphibious training will occur in undisturbed areas, and no new or increased frequency of training is anticipated under the proposed action. Therefore, amphibious training will not be analyzed in this BO.

New aviation training for external loads will occur at Orote Airfield on NBG. The training requires access to pre-positioned cargo for practice, and ground access is needed for ground support team personnel. External loads cannot be carried across public roads or populated areas. External load training operations will involve one pass for landing zone orientation, followed by an approach of the landing zone, hovering approximately 30 ft (9 m) above ground level for approximately one minute while the ground support team attaches a load (e.g., concrete block, items in a cargo net, or a vehicle), departure of the landing zone vicinity with the load in tow, flying with the load in an arc, then returning to the landing zone with the load, and hovering for approximately 30 seconds while the ground support team retrieves the equipment, and then departing the landing zone vicinity. During each event, these operations will typically involve five repeated attachments and detachments of external loads at the same landing zone where the ground support team is positioned. Ground support teams will include up to 40 personnel at one time and will support landing zone operations. Approximately 10 to 12 wheeled vehicles (e.g., high mobility multipurpose wheeled vehicles) will be used by these teams.

Training Activities and Aircraft Operations within the Naval Munitions Site

The Naval Munitions Site (NMS) is approximately 8,646 ac (3,499 ha) with ground-training activities occurring in the Southern Land Navigation Area consisting of 3,357 ac (1,359 ha) and the Northern Land Navigation Area consisting of 508 ac (206 ha) (**Figure 1**). The NMS is comprised of primarily savanna, ravine forest and limestone forest vegetation communities. Company-level patrolling, jungle training, land navigation, and air-ground operations will occur on five to seven consecutive days, 12 weeks per year, day and night, for a total annual throughput at the NMS of 1,440 Marines. Sixteen events are authorized under the MITT BO (USFWS 2015b). The number of days and weeks described above represent an increase of training events per year due to the proposed action (revised total of 28 events per year). This site is rural and rugged, supporting land-navigation training primarily for Special Forces personnel.

Access to the NMS for training will occur via aircraft transport operations at proposed landing zones. Approximately eight CH-53 (heavy-lift transport helicopter) lifts will be required for a company-level training event. Personnel, hand-carried supplies, and equipment will typically be airlifted to the site on a Monday and lifted out on Friday of the same week. No other roads will be established and no vehicles will be used within the training site. The access road will have an associated parking area that will be periodically mowed to allow for parking and to reduce fuel loading and potential for fires. Foot trails will be established within the Southern Land Navigation Area of the NMS due to repeated use during maneuver training.

Terrain flight, ground threat reaction, defensive maneuvering, confined area landing, and external load training will occur at the NMS. Terrain flights require a route with varying terrain at 50 ft to 200 ft (15 m to 61 m) above ground level. Training for terrain flights will occur only within the southern portion of the NMS, south of the southern extent of Fena Reservoir. Aircraft will leave AAFB and transit to southern Guam using standard military flight procedures (i.e., greater than 1,000 ft. [305 m] above ground level). Aircraft may fly over land or over water on their way to the NMS. A typical training event may involve an aircraft leaving AAFB, moving to the east over the ocean, traveling along the coast at an altitude greater than 1,000 ft (305 m) until approximately the Talofofo River, and then flying up the river to the NMS still at an altitude equal to or greater than 1,000 ft (305 m). Flights may go up the Ugum River at altitudes of 1,000 ft (305 m) or greater above ground level until they reach 9,843 ft (3,000 m) from the mouth of the river at Highway 4 and then flights may conduct low-level terrain flights. Once aircraft cross into the NMS below Fena Reservoir (training restriction line), pilots will then be authorized to conduct low-level 50 ft to 200 ft (15 m to 61 m) above ground level terrain flights within the southern NMS. Low-level flights will not occur over munition bunkers, the main NMS, the area to the east of the munition bunkers, over Fena Reservoir, or over the Almagosa Springs.

Ground threat reaction training requires a tactical flight maneuver area or route (similar to terrain flight routes) where ground-based electromagnetic radiation threat simulators may be placed. Defensive maneuvers are also conducted along a route over land or water. Differing helicopter types (AH-1, CH-53E, UH-1) and the MV-22 tilt rotor aircraft, will be used to conduct terrain flights, ground threat reaction, and defensive maneuver training; however, terrain flight training operations are low altitude tactics and the ground threat reaction and defensive maneuver training are conducted more in a tactical navigation area than along a route. Ground threat reaction is also low-altitude training like terrain flights, while defensive maneuver training is higher in altitude (equal to or greater than 1,000 ft [305 m] above ground level). Approximately 100 terrain flights, 94 ground threat reaction flights, 94 defensive maneuvers, and 1,104 maneuver lift flights per year will occur in the NMS.

Confined area landing training operations will also occur at the NMS. Confined area landing training consists of one pass of the landing zone for orientation, a downwind approach, followed by the landing, and takeoff. To meet qualification requirements, confined area landing training events typically will have five associated operations. Typically, a number of different, closely located landing zones will be used during the training event. There will be approximately 125 confined area landing training operations per year at the NMS. Approximately 63 external load training operations per year will also occur at the NMS originating from NBG.

**Conservation Measures to Avoid or Minimize Project Impacts**

The project's conservation measures are designed to avoid or minimize project effects to listed species and their habitats or to contribute to the recovery of a listed species. The Conservation Measures in the 2015 BO (USFWS 2015a, p. 36-46) remain intact and binding unless noted below. Conservation measures are considered part of the proposed action and are vital to determining the scope of the proposed action.

Implementation of conservation measures is required under the terms of the proposed action. The Service's effects analyses and determinations assume proposed project conservation measures will be implemented in full. Any changes to, modifications of, or failure to implement these conservation measures may result in a need to reinitiate this consultation. Modifications to certain aspects of a conservation measure, described herein, may be substituted for those provided in this BO, so long as such modifications provide protection equal to or greater than the protection afforded by the measure, as it is proposed and analyzed in this BO, and the Service's written concurrence is given. All conservation measures must be implemented prior to or concurrent with construction, unless otherwise stated.

After the conservation measures have been fully implemented, the long-term management of the species addressed in this consultation within the project areas, must be incorporated into the final JRM INRMP.

The proposed action's conservation measures are organized into five categories listed below and described in subsequent sections.

- Measures to contribute to the recovery of listed species;
- Measures to minimize the effects of construction;
- Measures to minimize the effects of invasive species;
- Measures to minimize the effects of fire; and
- Measures to minimize the effects of training.

<u>Conservation Measures that will Contribute to the Recovery of Listed Species</u>

This subsection is organized into general measures, core measures, species specific targets, and a conceptual implementation plan. General measures are designed to protect listed species during construction and operation phases of the proposed action.

These general measures are as follows, and are also referred to in subsequent paragraphs that discuss specific species conservation measures (DON 2017a, pp. 34-36):

1. *Fencing of the Haputo Ecological Reserve Area (ERA) Access Trail, Signage, and Education*. The DON will fence the Haputo ERA access trail to manage access in order to assist in maintaining the characteristics and integrity of the ERA. The fencing will prevent overuse by military and civilian personnel and potential damage to terrestrial biological resources within the ERA. These measures are consistent with the goals and objectives of the Haputo ERA Management Plan (NAVFACMAR 2010). In addition, in

accordance with the Haputo ERA Management Plan, the DON will develop and install informational and educational signage on the cliff line above the Haputo ERA. The educational materials will educate military and civilian personnel on the sensitive biological resources within the Haputo ERA, and monitor and document visitor use of the area, and prevent overuse and potential damage to terrestrial biological resources.

2. *Pre-construction Surveys, General Listed Plant Salvage and Translocation*. The DON will conduct pre-construction surveys to identify all listed plant species prior to the commencement of construction activities. If pre-construction surveys identify a listed plant species present in the construction area and the individuals cannot be avoided or translocated, then healthy plant material will be salvaged or available seeds will be collected, and such material will be housed in the Native Plant Nursery or directly transplanted into protected habitat or Forest Enhancement Sites (**Figure 5**). The ability to salvage the plants or collect seeds would be dependent on the health of the plant and whether or not it would survive transplantation or whether the plant produces seed. An authorized biologist would make the determination of "health." Transplantation timing will be site specific. Plants that cannot be immediately transplanted shall be stored at the DON Native Plant Nursery.
3. *Native Plant Nursery*. The DON is developing a Native Plant Nursery within the proposed Main Cantonment (**Figure 5**), for the storage and propagation activities of native and listed plant species, associated with the proposed action. Temporary locations adjacent to the Forest Enhancement Sites may also be developed in order to assist in the hardening off process for plants as they transition from the long-term Nursery to Forest Enhancement Sites or other protected areas.
4. *Authorized Biologist Qualifications and Propagation/Translocation Authorization Process*. All authorized biologists shall be considered agents of the DON and the Service for the purposes of conducting Conservation Measures described in this BO. Authorized biologists shall report directly to DON regarding all compliance issues or questions; this includes all draft and final reports of noncompliance (DON 2017a, p. 35). Prior to commencing translocation of the Mariana eight spot butterfly, Guam tree snail, humped tree snail, fragile tree snail, *T. guamense*, *B. guamense*, *D. guamense*, *T. rotensis*, *C. micronesica*, or *H. longipetiolata* the DON shall submit a statement of qualifications for potential biologists to the Service. The Service will provide a response (either concurrence or a detailed explanation of why the person may not meet the qualifications) no later than 30 calendar days after the statement is sent. If after 30 calendar days there is no response from the Service, DON will assume concurrence from the Service. The qualifications to work with the aforementioned species include the following:
    a. A bachelor's degree with an emphasis in botany, horticulture, ecology, or a related science;
    b. At least 100 documented hours of experience conducting propagation, translocation, transplantation, pest control, and monitoring of the aforementioned species or a closely related species; and
    c. Applicant must provide contact information of three references familiar with their work related to b (above).
5. *Annual Reporting of Conservation Measures*. The authorized biologist shall record each observation of each species handled in annual monitoring reports. The authorized

biologist will also include the type of activities (e.g., propagation, translocation) being conducted on each species and if relocated to another area, provide the location.

6. *Avoidance of Listed Orchid Species in a Small Location at Finegayan*. The DON will not construct within the area designated as "No Construction Area" within the proposed Main Cantonment because the location is not suitable for construction (**Figure 5**). The area is known to contain approximately 816 *T. guamense* and one *D. guamense*.

Forest Enhancement Sites, Ungulate Eradication Areas, and BTS Exclusion Fences

The core of DON's conservation measures that are intended to contribute to the recovery of listed species are focused on two Forest Enhancement Sites (North Finegayan and Finegayan), the NWF Ungulate Control Area, and two BTS Exclusion Fences (North Unit and South Unit) (**Figure 5**). The BTS Exclusion Fences would be located within the Forest Enhancment Sites. The DON's primary goal is to take an ecosystem approach to restoring, enhancing, and managing the limestone forest on DoD lands in support of range sustainment efforts on Guam (DON 2017b).

*Forest Enhancement Sites*

As stated in the 2015 BO (USFWS 2015a, p. 37), the DON will implement a forest enhancement project to enhance a minimum of 1,000 acres (404.7 ha) in Finegayan. The total minimum size of the Forest Enhancement Sites was determined under the 2015 BO in order to offset the loss of recovery habitat for the Guam Micronesian kingfisher, Mariana crow, Guam rail, and Mariana fruit bat (USFWS 2015a, p. 107).

Since 2015, the DON has refined the Forest Enhancement Conservation Measure to identify the sites and include the following:

1. The North Finegayan Forest Enhancement Site is approximately 650 ac (263 ha) and will be fully enclosed by an ungulate exclusion fence (**Figure 5**) that will be maintained and monitored throughout the life of the project.
2. The Finegayan Forest Enhancement Site (also referred to as the Finegayan Outplanting Site) is approximately 455 ac (184 ha) and will be located within the Main Cantonment area of Finegayan. This entire site will include ungulate control and be enclosed with a permanent fence (**Figure 5**) that will be maintained and monitored throughout the life of the project. Signage and other educational measures would be implemented to limit access to the Finegayan Outplanting Site.

Forest Enhancement activities will include the following:

- Installation of ungulate exclusion fences around approximately 1,000 acres (404.7 ha);
- Active removal of ungulates (i.e., trapping, snaring, shooting) with the goal of eradication within the fenced areas;
- Invasive plant removal; and
- Propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats (e.g., *A. mariannensis*, *B.*

> *guamense*, *D. guamense*, *E. calcareum*, *G. mariannae*, *F. prolixa*, *M. citrifolia*, *C. micronesica*, *W. elliptica*, *S. nelsonii*, *H. longipetiolata*, *P. pedunculata*, *T. rotensis*, and *T. guamense*).

The Conservation Measure has been modified from the 2015 BO (USFWS 2015a, p. 37) to allow for the translocation and outplanting of *T. guamense*, *D. guamense*, *B. guamense*, and Mariana eight spot butterfly host plants, *P. pedunculata* and *E. calcareum* within the Forest Enhancement Sites.

The process for initiating Forest Enhancement activities remains unchanged from the 2015 BO, "when a DON-related project is initiated that results in clearing of habitat that could aid int the recovery of listed species, a commensurate amount of forest enhancement will begin. The exact amount of recovery habitat that will be cleared will depend on final design specifications. The DON's Forest Enhancement project will enhance at least the same number of acres of recovery habitat as that cleared by the proposed action. The DON expects that approximately 1,000 acres of forest will need to be enhanced as part of the Project Description. The timeline for initiation of Forest Enhancement projects will be based on the construction timeline for the proposed action. The first construction project that will clear recovery habitat will trigger the initiation of forest enhancement. The sequence of forest enhancement will be: (1) ungulate exclusion fence, (2) ungulate removal, (3) invasive plant control, and (4) native plant establishment (USFWS 2015a, p. 37).

An overview of the DON's general process for forest enhancement and restoration activities is outlined below (DON 2017b):

1. Identify forest restoration/enhancement blocks.
2. Map the proposed forest restoration/enhancement area boundaries.
3. Receive authorization for specific area of forest to be restored or enhanced and vegetation clearance approach for permanent ungulate fences, access-grid trails, and temporary cross fencing.
4. Obtain clearance for any ground disturbing activities from UXO specialist.
5. Perform forest inventory for species density and dominance.
6. Construct permanent ungulate exclusion fence around perimeter of the enhancement site.
7. When fencing is complete, begin ungulate removal program.
8. Monitor ungulate removal program. Based on ungulate monitoring results, implement further ungulate control activities to achieve ungulate eradication.
9. Develop an invasive plant removal and native plant species outplanting and establishment plan based on the forest inventory.
10. Once ungulates are eradicated from the enhancement site, begin invasive species removal.
11. During the wet season, implement the out-planting of the enhancement site(s).
12. Annually, conduct vegetation and ungulate monitoring and if necessary, repair fencing, implement further ungulate removal activities, invasive plant removal and outplanting.
13. If a typhoon occurs during the forest enhancement process, fences will be inspected, repaired and if fences have been breached, conduct necessary ungulate control.

The DON understands that restoration/enhancement of a forest is a long-term program, requiring a sustained effort for 30 or more years (DON 2017b, p.1). Ongoing projects and management efforts will be coordinated and integrated with future management efforts to achieve the long-term goal of restoring and enhancing habitats for native species, including listed species.

*Brown Tree Snake Exclusion Fences*

The DON has initiated support for large-scale, long-term efforts to refine methods for BTS control that will reduce the BTS population on a landscape level more cost effectively and increase the efficacy of capturing BTS in low-density situations. In early 2012, the DON coordinated with the Service, USDA, and USGS on priority BTS projects. The development of a bait formulation for BTS suppression was determined to be the highest priority project need. The USDA National Wildlife Research Center (NWRC) was funded for a multi-year project by the DON at the start of fiscal year 2013 to implement the bait formulation project.

The DON will implement selected projects identified as priorities in the BTS Technical Working Group Strategic Plan that is compatible with the military mission on Guam for up to 10 years from the start of Main Cantonment construction, subject to Congressional funding guidelines and restrictions. DON and the Service acknowledge financial support is subject to the availability of funds, and no provision herein shall be interpreted to require obligation of payment of funds, in accordance with the Anti-Deficiency Act of 1982 (31 U.S.C. §§1341).

The DON's purpose for BTS control projects is to identify and use successful technology to severely suppress or eradicate BTS. To accomplish this goal, DON will install a BTS barrier surrounding the South Unit (**Figure 5**), to exclude BTS from approximately 160 acres (65 ha). Construction of the South Unit-BTS Exclusion Fence would begin after current experimental BTS suppression activities are deemed successful. Experimental BTS suppression activities, conducted by USDA Wildlife Services (USFWS 2011a, 2011b) are occurring within the existing 136-acre (55 ha) Habitat Management Unit (HMU) (**Figure 5**). The HMU is enclosed by a BTS exclusion fence. The Service and DON biologists are working closely to evaluate progression of experimental BTS suppression activities within the HMU.

Upon demonstrated reduction of BTS within the South Unit, the DON will initiate the construction of the North Unit- BTS Exclusion Fence, to exclude BTS from approximately 300 ac (121 ha). If landscape scale experimental BTS suppression activities are unsuccessful at any stage and as a result, large BTS Exclusion Fences would be ineffective, then DON would not construct new BTS Exclusion Fences and instead would manage those areas as Forest Enhancement Sites.

In response to decreased BTS densities, the rodent and feral cat populations are expected to increase. In order to address this anticipated increase the DON will implement rodent and feral cat control within necessary areas of DoD property.

*Northwest Field (NWF) Ungulate Control Area*

The DON will construct an ungulate exclusion fence to exclude feral ungulates from the LFTRC in the NWF (**Figure 5**). The ungulate exclusion fence would be approximately 3.69 kilometers (2.3 mi) in length and would tie-in to topographic barriers (i.e., cliffs) on each end. The DON is proposing to construct the LFTRC in the last remaining contiguous primary limestone forest habitat on Guam; therefore by constructing the NWF Ungulate Fence, habitat not within the proposed range footprint would be protected from ungulates. Approximately 218 ac (88.2 ha), 66.7 ac (27.0 ha), and 97.1 ac (39.3 ha) of primary limestone forest, secondary limestone forest, and herbaceous scrub, respectively would be protected from ungulates over the life of the project.

Ungulate control in the LFTRC may occur prior to NWF Ungulate Fence construction. All ungulate control and eradication activities, including those occurring in Finegayan may use any number of established ungulate control/eradication techniques: Ground Hunting by professional sharpshooters; Aerial Hunting; Recreational Hunters; Ungulate Control Specialists; Hunting with Dogs; Live trapping (including corrals); Snares; Lethal Baits; Nontoxic Baits to Attract Target Species; Divider Fencing; Radiotelemetry (Judas animals); and Fertility Control. The DON's objective of constructing the ungulate exclusion fences is to eradicate all ungulates within the fence.

In addition, the DON will adhere to the following 2015 BO Conservation Measures (USFWS 2015a, p. 38):

- The NWF Ungulate Control Fence will be completed within two years of awarding the contract for construction of the portion of LFTRC that removes the existing Ritidian Ungulate Fence (**Figure 3**).
- The DON will remove all ungulates from the NWF Ungulate Control Area within six months after completing the NWF Ungulate Fence (**Figure 5**).

Conservation Measures for Specific Species

*Mariana eight spot butterfly*

The DON will conduct pre-construction surveys to identify any stages of the Mariana eight spot butterfly prior to the commencement of construction activities. If any life stage of the Mariana eight spot butterfly (e.g., eggs, caterpillar, and chrysalis) is located within a project footprint during pre-construction surveys, it will be relocated onto an appropriate host plant (e.g., relocate pre-diapause larvae to *Procris pedunculata* or *Elatostema calcareum*) within similar sites away from the project footprint. This can be conducted by clipping the host plant and grafting the plant to another plant outside the project footprint (Cook and Delisle 2010). This method has been conducted successfully for the Sacramento Mountains checkerspot butterfly (*Euphydryas anicia cloudcrofti*) (USWFS 2002a, 2002b).

The DON will plant the Mariana eight spot host plants (*P. pedunculata* and *E. calcareum*) within the Forest Enhancement Sites and on the backside of the earthen berms of LFTRC ranges. The primary objective is to provide habitat corridors for the Mariana eight spot butterfly. The number of host plants that will be planted would be commensurate with the amount of Mariana eight spot host plants that are removed within the footprint of the LFTRC.

*Guam tree snail, fragile tree snail,* and the *humped tree snail*

The DON will conduct pre-construction surveys to identify any Guam tree snail, fragile tree snail, or humped tree snail within the project footprint prior to the commencement of construction activities. If any listed snail is found, the authorized biologist will translocate the listed snail away from the project footprint and into suitable habitat.

*Mariana fruit bat*

For projects within or in the vicinity of suitable Mariana fruit bat habitat, surveys following the Service-recommended JRM protocol (USFWS 2009) will be conducted one week prior to the onset of work (USFWS 2015a, p. 40). If a Mariana fruit bat is present within 492 ft (150 m) of the project site, the work will be postponed until the bat has left the area. The measure is intended to prevent, avoid and minimize potential effects to fruit bats, and will be implemented during pre-construction and construction activities.

*Listed Plant Species*

DON expects that six endangered or threatened plant species (*B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense*) would be affected by the proposed action. Effects are expected to be in the form of entire habitat removal (i.e., clearing of vegetation and grading). The DON will conduct conservation measures specifically designed to address each listed plant species (**Table 6**). Healthy listed plants located within a project footprint will be transplanted into Forest Enhancement Sites or other suitable protected areas (e.g., NWF Ungulate Control Area) prior to clearing. The ability to salvage the plants would be dependent on the health of the plant and whether or not it would survive transplantation. An authorized biologist will make the determination of "health." If DON is not able to meet the minimum percent survival ratio with whole plants or viable seeds from within the project footprint, then DON will pursue seed collection, tissue germination, and plant division and/or stem cuttings, as suitable to the species, from other sources outside the project footprint to provide seedlings to meet out-planting success targets (**Table 6**).

**Table 6.** Conservation measures for listed plant species, including out-planting site selection, monitoring and success criteria (DON 2017c).

| Scientific Name | No. of Plants Subject to Removal | % Survival Ratio of Salvaged Material[1] | Targeted No. of Plants to Survive[2] | Out-planting Site Selection Criteria | Maintenance | Monitoring |
|---|---|---|---|---|---|---|
| *Bulbophyllum guamense* | 3 | 50% | 2 | 1. Wind: reduce wind influence by planting in forest with intact canopy;<br>2. Host: native host trees, large trees (*Heritiera* spp., *Ficus* spp.);<br>3. Sunlight/moisture: lower branches of canopy tree in disturbed forests, higher branches of canopy tree in high humidity microclimates;<br>4. Orientation on host branch/trunk: top of horizontal/wide lateral branches in lower/mid-canopy of large host trees;<br>5. Stage of life: adult/large specimens can be affixed to bark of branches directly and secured; and<br>6. Habitat: disturbed limestone forest. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of fence protectors; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |

| Scientific Name | No. of Plants Subject to Removal | % Survival Ratio of Salvaged Material[1] | Targeted No. of Plants to Survive[2] | Out-planting Site Selection Criteria | Maintenance | Monitoring |
|---|---|---|---|---|---|---|
| *Cycas micronesica* | 3,191 | 50% | 1,596 | 1. Wind: reduce wind influence by planting in forest gaps;<br>2. Sunlight: half day sunlight, in forest gaps and along western forest edges that receive less wind flow;<br>3. Spacing: place in groupings (groves) with ~10 ft. between trunk centers;<br>4. Culture methods: adult trees, remove fruit, old fronds, reduce new frond length by half for remainder of fronds, or remove all fronds if tree is infested with cycad scale; and<br>5. Habitat: limestone forest, coastal limestone. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of fence protectors; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |

| Scientific Name | No. of Plants Subject to Removal | % Survival Ratio of Salvaged Material[1] | Targeted No. of Plants to Survive[2] | Out-planting Site Selection Criteria | Maintenance | Monitoring |
|---|---|---|---|---|---|---|
| *Dendrobium guamense* | 18 | 50% | 9 | 1. Wind: able to withstand exposed positions in tree canopies;<br>2. Orientation on host branch/trunk: top of horizontal/wide lateral branches, branch crotches and on upright branches in mid to upper canopy of large host trees;<br>3. Host: native host trees, large trees (*Heritiera* spp., *Ficus* spp.);<br>4. Sunlight: Require dappled to direct sunlight of upper tree canopy;<br>5. Stage of life: adult clumps can be removed as a clump and affixed to branch of tree directly and secured, juvenile specimens should be affixed on branch with moss around roots to prevent desiccation; and<br>6. Habitat: degraded/disturbed native limestone forest. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of fence protectors; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |

| Scientific Name | No. of Plants Subject to Removal | % Survival Ratio of Salvaged Material[1] | Targeted No. of Plants to Survive[2] | Out-planting Site Selection Criteria | Maintenance | Monitoring |
|---|---|---|---|---|---|---|
| *Heritiera longipetiolata* | 7 | 50% viable seed | 4 | 1. Sunlight: require half day sunlight, in forest gaps and along western forest edges that receive less wind flow;<br>2. Spacing: should have 10-15 ft. of growing room for adequate sunlight exposure. Due to large mature size should be spaced at a minimum of 50-ft. apart if planting more than one specimen in the same plot;<br>3. Habitat: Disturbed limestone forest; cliff sides, terraces, coastal limestone. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of fence protectors; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |
| *Tabernaemontana rotensis* | 217 | 50% viable seed | 109 | 1. Wind: can withstand moderate wind exposure;<br>2. Sunlight: requires high sunlight levels;<br>3. Spacing: place in groupings (groves) with ~10-ft. between trunk centers; and<br>3. Habitat: disturbed limestone forest, gaps, edges, terraces. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of braces; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |

| Scientific Name | No. of Plants Subject to Removal | % Survival Ratio of Salvaged Material[1] | Targeted No. of Plants to Survive[2] | Out-planting Site Selection Criteria | Maintenance | Monitoring |
|---|---|---|---|---|---|---|
| *Tuberolabium guamense* | 4,922[3] | 50% | 1,000 | 1. Wind: plant in forest with intact canopy;<br>2. Host: native host trees, large trees (*Heritiera* spp., *Ficus* spp.);<br>3. Sunlight/moisture: lower branches of canopy tree in disturbed forests, higher branches of canopy tree in high humidity microclimates;<br>4. Orientation on host branch/trunk: top of horizontal/wide lateral branches in lower/mid-canopy of large host trees;<br>5. Stage of life: adult/large specimens can be affixed to bark/branches;<br>6. Habitat: disturbed limestone forest. | One year of maintenance (e.g., supplemental watering, hand-weed removal, pest removal, treatments with insecticide, installation of fence protectors; etc.) after transplantation to ensure a minimum of 50% survivorship. | One year of monitoring for growth and establishment shall be conducted regularly to determine the status of the species, at least monthly and more frequently depending on the conditions of the out-planted plants. |

[1]Salvaged material from plants of the Orchid family (Orchidaceae) will be in the form of whole plants, whereas salvaged material from *H. longipetiolata* and *T. rotensis* will be in the form of seeds, and *C. micronesica* will be in form of whole plants or basal suckers, known as cycad pups.
[2]Survived is defined for Orchidaceae species as the documented observation of new root growth after transplantation into a protected area, or for *H. longipetiolata, T. rotensis*, and *C. micronesica* 'survived' is defined as the documented observation that the plant is ready to set fruit or flower.
[3]The DON has committed to relocating as many individuals of *T. guamense* as is feasible; however a minimum of 1,000 *T. guamense* individuals will survive.

Conservation Measures to Minimize the Effects of Construction

Construction activities would range from simple improvements to extensive clearing and earthmoving activities. For this reason, specific conservation measures have been designed to minimize the effects of construction:

1. *Contractor Education Program*. The DON will implement a contractor education program to ensure that construction contractor personnel are informed of the biological resources in the project area, including invasive species, special-status species, avoidance measures, and reporting requirements. The measure is intended to prevent inadvertent effects to terrestrial biological resources due to lack of awareness of resource presence, habitat requirements, and protective measures. The measure will be implemented during preconstruction and construction.
2. *Contractor Plans and Specifications*. DON will ensure that all construction activities will occur within the limits of construction shown in the plans and specifications. This measure is intended to prevent additional habitat loss. The measure will be implemented during pre-construction and construction.
3. *Access and Location Constraints*. Construction of the Main Cantonment components will take place on the upper plateau area of Finegayan and will not occur in the Haputo Ecological Reserve Area (ERA). Construction personnel are issued base passes for official business only within construction areas; these restrictions are specified in construction contracts.
4. *Guam Landscaping Guidelines*. Appropriate or non-invasive species will be planted in all new landscapes. This measure is intended to promote habitat for native species, reduce water consumption, and reduce the need for fertilizers. The measure will be implemented during construction.
5. *LFTRC Range Berm Controls*. LFTRC range berms will contain native or non-invasive herbaceous vegetation, and other measures as appropriate for listed species (see Conservation Measures to Contribute to the Recovery of Listed Species). This measure will help to manage storm water runoff and control erosion, and the berm will minimize the number of bullets in certain ranges that may fall outside the range footprint. The measure will be implemented during construction.
6. *Lighting Installations*. Lighting will be designed to meet minimum safety, sustainability, antiterrorism, and force protection requirements. Hooded-lights will be used to the maximum extent practicable at all new roads and facilities within known sea turtle land habitat and Mariana fruit bat roost areas. Either hooded or "night-adapted" lights will be installed at the LFTRC. Illumination of forest, coastline, or beach will be consistent with range safety and security requirements and kept to an absolute minimum including the shielding of lights and directing lighting away from the forest, shorelines and other wildlife habitat areas. This measure will be implemented during pre-construction, construction, and during all DON operations.
7. *Monitoring Construction Contractors*. The DON will be responsible for oversight of avoidance, minimization, and conservation measures implementation by the contractors for projects associated with the proposed action. The DON shall ensure that construction remains within the limits of construction and that sensitive resources are avoided, unless

otherwise specified in this Project Description. This measure will be implemented during pre-construction, construction, and operations.

Conservation Measures to Minimize the Effects of Invasive Species

To reduce the spread of invasive species and encourage a more holistic approach to managing invasive species including their pathways and other vectors, as part of the proposed action the DON funded the development of a Regional Biosecurity Plan (RBP) for Micronesia and Hawaii (formerly referred to as the Micronesia Biosecurity Plan). The RBP was completed in March 2015 with various contributions from government agencies, organizations, and individuals (DON 2015c). The goal of the RBP is to provide stakeholders in Micronesia and Hawaii with a platform for coordination and integration of interagency invasive species management efforts such as control, interdiction, eradication, and research. Several of the RBP recommendations are incorporated into this Project Description as best management practices (DON 2017a, p. 31-32). These best management practices include:

1. *Vegetation Waste Management Procedures*. Green waste will be handled by the contractors at designated onsite laydown areas within the limits of construction. Contractors will be required to divert all green waste. The larger-sized green waste consisting of trees and stumps will be processed into mulch and the smaller sized green waste will be processed into compost. Green waste would be processed in accordance with MCAG management procedures to prevent and reduce the spread of the invasive coconut rhinoceros beetle and little fire ant (DON 2016). A proposed green waste processing facility at NBG Landfill may also be used to process green waste generated during construction. The DoD will seek permit authorization from the GEPA for the proposed green waste processing facility.
2. *Implementation of Landscaping Guidelines*. The DON has developed an instruction manual providing landscaping design guidelines specific to appropriate plant selection and establishment for all the DON construction activities on Guam (DON 2011). This manual implements required DON policies including, but not limited to:
   - use of native regional plants for landscaping;
   - design, use, and promoting construction practices that minimize adverse effects on natural habitat;
   - pollution prevention by reducing fertilizer and pesticide use, integrated pest management practices, recycling green waste (composting), and minimizing runoff;
   - implementing efficient water practices; and
   - preventing the introduction of invasive species.

   The above measure is intended to reduce potential effects associated with non-native vegetation, promote habitat for native species, reduce water consumption, and reduce the need for fertilizers.
3. *Biosecurity Outreach and Education*. The DON has initiated and will continue to implement a targeted, comprehensive outreach and education program for DoD and civilian populations for biosecurity education focused on prevention. As a starting point, the DON initiated a contract for the development of biosecurity outreach and education materials. The contractor has designed and produced an activity booklet, a two-sided, tri-fold, educational brochure with an associated poster that differentiates native from

introduced species, defines invasive species, describes the known impacts of invasive species on native species and ecosystems, and what can be done to prevent and control invasive species. The DON will develop additional informational videos, expand the radio public service announcement (PSA) broadcasts, and other print media as well as active public outreach concurrent with the arrival of the first major influx of USMC personnel anticipated in 2020 and continue the educational outreach at this level for an additional 5 years.

4. *HACCP Planning*. Hazard Analysis Critical Control Point (HACCP) planning is a site specific pathway management tool implemented by the DON that provides a comprehensive method to identify risks and focus procedures to prevent spread of species through likely pathways. Construction work could unintentionally spread non-target (potentially invasive) species. These non-targets could hitchhike on construction equipment or be included in shipments of materials and supplies from locations outside of Guam. The pathways used by invasive species to move into new locations are not always obvious. Many problematic species, diseases, and parasites have been transferred to new locations as undetected (and unplanned) hitchhikers. Understanding pathways and developing plans to reduce non-target species and prevent biological contamination is necessary to avoid unintended spread of species. To achieve this goal, the DON will conduct the following steps related to HACCP planning:
    a. All construction contracts will contain a requirement to develop a HACCP Plan which will identify risks and potential pathways for non-native species and will outline procedures for controlling and removing risks identified. Construction contractors are required to provide documentation that supports prevention, worker awareness training, and control of non-native invasive and pest species in the project area and efforts to prevent the movement of non-native invasive species to areas outside the project area, whether in a purposeful or inadvertent manner. The contractor is responsible for ensuring that employees receive applicable environmental and occupational health and safety training and are up to date on all regulatory requirements for specific training for the type of work to be conducted onsite.
    b. Construction contracts will contain a requirement for inspections and proper re-use or disposal of vegetation to avoid contributing to the further spread of the coconut rhinoceros beetle. The construction contractors are to identify and implement control measures to prevent the inadvertent movement of non-native, invasive species to Guam and to and from the project site to other locations on Guam. The contractor is required to establish appropriate facilities that comply with all environmental laws and regulations, provide training for proper vehicle hygiene, and promptly take corrective and preventative actions for noncompliance. This includes thorough vehicle wash down and inspection for soil and other materials prior to leaving or entering a new project site.
    c. All HACCP planning and implementation related to the proposed action will be the responsibility of the awarded project contractor(s) to ensure that proper control measures are used throughout the construction activities to prevent the inadvertent movement of invasive species from one location to the project site, and/or from the project site to other locations. It will be the responsibility of DON to review and

concur with the development phase of the HACCP planning process to ensure proper compliance by contractors.

d. HACCP plans will be approved and inspected by the DON.

5. *Monitoring to Evaluate Effectiveness of HACCPs*. The DON shall provide training, review, and technical guidance on HACCP plan development, implementation, and revision during the construction phase of the buildup on Guam. The HACCP planning covers Guam-related rapid response actions. The DON contracted a baseline ecosystem monitoring study for projects on AAFB in 2011. Transects were focused on areas where newly introduced species were most likely to occur. The intent of the project was to establish a baseline of both native and non-native plants present prior to the beginning of planned construction activities. The baseline will serve as a reference for subsequent monitoring efforts conducted concurrently with construction in order to aid in evaluating the success of implemented HACCP plans. The baseline and subsequent monitoring efforts will help to determine whether any non-native plant species detected during surveys are newly introduced or were present prior to the beginning of construction. The AAFB project was completed in December 2012.

   To document the effectiveness of HACCP implementation at construction sites, the DON has developed and will implement a long-term monitoring program for terrestrial vegetation. For any clearing of vegetation that is adjacent to or contiguous with recovery habitat, the perimeter and 98.4 ft (30 m) into the habitat will be surveyed to identify vegetation community species composition. This survey will be repeated six months and one year after vegetation removal to ensure effectiveness of the HACCP implementation (clean equipment, supplies, and materials) during construction activities. If new non-native, invasive species are detected, the DON will notify the Service and the DON will develop and implement an eradication plan or control effort to prevent infestation. The DON will develop an early detection and rapid response component to be implemented immediately when an incipient invasive species is discovered in the proposed action area.

6. *Brown Tree Snake Interdiction*. The JRM has established a comprehensive BTS interdiction program to ensure that military activities, including the transport of civilian and military personnel and equipment to and from Guam, do not contribute to the spread of the BTS to other islands or regions. The BTS interdiction requirements are specified in DoD instructions (i.e., *36 Wing Instruction 32-7004, BTS Control Plan and JTREGMARIANASINST 5090.10A, BTS Control and Interdiction*). The proposed action will continue to comply with these established procedures:

   a. The DON will fund any increase of current federally funded BTS interdiction measures (in Guam, CNMI, and Hawaii) where the need for the increase is to address direct or indirect effects related to the USMC relocation to Guam. The fiscal year (FY) 2010 level of funding for the Federal interagency BTS interdiction effort on Guam, CNMI, and Hawaii and 2010 transportation levels associated with outbound cargo from Guam for the U.S. or U.S. territories will be used as the baseline. The Service agrees that it is not DON's responsibility to fund increased interdiction measures that are identified more than one year after the end of the fiscal year in which the USMC relocation construction activities have ended and permanent non-transient USMC military units have completed their relocation to Guam. For the

purposes of this Project Description, interdiction is defined as: "to hinder, prohibit, or prevent the BTS from becoming established in new locations by conducting inspection and suppression processes." Since 2010, the DON has worked with USDA and the Service to determine BTS interdiction cost increases. To date, there has been no measurable increase in interdiction costs according to the USDA.

b. *Coordination with the USGS.* Close coordination between USGS and DON will continue to occur in support of the BTS Research Closed Population Facility at NWF (located adjacent to the LFTRC and within the SDZ). The DON will ensure through briefings or information packages that the personnel using the LFTRC know the importance of the facility and maintain the integrity of the fence. Standard operating procedures will be developed and incorporated into the Range Management Plan (RMP) for the LFTRC to ensure protection of the USGS BTS Closed Population Facility fence and require immediate notification to the proper authorities in the event that the fence is accidentally damaged, to allow for a quick repair.

Conservation Measures to Minimize the Effects of Fire

The DON will prepare a Range Fire Management Plan (RFMP) and provide the RFMP to the Service prior to LFTRC operations. The RFMP will include protocols for monitoring fire conditions and adjusting training as needed (e.g., certain types of training will be restricted under certain fire conditions) and include the location and management protocols for fire breaks, firefighting roads, and a firefighting water-system. In addition, military units undergoing training will be briefed on requirements suitable to the conditions of the day and protocols should a fire occur (e.g., fire suppression protocols and capabilities, and the priority of habitat protection in relation to all other factors considered in the plan).

Fire management is a key component of range management. The DON goal is to reduce the effects of fires by limiting their frequency, size, and severity while still allowing the USMC to maintain a high level of combat readiness. In order to avoid or minimize impacts to listed species or recovery habitat, the RFMP will include the following elements of fire management (DON 2017a, p. 33-34):

1. *Implementation of a Fire Danger Rating System*. A Fire Danger Rating System will be tailored to specific military uses (i.e., training activities) at the LFTRC and the local weather and fuel conditions will be established. Weather readings will be taken every hour by remote automated weather stations (RAWS) on the installation. This information is immediately available to Range Control, who will use the output from the remote automated weather stations to determine the level of fire danger. This, in turn, determines any restrictions placed on military training for that hour. Restrictions are relayed to troops in the field via radio transmission. By restricting highly fire prone activities during periods of high fire danger, the likelihood of a fire start is reduced. Additionally, fires that are ignited are more likely to occur during periods of low or moderate fire danger, making them easier to control and extinguish.
2. *Fuels Management*. All available fuel management techniques will be considered for fire break and fuel break maintenance, as well as fuel management control. Standard on-the-ground application is limited to mechanical cutting, herbicide application, and prescribed fire. If herbicide is to be applied, care will be taken to ensure there is no overspray into adjacent forested areas.

3. *Locations and Standards of Fire Breaks and Fuel Breaks*. Fire breaks are similar to four-wheel drive roads and are cleared of all vegetation to mineral soil. Fuel breaks are swaths of cut, burned, grazed or otherwise modified vegetation so that a fire's behavior is reduced. The fuel break widths are determined by fuels, topography, and prevailing winds. Fuel management corridors will be established and maintained providing areas through which fire will not carry. These corridors will provide several distinct areas where fire may be contained in order to prevent a catastrophic fire event. Each corridor will be approximately 328 ft to 985 ft (100 m to 300 m) wide, although terrain, safety concerns, or protected resources may constrain the width in some areas. Fire breaks and fuel breaks shall be established immediately adjacent to the forest edge, along the outer perimeter of each range, so that there is no herbaceous vegetation along the edge of the forest.

   Fuel specifications within the corridor require that canopy cover not exceed 20 percent. Cover of fuel within the fuel management corridors will be measured at a scale of 33 ft (10 m). Within the fuel management corridors, no 33 ft x 33 ft (10 m x 10 m) area will have greater than 20 percent cover of fuel. Cover 'starts/stops' at the edge of a plant clump's canopy. The clump includes the dead herbaceous fuel on the ground. The frequency of a fuel break's upkeep is dependent on the speed of regrowth and/or colonization. If the vegetation within the range footprint is less than 3 ft (1 m) tall, then no active management would be needed to maintain fuels below 3 ft (1 m) in height, within the 131 ft to 197 ft (40 m to 60 m) wide fuel break area.
4. *Standard Operating Procedures*. Standard Operating Procedures (SOPs) outline responsibilities for fire prevention, Fire Danger Rating System usage, staffing levels, equipment caches, fuel modifications, proper fire suppression actions, and post-fire reports. The SOPs also include fire prevention briefings to be given to range users prior to commencement of training, notification lists in case of fire, operational decision charts for fires, and maps of protected resources, fuels, fire breaks, and Fuel Management Areas.
5. *Range Control Approval and Guidance*. Prior to firing all pyrotechnics (including tracers), Range Control approval and guidance must be obtained. Fire Department and Range Control personnel will have the authority to stop live-fire training for non-compliance with any training regulation and/or SOPs.
6. *Fire Suppression*. Water trucks (pickup truck with a tank in the back) will be on-site as a first responder vehicle. Water trucks may be supported by a fire truck or helicopter, as warranted. All locations for fire suppression activities will be prioritized in order to minimize or prevent fire effects to listed species.
7. *USFWS Review*. The Service will be provided a 30-day review period, from the date of receipt of the Draft RFMP, to provide comments and recommendations for the DON's consideration. The RFMP will be finalized for the LFTRC prior to operation of the first range at the LFTRC.

<u>Conservation Measures to Minimize the Effects of Training</u>

1. *Aviation Training in NMS* (see NMS Operations). All aviation training will be conducted so that aircraft approach the southern portion of the NMS over the Talofofo River watershed and Fena Reservoir at heights of 1,000 ft (305 m) or greater above ground

level. Flights may go up the Ugum River at altitudes of 1,000 ft (305 m) or greater above ground level until they reach 9,843 ft (3,000 m) from the mouth of the river at Highway 4 and then aircraft may conduct low level terrain flights. Low-level training flights will be restricted to the southernmost portion of the NMS where Mariana swiftlets are not commonly present.

2. *Ground Training in NMS* (see NMS Operations). The DON will maintain 328 ft (100 m) 'No Training Buffers' around the known Mariana swiftlet nesting caves (*e.g.*, Mahlac Cave, Fachi Cave, Maemong Cave) in the NMS. This measure is intended to avoid and minimize effects to Mariana swiftlets, and will be implemented during operations.
3. *Designated No Wildlife Disturbance Areas.* The DON will ensure that military training units work in close coordination with JRM MITT to clearly define authorized training restrictions, and where appropriate, designate No Wildlife Disturbance (NWD) areas or other designations to prohibit training in sensitive sites. The DON will work closely with DON Biologists to identify new NWD areas, consistent with USMC combat readiness and training requirements. Proper designation of NWD areas will ensure that bivouacs do not cause additional disturbance to endangered species or tree snails.

**Term of the Proposed Action**

The DON will be using an adaptive management approach to adjust the schedule for construction and implementation of the various project components in order to reduce the peak workforce population, ensure conservation measures are initiated prior to or concurrently with specific project impacts, and allow the DON to adhere to contract and fiscal constraints. This approach precludes the need for a specific construction schedule that is difficult to estimate. All construction projects are anticipated to be completed by 2032 or within 15 years of signing of this Opinion. Maintenance, operations and monitoring measures may continue indefinitely. The Service anticipates that the long-term management of the species addressed in this consultation within the project areas, must be incorporated into the final JRM INRMP. Refer also to section 15, Reinitiation Closing Statement.

**Action Area**

The term "action area" is defined in the implementing regulations for section 7 at 50 C.F.R. §402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." In delineating the action area, we evaluated the farthest reaching physical and biotic effects of the action on the environment, including all DON facilities, infrastructure and training activities, as well as conservation measures described in the Project Description.

The action area for this consultation is the island of Guam (**Figure 1**). The specific areas likely to be affected directly or indirectly by the proposed action are discussed in detail in the Revised 2017 BA (DON 2017a). In addition to what is detailed in the Revised 2017 BA, the following effects from the action may be Guam-wide: 1) effects from introduction of invasive species by the proposed action could spread throughout the whole island of Guam and 2) the population increase resulting from the proposed action will cause additional human disturbance throughout the island, including at recreation sites, hunting areas, traffic along roads, etc.

## ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND DESTRUCTION/ADVERSE MODIFICATION OF CRITICAL HABITAT ANALYSIS

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis of this BO relies on four components: (1) Status of the Species, which evaluates the range-wide condition of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, fragile tree snail, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* and the factors responsible for that condition, and the survival and recovery needs of each species; (2) the Environmental Baseline, which evaluates the current condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of each affected species; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action, along with any interrelated or interdependent effects, on these species; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, fragile tree snail, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, fragile tree snail, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* in the wild.

The jeopardy analysis in this BO places an emphasis on consideration of the range-wide survival and recovery needs of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, fragile tree snail, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* and the role of the action area in the survival and recovery of these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

Past designations of critical habitat have used the terms “primary constituent elements” (PCEs), “physical or biological features” (PBFs) or “essential features” to characterize the key components of critical habitat that provide for the conservation of the listed species. The new definition of destruction or adverse modification of critical habitat was published as a final rule on February 11, 2016 (81 FR 7214) and discontinues the use of the terms PCEs or essential features, and relies exclusively on use of the term PBFs because that term is contained in the Act. However, the shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the

original designation identified PCEs, PBFs or essential features. The only species addressed in this BO with designated critical habitat is the Mariana fruit bat. The adverse modification analysis for Mariana fruit bat critical habitat was conducted on the proposed Federal action in the 2015 BO (USFWS 2015a, pp. 103-104 and pp. 144-145). This analysis and the information used in the analysis remain unchanged and are referred to by reference in appropriate sections of this consultation.

## STATUS OF THE SPECIES

### Status of the Mariana fruit bat

Species Description

The Mariana fruit bat (fanihi in Chamorro) was listed as endangered in 1984, but was downlisted to threatened on January 6, 2005 when it was determined that all fruit bats on Guam and throughout the Commonwealth of the Northern Mariana Islands (CNMI) comprise a single subspecies (70 FR 1190). The Mariana fruit bat is the only fruit bat species under U.S. jurisdiction. In 2004, critical habitat for the fruit bat was designated at the GNWR in the Ritidian Unit (69 FR 62944).

The Mariana fruit bat is a medium-sized fruit bat in the family Pteropodidae, and weighs between 0.73 lb to 1.27 lb (331 g to 577 g). Male Mariana fruit bats are slightly larger than females. The underside (abdomen) is black to brown with gray hair interspersed that creates a grizzled appearance. The shoulders (mantle) and sides of the neck are bright golden brown, but may be paler in some individuals. The head varies from brown to dark brown. The well-formed, rounded ears and large eyes give the face a canine appearance (USFWS 2009 p. 4).

The paleotropical genus *Pteropus* is represented by approximately 63 species distributed across the Indian Ocean, Southern Asia, Australia, and in Oceania as far east as the Cook Islands (Almeida et al. 2014 p. 83). Most species in the genus *Pteropus* occur on islands or in coastal areas (Almeida et al. 2014 p. 84). Four species in the genus *Pteropus* are extinct and 38 species (60 percent of the genus) are considered critically endangered, endangered, threatened, near threatened, or vulnerable under the definitions of the IUCN (IUCN 2017). One of the four extinct species, *Pteropus tokudae,* occurred only on Guam and has not been detected since 1968 (Bonaccorso et al. 2008; USFWS 2009).

Flannery (1995) and Simmons (2005) consider the Mariana fruit bat as one of two subspecies of fruit bats restricted to the Mariana Archipelago, with the Mariana fruit bat inhabiting the islands from Guam to Saipan and *P. mariannus paganensis* occurring on Pagan and Alamagan islands. However, subsequent genetic analysis conducted by Brown et al. (2011) indicate no genetic differentiation among islands within the Mariana Archipelago and that the bats on these islands, currently classified as two subspecies, should be managed as a single subspecies, *P. mariannus mariannus* (p. 940). In addition to the Mariana fruit bat, there are several other subspecies of *P. mariannus* endemic to other archipelagos, including the Caroline Islands and the Palau Archipelago (Brown et al. 2011 p. 934).

Critical Habitat Description

Approximately 376 ac (152 ha) were designated as critical habitat for the Mariana fruit bat on Guam (USFWS 2004, 46 pp). Critical habitat was identified using the guidelines provided by the Mariana fruit bat recovery plan (1990). Although the current population of Mariana fruit bats on Guam is small, and most Mariana fruit bats roost in a limited area, the foraging behavior and diverse diet of the Mariana fruit bats cause them to use most of the island for foraging (Wiles et al. 1995). Thus, all of the designated critical habitat for this species is used for foraging and/or roosting and is considered occupied.

*Guam Critical Habitat Unit*

The Guam critical habitat unit consists of approximately 376 ac (152 ha) of land in the fee simple portion of the GNWR. The vegetation in this unit consists of coastal, limestone, and secondary limestone forests, composed of native and introduced plant species and contains the full range of physical or biological features needed for the conservation of the Mariana fruit bat. This area is important because it contains areas used for foraging by the last known Mariana fruit bat colony (currently abandoned) on Guam. This area also contains roosting and foraging sites historically and currently used by Mariana fruit bats (USFWS 2004, p. 62951; J. Schwagerl, Service, pers. comm. 2015). This unit also encompasses essential conservation areas identified in the Mariana fruit bat recovery plan (USFWS 1990b). The draft revised recovery plan (USFWS 2009d) does not contain specific areas for recovery.

Current threats to Guam critical habitat unit include habitat loss, degradation, and fragmentation due to development, military training, and fire, human disturbance, introduced ungulates, invasive plants, and non-native predators. Actions that exacerbate these threats or result in new threats, individually or in combination, may result in appreciably decreasing habitat value or quality of habitat necessary for the recovery and survival of Mariana fruit bats on Guam.

Recent conservation actions in the Guam critical habitat unit include construction of a multi-species enclosure fence at the GNWR at Ritidian Point, BTS trapping and ungulate removal within the enclosure fence; and out-planting of native plants including *S. nelsonii*.

*Physical or Biological Features*

The physical or biological features required by the Mariana fruit bat for the biological needs of foraging, sheltering, roosting, and rearing of young are found in areas supporting limestone, secondary, ravine, swamp, agricultural, and coastal forests composed of native and introduced plant species. These forest types provide the physical or biological features of:

- Plant species used for foraging, such as *Artocarpus* spp., *Carica papaya*, *Cycas micronesica*, *Ficus* spp., *Pandanus tectorius*, *Cocos nucifera*, and *Terminalia catappa*; and
- Remote locations, often within 328 ft. (100 m) of cliff lines that are 260 to 590 ft. (80 to 180 m) tall, with limited exposure to human disturbance and that contain mature *Ficus* spp., *Mammea odorata*, *Casuarina equisetifolia*, *Macaranga*

*thompsonii*, *Guettarda speciosa*, *Neisosperma oppositifolia*, and other tree species that are used for roosting and reproductive activity.

Life History

Mariana fruit bats, similar to other bats in the Pteropodidae family, do not use laryngeal echolocation, instead relying primarily on vision and smell to avoid obstacles and locate food sources (Almeida et al. 2014) . Mariana fruit bats vocalize readily within colonies and when roosting. The diet of the Mariana fruit bat is comprised of fruits, nectar, pollen, and some leaves from at least 45 different plant species (Mildenstein & Johnson 2017) . Rapid digestion and metabolism of such foods makes these animals reliant on forest habitat with diverse food resources available throughout the year (USFWS 2009 p. vi). Mariana fruit bats use several forest types for foraging, roosting, and breeding, including native primary and secondary limestone forest, volcanic (or ravine) forest, old coconut plantations, and groves of *Casuarina equisetifolia* (Rice & Taisacan 1988; Worthington et al. 2001 p. 137; Wiles & Johnson 2004 p. 589,591). Most Mariana fruit bats roost during the day in maternity colonies at sites to which they show a high level of fidelity (unless disturbed). A small proportion of Mariana fruit bats, usually males, roost alone or in small groups called bachelor colonies. Within colonies, Mariana fruit bats typically group themselves into harems (one male and 2-15 females) or bachelor groups (predominantly males) (Wiles 1987).

Population Dynamics

Population demographic information for the Mariana fruit bat is limited. Based on three-years of field observations on Guam similar to other Pteropodidae species, female Mariana fruit bats rear up to one pup annually (USFWS 2009) and likely have a gestation period of approximately 4.6 to 6.3 months (Pierson & Rainey 1992 pp. 1–17). Many *Pteropus* species typically do not give birth until 18 months of age (Pierson & Rainey 1992 pp. 1–17; McIlwee & Martin 2002 p. 76). Lifespan of substantially larger species, *P. alecto*, in Australia is four to five years, with a maximum of eight years (Vardon & Tidemann 2000).

Based on this demographic information, several authors have suggested that *Pteropus* bats have a low maximum population growth rate and thus a slow rate of recovery when a population is diminished (Pierson & Rainey 1992 p. 76; McIlwee & Martin 2002). **Table 7** provides current population sizes per island and other demographic data (Mildenstein & Johnson 2017 p. 20).

**Table 7.** Mariana fruit bat population sizes and density by island.

| Island | Forest Habitat (ha) | No. of Bats | Density |
|---|---|---|---|
| Guam | 25,711 | 45 | 0.00 |
| Rota | 6,663 | 4,149 | 0.62 |
| Aguiguan | 302 | 50 | 0.17 |
| Tinian | 6,481 | < 25 | 0.00 |
| Saipan | 5,355 | < 50 | 0.01 |
| Farallon de Medinilla | < 1 | < 5 | -- |
| Anatahan | N/A[2] | 150 | -- |

| | | | |
|---|---|---|---|
| Sarigan | 169 | 157 | 0.93 |
| Guguan | 170 | 226 | 1.33 |
| Alamagan | 485 | 86 | 0.18 |
| Pagan | 1,971 | 1,017 | 0.52 |
| Agrihan | 2,336 | 858 | 0.37 |
| Asuncion | 316 | 573 | 1.81 |
| Maug | 48 | 11[1] | |

[1]Insufficient data available.

Status and Distribution

The Mariana fruit bat is endemic to the Mariana Archipelago (**Figure 6**). The Mariana Archipelago extends across 459 nautical miles (nmi) (850 km) and is comprised of the U.S. Territory of Guam and 14 islands constituting the CNMI. The Mariana fruit bat is found on all 15 islands within the Marianas, except for Uracas, the northernmost island (Wiles et al. 1989 p. 69). The Mariana fruit bat is currently thought to be extirpated from Tinian (USFWS 2014 p. 3). A single Mariana fruit bat was photographed on Farallon de Medinilla on two occasions, in 1996 and in 2008 (DON 2013 pp. 4–123).

Mariana fruit bats in general are strong fliers and highly mobile and small groups have been observed flying over the ocean between islands (Wiles & Glass 1990 p. 2; Wiles & Johnson 2004 p. 593). Distances between are: Guam to Rota, 32.3 nmi (60 km); Rota to Aguijan, 42.1 nmi (78 km); Aguijan to Tinian, 4.9 nmi (9 km); Tinian to Saipan, 2.7 nmi (5 km); Saipan to Farallon de Medinilla, 45.9 nmi (85 km); and Saipan to Anatahan, 64.3 nmi (119 km). In the remaining northern Marianas, interisland distances range from 15.7 nmi to 54.0 nmi (29 km to 100 km). All islands have a maximum elevation ranging from 551 ft to 3,166 ft (168 m to 965 m) with the exception of Farallon de Medinilla, which has a maximum elevation of 266 ft (81 m). All islands are visible in clear weather from the tops of adjacent islands (Wiles & Glass 1990 p. 1).

Distribution of occupied Mariana fruit bat roost sites have fluctuated sharply in the southern islands and are thought to be due to variations in survey methods, coverage, and movements of Mariana fruit bats between islands (USFWS 2009 p. 9). Initial observations of Mariana fruit bats in the southern islands (Aguiguan, Tinian, and Saipan) in 1983 and 1984 revealed populations of less than 25 to 50 Mariana fruit bats on each island. Mariana fruit bat numbers increased to about 75 to 100 individuals on Saipan in 1986 and to about 300 individuals on Aguiguan by 1988 (Wiles & Glass 1990 p. 2). Mariana fruit bats on Rota are believed to move periodically among the southern islands, and thus Rota is considered to be important to the long-term stability of the species in the southern part of the Marianas (Wiles & Glass 1990 p. 2; Wiles et al. 1995). Historic numbers of Mariana fruit bats on Guam have been between 400 and 800 since 1984, but have since been decreasing. By the early 1980s nearly all Mariana fruit bats on Guam lived in Northern Guam in a single colony, which occasionally divided into several smaller aggregations (Wiles & Glass 1990 p. 2; Mildenstein & Johnson 2017 p. 25).

Survey data in the northern islands (Anatahan, Sarigan, Guguan, Alamagan, Pagan, and Agrihan; excluding Asuncion and Maug, which were not surveyed during this time period), indicate a 40

percent decline in Mariana fruit bat numbers between 1983 and 2000 (USFWS 2009 p. 11). In the 2014 5-year review, Mariana fruit bats were found to be stable or declining throughout most of their range; the only exception being on Rota where populations were increasing since 2008 due to increased enforcement of wildlife reguations (USFWS 2014). Approximately 42 percent and 58 percent of the entire Mariana fruit bat population resides in the northern and southern islands, respectively (**Figure 6**; (Mildenstein & Johnson 2017)).

*Threats*

Illegal hunting, loss of native forest, predation by the BTS on Guam, and the increased risk of extirpation or extinction faced by small, fragmented populations are the most significant threats to the survival of the Mariana fruit bat (USFWS 2014). These current known and potential threats are discussed below.

Threats:

- Loss or Degradation of Habitat:
    - Human development is a factor in habitat loss on all inhabited southern islands and on northern islands with military activity.
    - Feral ungulates and Philippine sambar deer (*Rusa marianna*) degrade habitat on many of the Mariana Islands. The successful eradication of feral ungulates from Sarigan and Anatahan suggests that similar projects may succeed on other islands. However, once grazing and browsing pressure is removed, the potential invasion of native forest by alien plants may be a more difficult and long-term recovery issue.
- Human Disturbance:
    - Illegal hunting is a threat to Mariana fruit bats throughout its range. Although law enforcement activity has increased since 2009 (CNMI -DLNR 2008; CNMI-DLNR 2009a, 2009b, 2010), illegal hunting of Mariana fruit bats on Rota continues and will likely resume to historical levels unless consistent, effective law enforcement efforts in tandem with education and outreach programs continue. Mariana fruit bats appear to be declining on Tinian, Saipan and Guam, and illegal hunting is thought to have greatly contributed to the decimation or decline of those populations (Wiles & Payne 1986; Wiles & Glass 1990; Sheeline 1991; Stinson & Glass 1992; Esselstyn et al. 2006). As with Rota, recovery of the Mariana fruit bat on human-inhabited islands will not likely be possible without strong education programs combined with effective control of illegal hunting.
- Nonnative Snake Predation:
    - Brown tree snakes prey on non-volant young left at the roost during the night, thus preventing the recruitment of young bats into the breeding population. Effective control of BTS must be achieved before the Mariana fruit bat population on Guam can recover. The interdiction, control, and ultimate eradication of BTS in the archipelago are the focus of major, ongoing projects, and the Mariana fruit bat is likely to benefit from these efforts in the long term. This prognosis would change drastically if the BTS were to become established widely throughout the archipelago.
- Stochastic Events:

- Typhoons and volcanic eruptions result in mortality, reduced population viability, and habitat loss. Natural disasters can be especially damaging to the viability of smaller Mariana fruit bat populations (e.g., on Guam, Saipan, Aguiguan, and Maug). The significant loss of habitat on Anatahan after the volcanic eruption in 2003 resulted in the loss of a substantial Mariana fruit bat population that has not yet recovered.

Mariana Fruit Bat Recovery Criteria

A draft revised recovery plan for the Mariana fruit bat (USFWS 2009d) addressed actions needed for the survival and recovery needs of the Mariana fruit bat. Since publication of the draft revised recovery plan, new information on the Mariana fruit bat has resulted in changes to how we look at recovery for the species. We now consider recovery in terms of stable or increasing subpopulations of sufficient size distributed across Guam and the Mariana Islands. To meet recovery objectives, stable or increasing fruit bat subpopulations should at a minimum be distributed on the islands that currently have extant populations (USFWS 2009d). Actions that reduce or eliminate the potential for self-sustaining populations of resident Mariana fruit bats on Guam may hamper or preclude recovery of the species. The reduction or elimination of this potential may take many forms: degradation or loss of habitat and resources required by the fruit bat for foraging, roosting, and reproduction; increased exposure of fruit bats to illegal hunting and other sources of human disturbance; and introduction of non-native predators that prey upon fruit bats. In order for the Mariana fruit bat's population to recover on Guam, sufficient amounts of functional habitat will need to be protected and restored on Guam (USFWS 2009d).

Guam contains a large proportion of the remaining native limestone forest in the southern inhabited Mariana Islands, and most of that habitat is located within DoD lands. Habitat loss and degradation, illegal hunting, predation by non-native predators, and human disturbance currently impact fruit bats within the action area. If threat levels increase within Mariana fruit bat habitat in the action area, it may further inhibit the potential for the species to recover.

*Survival and Recovery Needs*

Before the Mariana fruit bat is considered for delisting, the Service proposes that stable or increasing populations should exist on three of the five southern islands (Saipan, Tinian, Aguiguan, Rota, and Guam), and six of the northern islands where Mariana fruit bats have persisted historically (Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, and Maug; (USFWS 2009 pp. 40–41). Of the six northern islands that require stable or increasing numbers, two of these must include Pagan, Anatahan, or Agrihan. Since publication of the draft revised recovery plan in 2009 (USFWS 2009), new information on the Mariana fruit bat has resulted in changes to how we look at recovery for the species. We now consider recovery in terms of stable or increasing subpopulations of sufficient size distributed across Guam and the Mariana Islands. To meet recovery objectives, stable or increasing Mariana fruit bat subpopulations should at a minimum be distributed on the islands that currently have extant populations (USFWS 2009). The final version of the Mariana fruit bat recovery plan is currently in review, and recovery criteria stated here may change upon completion of the final plan.

Of the six northern islands, the only evidence for a possibly increasing population is on Asuncion (USGS 2010 p. 33). Of the five southern islands, only Rota has achieved an increasing population. Although a conservation area containing some important habitat for Mariana fruit bats was established on Rota (USFWS 2011 p. 1), there is not currently enough protected Mariana fruit bat habitat on Rota, Guam, Tinian, or Saipan to support substantial population recovery on any of those islands. Even if sufficient habitat is set aside in conservation to support recovery of populations, controlling illegal hunting may continue to be a challenge that limits recovery of the species (USFWS 2014 p. 5).

**Status of the Mariana eight spot butterfly**

Species Description

The Mariana eight spot butterfly (abbabang in Chamorro, or libweibwogh in Carolinian) was federally listed as endangered under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for the Mariana eight spot butterfly has not been completed.

The Mariana eight spot butterfly is a medium-sized butterfly in the Nymphalidae family (Schreiner & Nafus 1997 p. 28). The Mariana eight spot butterfly was originally described by Butler in 1869 and is recognized as a distinct taxon in Swezey (1942 p. 35), the most recent and accepted taxonomy for this subspecies. In addition to the Mariana eight spot butterfly, there are several other subspecies endemic to specific archipelagos, including New Caledonia, Vanuatu, and Palau (Samson 1986 p. 16; Schreiner & Nafus 1997 p. 36).

Like most nymphalid butterflies, orange and black are the two primary colors exhibited by Mariana eight spot butterfly. Unlike other species in the genus *Hypolimnas*, male and female Mariana eight spot butterflies are similar and exhibit no sexual dimorphism (Schreiner & Nafus 1996 p. 36; Campora & Lee 2009 p. 5). The larvae of Mariana eight spot butterfly maintains a black head through all instars, and their spines are more red than orange (Schreiner & Nafus 1997 p. 36). This characteristic sets them apart from larvae of the non-native *H. bolina* from New Zealand and *H. anomala* from Malaysia, both which occur on Guam. All three species (*H. bolina*, *H. anomala*, and the Mariana eight spot butterfly) have larvae that look similar in appearance during their immature stages (Schreiner & Nafus 1997 p. 36; Campora & Lee 2009 p. 4; Lindstrom & Benedict 2014 p. 18).

Life History

The Mariana eight spot butterfly undergoes seven life stages before pupating into a reproductive adult (**Table 8**) (Schreiner & Nafus 1996 pp. 3–5). Large sixth instar caterpillars of the Mariana eight spot butterfly often travel farther distances in search of food and will find a cryptic location for pupation (Schreiner & Nafus 1996 p. 3). As a result, the length of time spent as a pupa and longevity of adults is unknown (Moore 2014 p. B17). Adult Mariana eight spot butterflies are most abundant between December and February (Moore 2014 p. B16). These months include the end of the rainy season and the beginning of the dry season on Guam.

Butterflies in general require sufficient food resources to support various stages of growth. Larval feeding first supports growth of the larval insect, and at subsequent instar stages, growth stops and accumulated larval nutrients are stored for proper adult growth (Boggs & Freeman 2005 p. 353). Boggs and Freeman (2005) found that restricting the food intake at the larval stage decreased adult longevity and female fecundity levels (p. 359).

**Table 8.** Estimated life stages of the Mariana eight spot butterfly and mortality rates at each stage, based on a year-long study at a single site on Guam.

| Stage | Duration (days) | No. Found | No. Found After Hatching / Molting to Next Stage | Percent Recovered |
|---|---|---|---|---|
| Egg | 6 | 445 | 45 | 10 |
| 1st Instar | 2.4 ± 0.6 | 47 | 21 | 44 |
| 2nd Instar | 2.0 ± 0.7 | 37 | 21 | 57 |
| 3rd Instar | 2.5 ± 0.8 | 36 | 32 | 88 |
| 4th Instar | 2.9 ± 0.8 | 46 | 30 | 65 |
| 5th Instar | 3.7 ± 1.0 | 46 | 33 | 72 |
| 6th Instar | 6.1 ± 1.5 | 51 | 15 | 29 |

Population Dynamics

Little is known about the factors affecting population dynamics of the Mariana eight spot butterfly. However, recently Rubinoff (2016) suggested that Mariana eight spot butterflies show metapopulation dynamics (pp. 4-5). Because most insects are short-lived in the adult stage, and cryptic in other stages, detection and assessment of minimum viable habitat size may require repeated visits over multiple years to properly assess occupied patches that may depend on varying environmental conditions or site characteristics (Eiben & Rubinoff 2014 p. 1077). Some sites on Guam are used occasionally by populations of the Mariana eight spot butterfly or may be used to support connectivity across the landscape (Rubinoff 2016 p. 5).

Within a population, Schreiner and Nafus (1996; Table 11) found that mortality rates are high in the juvenile stages. The Mariana eight spot butterfly occurs in low numbers (Moore 2014 pp. B7-16) likely in response to habitat loss and fragmentation that has reduced the distribution and abundance of host plants, and reduced the connectivity between extant, but discrete local populations. For example, over a year-long survey on Guam across 12 different sites, a maximum total of six adult Mariana eight spot butterflies were observed in one day (Schreiner & Nafus 1996 p. 2). If the distribution and abundance of host plants and the connectivity between Mariana eight spot butterfly populations continue to decline and they become increasingly isolated in distribution, the distance between patches of suitable habitat may become too great to sustain the species (Rubinoff 2016 p. 6).

Status and Distribution

The Mariana eight spot butterfly is endemic to Guam and Saipan (Lindstrom & Benedict 2014 p. 9). The Mariana eight spot butterfly is likely extirpated from Saipan (Schreiner & Nafus 1997 p. 36; Moore 2014 pp. B7–B10). In 2014, *H. octocula marianensis* was known from six locations on Guam: Orote Point, Hilaan, Tweed's Cave area, Pagat Cave area, Mangilao golf course and

Fadian cove (Lindstrom & Benedict 2014 p. 9). Other locations have also been reported by Dr. Curt Fiedler (pers comm 2017). Dr. Fiedler has reported observations in four additional locations: (1) east and (2) west of the GNWR headquarters along the base of the cliff at sea level, (3) patches of host plants near Taguan (1,000 steps trail), and (4) large patches of host plants inland at Faifai beach (northern edge of Tumon Bay). An estimate of a one-kilometer buffer is used to distinguish between subpopulations and represents maximum butterfly flight distance, based on similar species under similar conditions (Hill et al. 1996 p. 730).

The Mariana eight spot butterfly appears to be constrained by available host plants. Larvae of Mariana eight spot butterfly feed on two native plants: *Elatostema calcareum* and *Procris pedunculata* (Campora & Lee 2009 p. 1; Moore 2014 p. B16). Both host plants are from the family Urticaceae and occur in wet, native forest areas with exposed limestone karst. Schreiner and Nafus (1996) noted a close association in the occurrence of the butterfly's life stages with the presence of host plants (p. 2). On Guam, multi-year surveys show that *E. calcareum* and *P. pedunculata* are rare and usually are observed in small patches irregularly distributed almost exclusively along the cliff edges, or embedded in tall towers of karst along the shore or in forested areas, where nonnative ungulates cannot reach them easily (Moore 2014 p. B22).

*Threats*

The following list of factors influencing the current condition of the Mariana eight spot butterfly are based on the findings reported by (Lindstrom & Benedict 2014 pp. 34–35; Moore 2014 pp. B21-21; Rubinoff 2016 p. 4):

- Loss and Degradation of Habitat (especially host plants):
    - Urban and agricultural development, ungulates, military training, urbanization, the spread of nonnative plants that displace native plants, and inadvertent damage to host plants by humans (e.g., coconut crab hunters who deploy traps near host plants) – all contribute to the loss of habitat for *H. octocula marianensis*.
    - Loss or degradation of habitat causes the loss of important habitat corridors that function to support gene flow and maintain population connectivity.
- Predation from Non-native Species:
    - Two genera of parasitic wasps (*Ooencyrtus* sp. and *Telenomus* sp.) have been documented to cause mortality of *H. octocula marianensis* eggs.
    - Species of nonnative ants have also been documented predating on eggs and larvae.
- Stochastic Events:
    - Typhoons result in mortality, reduced population viability, and habitat loss. Natural disasters can be especially damaging to the viability of already fragmented populations.

*Survival and Recovery Needs*

The range-wide population of the Mariana eight spot butterfly is comprised of up to 10 known local populations. All of these local populations are small, geographically restricted, and subject to further decline due to habitat loss and predation from non-native species. The likelihood of this species surviving and recovering is dependent on ensuring a functional metapopulation of

Mariana eight spot butterflies. Given the current status of this species, achieving that condition requires maintaining and enhancing the viability of all ten known populations and the reestablishment of additional populations in forest habitat patches that facilitate connectivity between Mariana eight spot butterfly local populations. Avoiding or effectively offsetting adverse effects to butterfly-occupied habitat is critical to maintaining the diminished resiliency of the entire Mariana eight spot butterfly population during this population bottle-neck.

More specifically, the conservation needs of the Mariana eight spot butterfly are as follows:

1. Protection, restoration, and enhancement of interconnected patches of high quality butterfly habitat (containing host plants) that are distributed across the landscape of Guam within the flight range of dispersing Mariana eight spot butterflies is essential to its conservation. Based on best available information on the conservation biology of nymphalid butterflies (Bonebrake et al. 2010 pp. 1831–1841) and consideration of the basic principles of conservation biology (Groom et al. 2006 pp. 15–19), the Service finds that a minimum of six discrete populations that are spatially distributed to accommodate a sufficient degree of connectivity between populations are needed to sustain a persistent population of the Mariana eight spot butterfly on Guam. Habitat protection is essential to the Mariana eight spot butterfly. Habitat should be contiguous and include both nectar and known host plants, with the protection of occupied host plants given the highest priority (A. Moore, UOG, pers. comm. 2016; M. Richardson, USFWS, pers. comm. 2016.). Because the Mariana eight spot butterfly is dependent on two rare host plant species (*E. calcareum* and *P. pedunculata*), the Mariana eight spot butterfly is at a high risk of extinction on Guam from ongoing habitat loss and destruction. Because the population is currently small and geographically restricted, it is vulnerable to loss of genetic diversity, catastrophic environmental events, and random fluctuations in demographic parameters. Expansion of the existing metapopulation and reestablishment of populations in unoccupied suitable habitat is essential to protect this species against these threats.
2. Given its highly degraded and vulnerable status in the wild, a timely and effective captive propagation and reintroduction program for the Mariana eight spot butterfly is needed.
3. A high priority should be placed on the timely gathering of additional life history information on the Mariana eight spot butterfly, especially in terms of understanding the metapopulation structure and needs of the overall population. Maintaining adequate connectivity between and among habitat patches and local populations is essential to both its survival and recovery. If host plant populations continue to decline and become further isolated, the distance between patches may become too great to sustain the species (Rubinoff 2016 p. 6).
4. The exclusion of feral ungulates from, and the reintroduction of larval host plants to, limestone forest areas is a very important and promising conservation measure (Moore 2014 p. B22).
5. Control of non-native plants, ants, and slugs is also important for the Mariana eight spot butterfly's survival and recovery in the wild.

**Status of the Partulid Snails**

The family Partulidae consists of approximately 120 species of snails in three genera (*Eua*, *Samoana* and *Partula*) across the Pacific Islands, many of which are restricted to a single island. *Partula* is the most diverse genus with approximately 92 species described; there are 23 *Samoana* species and four *Eua* species (Lee et al. 2014). Partulid snails are endemic to the high islands of Oceania (i.e., islands with sufficient elevation to generate their own precipitation and support rain forest formation). Of the six partulid snail species described from the Mariana Islands, only three extant species remain: the Guam tree snail (*P. radiolata*), humped tree snail (*P. gibba*), and the fragile tree snail (*S. fragilis*).

Endemic Partulids have become increasingly exposed to continental predators as human settlement and globalization have facilitated these introductions. Some degree of biotic isolation that can be maintained can provide refuge for these tree snails and will contribute to the increased survival of species in their native habitats (Lee et al. 2014).

The Guam tree snail, humped tree snail, and fragile tree snail share similar life history characteristics described below and co-occur within extant populations. Species in the Partulidae family are predominantly nocturnal, arboreal, herbivorous and are relatively long-lived. They are also slow reproducing, ovoviviparous (give birth to live young), and cross- or self-fertilizing hermaphrodites (Cowie 1992). The life-expectancy of partulids can be greater than 5 years and reproduction of up to 18 young per year begins within the first year through the entire life-span (Cowie 1992).

**Status of the Guam tree snail**

Species Description

The Guam tree snail (akaleha or denden in Chamorro), is a member of the Partulidae family, was federally listed as endangered under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for the Guam tree snail has not been completed. The species was also listed as endangered by the Government of Guam in 2009.

Guam tree snail shells are dextral with an obtuse spire, and five whorls. The peristome is simple thin and white. The background color is pale straw with darker axial rays and brown lines. Adult length is 0.5 in to 0.7 in (13 mm to 18.5 mm), and 0.3 in to 0.5 in width (8 mm to 12 mm) (Smith et al. 2008). Juveniles can be mistaken for the fragile tree snail.

Life History

Little is known about the life history of the Guam tree snail. This species is found in bushes on the undersides of leaves. The preferred habitat is cool, shaded forest habitat with high humidity and reduced air movement that prevents excessive water loss. Increased mobility is associated with snails in habitats with greater humidity and precipitation. Partulids feed primarily on a range of living, dead or decaying plant material (Cowie 1992 p. 167) and there is no clear obligate relationship with any particular type of tree or bush. Guam tree snail populations showed a very low degree of genetic heterogeneity among all surveyed populations indicating some degree of population specific genetic diversity, there was no discernible colony specific/geographic patterns (Lindstrom & Benedict 2014).

Population Dynamics

The historic population size of the Guam tree snail is unknown; however, more than 2,000 individuals were collected across 37 sites in the 1920s (Crampton 1925). Lindstrom and Benedict (2014) indicated that the Guam tree snail was not found in many sites surveyed in 1989 (Hopper & Smith 1992). However, in both 1989 and 2013, the Guam tree snail was both the most widespread and common Partulid snail on Guam (Hopper & Smith 1992; Moore 2014). At the time of listing in 2015, there were no more than 26 colonies of Guam tree snails, with between 10 and 150 individuals per colony.

Surveys in 2013 on Guam provide the most complete population information that is currently available. On DoD property, 328 Guam tree snails were found in two locations (Lindstrom & Benedict 2014). In addition, a total of 38 live snails were documented in Anderson South in February 2017 (**Figure 10**). Outside of DoD property, more than 363 Guam tree snails were documented during timed searches in 11 different locations (Lindstrom & Benedict 2014).

Status and Distribution

The Guam tree snail is endemic to the island of Guam and is the most commonly encountered Partulid snail on the island. Historically, Guam tree snails occurred across the island in suitable and widely available strand vegetation, forested river borders and lowland and highland forests. The Guam tree snail has been found in coconut forests, similar to the humped tree snail; however, the Guam tree snail's range also includes range into scrub forests and limestone forests, especially those dominated by *O. oppositifolia*. They have been found on a wide variety of plants including both natives and nonnatives (Lindstrom & Benedict 2014).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Ungulates not only graze upon snail host plant species (both native and nonnative), but cause profound changes to the understory of forest habitats, which in turn affect tree snail populations (Smith et al. 2008; Smith 2013).
    - *Leucaena leucocephala*, an introduced shrub or tree, grows quickly and forms dense thickets that crowd out native canopy trees. This transition has created a drier understory which is likely less suitable for the Guam tree snail and other listed tree snails (Hopper & Smith 1992).
    - Human development, urbanization and military activity threaten all Partulid populations on both inhabited and uninhabited islands as they result in a loss, fragmentation and/or degradation of native forest habitat and the plants on which the tree snails live.
- Low population numbers

    - The low degree of genetic heterogeneity throughout the island makes the species less resilient evolutionarily and more prone to extinction pressures
    - Stochastic events (i.e. typhoons, disease) are likely to have disproportionate effects on small populations and/or those with little to no genetic diversity
- Nonnative species predation
    - The alien carnivorious flatworm (i.e. manokwari flatworm), predatory snails (i.e. rosy wolf snail and *Gonaxis* spp.) and rats significantly threaten tree snail persistence.
- Direct human impact
    - The collection of snail shells for trade may contribute to additional decline of the Guam tree snail.

*Survival and Recovery Needs*

The eradication of ungulates from occupied sites, as well as sites that previously contained the Guam tree snail (Crampton 1925; Hopper & Smith 1992), will serve both to enhance conditions for populations already present and contribute to additional habitat that may become occupied.

Predation rates and sources of predation must be assessed in order to minimize their impact when possible and effectively manage Partulid snail populations on Guam. It is necessary to further characterize the impact of the flatworm, by assessing their activity patterns, habitat and dietary preferences, distribution and reproductive capacity in order to reduce predation by the nonnative species.

Comprehensive studies are needed on the basic biology of the Guam tree snail. Relatively little is known about their life history and much needs to be learned before their conservation can be effectively addressed. There is very little knowledge about basic biological requirements, reproductive output, survival rates, longevity, predation risks, activity patterns, feeding behavior, and seasonal patterns of abundance.

Additional surveys focused in locations that have not yet been adequately surveyed should be prioritized. Surveys are needed to examine locations that are isolated and physically difficult to access on Guam, or determine the presence and status of populations on other Mariana Islands. However, conducting repetitive exploratory surveys in the same locations on Guam at the expense of general biological studies and protecting current occurrence locations could divert resources away from where they are needed most.

**Status of the Humped Tree Snail**

Species Description

The humped tree snail (akaleha or denden in Chamorro) was federally listed as endangered on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for the humped tree snail has not been completed. The species was also listed as endangered by the Government of Guam in 2009. The species is part of the Partulidae family, as described above.

Humped tree snail shells are primarily dextral with an acute spire, 4 to 4 ½ whorls with the last whorl gibbous. Humped tree snail whorls are various shades of white or brown with the background color variable, chestnut brown to whitish-yellow, and purple. Adult length is 14 to 18 mm, and width 10 to 14 mm (Smith et al. 2008).

Life History

Little is known about the life history of the humped tree snail. Humped tree snails are generally an arboreal species, found in the sub-canopy of mixed native forests with good understory and ground cover (Hopper & Smith 1992; Smith et al. 2008; Hadfield 2010). There is no particular obligate relationship with any particular type of tree or bush; however, they are most often found on the endemic *Piper guamensis*. They are also commonly found on coconut palms and ferns, including *Microsorium punctatum*, on Guam. Compared to the Guam tree snail, humped tree sanils were generally observed on fewer host species (Hopper & Smith 1992).

Increased mobility is associated with snails in habitats with greater humidity and precipitation. Humped tree snails feed primarily on a wide range of living, dead or decaying plant material (Cowie 1992 p. 167). The humped tree snail has also been observed consuming Mariana fruit bat ejecta (Berry 2016).

Population Dynamics

Partulid snails face a significant conservation crisis across the Pacific, as seen by declines in abundance and a number of extinctions (Lydeard et al. 2004). In 1992, Hopper and Smith described their concern for the apparent drastic loss of humped tree snails since the initial 1920 survey (Crampton 1925). At the time of listing in 2015, the population of humped tree snails on Guam declined to approximately 100 individuals and today, the humped tree snail is only found at one location, Haputo Beach (Lindstrom & Benedict 2014). The humped tree snail is the least common of the three listed tree snail species on Guam. By 2008, no humped tree snails were found on Rota, Tinian, or Aguiguan potentially due to extensive deforestation and agriculture (Smith et al. 2008; Hadfield 2010). Population decline of humped tree snails has been reported on most islands of the CNMI; however, population estimates on the islands are unknown (CNMI-DLNR 2015).

Status and Distribution

The humped tree snail was the first *Partula* described from the Mariana Islands in 1821 and was distributed across the archipelago (Kerr 2013). The range of the humped tree snail includes Guam, Rota, Aguiguan, Tinian, Saipan, Anatahan, Sarigan, Alamagan, and Pagan (Kurozumi 1994; Smith et al. 2008). Current comprehensive surveys have not been conducted, however data indicate that the humped tree snail is declining across its range but may still be common on some northern islands, such as Pagan and Sarigan (Kerr 2013).

In 1920, humped tree snails were initially observed on Guam in at least 39 sites. By 1989, the humped tree snail was known from only one location, Haputo Beach which was not originally

identified as an occupied site (Hopper & Smith 1992). At the time of listing in 2015, humped tree snails were no longer found on Anatahan, possibly due to volcanic activity and were also not found on Aguiguan.

*Threats*

The following threats to the species contributed to its listing and continue to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Ungulates not only graze upon the host plant species, but cause profound changes to the understory of forest habitats, which in turn affect tree snail populations (Smith et al. 2008; Smith 2013).
    - *Leucaena leucocephala*, an introduced shrub or tree, grows quickly and forms dense thickets that crowd out native canopy trees. This transition has created a drier understory which is likely less suitable for the humped tree snail and other listed tree snails (Hopper & Smith 1992).
    - Human development, urbanization and military activity threaten all Partulid populations on both inhabited and uninhabited islands as they result in a loss, fragmentation and/or degradation of native forest habitat and the plants on which the tree snails live.
- Low population numbers
    - A single humped tree snail colony with few individuals likely exhibits little to no genetic diversity and is thus at extreme risk of extirpation as it is less resilient evolutionarily and more prone to extinction pressures.
    - Stochastic events (i.e. typhoons, disease) are likely to have disproportionate effects on small populations and/or those with little to no genetic diversity
- Nonnative species predation
    - The alien carnivorious flatworm (i.e. manokwari flatworm), predatory snails (i.e. rosy wolf snail and *Gonaxis* spp) and rats significantly threaten tree snail persistence.
- Direct human impact
    - The collection of snail shells for trade may contribute to additional decline of the humped tree snail.

*Survival and Recovery Needs*

The eradication of feral ungulates from sites that contain tree snails, as well as those that previously contained them, will serve both to enhance conditions for populations already present, and contribute to additional habitat that may become occupied. Tarague Basin was reported by Crampton in 1925 to have had all three snail species present. The area is still occupied by the Guam tree snail and may be a suitable habitat for the humped tree snail, as well as the fragile tree snail if ungulates are removed from the area (Crampton 1925; Lindstrom & Benedict 2014).

Predation rates and sources of predation must be assessed in order to minimize their impact when possible and effectively manage Partulid snail populations on Guam. It is necessary to further

characterize the impact of the flatworm, by assessing their activity patterns, habitat and dietary preferences, distribution and reproductive capacity in order to reduce predation by the nonnative species.

Comprehensive studies on the basic biology of the fragile tree snail are needed. Relatively little is known about their life history, and more needs to be learned before their conservation can be effectively addressed. There is very little knowledge about basic biological requirements, reproductive output, survival rates, longevity, predation risks, activity patterns, feeding behavior, and seasonal patterns of abundance. Thoroughly quantified population assessments of the humped tree snail across the range are needed to understand population trends.

Additional surveys focused in locations that have not yet been adequately surveyed should be prioritized. Surveys are needed to examine locations that are isolated and physically difficult to access on Guam, or determine the presence and status of populations of species on other Mariana Islands. However, conducting repetitive exploratory surveys in the same locations on Guam at the expense of general biological studies and protecting current occurrence locations could divert resources away from where they are needed most.

**Status of the Fragile tree snail**

Species Description

The fragile tree snail (akaleha or denden in Chamorro) was federally listed as endangered under the ESA on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for the fragile tree snail has not been completed. The species was also listed as endangered by the Government of Guam in 2009. The fragile tree snail is a member of the Partulidae family as described above.

The *Samoana* genus has a disjunct distribution: extensively distributed throughout Samoa to the Marquesas Islands in Polynesia. However, the fragile tree snail is the solitary western species, the only *Samoana* species to occur outside of southeastern Polynesia, 5,000 kilometers from its nearest congener in Fiji (Lee et al. 2014). It is now believed that the evolutionary origin of the *Samoana* genus is in the far western portion of the range. In the portion of the range, the fragile tree snail is only one of 22 species in the genus which can still be found (Lee et al. 2014). One hypothesis for the absence of the genus *Samoana* from much of the Western range of the genus may stem from (as yet unidentified) ecological factors that have driven original populations to extinction and prevented rare long-distant migrants from reestablishing new populations (Lee et al. 2014).

Fragile tree snail shells are dextral and pellucid with a conic spire, and four whorls. The peristome is thin but well expanded. The background color is buff with narrow darker maculations and whitish banding. Adult length is 12 to 16 mm, and width 10 to 12 mm. (Smith et al. 2008). Adults can be mistaken for juvenile Guam tree snails.

Life History

The life history of Mariana partulids is unknown. Cool, shaded forest with high humidity and reduced air movement that prevents excessive water loss is the preferred habitat. They live on subcanopy vegetation. Increased mobility is associated with snails in habitats with greater humidity and precipitation. Partulids feed on a range of living, dead or decaying plant material (Cowie 1992) and there is no clear obligate relationship with any particular type of tree or bush. However, the fragile tree snail was found on a smaller number of plants (approximately five) compared to the Guam tree snail (found on approximately 30 different plants) during one survey (Hopper & Smith 1992).

Thie fragile tree snail is unique among Mariana partulids in that the eggs are large (4.2 mm × 3.3 mm) and encapsulated by a calcareous shell. Further, the fragile tree snail reaches sexual maturity before growing a reflexed peristome, a trait not reported for any other partulid species (Crampton 1925).

Population Dynamics

Populations of the fragile tree snail have not been extensively quantified but are thought to be in decline compared to originally rare population sizes. Approximately 20 fragile tree snails were found in the two occurrences during recent surveys (Lindstrom & Benedict 2014). It was not possible to determine the maturity of individuals in the colony because of the unique characteristic of this species to reach maturity before the formation of the varical lip (Smith et al. 2008). In 1996, one colony of the fragile tree snail was found on the southern edge of the Sabana with unknown quantitative estimates of the number of individuals in the colony (Bauman 1996). The species has not been observed on Rota since 1996.

Status and Distribution

The fragile tree snail is endemic to Guam and Rota (Kerr 2013). Fragile tree snails are the only *Samoana* species to occur outside of southeastern Polynesia. Fragile tree snails are more commonly found in limestone forest habitat, but have also been found in beach back strand vegetation, generally dominated by the trees *Hernandia* spp. and *Cordia* spp., or in riverine forest where *Hibiscus tiliaceus* is predominant (Kerr 2013).

Historically, the fragile tree snail was known from 13 populations in northern Guam and one on Rota. It was originally described as rare and low in number (Crampton 1925; Easley 1970). In 1989, fragile tree snails were found only in the presence of the Guam tree snail and in only 6 of 26 surveyed sites distributed across Guam (Hopper & Smith 1992). By 2013, only two colonies were known on Guam (Pagua Point and Lost Pond) (Lindstrom & Benedict 2014) and one colony on Rota, but in a different location from the original colony (Bauman 1996). No genetic heterogeneity was found between the two fragile tree snail populations on Guam (Lindstrom & Benedict 2014).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Ungulates not only graze upon host plant species (both native and nonnative), but cause profound changes to the understory of forest habitats, which in turn affect tree snail populations (Smith et al. 2008; Smith 2013).
    - *Leucaena leucocephala*, an introduced shrub or tree, grows quickly and forms dense thickets that crowd out native canopy trees. This transition has created a drier understory which is likely less suitable for the fragile tree snail and other listed tree snails (Hopper & Smith 1992).
    - Human development, urbanization and military activity threaten all Partulid populations on both inhabited and uninhabited islands as they result in a loss, fragmentation and/or degradation of native forest habitat and the plants on which the tree snails live.
- Low population numbers
    - The two colonies of fragile tree snails showed no genetic heterogeneity, which is indicative of a small population that has recently undergone a population bottleneck and is isolated from other colonies. The lack of genetic diversity throughout the island makes the species less resilient evolutionarily and more prone to extinction pressures.
    - Stochastic events (i.e. typhoons, disease) are likely to have disproportionate effects on small populations and/or those with little to no genetic diversity.
- Nonnative species predation
    - The alien carnivorious bipaliid flatworm (*P. manokwari*), predatory snails (i.e., rosy wolf snail and *Gonaxis* spp.) as well as rats, significantly threaten tree snail persistence.
- Direct human impact
    - The collection of snail shells for trade may contribute to additional decline of the fragile tree snail.

*Survival and Recovery Needs*

The eradication of feral ungulates from sites that contain tree snails, as well as those that previously contained them, will serve both to enhance conditions for populations already present, and contribute to additional habitat that may become occupied. Tarague Basin was reported by Crampton in 1925 to have had all three snail species present. The area is still occupied by the Guam tree snail and may be a suitable habitat for the humped tree snail, as well as the fragile tree snail if ungulates are removed from the area (Crampton 1925; Lindstrom & Benedict 2014).

Predation rates and sources of predation must be assessed in order to minimize their impact when possible and effectively manage Partulid snail populations on Guam. It is necessary to further characterize the impact of the flatworm, by assessing their activity patterns, habitat and dietary preferences, distribution and reproductive capacity in order to reduce predation by the nonnative species.

Comprehensive studies on the basic biology of the fragile tree snail are needed. Relatively little is known about their life history, and more needs to be learned before their conservation can be effectively addressed. There is very little knowledge about basic biological requirements, reproductive output, survival rates, longevity, predation risks, activity patterns, feeding behavior, and seasonal patterns of abundance. Thoroughly quantified population assessments of the fragile tree snail across the range are needed to understand population trends.

Additional surveys focused in locations that have not yet been adequately surveyed should be prioritized. Surveys are needed to examine locations that are isolated and physically difficult to access on Guam, or determine the presence and status of populations of species on other Mariana Islands. However, conducting repetitive exploratory surveys in the same locations on Guam at the expense of general biological studies and protecting current occurrence locations could divert resources away from where they are needed most.

**Status of the *Bulbophyllum guamense***

Species Description

*Bulbophyllum guamense* (siboyas hålum tåno in Chamorro) was federally listed as threatened under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *B. guamense* has not been completed. *Bulbophyllum* is the largest genus in the Orchidaceae with an estimated 2,000 polymorphic epiphytes (growing on other plants), lithophytes (growing on rocks), or rarely terrestrial (growing on the ground) orchids (Costion & Lorence 2012).

*Bulbophyllum guamense* is an epiphytic orchid which occurs in large mat-like formations high on branches of big trees, as well as on smaller trees of coastal lowland/limestone forests. The pseudobulbs form a thick clump connected by very short rhizomes. *Bulbophyllum guamense* has leaves that are oblong, elliptic, 10 - 15 cm long and 2.6 - 3.8 mm wide (Stone 1970 p. 155). Flowers are single, fleshy, and greenish-yellow in color (Raulerson & Rinehart 1992 p. 90). The sepals are the most conspicuous part of the flower, while the yellow-green lip with its wine markings is hinged and extremely mobile (Raulerson & Rinehart 1992 p. 90).

Life History

Little is known about the life history of *B. guamense*. *Bulbophyllum guamense* is epiphytic and grows on trees within limestone forest type ecosystems. On Guam, *B. guamense* was found in the lower canopy of closed forests (about 10 feet {3 m}or less) (Zarones et al. 2015). On Rota, the species has been found at elevations greater than 984 ft (300 m) in the Sabana tableland, Sabana slopes and water cave regions, within tall and short limestone forest and secondary pandanus forest on emergent trees (Zarones et al. 2015). *Bulbophyllum guamense* has been observed in many native and non-native host tree species including: *Hernandia labyrinthica*, *Elaeocarpus joga, Premna serratifolia, Heritiera longipetiolata, Pisonia umbellifera*, *Persea Americana, Vitex parviflora, Areca catechu, Eugenia* spp*., Ficus* spp*., Dypsis* spp. or *Pandanus tetorius,* as well as in dead trees (Zarones et al. 2015; JRM 2016; DON 2017).

Typical to orchids in this genus, *B. guamense* has a carrion-like scent (Raulerson & Rinehart 1992 p. 90), and it is almost ever-blooming, as one flower drops, another replaces it until one is pollinated. The ovary then enlarges to form a ribbed capsule about five cm by one cm, where the dust-like seeds develop (Raulerson & Rinehart 1992 p. 90). *Bulbophyllum guamense* has a sympodial growth habit that form sequential pseudobulbs (with determinate growth). Research is currently being conducted to determine if the numbers of orchids can be increased vegetatively by division within a nursery environment (J. McConnell 2016).

Population Dynamics

At the time of listing in 2015, approximately 500 *B. guamense* individuals were identified throughout the species range, with approximately half on Guam and half on Rota, representing a population decline. There is limited information on the population structure on Guam. On Rota, approximately 200 *B. guamense* individuals were found with a population structure consisting of seedlings, juveniles, and flowering adults in a specialized niche habitat within the forest ecosystem (Zarones et al. 2015).

Status and Distribution

*Bulbophyllum guamense* is endemic to Guam and Rota and is widely-distributed (Raulerson & Rinehart 1992 p. 90). Historically, *B. guamense* was recorded on Guam from clifflines encircling the island, and on the slopes of Mt. Lamlam and Mt. Almagosa. In 1992, this species was reported to occur in large mat-like formations on trees "all over the island," (Guam) (Raulerson & Rinehart 1992 p. 90). At the time of listing in 2015, there were 12 known occurrences, three on Guam and nine on Rota, along Rota's Sabana tableland and slopes above 980 ft (300 m) elevation (Zarones et al. 2015).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Ungulates grazing upon forest plant species impact many native plants resulting in profound changes to the forest habitat. In the absence of ungulates, healthier and more pristine forest habitats contain a broader species composition and structure on which epiphytic orchids depend.
    - Nonnative plants can degrade forest habitats. *B. guamense* has been found on both native and nonnative trees; however, the health and persistence of the orchid on native and nonnative trees is unknown.
    - Urbanization and development as well as natural or incidental fire, directly impact and reduce habitat availability for epiphytic orchids.
    - Edge effects due to disturbance and fragmentation have been shown to negatively impact orchids in cloud forests (Parra Sánchez et al. 2016).

- Stochastic Events, primarily typhoons degrade forest. Affected forest areas may require several years to become reestablished and this can be exacerbated if habitats are reduced or degraded.

*Survival and Recovery Needs*

In order to ensure the survival of *B. guamense*, wild populations and habitat needs to be protected and maintained on Guam and Rota. Control of nonnative ungulates will help restore native forest habitat and host trees for the species.

**Status of the *Dendrobium guamense***

Species Description

*Dendrobium guamense* (no common name) was federally listed as threatened on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *D. guamense* has not been completed.

*Dendrobium guamense* is an epiphyte in the orchid family (Orchidaceae). This orchid usually occurs on tree branches in forests in filtered sunlight. Stems are crowded and up to 60 cm long (Stone 1970). Leaves are arranged alternately in two opposite vertical rows, are up to 10 cm long and 7-15 mm wide (Stone 1970). Two small white flowers emerge between two leaves, and are open only one day, appearing as balls on the second day.

Life History

*Dendrobium* orchids typically produce large numbers of very small and easily dispersed seeds. These seeds contain almost no food reserves. Seedlings must quickly form mycorrhizal associations with appropriate fungi to supply them with needed nutrition as they develop (Lavarack et al. 2000). As an epiphytic orchid, *D. guamense* are supported by trunk and thick lower branches, sometimes in small twigs in the top of the canopy of trees. They cling strongly onto their hosts with a developed root system and use the moisture and organic debris caught in the crevices and bark of the host for nourishment. The humid tropical air is absorbed for additional moisture and nutrients. In northern Guam, individuals of *D. guamense* were observed mostly on *Ficus* spp. proximal about 10 ft. to 25 ft. (3 m to 7.6 m) high in the canopy (JRM 2016 p. 7). *Dendrobium* species take advantage of the microclimate, which are found on the trunk, lower branches, under the canopy, and prefer shade or moderate light. In the Naval Magazine in southern Guam, *D. guamense* was observed at all elevations along rivers and on ridges and plateaus, and on numerous tree species (JRM 2016).

Population Dynamics

*Dendrobium guamense* was identified as the most abundant of the three epiphytic orchids federally listed as threatened in 2015 and was found to be the most abundant of the three listed orchids on Rota (Zarones et al. 2015). Given the recent discovery of *D. guamense* on Aguiguan, it is possible that the species could be found on other northern islands of the CNMI if more

extensive surveys were done. In the 1980s, this species was common in trees on Guam and Rota, with more than 12 occurrences on Guam and 17 occurrences on Rota (Raulerson & Rinehart 1992 p. 98; Thomas & Rock 2015). At the time of listing in 2015, at least 21 locations totaling approximately 1,250 individuals were reported on Guam (4), Rota (15), Tinian (1) and Aguiguan (1).

On Guam, the four occurrences contain approximately 250 individuals, primarily in the Naval Magazine area and Andersen Air Force Base (Quinata 1994 p. 8). Three individuals were also found in Anao Pt. and Ipan outside of DoD property since the time of listing (GPEPP 2015). On Rota, a survey team reported more than 700 individuals of *D. guamense* on the western third of Rota, represented by seedlings, juveniles, and flowering adults (Zarones et al. 2015). The presence of multiple generations in a healthy population structure indicates that the status of *D. guamense* on Rota is better than previously known.

Status and Distribution

*Dendrobium guamense* occurs in the forest ecosystem on Guam, Rota, Saipan (historically), and Tinian, and recently recorded for the first time on Aguiguan (Raulerson & Rinehart 1992; Quinata 1994; Costion & Lorence 2012; Zarones et al. 2015). As recently as the 1980s, this species was common in trees on Guam and Rota, with more than 12 occurrences on Guam and 17 occurrences on Rota (Raulerson & Rinehart 1992; Thomas & Rock 2015).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Ungulates graze upon forest plant species impacting many native plants resulting in profound changes to the forest habitat. In the absence of ungulates, healthier and more pristine forest habitats contain a broader species composition and structure on which epiphytic orchids depend.
    - As numbers of cattle and ranchers increase on Tinian, there may be a greater risk of cattle potentially escaping and becoming feral. Both feral and domestic cattle can drastically alter the landscape (Wiles et al. 1990 pp. 176, 177), and depending on the location and amount of land designated as pasture land for domestic cattle, negative impacts to the forest ecosystem may be observed in the future, minimizing the available habitat.
    - Nonnative plants can degrade forest habitats. *D. guamense* has been found on both native and nonnative trees; however, the health and persistence of the orchid on nonnative trees is unknown.
    - Urbanization and development as well as natural or incidental fire, directly impact and reduce habitat availability for epiphytic orchids.
    - Edge effects due to disturbance and fragmentation have been shown to negatively impact orchids in cloud forests

- Stochastic events, primarily typhoons degrade forest. Affected forest areas may require several years to become reestablished and this can be exacerbated if habitats are reduced or degraded.

*Survival and Recovery Needs*

In order to recover *T. guamense*, individuals of this species in the wild and their habitat need to be protected on islands throughout their range. Reducing or eliminating nonnative ungulates will help restore native forest habitat and host trees for the species.

**Status of the *Tuberolabium guamense***

Species Description

*Tuberolabium guamense* (no common name) was federally listed as threatened under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *T. guamense* has not been completed.

The genus *Tuberolabium* consists of 17 epiphytic orchid species. *T. guamense* has roots that elevate the leaves and flowers away from the tree trunk. Leaves are leathery, oblong, about 13 cm long and 1.5 cm wide. Small white flowers are on a rachis about 3.5 cm long (Raulerson & Rinehart 1992 p. 127).

Life History

Similar to other epiphytic orchids, *T. guamense* grows slowly and requires specific microclimates, which are found on the trunk, lower branches, and under the forest canopy. *Tuberolabium guamense* clings onto their host trees with a strong developed root system and uses the moisture in the air and organic debris caught in the crevices and bark of the host for nourishment (Tibbs 2008).

There is limited information on the life history and habitat preferences of *T. guamense*. The age of maturity and the lifespan of the species are unknown. However, McConnell (2016) indicated *T. guamense* grows slowly and is a long-lived plant. In addition, *T. guamense* exhibits a monopodial growth habit in which the stem may continue to grow indefinitely (McConnell 2016). Monopodial orchids lack pseudobulbs, which store water. They rely on high humidity in the air for water. Observations of *T. guamense* indicate that this species is associated with the native orchid *Taeniophyllum mariannense* (worm orchid) and moss on host trees. *T. guamense* has primarily been found in the shade of the forest canopy at a range of heights from one to 20 feet (JRM 2016). On Guam, *T. guamense* has been observed on a wide variety of host trees, both native and nonnative (more than 19 species) as well as on dead branches and trees. The majority have been found on *Vitex parviflora* and *Pandanus tectorius* depending on the dominant vegetation (JRM 2016; DON 2017).

On Rota, the *T. guamense* population occurs within a specialized niche of limestone forest within tall and short limestone forest and secondary pandanus forest at elevations greater than 300

meters of the Sabana region (Zarones et al. 2015). Forests located within the Sabana are often shrouded in clouds and mist, and some areas include healthy growths of epiphytes (Falanruw 1989 p. 6). *Tuberolabium guamense* has been found on seven native host plants: primarily *Hernandia labyrinthica*, *Premna obtusifolia, and Elaeocarpus joga* with fewer occurrences on: *Pipturus argenteus*, *Ficus prolixa*, *Macaranga thompsonii*, and *Pisonia umbellifera* (Zarones et al. 2015).

Population Dynamics

In 1992, Raulerson and Rinehart (p. 87) stated that although *T. guamense* may appear abundant on the limestone ridges, the habitats are limited and in reality these orchids are rare on Rota and Guam (1992). For example, the Rota *T. guamense* population occurs in clusters within limestone forest in the Sabana region. At the time of listing in 2015, *T. guamense* was known from seven occurrences: one occurrence of one individual on Guam and six occurrences of 239 individuals on Rota, in the forest ecosystem (80 FR 59423). On Guam, surveys since the time of listing conducted by DON identified over 12,800 individuals, a substantial increase in the known population size. (DON 2017). Because individuals were defined as a single plant, regardless if it was part of a large cluster or clump, more research should be done to determine if this is an effective measure to distinguish an individual of *T. guamense* to avoid over counting during surveys. Winker et al. (2009) suggests that epiphytic orchid clusters be defined as inhabiting a single tree, and that within each tree only reproductive individuals be counted for monitoring purposes (pp. 997-1003).

Status and Distribution

*Tuberolabium guamense* is predominantly known from the islands of Guam and Rota, with a few scattered historical occurrences on Tinian and Aguiguan (Raulerson & Rinehart 1992 p. 127; Thomas & Rock 2015). Most orchids are narrowly distributed in specific habitats (Cribb et al. 2003). In 1992, *T. guamense* was found in "trees and shrubs all over the island" (Raulerson & Rinehart 1992 p. 127), and the Consortium of Pacific Herbaria has records of 22 collections from Guam, five collections from Rota, 15 collections from Tinian, and three collections from Aguiguan (Thomas & Rock 2015). *Tuberolabium guamense* individuals are also not distributed uniformly throughout the forests; and where they occur, are often present in clusters.

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
  - Ungulates graze upon forest plant species impacting many native plants resulting in profound changes to the forest habitat. In the absence of ungulates, healthier and more pristine forest habitats contain a broader species composition and structure on which epiphytic orchids depend.
  - Nonnative plants can degrade forest habitats. Invasive vines such as *Coccinia grandis* (ivy gourd) and *Antigonon leptopus* (chain of love) are aggressive invaders of

disturbed or edge habitat, and can form dense blankets that cover individuals of *T. guamense* (Space & Falanruw 1999).
- *Tuberolabium guamense* has been found on both native and nonnative trees; however, the health and persistence of the orchid on nonnative trees is unknown.
- Urbanization and development as well as natural or incidental fire, directly impact and reduce habitat availability for epiphytic orchids.
- Stochastic events, primarily typhoons degrade forest. Affected forest areas may require several years to become reestablished and this can be exacerbated if habitats are reduced or degraded.

*Survival and Recovery Needs*

In order to recover *T. guamense*, individuals of this species in the wild and their habitat need to be protected on islands throughout their range. Reducing or eliminating nonnative ungulates will help restore native forest habitat and host trees for the species.

**Status of the *Cycas micronesica***

Species Description

*Cycas micronesica* (fadang in Chamorro) was federally listed as threatened under the ESA on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *C. micronesica* has not been completed.

*Cycas micronesica* is part of the Cycadaceae family which contains only one genus, *Cycas*, a very ancient genus of trees dating back to the Jurassic period. Ninety-eight *Cycas* species are described, and 75 species (77 percent of the genus) are considered critically endangered, endangered, threatened, near threatened, or vulnerable under the definitions of the (IUCN 2017). All *Cycas* species are restricted to the equatorial regions.

*Cycas micronesica* is a palm-like plant, usually unbranched tree with a thick trunk. Adult stem lengths reach 8m, rarely to 12m, and 14-25 cm in diameter with pinnate leaves 150-180 cm long (Hill 1994).

Life History

*Cycas micronesica* is the only native gymnosperm in the Mariana Islands. Cycads are dioecious, and both sexes bear reproductive structures that are relatively massive amongst gymnosperms (e.g. conifers). *Cycas micronesica* occurs in limestone forests in Guam and Rota, with fewer occurrences in volcanic soils typical of southern Guam (Stone 1970 p. 65; Hill 1994). Few studies exist that describe cycad natural history and ecology in the Mariana Islands, and much of the current literature is focused on its decline and effects from introduced pests. However, *C. micronesica* (identified as *C. circinalis* at the time) is a food source for the Mariana fruit bat (*P. mariannus mariannus*), which feed on its fruits (Wiles & Fujita 1992 p. 27), as well as for the Chamorro people, who process the fruits to rid the naturally-occurring toxins (Whiting 1963). *Cycas micronesica* emits chemical cues to attract specialist insects for pollination (Schneider et

al. 2002); however, there is also evidence of wind as a pollen vector in open areas or forested areas with some wind on Guam (Terry et al. 2009 p. 96; Hamada et al. 2015).

Population Dynamics

At the time of listing, there were fewer than 516,000 individuals on Guam (Marler 2013). This number does not distinguish between successfully reproducing adults and juveniles (Marler 2013), which, because of the effects of the cycad aulacaspis scale (*Aulacaspis yasumatsui*), implies that the number of extant individuals that can successfully reproduce is much lower. Within Guam's AAFB, over 257,000 individuals were documented in July 2013; however, the population structure was dominated by adults with little recruitment and declining reproductive success (Marler 2014). In a separate survey, an unquantified number of *C. micronesica* individuals were found at 11 sites across Guam, some of which were on AAFB (Harrington et al. 2012). Between March 2015 and January 2017, natural resources personnel from the MCAG P&D office conducted surveys which identified 19,852 mature individuals (DON 2017). On Rota, fewer than 111,500 individuals are present across the four occurrences (Marler 2013). Nearly 300,000 *C. micronesica* trees were documented on Yap (Marler 2013). The number of *C. micronesica* across Palau is the smallest with approximately 2,500 individuals (Marler 2013). As of February 2016, the total outplanted population on Tinian was 903, half of which were small and required continued maintenance (NAVFACMAR 2016).

Status and Distribution

*Cycas micronesica* is known historically from Guam, Rota, Palau (politically the independent Republic of Palau) and Yap (geographically part of the Caroline Islands; politically part of the Federated States of Micronesia (Hill 2004; Hill et al. 2004) and has also been out-planted on Tinian (NAVFACMAR 2016). It was the most abundant tree on Guam forest inventory surveys in 2002 with over 1.5 million trees identified (Donnegan et al. 2004 p. 16) and was similarly common on Rota. At the time of listing in 2015, there were a total of 15 to 20 occurrences of *C. micronesica* with 900,000 to 950,000 individuals on Guam, Rota, Yap, and Palau (80 FR 59423). The number of occurrences per island (or group of islands) was as follows: four fragmented occurrences on Guam, three of which were in the north; four on Rota; three on the Yap islands; and four across Palau (80 FR 59423).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
    - Loss and degradation of habitat from development, urbanization, agriculture, as well as wild or incidental fire.
    - Exotic plants, trees, shrubs, and vines have all been found to compete with *C. micronesica* for space, reducing available habitat.
    - The presence of nonnative ungulates degrades remaining forest habitats through herbivory and physical damage impeding their ability to survive.

- Low population number
    - A lack of recruitment into the population which on Guam is currently dominated by adults increases the vulnerability of the species to maintain a population structure which can maintain or promote the population.
- Nonnative pest species
    - *Cycas micronesica* is severely affected by multiple pest species, with *A. yasumatsui*, an introduced cycad specialist armored scale insect, being the most significant threat (Marler & Muniappan 2006 p. 3). The cycad aulacaspis scale is causing rapid mortality of all life stages of the plant (Marler 2014). As of January 2013, *C. micronesica* mortality reached 92 percent on Guam, and cycads on Rota are experiencing a similar fate from the cycad aulacaspis scale (Marler 2013). *Aulacaspis yasumatsui* has also invaded Palau; however the effects of the invasion on *C. micronesica* have not yet been determined. All seedlings of *C. micronesica* in a study area were observed to die within 9 months of infestation by *A. yasumatsui* (Marler & Muniappan 2006 p. 3; Marler & Lawrence 2012 p. 233; WPTRC 2012 p. 4). A specialist scale predator beetle, *Rhyzobius lophanthae*, was introduced purposefully to treat the *A. yasumatsui* outbreak with some positive results (Marler & Lawrence 2012 pp. 234–238). However, a number of other insects, including cycad blue butterfly (*Chilades pandava*) and a native longhorn beetle that bores cycad stems (*Dihammus marianarum*), also contribute to declining health and mortality in Guam cycad populations (Marler & Muniappan 2006 p. 3; Marler & Lawrence 2012 pp. 238–240).
    - In the absence of subsequent disturbances (i.e. typhoons) a healthy *C. micronesica* plant is resilient to typhoon damage (Hirsh & Marler 2002). However, the poor health status of remaining trees indicates that the natural resilience of this taxon to typhoon effects has been decreased by the chronic *A. yasumatsui* damage.

Survival and Recovery Needs

In order to recover *C. micronesica*, individuals of this species need to be protected throughout its range. *Cycas micronesica* populations should have age structures consisting of seedlings, juveniles, and adult plants. Expanded trials with biocontrol, especially targeting *A. yasumatsui*, should be considered to help stabilize the population (Marler & Lawrence 2012 p. 240). In addition, future invasions from other pests must be prevented (Marler & Lawrence 2012 p. 240). Feral pigs and introduced deer are also threats through herbivory and physical damage, further compounding effects from insects (Marler & Lawrence 2012 p. 238); therefore, ungulate control and fencing restoration sites are also crucial steps in managing cycad populations.

**Status of the *Heritiera longipetiolata***

Species Description

*Heritiera longipetiolata* (ufa halomtano in Chamorro) was federally listed as endangered under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *H. longipetiolata* has not been completed.

*Heritiera longipetiolata* is part of the hibiscus family, Malvaceae, which are flowering plants. The family contains 244 genera with over 4,000 species. There are two *Heritiera* species on Guam (Stone 1970). *Heritiera longipetiolata* is a stout, medium-sized tree and the trunk is often twisted. The alternate ovate-oblong leaves are large (15-30 cm long and 8-15 cm wide) and borne on long petioles that are abruptly enlarged at the base of the leaf blade. The upper leaf surface is dark green and slightly glossy. Flowers are yellowish-tan in color. The fruits are brown, woody and about the size of a Brazil nut, with thick walls (Stone 1970; Raulerson & Rinehart 1991 p. 94).

Life History

Little is known about the life history of *H. longipetiolata*. This species can be propagated by seeds. It is never found in riverine or coast strands instead, it occurs rooted in crevices in dissected limestone slopes and plateaus in the Marianas (Costion & Lorence 2012). Stone (1970) reported that *H. longipetiolata* was rarely found in flower or fruit; however, 70percent of a population on Saipan was observed with flowers or fruit buds (EFC & Services 2002) On Guam, *H. longipetiolata* occurs mostly on limestone cliffs.

Population Dynamics

In 1997, there were about 1,000 individuals on Guam, several hundred on Tinian, and fewer than 100 on Saipan, with no known remaining individuals on Rota (Wiles 1998). At the time of listing in 2015, *H. longipetiolata* was known from 10 occurrences totaling approximately 200 individuals, on Guam, Saipan, Tinian, and Rota, all within the forest ecosystem (80 FR 59423). The total population of *H. longipetiolata* on Guam was approximately 90 individuals; on Tinian, there were between 30 and 40 individuals, and possibly more in forest areas; on Saipan, *H. longipetiolata* was known from three occurrences, totaling at least 53 individuals, with several hundred seedlings beneath the trees; and on Rota, more recent information indicates that there was at least one individual of *H. longipetiolata* (80 FR 59423).

Surveys since the time of listing documented 255 *H. longipetiolata* at four different DoD locations on Guam (DON 2017). Additionally, during surveys in 2014 and 2015, 1,816 individuals were tagged at five locations outside of DoD property on Guam, 149 of which were mature trees (GPEPP 2015).

Status and Distribution

Historically, *H. longipetiolata* is endemic to the islands of Guam, Rota, Saipan, and Tinian and the only location outside of the Mariana Islands is in Pohnpei (Stone 1970; Raulerson & Rinehart 1991; Costion & Lorence 2012).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
  - Incremental habitat loss due to wild fire, urbanization, and agricultural development is increasingly threatening the availability of habitat.
  - The presence of nonnative plants and other nonnative ungulates (pigs, goats, and water buffalo), and Philippine deer, is likely to further degrade remaining forest habitats, thus impeding their ability to survive.
  - The spatial distribution is a major concern, as so many individuals are growing in close proximity throughout AAFB. This aggregated pattern increases the vulnerability of the population, especially to the threat of habitat loss and is exacerbated by the fact that most individuals on AAFB are located in sites with less than 15percent slope, which is also terrain suitable for human development.
- Low population number
  - A small number of individuals in the population increases the likelihood of reduced genetic diversity, vulnerability to stochastic events (i.e. typhoons or disease) and ultimately extinction pressure.

*Survival and Recovery Needs*

In order to recover *H. longipetiolata*, the remaining populations or occurrences of this species need to be protected throughout its range. *Heritiera longipetiolata* populations should have age structures consisting of seedlings, juveniles, and adult plants. Ungulate control should be implemented throughout its range, especially on Guam since the majority of the rangewide population exists on the island. In addition, control of nonnative plants and invasive insects and outplanting of *H. longipetiolata* in protected areas are critical for its recovery. Restoration works should focus on outplanting saplings within protected and ungulate-free areas.

**Status of the *Tabernaemontana rotensis***

Species Description

*Tabernaemontana rotensis* (no common name) was listed as threatened under the Act on October 1, 2015 (80 FR 59423). No critical habitat has been designated for this species. A recovery plan for *T. rotensis* has not been completed.

*Tabernaemontana rotensis* is in the dogbane family, Apocynaceae, which includes trees, shrubs, herbs, stem succulents, and vines. The family contains 366 genera, and the *Tabernaemontana* genus consists of 103 species (The Plant List 2013). *Tabernaemontana rotensis* is a small to medium-sized (8-10 m tall) tree with leaves that are thin, light green, opposite, and 15-30 cm long (Stone 1970). Flowers are white, elongate, slender, and branch from the tree. *Tabernaemontana rotensis* produce conspicuous orange fruit that are twinned or single and beaked (UOG 2007 p. 6; GPEPP 2015 p. 22).

Life History

*Tabernaemontana rotensis* occurs in forests with crevices of rough limestone (Raulerson & Rinehart 1991 p. 94) and are able to colonize sites that occur in full sun or in deep shade (UOG

2007 p. 16). The species has primarily been found in areas of little to no slope (<15%) (UOG 2007; JRM 2016). *Tabernaemontana rotensis* has been found in forest habitats most often co-occurring with *C. micronesica*; however, *T. rotensis* were not found in areas that were dominated by alien tree species (UOG 2007).

*Tabernaemontana rotensis* populations typically flower in August through October, followed by the production of immature or orange fruit (UOG 2007 p. 23). During this time period, 40 to 80 percent of trees were found to have at least some flowering occur every month (cite). The fruit of *T. rotensis* reaches full size approximately 30 to 35 days after flowering. Fruit color changes from bright green to dull green in subsequent months, and a dull orange color break occurs in 50 to 60 days after flowering (UOG 2007 p. 24).

Seed dispersal of *T. rotensis* is dependent on birds and therefore a lack of frugivore bird species on Guam has resulted in limited spatial distribution of *T. rotensis*. Today, *T. rotensis* is generally found clumped within confined areas, as seedling establishment is restricted to within the vicinity of the parent tree (UOG 2007). This phenomenon does not support seedling recruitment, as seedlings develop in extreme competition with one other, and many of them become stunted and die (UOG 2007 pp. 14, 22).

In typhoon conditions, *T. rotensis* develops a synchronized pulse of flowering about one month after the typhoon. This pulse of flowering leads to mast seeding event about four months after a typhoon (UOG 2007 p. 29). This species may behave like a pioneer species since germination and seedling emergence have been shown to be maximized in full sun conditions (i.e., after typhoon damage) (UOG 2007).

Population Dynamics

In a study specific to AAFB, the species occurred in clumped patches within 256 sites across the base (UOG 2007). The population structure of over 21,000 individuals included emerging seedlings, young juveniles, and reproductive mature individuals with an extensive canopy size. The species was observed in Northern Guam in the following areas: Ritidian Point, Pati Point, HMU, and central and southeast edge of AAFB (UOG 2007; JRM 2016). At least five individuals of *T. rotensis* also occur within the GNWR. At the time of listing, *T. rotensis* was known from six occurrences on Guam and nine individuals on Rota (80 FR 59423). Individuals on Rota varied in size between 0.5 m and 6 m (1.6 ft. to 19.7 ft.) spread across the western, southern, and eastern parts of the island (CNMI-DLNR 2015).

Since the time of listing, additional surveys have identified and tagged 196 total individuals (88 of which were mature) at two locations outside of DoD property (GPEPP 2015). A total of 23,325 individuals have been identified at six locations on DoD property, over 85percent of which are on AAFB (Department of Navy 2017).

Status and Distribution

*Tabernaemontana rotensis* is endemic to Guam and Rota and was suggested to be restricted to limestone forest habitat (Stone 1970). It was originally noted as very rare needing seed cultivation or cuttings to assure the existence of the species (Stone 1970).

*Threats*

The following threats to the species contributed to its listing or were identified subsequent to listing and continue to to be an issue in the ability of the species to recover.

- Loss or degradation of habitat
  - Incremental habitat loss due to wild fire, urbanization, and agricultural development is increasingly threatening the availability of habitat.
  - The presence of nonnative plants and other nonnative ungulates (pigs, goats, and water buffalo), and Philippine deer, is likely to further degrade remaining forest habitats, thus impeding their ability to survive.
  - The spatial distribution is a major concern, as so many individuals are growing in close proximity throughout AAFB. This aggregated pattern increases the vulnerability of the population, especially to the threat of habitat loss and is exacerbated by the fact that most individuals on AAFB are located in sites with less than 15percent slope, which is also terrain suitable for human development.
- Population recruitment
  - The lack of dispersal by birds restricts the spatial extent of the populations on Guam. Clustered populations can exhibit less genetic diversity becoming less resilient evolutionarily and more vulnerable to stochastic events causing a disproportionate effect (extreme events or disease) and thus prone to extinction pressures.
  - Typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate. Typhoons may actually open canopy space to germinate *T. rotensis* seeds and promote the population; however, in order for successful regeneration following thyphoons is dependent on a viable seed bank and if there is regeneration, it will likely result in clustered spatial distribution (UOG 2007).

*Survival and Recovery Needs*

In order to recover *T. rotensis*, the remaining individuals of this species need to be protected on Guam and Rota. *Tabernaemontana rotensis* populations should have age structures consisting of seedlings, juveniles, and adult plants. Ungulate and invasive species control should be implemented throughout its range. On Guam, restoring areas with this species' natural dispersers (*e.g.*, native frugivore birds) would expand the distribution of *T. rotensis* population into new habitat niches, niches that would have likely been naturally occupied by the *T. rotensis* population prior to the loss of seed dispersal on Guam. Outplanting or relocation of wild seedlings within protect areas would help increase their abundance and distribution on Guam and Rota.

## ENVIRONMENTAL BASELINE

### General Environmental Baseline

A general overview of the status of, and threats to, limestone forest habitat within the action area, followed by species-specific environmental baseline sections, are presented below. This overview reflects the important role of forest habitat in the conservation of all the listed species addressed in this BO.

Overview of Guam

Guam is the largest and southernmost island of the Marianas Archipelago. It is almost 30 mi (50 km) long and from 4.3 mi to 9.3 mi (7 km to 15 km) wide. The northern part of Guam is a limestone plateau interrupted by a few low hills that are volcanic in nature and other hills that are exclusively coralline (formed from coral). The original forest on limestone was of large trees, with a thick canopy overhead (see below for further description). The northern part of the island gently slopes to the southward from about 656 ft (200 m) to about 328 ft (100 m) at the narrow waist of the island. There is no surface water in the northern part of the island (Fosberg 1960, pp. 51-52). Only in the southern and central parts of Guam are there permanent streams (Stone 1970, p. 12). The central part of Guam includes a mixture of volcanic and limestone substrate. The southern part of Guam is hilly, largely of volcanic origin (*e.g.*, basalts) but in several places the hills are capped with a layer of limestone (Stone 1970, p. 12). The southern half of the island is made up of deeply weathered volcanic material with patches of limestone and numerous streams (Fosberg 1960, p. 52). Forest habitat is broken up by ridges and flats covered by grass. The forests in these areas tend to resemble that on limestone; however, the forest is thicker and is dominated by lower stature trees (Fosberg 1960, p. 53; Stone 1970, p. 18). At lower elevations, forest occurs primarily in ravines, valley bottoms, and on steep slopes.

Limestone Karst Forests on Guam

Limestone karsts are sedimentary rock outcroppings consisting primarily of calcium carbonate and are recognized as important ecosystems with high species diversity (Mueller-Dombois and Fosberg 1998, p. 217; Clements et al. 2006, pp. 733-734). The high species diversity on karst arises from the numerous ecological niches created by complex terrains and variable micro-climatic conditions (Clements et al. 2006, p. 734). On Guam, karst is found on an uplifted plateau located on the northern half of the island and on uplifted weathered volcanic terrain in the southern half (Fosberg 1960, p. 54; Stone 1970, p. 12; Mueller-Dombois and Fosberg 1998, p. 241). The limestone soils of north and south Guam were historically forested (Stone 1970, p. 14; Mueller-Dombois and Fosberg 1998, p. 270; Guam Department of Agriculture 2010, p. 7), and limestone forest on Guam is composed primarily of mature growth of native trees and plants with a moderately dense canopy 33 ft to 98 ft (10 m to 30 m) in height (DAWR 2006, p. 19). We define primary limestone forest as forest with vegetation that was never cleared and is dominated by native species (Fosberg 1960, p. 56; DAWR 2006, p. 218).

Primary limestone forests are critically important to Guam's native flora and fauna (Stone 1970, p. 22; USFWS 2005a, p. iv; DAWR 2006, p. 28; DON 2014b, p. 3-40). They retain key functional components of native forests such as large native trees and high canopy cover (Fosberg 1960, p. 56; Mueller-Dombois and Fosberg 1998, p. 217 and 270; DON 2014b, p. 3-40), and are necessary for the recovery of Guam's terrestrial native species (DAWR 2006, p. 27; Jenkins 1983, p. 22; Michael 1987; Morton et al. 1999, p. 22). Intact primary limestone forests harbor greater tree species diversity than degraded habitat (Stone 1970, p. 22) and provide habitat for a broad diversity of wildlife. These forests are also highly productive and often store more carbon than degraded forests (Caves et al. 2013, p. 7). The primary limestone forest on AAFB is considered some of the highest quality native limestone forest left on Guam to serve as habitat for listed species (Morton 1996, p. 69).

Threats to Guam's Limestone Forests

Over the past several centuries, Guam has lost much of the native forest to agriculture, a growing human population, economic development, and military activities (Mueller-Dombois and Fosberg 1998, p. 270; USFWS 2009d, p. 27). The distribution of primary limestone forest on Guam has been steadily declining (Fosberg 1960, p. 54; DAWR 2006, p. 28). Although little is known about the nature of Guam's vegetation before World War II, progressive alteration of the island's vegetation clearly began with human colonization (Fosberg 1960, p. 54). On limestone soils, native forest was cleared and replaced by coconut plantations, open fields and gardens, pasture, and secondary forest (Mueller-Dombois and Fosberg 1998, p. 242). During World War II, large areas were cleared and some habitat was destroyed during heavy fighting (Fosberg 1960, p. 54).

Currently, the remaining limestone forests on Guam face numerous threats including habitat fragmentation and loss, lack of management, introduced ungulates, invasive species, typhoons, forest conversion, and loss of seed dispersers (USFWS 2005a, p. 27; DAWR 2006, p. 28; USFWS 2008a, p. 17-18). These combined threats are degrading the habitat quality of remaining limestone forests and limiting the acres of high quality primary limestone forest habitat available to recover listed species on Guam. Currently, forested areas cover approximately 48 percent of Guam (DAWR 2006, p. 31). Of this, about 13 percent consists of limestone forest habitat (Brown 2005 as cited in DAWR 2006, p. 28).

Forest Habitat Fragmentation, Degradation, and Loss

Habitat fragmentation is a change in habitat configuration caused by clearing, development, invasive species, typhoons, and ungulates that result in the remaining habitat to occur in patches intermixed with areas of non-habitat (Noss et al. 2006, p. 213). Habitat fragmentation creates edges that have different properties than the habitat itself. For example, edges often have different microclimate patterns that are drier, less shaded, and warmer than forest interiors. They are often areas with increased predation and serve as entry points into native habitats for invasive vegetation, pests, and pathogens (Noss et al. 2006, p. 228). The effects of edges that are caused by habitat fragmentation can occur up to 492 ft (150 m) into the forest (Murcia 1995, p. 59). Habitat fragmentation and edges can result in localized extirpations of species, shifts in community composition, increases in invasive species, increased predation, and in suitable

habitat becoming unsuitable due to pollution, invasive species, physical size, or barriers blocking access to habitats (Groom and Vynne 2006, p. 174; Noss et al. 2006, 38 pp). Habitat fragmentation has been implicated in reduced species richness, avian abundance, productivity, and food supply (Blake and Karr 1987, VanderWerf 1993, Burke and Nol 1998, Trine 1998, Porneluzi and Faaborg 1999). Overall, edges may have adverse effects to some wildlife populations and ecological processes (Murcia 1995, p. 58; Laurance 2000, p. 134) and may affect forests at larger landscape scales (Laurance 2000, p. 134).

Habitat degradation and loss on Guam has been caused by various human activities including agriculture, mining, forestry, fires, infrastructure development, military training, urbanization, industry, pollution (including light, noise, and toxic chemicals), and changes in community and ecosystem structure due to invasive species (Groom and Vynne 2006, p. 164; USFWS 2008a, p. 17). Habitat loss and degradation from human activities is a threat to the recovery of many listed species on Guam (USFWS 2008a, p. 17; USFWS 2012c, p. 3).

Feral Ungulates

Feral ungulate species that occur on Guam include pigs (*Sus scrofa*), Philippine deer (*Rusa marianna*), and the Asiatic water buffalo (*Bubalis bubalis*) and are not native to the island. Feral ungulates have caused severe damage to Guam's forests by browsing on plants, causing erosion, inhibiting plant growth and regeneration, and facilitating the establishment of invasive plants, which can impede forest regeneration by displacing or smothering native species (USFWS 2009d, p. 27). For example, deer and pigs foraging on fallen fruits and seedlings of the native breadfruit (*Artocarpus mariannensis*), an important Mariana fruit bat food, in combination with impacts from typhoons, have resulted in a decline in the number of native breadfruit trees on Guam (Wiles 2005, p. 509).

Feral pigs are extremely destructive and have both direct and indirect effects on native plant communities. While rooting in the soil in search of invertebrates and plant material, pigs directly affect native plants by disturbing and destroying vegetative cover and trampling plants and seedlings. They may also reduce or eliminate plant regeneration by damaging or eating seeds and seedlings. Pigs are a major vector for the establishment and spread of competing invasive non-native plant species, by dispersing plant seeds on their hooves and coats as well as through the spread of their feces (Matson 1990, p. 245; Siemann et al. 2009, p. 547). Feral pigs feed preferentially on the fruits of many non-native invasive plants, spreading the seeds of these species through their feces as they travel in search of food. In addition, rooting pigs contribute to erosion by clearing vegetation and creating large areas of disturbed soil, especially along hillsides (Smith 1985, pp. 190, 192, 196, 200, 204, 230–231; Stone 1985, pp. 254–255, 262–264; Medeiros et al. 1986, pp. 27–28; Scott et al. 1986, pp. 360–361; Tomich 1986, pp. 120–126; Cuddihy and Stone 1990, pp. 64–65; Aplet et al. 1991, p. 56; Gagne and Cuddihy 1999, p. 52).

On Guam, feral pigs were introduced in the 1600's, established a population by 1772, and were distributed island-wide by the early 1900's (Conry 1988, p. 26). As documented in other locations, wallowing, rooting, and trampling are common in most forested areas and can be locally severe (Conry 1988, p. 27). A large complex of wallows and feeding sites in Tarague Basin on AAFB measured over 5.7 ac (2.3 ha), and was stripped of all ground cover with no tree

regeneration (Conry 1988, p. 27). On AAFB, densities of Philippine deer and feral pigs were estimated at 0.8 deer per acre (1.8 deer per hectare) and 0.2 pigs per acre (0.4 pigs per hectare), which are some of the highest densities recorded in the world (Knutson and Vogt 2003, unpubl. manuscript).

Philippine deer were introduced to Guam in the 1770's (Safford 1905, p. 76), and are distributed throughout the island (Conry 1988, p. 27). Heavy browsing pressure has been documented and browse lines are common (Conry 1988, p. 27). Deer populations in the 1990s appeared to be expanding (Wiles et al. 1999, p. 193), and may be the largest in Micronesia (p. 200). Philippine deer have caused significant changes in forest structure and species composition in native ecosystems on Guam, and are not considered compatible with conservation of native ecosystems and recovery of endangered species (Wiles et al. 1999, p. 193).

The Asiatic water buffalo was introduced to Guam in the 1600's from the Philippines (Conry 1988, p. 27). High densities, and the gregarious habits of Asiatic water buffalo, have resulted in habitat damage such as mud wallows, broad trails, vegetation trampling, and tracks, with some areas so heavily trampled that ground cover has been denuded and soil erosion scars and slumping are evident (Conry 1988, pp. 27-28). The Asiatic water buffalo occurs primarily on the Ordnance Annex and surrounding non-Navy lands in southern Guam, with a population estimated at 50-60 animals (USFWS 2008a, p. 18).

Conversion of Forest to Savanna in Southern Guam

Savanna areas in southern Guam are enlarging into previously forested areas as a result of human-caused wildfires and grazing (Stone 1970, p. 14; Mueller-Dombois and Fosberg 1998, p. 242). To estimate the rate of historical forest conversion to savanna, Greenlee (2010) delineated areas that were dominated by forest vegetation in 1975 using aerial photographs and compared these areas to recent infrared imagery. Based on this analysis, approximately 1,119 ac (453 ha) of forest has been converted to savanna in southern Guam since 1975; this estimate indicates the average rate of forest loss in southern Guam is approximately 37 ac/year (15 ha/year) (Greenlee 2010).

Habitat Destruction and Modification by Typhoons

Guam has been affected by typhoons in 37 of the last 50 years (USFWS 2005a, p. 32). Super-typhoons (with wind gusts of over 150 mi (240 km) per hour) occur approximately once every five years (the last one, Pongsona, occurred in 2002). Typhoons destroy native vegetation by opening the canopy and modifying the availability of light, and create disturbed areas conducive to invasion by non-native pest species (Asner and Goldstein 1997, p. 148; Harrington et al. 1997, pp. 539-540). Typhoons also can cause defoliation (loss of leaves), uprooting of trees, and breakage of stems, branches, and trunks of trees depending on the severity and duration of the storm and its point of impact (Brokaw and Walker 1991, p.442). Super-typhoons fragment and decrease the suitability of existing habitat, and exacerbate the effects of introduced plants and ungulates (USFWS 2005a, p. 34). Climate models indicate that typhoons in the northwestern Pacific are expected to increase in intensity, frequency, and duration by 2200 (Emanuel et al. 2008, p. 360).

Loss of Pollinators, Seed Dispersers, and Frugivores

The loss of forest birds on Guam caused by BTS predation has caused a disruption in the ecosystem services provided by birds as pollinators, seed dispersers, and frugivores (Mortenson et al. 2008, p. 2146; Caves et al. 2013, p. 7). Seeds are dispersed significantly farther from parent trees on islands with birds compared to Guam, and seed ingestion by birds doubles to quadruples the chance of germination for plant species (Rogers 2011, p. 2). The combination of loss of seed dispersal and reduced germination can produce major changes in the spatial pattern, abundance, and diversity of Guam's forests (Rogers 2011, p. 2). In addition, seed set and seedling recruitment were significantly higher on Saipan (where BTS is absent) than Guam for bird pollinated trees (Mortensen et al. 2008, p. 2146). These studies concluded that the loss of ecosystem services provided by birds will result in the loss of species diversity, distribution, and abundance; slow regeneration of degraded forests; and a reduction of plant species recruitment (Mortensen et al. 2008, p. 2146 and 2153; Rogers 2011, p. 2; Caves et al. 2013, p. 5).

Human Disturbance

The listed species on Guam are also threatened by disturbance from human activities including, but not limited to, noise from military training (aircraft, munitions, firing ranges, vehicles, etc.), noise from recreational pursuits (hiking, and hunting), and construction noises. These disturbances not only negatively affect species, but reach into forested interiors and degrade the quality of habitat for listed species. The Mariana fruit bat is sensitive to human disturbance, and as development continues on Guam, disturbance-free forested habitats are increasingly rare on Guam.

Land Management on DoD Lands

The majority of remaining limestone forests on Guam occurs on DoD lands at AAFB and the NBG's NMS. As noted above, the primary limestone forest on AAFB is considered some of the best native limestone forest remaining that provides habitat for threatened and endangered species (Morton 1996, p. 69). The Service and the DoD (USAF, DON, and JRM) have worked together over the past 20 years to manage DoD lands for threatened and endangered species. In 1994, a Cooperative Agreement (Agreement) was established between the USAF, DON, and the Service for purposes of establishing and managing the GNWR Overlay on DoD lands (USFWS 1994). The GNWR includes approximately 376 ac (152 ha) of fee simple Service-owned land and 22,501 ac (9,106 ha) of Overlay Refuge areas on land owned by DoD. The Agreement, which is still in effect, affirms the signatory parties commitment for a "coordinated program centered on the protection of endangered and threatened species and other native flora and fauna, maintenance of native ecosystems, and the conservation of native biological diversity in cooperation with the Guam's DAWR, consistent with the national defense mission of the Navy." Notably, all signatory parties to agreed that DON lands included within the GNWR shall be managed and administered, consistent with the national defense mission of the DON and the requirements of section 7(a)(2) of the Act, and other laws as applicable.

Management of listed species habitat on DoD lands has occurred with some success. The approximately 180 ac (73 ha) Haputo ERA and the 30 ac (12 ha) Orote Point ERA, both on NBG are two examples. Both were established in 1984, prior to the Agreement, as mitigation for the Kilo Wharf project. The 133 ac (54 ha) Habitat Management Unit (HMU) on AAFB was developed as a conservation measure under the 2006, informal consultation on the Beddown of Training and Support Initiative at the NWF (USFWS 2006c, p. 2), and currently serves as an experimental site for BTS research and control.

**Environmental Baseline for the Mariana Fruit Bat**

Other than a few isolated periods of increase, Mariana fruit bats have been declining on Guam since the early 1900s (Wiles 1987b, p. 1; USFWS 2009d, pp. 6 & 7 and references cited therein). Although the decline of the Mariana fruit bat was likely initiated by the introduction of firearms and increased hunting efficiency in the early 1900s, predation by BTS has contributed to the continued decline (Wiles et al. 1987, p.148; Lemke 1992, p. 137; Wiles et al. 1995, p. 32; Janeke 2006, p. 3; Brooke 2008, p. 2; USFWS 2009d, p. 19, 30). By 1995, nearly all of Guam's remaining Mariana fruit bats were located on AAFB (Wiles et al. 1995, p. 39). In 2006, the only known maternity colony on Guam was located on AAFB at Pati Point and had less than 100 individuals (Janeke 2006, p. 4). By 2010 the Pati Point colony no longer existed, and no other colonies were known to exist on Guam (SWCA 2012, p. 20, DON 2014c, p. 2).

In December 2015, Mariana fruit bats were observed within the HMU at AAFB. Preliminary estimates were 30 to 50 Mariana fruit bats present within the HMU (D. Lujan, AAFB, pers. comm. 2016). Since that time, Mariana fruit bats have been regularly using the forest of the HMU for foraging and roosting. According to direct observation and indirect evidence of Mariana fruit bat presence (e.g., excrement, discarded fruits with bat-teeth markings), the Mariana fruit bats appear to be using most of the interior forested area in the HMU. Four different Mariana fruit bat roosting locations were identified during three perimeter and eight interior surveys of the HMU in 2016. The largest group of Mariana fruit bats counted in one area was 112 bats (Mildenstein 2016, p. 1). Mariana fruit bats were also observed flying from and to adjacent areas outside of the HMU (Mildenstein 2016, p. 2).

As described below, individual Mariana fruit bats have been detected at multiple locations on Guam in the past eight years.

Mariana fruit bat detections in northern Guam (GNWR, AAFB, Finegayan, and Haputo):

- In December 2015-February 2016, bats were observed within the HMU on AAFB. It is estimated that 112 bats were present within a colony at the HMU. This represents greater than a 200 percent increase in the estimated Mariana fruit bat population on Guam in early 2015. The increase in the Guam bat population is evidence of the periodic movement of bats between Guam and Rota.
- In July 2014, a large-scale survey throughout AAFB resulted in an estimate of 8-21 bats (DON 2014c, p. 2). Annual base-wide surveys on AAFB have been conducted in 2014, 2015, 2016 and 2017 (A. Brooke, DON, pers. comm 2017).
- Surveys on AAFB in 2012 recorded 50 detections of Mariana fruit bats at 84 stations, some of which could have been the same individuals. Mariana fruit bats were primarily

recorded along the cliff line extending from above the Combat Arms Training and Maintenance (CATM) Range east to Pati Point, in the MSA, and in the vicinity of the HMU (SWCA 2012, p. 58).

- In 2011, three Mariana fruit bats were observed flying west along the beach in front of the headquarters at GNWR (Schwagerl, pers. comm., 2015).
- Extensive surveys throughout AAFB from December 2010 to December 2011 resulted in a conservative estimate of approximately 25 Mariana fruit bats (DON 2014c, p. 48).
- From 2010-2013, a single Mariana fruit bat was observed flying across Route 3A on six occasions; four observations of a Mariana fruit bat flying into the HMU from Finegayan, and two observations of a Mariana fruit bat flying out of the HMU into Finegayan in the late afternoon (J. Schwagerl, USFWS, pers. comm. 2015). Mariana fruit bats from AAFB may use forested areas of Finegayan for foraging and roosting.
- During 10 observation days in 2008, one fruit bat was observed in the Haputo ERA and one in the northeastern portion of Finegayan (Brooke 2008, p. 1). The Haputo ERA contains some of the best remaining fruit bat habitat on the DON-managed lands (Brooke 2008, p. 2; DON 2010c).

Mariana fruit bat detections at Naval Magazine, Naval Base Guam, and in Southern Guam:

- In August 2014, two observations of a Mariana fruit bat in flight occurred at Fena Reservoir within the NMS (L. Takano, USFWS, pers. comm. 2014).
- In May and June of 2012 seven detections were recorded during surveys on six separate occasions at four locations on the NMS; it could not be determined whether observations were of a single individual or multiple individuals (DON 2014a, p. 48).
- In 2012, Mariana fruit bat surveys were conducted within the NMS and at a site on private land located in southern Guam (DON 2013b). Seven observations were recorded of a solitary Mariana fruit bat in flight at NMS, but it could not be determined if these observations represent one, or multiple individuals (DON 2013b, p. 11). These observations supplement Mariana fruit bat sightings previously documented in the vicinity of the NMS where foraging and roosting habitat is present (Brooke 2008, pp 1-2). No observations were recorded at the private lands site where suitable Mariana fruit bat roosting and foraging habitat is limited. However, known food plants of the Mariana fruit bat are present in the vicinity and this area may be used for roosting, foraging, and other activities (DON 2013b, p. 12).
- One Mariana fruit bat was sighted on NBG lands in 2008 during 90 hours of surveys at 14 survey locations on or near NBG lands. (DON 2014a, p. 48).

Threats to the Mariana Fruit Bat within the Action Area

In addition to the threats described in the General Environmental Baseline section, the following threats also affect Mariana fruit bat populations on Guam.

*Hunting*

Humans have been using Mariana fruit bats as a food source since human arrival in the Marianas. Consumption of Mariana fruit bats represents a significant Chamorro cultural tradition (Lemke 1992, p. 135; Sheeline 1991, p. 14). Demand for Mariana fruit bats for human

consumption is demonstrated by the large commercial trade in Mariana fruit bats that existed in the Marianas in the late 1960s until it became illegal through the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) (Wiles and Payne 1986, p. 143; Stinson et al. 1992, p. 63-66; Wiles et al. 1997, p. 204; CITES 2015). It is estimated that approximately 221,000 Mariana fruit bats were imported to Guam between 1975 and 1989 (Wiles 1992, p. 54). Illegal hunting appears to be the key reason for the Mariana fruit bat's dramatic decline on Guam (Wiles 1987b, p. 154; Wiles and Brooke 2009; USFWS 2009d, p. vii).

Even though Mariana fruit bats are protected by Guam and Federal law, they are likely still hunted opportunistically on private property when they transit the island and by hunters on AAFB (GNWR, unpublished data, 2005). For example, in 2007, reports were made of construction workers illegally hunting Mariana fruit bats at the Pati Point colony. The number of Mariana fruit bats at the colony declined from 55 (summer 2007) to 21 (December 4, 2008 survey) (PEER 2009). A recreational public ungulate hunting program has been in effect on AAFB since 1964 (D. Lujan 2015, pers. comm.), and is managed by a small group of hunters known as the Volunteer Conservation Officers (VCOs). The public is authorized to hunt on weekends in designated areas, and VCOs may hunt after regular working hours during the week. All hunting effort is documented by the VCOs. Currently, archery-only hunting is allowed in four areas (D. Lujan 2015, pers. comm.) and shotgun and muzzle loading hunting is prohibited. Elimination of shotgun and muzzle-loading hunting likely reduced the chance of illegal hunting of Mariana fruit bats on AAFB; however, it is possible that they are still hunted opportunistically on AAFB. SWCA (2012, p. 58) reported that roosting Mariana fruit bats were approached by observers as close as 16 ft (5 m), and suggested that hunters could, without difficulty, shoot and kill a roosting Mariana fruit bat.

*Noise*

Air traffic is the primary source of noise disturbance for Mariana fruit bats on Guam (SWCA 2008, p. 2-3; SWCA 2012, p. 23, 37). The first known study examining the effects of aircraft overflights on Mariana fruit bats on AAFB was conducted at Pati Point, where a colony of approximately 400 Mariana fruit bats roosted (Morton 1996). During this study, roosting Mariana fruit bats responded to some low-altitude aircraft overflights with distress and flushing, which increased time spent in alert, aggression, and maintenance behaviors. Four-engine carriers and bombers generally elicited a greater response from roosting Mariana fruit bats than fighter aircraft. Morton (1996, p. iii) suggested that higher levels of air-traffic volume would result in increased energy expenditure and perhaps roost abandonment by some or all of the Mariana fruit bats present at AAFB.

In 2006, the effects on Mariana fruit bats from noise resulting from increased jet aircraft and helicopter use at AAFB were analyzed in the ISR-Strike BO (USFWS 2006b). In that consultation, noise effects were expected to adversely affect the Mariana fruit bat to the extent that the nearby Pati Point colony would be abandoned, and Mariana fruit bats would relocate from Pati Point to other, less-protected areas on the island (USFWS 2006b, p. 49). In the ISR-Strike BO, we concluded that Mariana fruit bats on Guam would be taken as a result of the proposed action, but that action would not jeopardize the continued overall existence of the Mariana fruit bat (USFWS 2006b, pp. 49-52).

In 2007-2008, another study was conducted to document potential effects of aircraft noise on fruit bats at AAFB (SWCA 2008). During this period, the number of fruit bats at the Pati Point colony had decreased from 55 to 21 by the end of the surveys (PEER 2009). Aircraft noise affected the Mariana fruit bats by increasing alertness behaviors, preventing Mariana fruit bats from resting and sheltering in place, compared to surveys with no overflight occuring. However, the proportion of bats displaying alertness behaviors following an overflight was variable. Overflights did not appear to affect active thermoregulation. Six percent of overflights resulted in flushing events, and all flushing events were at noise levels exceeding 106 dBc, the highest reading being 122.6 dBc (SWCA 2008, pp. 2-3).

In 2010, another study was was funded to assess the effects of aircraft noise on Mariana fruit bats at AAFB (SWCA 2012); however, the colony at Pati Point no longer existed. Although up to eight individual Mariana fruit bats were observed roosting there at any one time, most departed the site by the end of each sampling period, indicating the site was no longer used as a colonial roost (SWCA 2012, p. 2). Increases in active thermoregulation (32 percent), maintenance (14 percent), locomotion (74 percent), and alertness (62 percent) were recorded during aircraft overflights. All flush events were at recorded peak noise levels above 90 dBA/101 dBc; the highest reading at 124.9 dBA/125.5 dBc (two F-15 aircraft). The observed flush events were associated with fighter, bomber, transport, and helicopter aircraft overflights (SWCA 2012, p. 23, 37).

Observations suggest that Mariana fruit bats may also be affected by small arms noise at the existing CATM Range at Tarague (J. Quitugua, DAWR, pers. comm. 2015). When the Mariana fruit bat colony was still roosting at Pati Point, a DAWR wildlife biologist observed Mariana fruit bats avoiding the firing range area as they left the roost to fly to their foraging grounds. Some flew away from land over the ocean, and returned to land by the Tarague beach area. Others flew up to the cliff line heading towards the ISR-Strike area. These observations occurred while the firing range was active on two different days. During the time period between the two observations, the number of Mariana fruit bats in the colony dropped from approximately 40 to less than 20 individuals. When the firing range was inactive, Mariana fruit bats were observed to fly along the cliff line near the range (J. Quitugua, DAWR, pers. comm. 2015).

*Typhoons*

Mariana fruit bats evolved in the presence of typhoons, the principal natural disturbance in the archipelago, but today these storms are a threat to the species because they can exacerbate the effects of the anthropogenic threats listed above (USFWS 2009d, p. 34). Evidence from Rota suggests that typhoons may not be a substantial source of direct mortality for Mariana fruit bats (Stinson et al. 1992, p. 65; Esselstyn et al. 2006, p. 536). However, the synergistic effect of illegal hunting and severe storms on Mariana fruit bats is documented on Rota (e.g., Stinson et al. 1992; Esselstyn et al. 2006). Severe storms can alter Mariana fruit bats foraging and roosting behavior by decimating food resources, removing protective foliage cover, temporarily modifying forest structure, and changing vegetation composition, especially by facilitating encroachment of non-native species. Loss of food resources can drive Mariana fruit bats to forage on the ground, during daylight hours, and closer to areas of human activity; thereby

increasing their vulnerability to illegal hunting (Stinson et al. 1992, p. 65; Esselstyn et al. 2006, p. 532).

Mariana Fruit Bat Survival and Recovery Habitat

Although Mariana fruit bats have been observed in a variety of habitat types, they are more likely to occur in native primary or secondary limestone forest (see Status of the Species above). Mariana fruit bat populations that have been subject to intense hunting pressure (e.g., populations on Saipan, Tinian, Rota, and Guam) are sensitive to human presence, and in recent history, maternity roosts are not known to occur in close proximity to areas inhabited by humans (Wiles 1987b, p. 151; J. Boland, unpublished data 2008-2014). However, Mariana fruit bats may forage on or near human-inhabited lands, in spite of hunting pressure (Wiles 2006, pers. comm. as cited in USFWS 2006b; Boland 2008-2015, pers. obs.). Therefore, for this BO, we assume that all areas identified as limestone and ravine forests on the 2006 Forest Service landcover maps (Liu and Fisher 2006a) are potential habitat for the fruit bat on Guam. We then updated the amount of available habitat on Guam by removing all forested areas cleared since the landcover map was completed using 2011 satellite imagery of Guam (Metevier 2014, unpubl. data). Although primary limestone forest is higher quality habitat that secondary limestone forest habitat, we did not account for habitat quality in these calculations due to our inability to differentiate between these forest categories using imagery alone. Similarly, we were unable to account for other aspects of habitat quality such as hunting and predation threats. As such, our estimate of available survival and recovery habitat (hereafter, referred to as habitat) on Guam is likely an oversetimate.

Using the methods above, the total area of Mariana fruit bat habitat on Guam was estimated to be 27,096 ac (10,965 ha) (**Figure 7**). Based on our estimate of 27,096 ac (10,965 ha) of existing survival and recovery habitat for the Mariana fruit bat (Metevier 2014, unpubl. data), the estimated carrying capacity for Mariana fruit bats on Guam is 19,847 bats (DON 2013d, p. 26, 45). In order for native limestone forest to serve as habitat for the Mariana fruit bat, it will need to be managed to reduce threats to the species, including the BTS, illegal hunting, invasive plant species, and feral ungulates (USFWS 2009a, pp. 42-43). Only 576 ac (233 ha) of this habitat is designated for the purposes of conservation. Most of the lands set aside for conservation are not currently managed to reduce threats. Therefore, it is important to protect and manage Guam's forest habitat to allow for recovery of the Mariana fruit bat. If habitat continues to be degraded, it may no longer provide the appropriate attributes necessary to support the Mariana fruit bat.

**Environmental Baseline for the Mariana Eight Spot Butterfly**

The Mariana eight spot butterfly relies on the limestone forest and thus is affected by the same stressors within the action area threatening Guam's limestone forest habitat, described above. The DoD lands affected by the proposed action encompass six of 10 host plant populations used by Mariana eight spot butterflies on Guam (Rubinoff 2016, p. 6). Within the action area, Mariana eight spot butterflies of all life stages were always found in close proximity to their two host plant species, *E. calcareum* and *P. pedunculata* (Rubinoff 2011, in litt.; Rubinoff 2013). Both of the host plant species are rare in their range and are susceptible to feral ungulate grazing, based upon observations that the plants occur only in the extremely rugged limestone karst that is

inaccessible by most feral ungulates (Rubinoff 2013, in litt.). The amount of total suitable habitat for the Mariana eight spot butterfly within the action area has not been quantified.

In northern Guam, the Ritidian and Haputo areas are important sites because they include the most current and consistent observations of Mariana eight spot butterfly adults and their other life stages. Extensive host plant patches and five occurrences with adult or larval butterflies were documented within the Ritidian Point, NWF area (DON 2016, p. 3). All adult and larva observations were near the cliff line in the area of the proposed MPMG Range. Host plant patches and observations of Mariana eight spot butterflies, caterpillars and eggs also occur within the Haputo ERA (Rubinoff 2016, attachment). It is likely that protection from feral ungulates and the presence of large stands of host plants support these important, larger populations and result in greater population persistence (Rubinoff 2016).

The host plants for the Mariana eight spot butterfly are also present at AAFB Golf Course, AAFB Pati Point, and AAFB Tarague (USFWS 2012a; Globteck and HDR 2012; Rubenoff 2013; Lindstrom and Benedict 2014, DON 2015; Rubinoff 2016). These three areas are situated west of Ritidian Point, along the northern plateau around to the south. Mariana eight spot butterflies, or their life stages, have been observed using these areas (USFWS 2012a; Globteck and HDR 2012; Rubenoff 2013; Lindstrom and Benedict 2014, DON 2015; Rubinoff 2016). A sixth area with host plants and butterflies, Spanish Steps/Orote, is within an ERA; this area is located the furthest south. The Mariana eight spot butterfly has likely been able to survive in this area because feral ungulate access is limited due to steep topography and is surrounded by cliff line and ocean. In total, surveys in the action area, while not comprehensive, have documented 2,310 individual host plants of *E. calcareum* and *P. pedunculata.*

**Figure 9** shows all locations where Mariana eight spot butterflies were documented within the action area. An estimate of a 1-kilometer buffer is used to distinguish between subpopulations and represents maximum Mariana eight spot butterfly flight distance, based on similar species under similar conditions (Hill et al. 1996, p. 730). However, recent comprehensive surveys have not been conducted within the action area to verify persistence of these subpopulations.

Since reintiation of this consultation, in 2016, the GNWR and Guam Plant Extinction Prevention Program (GPEPP) began propagating host plants (*E. calcareum and P. pedunculata*) successfully in their nurseries, for future outplanting and forest restoration activities.

**Environmental Baseline for the Partulid Snails: Humped Tree Snail, Guam Tree Snail, and Fragile Tree Snail**

Tree snails rely on primary and secondary limestone forest habitat and thus are affected by the same stressors within the action area threatening Guam's limestone forests, described above. Tree snails prefer cool, dense, shaded native forest communities, with high humidity and reduced air movement to conserve moisture (USFWS 2012a, 2012b). The humped tree snail, Guam tree snail, and the fragile tree snail were all reported in 1989 within the Haputo ERA (Hopper and Smith, 1992). A 2008 survey found two colonies within the Haputo ERA, one known historically at Haputo Beach and another further north at Pugua Point, but still within Haputo ERA. The Pugua Point site contained fragile tree snails and Guam tree snails, while the Haputo Beach site

contained humped tree snails and Guam tree snails (Smith et al., 2008). During surveys conducted in 2011, one colony of Guam tree snails and fragile tree snails were observed in back strand and *Neisosperma* forest vegetation at the east end of Tarague basin (DON, 2013d), north of the project footprint on AAFB. In surveys conducted in 2011 and 2013, no tree snails were observed in the NWF area (DON, 2013d; UOG 2014). Although tree snails were not found within the project footprint of the LFTRC, potential tree snail habitat does occur within the areas subject to clearing for the LFTRC (DON 2017a, p. 44).

Surveys conducted in 2013 found approximately 245 individual Guam tree snails, 112 humped tree snails, and three fragile tree snails within the Haputo ERA (UOG 2014). There are no records of tree snails within the Finegayan impacted areas. No tree snails have been reported from the support areas on AAFB and adjacent lands.

On NBG, Lindstrom and Benedict (2014) reported three populations of Guam tree snails on one of the 47 transects. A colony of 10 individuals of Guam tree snails was detected near Apra (Lindstrom and Benedict 2014). Two other populations of Guam tree snails were also identified along the same transect (Lindstrom and Benedict 2014). The second population consisted of five individuals observed in a one person-hour search and individuals were found on leaves less than 16.4 ft (5 m) high on a large *Annona reticulata* tree, approximately 49 ft (15 m) tall. Both of the populations were found within 65.6 ft (20 m) of a small freshwater stream. The third population of Guam tree snails, 68 individuals in total, was observed on *Morinda citrifolia* trees in a one person-hour search and this population was no less than 164 ft (50 m) from a freshwater source. No other colonies of tree snail species were observed in NBG (Lindstrom and Benedict 2014).

Guam tree snails were sighted in August 2016 in the Anderson South area and again in November 2016. Confirmation that these sightings were Guam tree snails were provided by subject matter experts at the University of Guam (Megan Volsteadt and Dr. Curt Fiedler) (Gosnell, 2017, personal communication). Surveys in the same area by USDA Wildlife Services personnel reported three live snails in 2016, DON personnel returned to the locations where these snails were sighted and confirmed presence of 35 live snails (and 51 snail shells) in February 2017 (Olmsted, 2017, personal communication). A total of 38 live snails were documented in the Andersen South project location (**Figure 10**).

Below is a summary of Partulid snail detections on non-DoD properties within the action area (Lindstrom and Benedict 2014):

- Hagåtña Springs, Hagåtña River and Asan Beach Memorial Park were all visited to conduct targeted searches in July 2013. At Hagåtña Springs, 11 Guam tree snails were documented during a timed search, but many other individuals were observed subsequently in that location away from the area searched. At Hagåtña River, at least 17 Guam tree snails were documented. At Asan Beach Memorial Park, 119 Guam tree snails were documented during a one person-hour search, with many others observed in that general location outside of the timed search period.
- Pigo Cemetary, Namo River, and Sella Bay were visited in July 2013. Pigo Cemetery was found to have four Guam tree snails, Namo River had 10 Guam tree snails, and at Sella Bay, eight Guam tree snails were observed. Ritidian Point was the site of a targeted

search on July 17, 2013 and 20 Guam tree snails were documented (but many more observed).

- The Lost Pond area was visited on July 20, 2013, and 118 Guam tree snails were recorded.
- On July 23, 2013, at the Ylig River, 22 Guam tree snails were observed. At Fua Bay on July 25, 2013, 74 Guam tree snails were observed and on July 26, 2013, at Cetti Bay, 30 Guam tree snails were documented (Lindstrom and Benedict 2014). Fragile tree snails were recorded during the wet season at Pugua Point and Lost Pond (Hilaan) during targeted searches. It was thought that some snails from other locations were also fragile tree snails, DNA samples from these individuals indicated they were actually juvenile Guam tree snails. Tarague Basin was reported to have sightings of fragile tree snails; however, surveys by Lindstrom and Benedict observed only Guam tree snails. Since some Guam tree snails have very similar color patterns to fragile tree snails, particularly as juveniles (Hopper & Smith, 1992), the previous identifications may have resulted in juvenile Guam tree snails being misidentified as fragile tree snails. The humped tree snail is only found at one location, Haputo Beach (Lindstrom & Benedict 2014). As stated in the Status section, the humped tree snail is the least common of the three listed tree snail species on Guam.

**Environmental Baseline for the Orchids (Orchidacea): *Bulbophyllum guamense*, *Dendrobium guamense*, and *Tuberolabium guamense***

Orchids are known for their specialized niches and often, specific pollinators (Williams 1973). *Bulbophyllum guamense*, *D. guamense*, and *T. guamense* are not exceptions to the need for specialized conditions, which include certain requirements for humidity, air circulation, and sunlight. However, more research is needed to delineate the specific abiotic and biotic factors that are needed for each of these orchids, to understand what is required to maintain viable populations of each, and to determine the amount of habitat available for recovery throughout their ranges. The number of individuals of each listed orchid species presented below is based on botanical surveys. The majority of surveys were conducted or funded by the DON on DoD administered lands and results are not comprehensive island-wide, thus the number of plants within the action area is considered a conservative value.

As noted above in the General Baseline section, habitat loss, fragmentation and degradation associated with urban development, ungulates, invasive species, and typhoons continue to negatively impact forests on Guam. *Bulbophyllum guamense*, *D. guamense*, and *T. guamense* are also at risk from herbivory by nonnative invertebrates such as slugs.

Environmental Baseline for *Bulbophyllum guamense*

Approximately 148 individuals of *B. guamense* are present within the action area (**Figure 11**) (DON 2017a). Of this amount, 127 occur within the NMS. *Bulbophyllum guamense* forms mat-like formations made of many bulbs on branches. We define an individual here as the entire mat-like formation because of the difficulty in delineating within the formation. The action area supports 36 percent of the range-wide population.

Environmental Baseline for *Dendrobium guamense*

Approximately 264 individuals of *D. guamense* are present within the action area. The greatest concentration of *D. guamense* occurs within the NMS (**Figure 12**). Approximately 17 individuals of *D. guamense* are present in the area proposed for the Main Cantonment at Finegayan and 41 individuals are present in the proposed LFTRC area (DON 2017a). *Dendrobium guamense* grows in large clumps on branches. However, we use individual to represent each unique orchid clump. The action area supports 31 percent of the range-wide population.

Environmental Baseline for *Tuberolabium guamense*

*Tuberolabium guamense* is present in the areas that include the proposed Main Cantonment at Finegayan, LFTRC, the HMU at NWF, and the NMS. During survey efforts, a total of 12,607 *T. guamense* individuals or occurences were identified within the action area (DON 2017a). Of these plants, 6,924 *T. guamense* were identified in Finegayan, 3,078 on NWF, and 2,314 on the main portion of AAFB (**Figure 13**). For some occurrences, over 100 individual *T. guamense* were found on a single tree. *Tuberolabium guamense* has been observed growing as a solitary individual and as a large cluster. When possible the survey counts represent an individual plant.

Surveys found *T. guamense* to occur within secondary limestone forests (82 percent of occurrences) and primary limestone forest (17 percent of occurrences). *T. guamense* is found in small numbers within other vegetation community types, such as ravine forests, coconut plantation, herbaceous-scrub, and savanna vegetation types (these vegetation community types accounted for one percent of occurrences.

The highest densities of *T. guamense* are seen in secondary forests (14.8 plants per ac, or 36.56 plants per ha) and primary limestone forests (5.9 plants per ac, or 14.49 plants per ha). Across all vegetation community types where this species is found, *T. guamense* occurs in an approximate density of 10.2 *T. guamense* per ac (25.2 *T. guamense* per ha). The action area supports 98 percent of the range-wide population.

**Environmental Baseline for *Cycas micronesica***

*Cycas micronesica* relies on a healthy limestone forest and thus is affected by the same stressors within the action area threatening Guam's limestone forest habitat, described in the General Baseline section above. During surveys conducted on AAFB in 2012-2013, 12,770 living and 12,425 dead *C. micronesica* were tallied (Marler 2014, pp. 89). During 2014-2015, surveys were conducted at Ritidian Point and NWF, containing the proposed LFTRC footprint. *Cycas micronesica* was reported as occurring in high densities with few scale infestations (JRM 2014). JRM (2016) reported at least 3,561 mature *C. micronesica* are present within the proposed NWF Ungulate Control Area, and little scale infection was noted at Ritidian Point. Most cycads had dark leaves and many healthy fronds (JRM 2016, p. 6). Because of the high numbers documented throughout forest and edge areas of AAFB, it is highly likely that a large number of cycads, both infested and relatively healthy, are located within the proposed project footprint,

much of which is within AAFB. The proposed footprint for the Main Cantonment area in Finegayan is comprised of approximately 500 ac (202 ha) of similar limestone forest habitat (DON 2014, p. 96) which, based on numbers from nearby AAFB, likely contain high numbers of cycads. In addition, corridors for utilities and other development under this action are located throughout northern Guam with likely occurrences of *C. micronesica*. Updated surveys conducted in 2015 through 2017, reported a total of 19,852 *C. micronesica* plants (both mature and juvenile) within the action area (DON 2017a, p. 82). **Figure 14** shows all locations where *C. micronesica* were documented within the action area. The action area supports five percent of the range-wide population of *C. micronesica*.

Despite the relatively high numbers of *C. micronesica* within the action area, the health of *C. micronesica* subpopulations are poor and subpopulations are declining, due largely to invasive insect damage (Marler and Lawrence 2012, p. 240). Over a five-year survey period, Marler and Muniappan (2006) recorded 10 invasive insect species on Guam predating on *C. micronesica* plants, including four records of invasive insects new to Guam (**Table 8**).

The Cycad aulacaspis scale is among the most damaging threat to *C. micronesica* within the action area. This scale, native to Thailand and unintentionally introduced to Guam in 2003, attacks all age classes and major plant parts of *C. micronesica*. A six-year study that surveyed 687 *C. micronesica* plants in one area before and after Cycad aulacaspis scale infestation, found all *C. micronesica* seedlings were killed within 9 months and all juvenile *C. micronesica* plants were killed within 30 to 50 months after initial scale exposure (Marler and Lawrence 2012, p. 233). By the end of the study, Marler and Lawrence (2012) estimated a 92 percent mortality rate for *C. micronesica* once exposed to the Cycad aulacaspis scale (p. 233) and the loss of 75 percent of mature trees (p. 238), due to Cycad aulacaspis scale damage. Other invasive insects, such as the Cycad leaf miner and stem borer species (**Table 8**) compound effects of the Cycad aulacaspis scale, as the leaf miner further damages the naturally long-lived leaves of *C. micronesica* and the stem borers preferentially attack already stressed plants, contributing to their mortality (Marler and Lawrence 2012, p. 238).

A biological control agent, *Rhyzobius lophanthae* that naturally predates on the Cycad aulacaspis scale was introduced to Guam in 2004 with limited success. The *R. lophanthae* scale predator has extended the life of many mature *C. micronesica* plants, however the size differential between *R. lophanthae* and *A. yasumatsui* limits ongoing efficacy of biocontrol efforts, as the Cycad aulacaspis scale is able to find locations on *C. micronesica* plants that the predator cannot access (Marler and Lawrence 2012, p. 238). As a result of ongoing invasive insect damage, no new wild seedlings have been observed within the action area since 2008, and recruitment appears to be severely limited for the *C. micronesica* Guam subpopulation (Marler and Terry 2011, p. 778).

**Table 8.** Summary of invasive insect species on Guam and the type of damage caused to *C. micronesica* plants (Adapted from Marler and and Muniappan 2006, p. 3).

| Common name | Scientific name | Order | Family | Damage to leaf | Stem | Cone |
|---|---|---|---|---|---|---|
| Cycad leaf miner | *Erechthias* sp. * | Lepidoptera | Tineidae | X | | |
| Cycad aulacaspis scale | *Aulacaspis yasumatsui** | Hemiptera | Diaspididae | X | X | X |
| Armored scale | *Lepidosaphes* sp. near *rubrovittata* | Hemiptera | Diaspididae | X | | |
| Indian wax scale | *Ceroplastes ceriferus* | Hemiptera | Coccidae | X | | |
| Hemisperical scale | *Saissetia coffeae* | Hemiptera | Coccidae | X | | |
| Stem borer | *Dihammus marianarum* | Coleoptera | Cerambycidae | | X | X |
| Sap beetle | *Carpophilus mutilatus* | Coleoptera | Nitidulidae | | X | X |
| Stem borer | *Dasyses rugosella** | Lepidoptera | Tieneidae | | X | |
| Cycad male cone borer | *Anatrachyntis* sp.* | Lepidoptera | Cosmopterigidae | | | X |
| Oriental flower beetle | *Protaetia orientalis* | Coleoptera | Scarabaeidae | | | X |

*New records for Guam

### Environmental Baseline for *Heritiera longipetiolata*

*Heritiera longipetiolata* is found rooted in crevices in limestone slopes and plateaus within the action area (Costion and Lorence 2012, p. 79). Approximately 404 individuals of *H. longipetiolata* are present on Guam (DON 2017a, p. 110; GPEPP 2015). The 82 individuals in northern Guam represent over 20 percent of the known population on the island (**Figure 15**). The factors limiting the *H. longipetiolata* subpopulation within the action area include heavy predation on seeds by deer and the browsing of seedlings by deer and pigs (Wiles et al. 1995, p. 43). The action area supports 83 percent of the range-wide population of *H. longipetiolata*.

### Environmental Baseline for *Tabernaemontana rotensis*

*Tabernaemontana rotensis* on Guam was once thought to be extremely rare, but recent surveys have found thousands of individuals along forest margins and open patches. It should be noted that some of the clusters of *T. rotensis* included one adult plant and numerous seedlings. **Figure 16** shows the known locations for all *T. rotensis* within the action area. The factors limiting the *T. rotensis* subpopulation within the action area include lack of frugivores and natural seed dispersers, and browsing of seedlings by feral ungulates (UOG 2007). Approximately 22,413 *T. rotensis* plants occur within the action area (DON 2017a, p. 110; GPEPP 2015), which supports approximately 99 percent of the range-wide *T. rotensis* population.

### Previous Consultations in the Action Area

The following section 7 consultations have been conducted within the action area of this BO.

- In October 2006, the Service issued a non-jeopardy BO on the ISR-Strike Project on AAFB, Guam (ISR BO; USFWS 2006) and effects to the Mariana Crow and the Mariana fruit bat. The incidental take statement accompanying the ISR-Strike BO authorized the take of up to one Mariana fruit bat foraging territory in the form of harm as result of clearing and construction of the Aircraft Staging Area Facility. In addition, the take of two Mariana fruit bat colonies and 21 Mariana fruit bats on Guam and 36 Mariana fruit bats from Rota (or six premature migrations to Rota) in the form of harassment and death as a result of aircraft disturbance associated with overflights and subsequent illegal hunting impacts was authorized throughout the duration of the proposed action. The conclusion relied on provisions in the proposed action to monitor the status of Mariana fruit bats observed to ensure no additional take occurred due to construction activities, as well as minimizing, avoiding and/or offsetting the impacts of increased aircraft operations on the species. The measures would offset the impacts of incidental take and provide a net conservation benefit to the species as a whole.
- In September 2010, the Service issued a non-jeopardy BO on the Joint Guam Program Office (JGPO) Relocation of the USMC from Okinawa to Guam and Associated Activities on Guam and Tinian (JGPO BO; Service File #2010-F-0122) and effects to the Mariana fruit bat, Guam Micronesian kingfisher, Guam rail, Mariana common moorhen, Mariana crow, Mariana swiftlet, Micronesian megapode, Green sea turtle and Hawksbill sea turtle. The incidental take statement accompanying the JGPO BO authorized up to 10 of the remaining Mariana fruit bats at the Pati Point natural area colony to be taken in the form of harassment due to loud aircraft noise resulting from the proposed action. To minimize impacts of incidental take of the Mariana fruit bat, DON would minimize the level of incidental take occurring as a result of aircraft operations on Guam by developing measures to control BTS, restore or enhance Mariana fruit bat habitat, reduce ungulates, restore forest habitat, manage four ecological reserve areas, reduce poaching by adding conservation law enforcement officers and fund research to fill knowledge gaps of Mariana fruit bat demography, movements, and phylogeography. DON would also monitor and report the number of Mariana fruit bats occupying all known roost sites on AAFB from one year prior to and one year after the proposed overflight increases were fully implemented.
- In February 2015, the Service issued a non-jeopardy BO on the MITT Program (MITT BO; USFWS 2010) and effects to the Mariana fruit bat and Micronesian megapode. The MITT BO included an incidental take statement which authorized one fruit bat to be killed every five years on Farallon de Medinilla (FDM) as a result of bombing, gunnery and missile exercises conducted under the program. The non-jeopardy conclusion included measures to monitor the impacts of take of Mariana fruit bat caused by the MITT program.
- In July 2015, the Service issued a non-jeopardy BO on the DON's Relocation of the USMC from Okinawa to Guam and Associated Activities on Guam (2015 BO; USFWS 2015) and effects to the Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher, as well as designated critical habitat for these three species. The 2015 BO allowed up to 30 Mariana fruit bats at AAFB and Finegayan (the current population size at the time) to be repeatedly taken in the form of harassment leading to injury from loud aircraft noise, operation of the LFTRC, construction noise, and other human disturbance resulting from the proposed action. Mortality was not anticipated from the proposed action. The non-

jeopardy conclusion relied on the following conservation measures: postpone construction activities if a Mariana fruit bat was present within 492 ft (150 m) of the site, use hooded lighting, provide education materials and survey for maternity colonies. On February 14, 2016, the DON informed the Service that up to 112 Mariana fruit bats were found within the HMU on AAFB during surveys, and that based on this finding, the DON requested an increase in the amount of take authorized in the form of harassment. DON's request for an increase in Mariana fruit bat take is addressed in this BO.

The remaining 10 species addressed in this BO are newly listed and therefore no previous consultations have been conducted on those species.

## EFFECTS OF THE ACTION

### Exposure Analysis Approach

The Service has developed an analysis framework for section 7 consultations that incorporates the general structure, primary concepts, and nomenclature of the U.S. Environmental Protection Agency's ecological risk assessment framework (USFWS 2005c). Factors causing adverse effects are called "stressors" and beneficial effects are called "benefits." Under this approach, the Service determines the effects of the action on listed species and critical habitat by evaluating the location, timing, duration, frequency, and intensity of listed species or critical habitat exposure to each stressor and benefit, and the likely effects of such exposure on the reproduction, numbers, and distribution of the listed species and on the recovery support function of critical habitat. The only species addressed in this BO with designated critical habitat is the Mariana fruit bat. The analysis of effects on Mariana fruit bat critical habitat was conducted on the proposed Federal action in the 2015 BO (USFWS 2015a, pp. 103-104 and pp. 144-145). This analysis and the information used in the analysis remain unchanged and are therefore not included in this consultation.

The proposed action's stressors include and are limited to:

- Habitat modification due to vegetation clearing and grubbing;
- Topsoil excavation and loss of karst substrate;
- Cut and fill earthmoving;
- Water well boring/drilling;
- Trenching and grading;
- Stockpiling of green waste;
- Disturbance from lighting systems;
- Aircraft traffic, including DoD aircraft;
- Vehicle traffic, including both civilian and military;
- Military training, including all ground maneuvers, munitions and firearm use; and
- Aviation training, including low-level terrain flights and external load training.

The proposed action's benefits include and are limited to:

- Enhancement and protection of limestone forest habitat;
- Control and eradication of ungulates in the Forest Enhancment Sites and the LFTRC;
- Creation of BTS exclosures and suppression of the BTS within the exclosures; and

- Landscape scale invasive species planning and prevention.

For purposes of this analysis, the term of effects of the proposed action associated with the permanent destruction of listed species habitat caused by earthmoving and vegetation clearing activities and degradation of listed species habitat associated with the operation of the training areas are considered to be indefinite.

**General Effects of the Action**

Habitat Loss and Fragmentation (All Affected Listed Species)

The proposed action is likely to cause forest habitat loss and fragmentation as a result of vegetation clearing and earthmoving activities. Definitions and descriptions of habitat fragmentation are described above in the Environmental Baseline section. The further loss, degradation, and fragmentation of forest habitat, is likely to decrease the amount of suitable habitat for recovery of all terrestrial listed species on Guam. Habitat suitable for the survival and recovery of the Mariana fruit bat has been delineated on Guam (Amidon in litt., 2015). Because *C. micronesica* has been considered one of the dominant trees within the forests on Guam and occurs within all Mariana fruit bat foraging habitat, we used the number of Mariana fruit bat habitat acres affected by the proposed action to estimate the amount of habitat loss for *C. micronesica*. Based on known species ranges and survey reports, the remaining nine species (the Mariana eight spot butterfly, Guam tree snail, fragile tree snail, humped tree snail, *B. guamense*, *D. guamense*, *T. guamense*, *H. longipetiolata*, and *T. rotensis*) co-occur or prefer similar habitat conditions, such as primary and secondary limestone forests; therefore the loss of those habitat types are used to represent the loss of habitat for the nine species affected by the proposed action. Habitat is defined as both occupied and unoccupied suitable habitat. The amount of habitat relied upon by the 11 listed species, which will be lost as a result of the proposed action is shown in **Table 9**.

**Table 9.** Anticipated loss of habitat relied upon by the affected listed species, resulting from implementation of the proposed action.

| **Project** | **Habitat Cleared** acres (hectares) | |
|---|---|---|
| | Mariana fruit bat & *C. micronesica* | Mariana eight spot butterfly, Guam tree snail, fragile tree snail, humped tree snail, *B. guamense*, *D. guamense*, *T. guamense*, *H. longipetiolata*, and *T. rotensis* |
| Finegayan, Main Cantonment | 449 ac (182 ha) | 683 ac (276 ha) |
| AAFB Main, Family Housing | 180 ac (73 ha) | 12 ac (5 ha) |
| LFTRC | 168 ac (68 ha) | 79 ac (32 ha) |
| AAFB South | 2 ac (1 ha) | 212 ac (86 ha) |
| Naval Base Guam | 5 ac (2 ha) | 86 ac (35 ha) |
| Water Wells and Sanitary Sewer Systems | 77 ac (31 ha) | 51 ac (21 ha) |
| Utilities & Site | 38 ac (15 ha) | 30 ac (12 ha) |

| | | |
|---|---|---|
| Improvements | | |
| TOTAL | 919 ac (372 ha) | 1,153 ac (467 ha) |

The largest effects on listed species habitat in terms of habitat fragmentation will be on AAFB near Ritidian Point from construction of the LFTRC. This area currently contains a large expanse (over 350 ac {142 ha}) of high-quality primary limestone forest that serves as occupied habitat for the Mariana fruit bat, Mariana eight spot butterfly, *B. guamense*, *D. guamense, Tuberolabium guamense*, *C. micronesica*, *H. longipetiolata*, and *T. rotensis*, and unoccupied habitat for the Guam tree snail, fragile tree snail, and humped tree snail (DON 2017a, p. 44). This primary limestone forest is also contiguous with GNWR, providing an even larger forested area serving as habitat for the above eleven listed species. In total, approximately 78 ac (32 ha) of primary limestone forest and 109 ac (44 ha) of secondary limestone forest would be permanently cleared for construction of the LFTRC.

In addition to LFTRC clearing activities, the proposed action will create a Surface Danger Zone (SDZ) over approximately 68 percent of the GNWR at Ritidian Point during operation of the LFTRC. The SDZ will cover the GNWR access road, visitor center, offices, and other facilities and thereby limit access to the GNWR while firing occurs at the LFTRC. Any entry into GNWR will require scheduling with and approval by LFTRC Range Control personnel. The limited access that GNWR staff will have to the refuge property during the estimated 39 weeks per year the LFTRC is active will limit the amount of habitat management that can occur at the GNWR. This could have an adverse effect on listed species by: 1) limiting maintenance of the predator exclusion fence at the GNWR, 2) limiting maintenance of native out-plantings, 3) limiting invasive plant control, and 4) limiting effective ungulate control. Per Section 2822 (Establishment of surface danger zone, Ritidian Unit, GNWR) in the 2015 National Defense Authorization Act, the Service and the DON may enter into an agreement to establish and operate a SDZ over the GNWR. The agreement may include relocation and reconstruction of GNWR facilities, mitigation for impacts to wildlife species, and use of DoD personnel to complete GNWR conservation actions; however, this agreement is not yet in place. Therefore, in this analysis we assume that the operation of the LFTRC will have an adverse effect on listed species by preventing the management, research, and monitoring that would have otherwise occurred at GNWR.

In summary, a total of 1,219 ac (493 ha) of limestone forest habitat will be cleared and permanently lost as a result of the proposed action. The loss of Guam's limestone forests and habitat for listed species furthers the long-term trajectory of loss of native forested habitat on Guam, and without the full implementation of conservation measures, may affect recovery of listed species on Guam. Given the small amount of habitat left on Guam, off-setting measures are provided to restore or protect the remaining limestone forest and listed species habitats. Such measures are important in terms of the conservation needs of affected listed species and the recovery support function of affected critical habitat. The effects of habitat loss are further discussed in the species-specific sections below.

Edge Effects (All Affected Listed Species)

Based on the approximately 187 ac (76 ha) of listed species habitat (primary and secondary limestone forest) that will be cleared for the LFTRC, approximately 6.2 mi (10 km) of new edge will be created. As discussed in the Environmental Baseline section above, edge effects can cause adverse effects to wildlife populations and ecological processes (Murcia 1995, p. 58; Laurance 2000, p. 134) not adapted to habitat edge conditions. Abiotic edge effects may include changes in microclimate, soil conditions, and wind. Biotic edge effects include increased predation, competition, disease, and parasitism (Ewers and Didham, 2006; Harper, et al., 2005). Microclimate effects include changes in light, temperature, and relative humidity (Kapos 1989; Kapos et al. 1993; Carmago and Kapos 1995). Soil changes due to edge effects may include changes in temperature, moisture, and nutrient cycling (Kapos 1989; Carmago and Kapos 1995; Grilli et al. 2011). Edge effects also tend to increase in severity with larger areas of disturbance. For example, large clearings, such as those proposed for the LFTRC and Main Cantonment provide a larger area to accumulate heat from the sun or a longer fetch in which wind speed can accelerate (Laurance et al. 2002; Laurance and Curran 2008; Laurance et al. 2011).

Edge effect responses by listed plant species may include mortality, reduced seedling recruitment, and reduced or stunted growth rates (Harper et al. 2005). The Mariana fruit bat and Mariana eight spot butterfly are also vulnerable to edge effect due to the alteration of available foraging and breeding habitat.

Fire Effects (All Affected Listed Species)

The proposed action may result in wildfires burning listed species habitat. Fires could start from live-fire training (including use of tracers), bivouacking with campfires, arson, barbeques, debris burning, cigarette smoking, aircraft mishaps, and vehicular malfunctions. Between 1991 and 2002, an average of 28 fires per year burned on DON lands on Guam (DON 2013e, p. 4-8), with 429 ac (174 ha) burned on average per year. Most of the area burned was savanna grasslands (DON 2013e, p. 4-8). This is approximately double the average annual number of fires on DON lands from 1979 to 1989, though the burned acreage on DON lands was similar (425 ac per year or 172 ha per year). Arson and debris burning account for approximately 70 percent of fires, and 87 percent of area burned, on DON lands from 1979 to 2002. Smoking (eight percent), unknown (three percent), and miscellaneous causes (including children, campfires, and equipment) account for approximately four percent of fires on DON lands on Guam (Nelson 2009, Ch. 3 p. 4).

Fires can lead to a variety of direct and indirect affects to wildlife and their habitats. Fire can burn habitat resulting in habitat loss, fragmentation, and degradation, and loss of foraging and breeding habitat. Fires could expose Mariana fruit bats to smoke, resulting in respiratory distress or abandonment of habitat.

*Range Fire Management Plan*

To minimize adverse effects to listed species resulting from fires, the DON proposes to develop and implement a Range Fire Management Plan (RFMP) for the LFTRC. The RFMP will be prepared, among other purposes, to minimize fire threat to surrounding habitat and listed species, specifically *B. guamense, D. guamense, T. guamense, C. micronesica, H. longipetiolata, T.*

*rotensis*, and habitat and host plant species for the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, and the fragile tree snail. The RFMP will be developed and implemented to ensure that any fire sparked during training will not spread beyond the firing range and into forested habitat. Because the LFTRC is surrounded by listed species habitats, the development and implementation of the RFMP will be critical to insure that the listed species and their habitat near firing ranges are not lost due to training activities.

Because a comprehensive RFMP will be reviewed by the Service and conservation measures implemented, as described above, we anticipate that no additional habitat will be lost due to wildfires igniting as a result of the proposed action. Although the DON's comprehensive RFMP may also minimize fire impacts on non-DoD lands on Guam by instituting fire prevention, detection, and suppression programs as well as implementing landscape-level fuel modifications in the NMS, the beneficial effects of this DON action to threatened and endangered species are difficult to assess because the RFMP has not been completed at this time.

Invasive Species (All Affected Listed Species)

Implementation of the proposed project is likely to increase the risk of introducing or spreading non-native terrestrial and aquatic invasive species including plants, animals, and microbes. Pathways associated with anthropogenic activities have a relative risk of introducing and dispersing non-native or invasive species. Hulme et al. (2008) described three broad mechanisms for non-native species introductions: importation as a commodity (e.g., purposeful importation as biocontrol, pet trade), arrival via transport vector, and natural dispersal. Of these mechanisms, Hulme et al. (2008) further described a framework for introductions that is supported by six principal pathways, of which two could potentially occur via the implementation of the DON's proposed action: contaminantion of a specific commodity and stowaway (independent of a commodity, like ballast water or airfreight). The pathways of contaminants and stowaways include, but are not limited to species transported via: construction equipment, personal protective equipment, and delivery of supplies, materials, goods, foot traffic, vehicles or vessel traffic. Invasive species introduced as contaminants and stowaways could occur as a result of inadequate sanitation and inspection during and prior to the movement of equipment, supplies, personnel, or vehicles. The repeated or routine movement of equipment and people increases the risk of introduction and establishment of a non-native and/or invasive species.

It is important to understand that the "risk" of introduction and establishment of invasive species is highly variable across taxa and habitats. Identifying and analyzing risk for all the species that could be moved via DON-related activities is not practicable. Instead, a more efficient approach is to identify pathways where numerous species from different taxa may be inadvertently introduced and implement prescriptive measures to control risks from those pathways. A pathway risk assessment will provide a structure for assessing where the greatest "risk" for a non-native species introduction occurs and locations where managing ingress or egress of these species is most efficient for control. Pathways must be controlled because repetition of an action has a direct effect on propagule pressure which as stated above increases the likelihood of a species to become established.

To address pathways and encourage a more holistic approach to managing invasive species, the DON funded the development of the Regional Biosecurity Plan (RBP) for Micronesia and Hawaii (formerly referred to as the Micronesia Biosecurity Plan). Individual activities for various species will continue, but the DON and others agree it is more efficient to manage pathways and prescribe corrective measures for a suite of species that will be monitored at discrete control points over time. The RBP will provide stakeholders in Micronesia and Hawaii with a platform for coordination and integration of inter-agency invasive species management efforts such as control, interdiction, eradication, and research. Several of the recommendations of the RBP are incorporated into the proposed action and are detailed in the Conservation Measures section. For example, to control points along potential invasive species pathways, the DON's HACCP program has been established for construction which includes control measures as well as baseline and follow on surveys to evaluate the effectiveness of the program (e.g., inspection of all DON related equipment or materials entering or leaving the action area, implementation of vehicle wash down procedures).

The DON is also committed to a comprehensive BTS interdiction program, also detailed in the Conservation Measures section, to ensure that military activities, including the transport of civilian and military personnel and equipment to and from Guam, do not contribute to the spread of the BTS (DON 2014a, p. 38). Brown tree snake interdiction requirements (e.g., trapping and inspections at ports, cargo facilities; and aircraft inspections of household goods, and biosecurity plans for training events) are specified in DoD instructions (i.e., 36 Wing Instruction 32-7004, BTS Control Plan and COMNAVMAR Instruction 5090.10A, BTS Control and Interdiction Plan) as well as the annual Work Financial Plan that is developed in cooperation with USDA Wildlife Services (DON 2014a, pp. 38-39).

In addition, the DON will fund any increase of current federally funded BTS interdiction measures (in Guam, CNMI, and Hawaii) where the need for the increase is to address direct or indirect effects related to the proposed action. The fiscal year (FY) 2010 level of funding for the Federal interagency BTS interdiction effort on Guam, CNMI, and Hawaii and 2010 transportation levels associated with outbound cargo from Guam to the U.S. or U.S. territories will be used as the baseline. The Service agrees that it is not DON's responsibility to fund increased interdiction measures that are identified more than one year after the end of the fiscal year in which the USMC relocation construction activities have ended and permanent non-transient USMC military units have completed their relocation to Guam. However, the Service understands the DON will continue to provide a baseline level of interdiction funding related to the direct, indirect, and induced-growth effects of its proposed action beyond one year.

Because of the DON's commitment to the RBP and BTS interdiction and with full implementation of the biosecurity measures described above, we anticipate that the proposed action will reduce the introduction and spread of invasive species both within the action area and beyond the borders of Guam.

**Beneficial Effects of the Proposed Action (All Affected Listed Species)**

In addition to the above measures that will minimize the risk of fire and spread of invasive species, the proposed action also includes other measures which will provide beneficial effects to all affected listed species.

- Enhancement and protection of two Forest Enhancement Sites in Finegayan totaling 1,108 ac (448 ha) of limestone forest habitat. In 2016, the DON conducted a vegetation survey (MCAG 2016) to determine the vegetation composition baseline prior to the commencement of forest enhancement activities (**Figure 17**). A majority of the current vegetation in the Forest Enhancement Sites consists of non-native *Vitex parviflora* (476 ac, 192.6 ha) or is comprised of grassland and disturbed limestone forest gaps (354 ac, 143.3 ha) (**Table 10**).
- Enhancement and protection of approximately 218 ac (88.2 ha), 66.7 ac (27.0 ha), and 97.1 ac (39.3 ha) of primary limestone forest, secondary limestone forest, and herbaceous scrub, respectively, by constructing an ungulate fence, creating an Ungulate Control Area in the Northwest Field, and eradicating ungulates within this area surrounding the LFTRC.
- Fencing of the Haputo Ecological Reserve Area (ERA) and providing signage and educational materials along the access trail to minimize human disturbance in the area and assist in maintaining the characteristics and integrity of the ERA. The fencing will prevent overuse by military and civilian personnel and potential damage to terrestrial biological resources.

**Table 90.** Vegetation-type totals within the North Finegayan Forest Enhancement Site and the South Unit BTS Exclusion Fence (MCAG 2016). General field classifications were used and overlap may exist.

| | Total | |
|---|---|---|
| **Dominant Vegetation** | **Acres** | **Hectares** |
| Vitex, Gaps, Disturbed Limestone Forest | 314 | 127.1 |
| Disturbed Limestone Forest, Gaps | 197 | 79.7 |
| Barren, Grassland, Shrub | 87 | 35.2 |
| Vitex, Gaps | 76 | 30.7 |
| Vitex | 48 | 19.4 |
| Gaps, Disturbed Limestone Forest, Vitex-minimal | 36 | 14.6 |
| Disturbed Limestone Forest, Vitex, Cocos | 27 | 10.9 |
| Vitex, Disturbed Limestone Forest | 19 | 7.7 |
| Vitex, Gaps, Cocos | 12 | 4.9 |
| Cocos, Vitex | 7 | 2.8 |
| Disturbed Limestone Forest | 7 | 2.8 |
| Total Area Surveyed | 830 | 335.8 |

Conservation measures with specific effects are described in species specific sections below.

### Direct and Indirect Effects of the Action on the Mariana Fruit Bat

In addition to the general and beneficial effects of the action discussed above, a species-specific effects analysis for the Mariana fruit bat is provided below.

The Service's draft recovery criteria for the Mariana fruit bat proposes that recovery of the Mariana fruit bat will require subpopulations on each island where they are currently extant, and those subpopulations must be of sufficient size to avoid genetic and demographic risks associated with small populations (USFWS 2009a, p. 9). The Mariana fruit bat subpopulation within the action area fluctuates due to periodic movements between Rota and Guam. For example, in February 2016, 112 Mariana fruit bats were documented within the AAFB HMU area on Guam. This connectivity between Rota and Guam is important to allow access to available food resources and ensure genetic flow between islands. Resilience of the Mariana fruit bat population on Guam is expected to be low given the critically small starting population, the species' slow reproductive rate (USFWS 2009a, p. 17 and references therein), infrequent and unpredictable immigration from other islands (DON 2013d, p. 78), and abundant, widespread, and uncontrolled threats (USFWS 2009a, p. 19-33 and references therein). Based on our estimate of 27,096 ac (10,965 ha) of existing survival and recovery habitat for the Mariana fruit bat (Amidon in litt., 2015), the estimated carrying capacity for Mariana fruit bats on Guam is 19,847 bats (DON 2013d, p. 26, 45).

Given the small population of Mariana fruit bats remaining on Guam, recovery will likely depend on immigration or translocation of Mariana fruit bats from Rota (Esselstyn et al. 2006, p. 531) and long-term conservation and maintenance of Mariana fruit bat habitat on Guam. The Mariana fruit bat has high energetic demands associated with flight and year-round breeding, and as such depends on a steady and ample supply of fruiting and flowering plants that are distributed patchily through space and time (Wiles and Fujita 1992, pp. 26-31; USFWS 2009d, p. vi; Amitai et al. 2010, p. 2693; Downs et al. 2012, p. 344). To meet requirements for breeding, feeding, and sheltering, a self-sustaining population of Mariana fruit bats will rely on threat-managed, native limestone forest habitat containing diverse food resources that are available throughout the year.

Noise Effects

The proposed action will generate noise from the use of a variety of vehicles and machinery (construction and engineering equipment, fixed-wing aircraft, helicopters, and other convoy vehicles) and munitions (small arm firing and projectile detonations). Noise resulting from weapons training and construction on Guam will affect areas occupied by the Mariana fruit bat and reduce the quality of Mariana fruit bat habitat within disturbance range of the noise. Increased jet and helicopter aircraft traffic throughout Guam and especially at AAFB will regularly expose the Mariana fruit bat to high levels of noise.

Upon operation of the LFTRC, live-fire operations would occur between 7:00 am and 7:00 pm for up to 39 weeks per year, plus night operations (two nights per week over 39 weeks per year) would occur between 7:00 pm to 10:00 pm or 6:00 am to 7:00 am. The noise disturbance from the training will be impulse noise with very intense sounds of short duration (e.g., the discharge of a weapon). Firing noise from single shots merged in bursts, machine gun burst, and concurrent firing of multiple weapons would result in short periods of intense firing followed by periods of silence. Live-fire operations may occur for hours at a time, for five days a week, or not occur for multiple weeks in a row.

Peak noise level measures sound from a single event (e.g., grenade detonation or firing of a small arms weapon) received at a defined location, and is often referred to as sound pressure level (SPL). The average daily noise level (ADNL) sound metric accounts for not only the maximum SPL, but also the duration and temporal variation of the sound exposure (US Army 2008, p. 3-61). The DON provided the Service with estimated ADNL noise levels for all activities of the proposed action, including operation of the LFTRC, aircraft overflights within the action area, and operation of the hand-grenade training range at AAFB South **(Figure 18)**. The DON conducted a noise study at AAFB at three sampling sites near the LFTRC and found that ambient noise was never below 50 dB, and on some days was above 65 dB almost 100 percent of the time (DON 2014a, p. 66). The DON provided ADNL levels for areas surrounding the LFTRC (DON 2014a, p. 68). In the areas closest to the training ranges in operation the estimated ADNL would increase approximately 20 to 25 dB over baseline conditions, with average daily sound levels rising above 85 dB.

Hall and Richards (2000, p. 38) reported that flying foxes had peak sensitivity at 11 kHz but could hear between 2-40 kHz. Given the sensitivity of Mariana fruit bats to noise and human disturbance on Guam, and because of the reaction of Mariana fruit bats to hunting disturbance (i.e. gunshots), we anticipate that Mariana fruit bats will avoid the LFTRC and surrounding areas while it is in operation. For this reason, we have conservatively chosen a 65 dB threshold for noise disturbance of Mariana fruit bats that would preclude them from using habitat for breeding, foraging, or sheltering. The 65 dB threshold is based on the high-end of current ambient noise levels; we can reasonably expect that all habitats with noise louder than 65 dB would be avoided by Mariana fruit bats given the level and type of noise (i.e., gunshots). Therefore based on GIS mapping of areas where noise levels above 65 dB are expected to occur, we anticipate that approximately 1,817 ac (735 ha) of Mariana fruit bat habitat will be lost or degraded in northern Guam (AAFB and LFTRC) due to noise effects from military training and aircraft flights (**Figure 19**).

The proposed construction of the Main Cantonment at Finegayan will increase human presence and noise in the area. The cantonment is near the Haputo ERA, which contains high-quality Mariana fruit bat habitat, where fruit bats have been observed in the past. Increased use of the Haputo ERA by humans could deter Mariana fruit bats from using these areas for foraging or roosting.

Training will also occur at the NMS in southern Guam, where Mariana fruit bats are routinely observed. Training will include air-ground operations on five to seven consecutive days, 12 weeks per year, day and night, for a total annual throughput at the NMS of 1,440 Marines. Training at the NMS will also include terrain flight, ground threat reaction, defensive maneuvering, confined area landing, and external load training. These training activities will result in an increase in temporary noise and other human disturbance at the NMS. Solitary Mariana fruit bats flushed as a result of project noise may travel to another area where the likelihood of poaching or harassment is greater overall than it is on DoD lands. Flight restrictions will limit low-level flights over much of the NMS and this will minimize, but not completely avoid, adverse noise impacts to the Mariana fruit bat in this area. Therefore, we anticipate that approximately 319 ac (129 ha) of Mariana fruit bat habitat will be degraded in Southern Guam due to noise effects from military aircraft training flights (**Figure 20**).

Species Response

Stress reactions caused by human disturbance can have an adverse effect on Mariana fruit bats by increasing energetic demands, disrupting hormonal balance, and forcing relocation to lower quality habitat (Klose et al. 2006, p. 347, and references therein; CNMI 2010, p. 7). All of these factors can lead to reduced time foraging, sheltering, or breeding and adversely affect survival. When a disturbance is experienced by a Mariana fruit bat colony, individuals may disperse on their own or in smaller groups (CNMI 2010, p.6). In some cases, the degree of colony dispersal (i.e., how many individuals leave the main colony) may be related to the degree and/or type of human disturbance. When Mariana fruit bats are forced to disperse from colonies as a result of human disturbance, infant mortality may increase because dependent, non-volant pups that are too big for the mother to carry are likely abandoned. Forced dispersal may also negatively affect the reproductive potential of the population because access to mates is compromised (CNMI 2010, p. 7). Even without dispersal, high levels of stress from any disturbance can disrupt reproductive cycles and/or lead to miscarriage (Wingfield et al. 1998, p. 192-193, Heideman 2000, pp. 169-199, Klose et al. 2006, p. 347).

The following reactions to aircraft noise have been reported:

- Mariana fruit bats have been reported to flush at noise levels exceeding 106 dBC (SWCA 2008, pp. 2-3) and at peak noise levels above 90 dBA/101 dBc (SWCA 2012, p. 23, 37).
- Mariana fruit bats at a maternity colony on Rota flushed when a helicopter was within 656 ft (200 m) and a military jet aircraft (type unknown) flew overhead within 984 ft (300 m) (J. Boland, pers. obs., 2009 and 2010).
- Successive launches of F-14 aircraft repeatedly flushed 50 Mariana fruit bats from a roost site and F-14s (95 dBA to 106 dBA) also caused agitated Mariana fruit bat vocalization and flushing (Grout 1993 in Morton 1996, p. 67).
- Increases in active thermoregulation (32 percent), maintenance (14 percent), locomotion (74 percent), and alertness (62 percent) of Mariana fruit bats were recorded after aircraft overflights (SWCA 2012, p. 23, 37).

Mariana fruit bats in the vicinity of construction could be disturbed or harassed by noise and human presence. In order to avoid disturbance to Mariana fruit bats in the vicinity of construction, the DON will conduct surveys for Mariana fruit bats one week prior to onset of construction in areas within or in the vicinity of Mariana fruit bat habitat. If a Mariana fruit bat is present within 492 ft (150 m) of the project site, the work will be postponed until the bat has left the area (DON 2014a, p. 33). The DON clarified that this conservation measure does not mean that work will halt if a Mariana fruit bat enters the vicinity of a construction site while construction is on-going (C. Cobb, DON, 2015, pers. comm.). In general, Mariana fruit bats are likely to avoid construction sites due to human presence and noise disturbance, and seek other locations to roost and forage. If a fruit bat is present near a construction site and not seen (for example, roosting below a cliff line) then it will likely be harassed or harmed by the proposed action.

Noise from construction of the proposed action would be temporary and intermittent. Construction noise reaching fruit bat habitat may rise above the disturbance threshold for the

Mariana fruit bat; however, this noise will be short-term in duration and will not lead to a permanent reduction in the capability of the habitat to serve as suitable habitat for Mariana fruit bats.

Most Mariana fruit bats will depart from roost sites to foraging areas from one hour before to one hour after sunset (J. Boland unpublished data, 2008-2011). Therefore the range will be operational when bats can be expected to be commuting to foraging areas. We expect that any Mariana fruit bats that are able to hear the LFTRC in operation will avoid the area and seek out a less disturbed area. While bats are capable of flying outside the disturbance zone, bats seeking alternate commuting corridors and/or foraging areas may be forced into lower quality habitat or exposed to increased risks of poaching and harassment. In addition, bats in the vicinity of the LFTRC when firing begins will likely flush and leave the area. As mentioned above, if reproductive females are exposed to stressors that cause flushing and dispersal, it can disrupt reproductive cycles, cause miscarriage, or cause abandonment of non-volant young (Wingfield et al. 1998, p. 192-193, Heideman 2000, pp. 169-199, Klose et al. 2006, p. 347).

A colony of bats may periodically roost within the HMU on AAFB. These bats forage within AAFB and are likely to be further harassed from the increase in aircraft overflights associated with the proposed action.

Mariana fruit bats are suspected to migrate from Rota to Guam periodically following typhoons, and the migrants are suspected to return to Rota when the effects of the storm have subsided (Wiles and Glass 1990, p. 3; Esselstyn et al. 2006, p. 536). Migrants from Rota are thought to have occupied the Pati Point roost site on Guam in the past (Esselstyn et al. 2006, pp. 535-536; Wiles and Glass 1990, p. 2-3). We suspect that if Rota migrants are subjected to high levels of noise disturbance from increased air traffic at AAFB, it may cause them to return to Rota prematurely. A premature return to Rota under post-typhoon conditions may expose Mariana fruit bats to high levels of hunting and decreased food and habitat availability.

It is also possible that the increased noise near Pati Point, and on AAFB in general, will limit the establishment and growth of the Mariana fruit bat colony in northern Guam. If the Mariana fruit bat population on Guam were to increase, individuals and colonies are not likely to establish roost sites in areas with high levels of human foot, vehicular, or aircraft traffic, due to hunting-induced sensitivities to human-presence (i.e., humans are predators), and sensitivity to loud noise and vibration from aircraft (see data presented above and in the Species Status section).

Habitat Conservation and Protection

The DON's protection and management of 5,234 ac (2,118 ha) of Guam Micronesian kingfisher habitat in northern Guam, in accordance with the GMK MOA (**Figure 21**), will have a beneficial effect on the survival and recovery of the Mariana fruit bat on Guam because these two species use similar habitat.

As part of the proposed action, the DON proposes to create two Forest Enhancement Sites at Finegayan, in low-quality secondary limestone forest, to benefit listed species, including the Mariana fruit bat. The DON has proposed the enhancement of the sites to include installation of

ungulate exclusion fences protecting a minimum of 1,000 ac (405 ha) and the creation of two BTS-free enclosures totaling 460 ac (186 ha), according to the schedule described in the Conservation Measures section, with the goal of ungulate eradication within the fenced areas; invasive plant removal; and the propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats. Although this site would not fully compensate for the loss of primary limestone forest in northern Guam, the enhancement of forest and protection of the site is expected to provide benefits to the Mariana fruit bat.

Summary

The proposed action is likely to adversely affect the Mariana fruit bat on Guam. Noise from, aircraft, operation of the LFTRC, and other military training activities will harm and harass Mariana fruit bats in the vicinity of the project activities. In total, 2,136 ac (864 ha) of Mariana fruit bat habitat will be lost, or degraded at least 75 percent of the time, due to noise effects of the proposed action (**Figure 13 & 14**). This loss or degradation of Mariana fruit bat habitat represents 8 percent of the existing Mariana fruit bat habitat on Guam.

While the maximum number of Mariana fruit bats seen at one time within the action area was estimated at 112 individuals, the number of Mariana fruit bats in Guam is unknown, but is believed to flunctuate as a result of migrations between Guam and Rota. The Guam population of Mariana fruit bats may forage throughout the action area in search of food resources and suitable roosting sites. Mariana fruit bats will avoid or be flushed from habitat areas with excessive noise above the ambient level, such as weapon fire or aircraft flights, as evidenced by documented observations. This disturbance, combined with existing threats to the Mariana fruit bats in the action area (as described in the Environmental Baseline), will make reestablishment of a Mariana fruit bat colony at Pati Point in northern Guam, unlikely. Increased human disturbance in northern Guam and in the NMS area may alter Mariana fruit bat behavior, increase stress reactions, or preclude use of high-quality foraging areas. Based on the increased disturbance throughout AAFB, where Mariana fruit bats have been historically detected, it is likely that individual bats may be harassed by the proposed action. Mortality to Mariana fruit bats as a result of the proposed action is unlikely. As part of the proposed action, the DON protect and management of 5,234 ac (2,118 ha) of Mariana fruit bat habitat in northern Guam, including 3,271 ac (1,324 ha) of occupied or suitable Mariana fruit bat habitat away from noise effects (**Figure 13**).

The areas of Mariana fruit bat habitat that will be permanently cleared are areas which, in the absence of the project and in the foreseeable future, would have remained intact to provide habitat for the species. Although this loss will not preclude the survival or recovery of the Mariana fruit bat, it will reduce the total number of bats the island can support. The proposed action will reduce the current estimate for the carrying capacity of Mariana fruit bats on Guam (see Environmental Baseline above) by approximately 1,559 bats.

**Effects to Mariana Fruit Bat Critical Habitat**

The proposed action may affect Mariana fruit bat critical habitat and its primary constituent elements (USFWS 2004). Although the current population of Mariana fruit bats on Guam is

small, the foraging behavior and diverse diet of the fruit bats cause them to use most of the island for foraging, as documented by Wiles et al. (1995). Thus, all of the designated critical habitat for this species is used for foraging and/or roosting and is considered occupied. Recent sightings of Mariana fruit bats at the GNWR within the critical habitat unit confirm this. Actions that affect the ability of the critical habitat unit to provide the conservation function for which it was designated (serving as habitat for roosting and foraging bats) may adversely affect critical habitat, regardless of whether the habitat features are actually physically altered.

The proposed project will not clear any designated critical habitat for the Mariana fruit bat. However, the proposed action will create disturbance that may affect the PCE (described above) requiring remote locations on clifflines with limited exposure to human disturbance. As described below, this primary constituent element will be adversely affected by the proposed action.

Construction

Construction of the MPMG range will take place over approximately three years beginning in 2021. Construction equipment will include standard heavy equipment including bulldozers, graders, haulers, large trucks. No blasting or use of dynamite will occur as part of the proposed project. The use of heavy equipment can reach noise levels of 96 dB (USFWS 2006a, p. 15). Noise levels within critical habitat, at the base of the cliff below the MPMG firing range, are anticipated to be 5 to 15 dB less than that above the cliff line (personal communication, M. Downing, Blue Ridge Research and Consulting, February 2014 in DON 2014b, p. 5-230). Therefore, we anticipate that noise from construction of the LFTRC would range between 81-91 dB within the critical habitat unit (without accounting for noise attenuation due to vegetation, humidity or other factors). Ambient noise within the critical habitat unit will depend on wind and surf conditions, and distance from the ocean. Based on ambient noise studies conducted above the cliff line at AAFB (DON 2014a, p. 66), we expect that ambient noise within the critical habitat unit is at least 60 to 65 dB. Therefore, noise from the construction of the MPMG firing range on AAFB may reach between 16 to 26 dB above ambient conditions in the critical habitat unit.

Noise from construction will not be heard within the entire critical habitat unit. While it is difficult to estimate what portions of the critical habitat unit will be affected, we assume that the noise above ambient levels would be heard in the portions of critical habitat immediately below the MPMG cliff line. In a conservative scenario, construction noise may be heard in a 100 ac (41 ha) portion of the 376 ac (152 ha) critical habitat unit (or 27 percent of the critical habitat unit). Noise from construction of the MPMG would be temporary and intermittent. Noise reaching the critical habitat unit would likely only come from construction activities at the MPMG range, which might occur for a few years of the total construction time.

Construction noise within the critical habitat (81-91 dB) will rise above the disturbance threshold for Mariana fruit bats (described in the Effects of the Action – Mariana Fruit Bat section). This noise will be short-term in duration and will not lead to a permanent reduction in the capability of the critical habitat unit to support recovery of the Mariana fruit bat. However, during construction, the critical habitat unit will not serve as a remote location with limited exposure to

human disturbance and this will limit the fruit bat's use of the clifflines for roosting or reproductive activity. Construction noise at this time, and for a period of time after while fruit bats still avoid the area, may have an adverse effect on the critical habitat unit serving as a remote location.

Operation of the LFTRC and aircraft overflights

Noise disturbance from the LFTRC and aircraft overflights could expose the critical habitat unit to increased human disturbance and preclude Mariana fruit bat roosting and reproductive activity. Based on the noise data shown in **Figure 17**, approximately two acres of fruit bat critical habitat, along a cliffline, will be exposed to noise levels above 65 dB. This includes approximately 150 linear meters (492 linear ft) of cliffline. There are approximately 2,500 m (6,652 feet) of cliffline within the critical habitat unit. Therefore, the amount of cliffline critical habitat precluded from use by the Mariana fruit bat is small.

In addition, based on the map of noise contours for aircraft at AAFB from the 2010 DON EIS (DON 2010b, Vol. 2, p. 6-25), we do not expect aircraft noise over the critical habitat unit to rise above ambient conditions.

**Direct and Indirect Effects of the Action on the Mariana Eight Spot Butterfly**

In addition to the general effects of the action discussed above, a species-specific effects analysis for the Mariana eight spot butterfly is provided below.

NOTE: In light of limited available empirical information on the biology and ecology of the Mariana eight spot butterfly, in the following analysis we have relied on information for other well-studied butterfly species in the same family (Nymphalidae). The Mariana eight spot butterfly appears to exhibit much of the same behavior, life history, and patchy distribution as other well-studied species in the family Nymphalidae. The Nymphalidae are the largest family of butterflies with about 6,000 species distributed throughout most of the world. These are usually medium-sized to large butterflies. Most species have a reduced pair of forelegs and many hold their colorful wings flat when resting. Many butterflies in this family exhibit a similar patchy distributional pattern because they exist as metapopulations [i.e., at any given point in time, butterflies may be using some areas and not others (Hanski and Gilpin 1991)]. Suitable habitat within the range of a species that exists as a metapopulation can play a pivotal role in maintaining natural metapopulations, especially for butterflies like the Mariana eight spot butterfly that may have limited dispersal abilities.

Habitat Loss

One of the most important factors likely influencing the status of butterfly species' populations in general and the Mariana eight spot butterfly population in particular is the distribution and abundance of nutritional resources, primarily food plants for larvae and nectar for adults. In many cases, the plant species providing nectar and those providing larval food are different, but grow together in the same habitat patches (Ehrlich 1984). The host plants for the Mariana eight spot butterfly are distributed in patches, and there is a strong association between the occurrence

of the species and its host plants. Schreiner and Nafus (1996) reported that at all locations where host plants were present, at least one of the life stages of the Mariana eight spot butterfly occurred. Recent surveys have shown that the Mariana eight spot butterflies are rarely observed except in close proximity to host plants.

Under the proposed action, 350 ac (142 ha) of high quality limestone forest habitat containing nectar and host plants known to be used by foraging Mariana eight spot butterflies and larvae within and surrounding the proposed LFTRC at Ritidian Point will be removed or degraded as a result of the construction and operation of this facility. The proposed action will directly and permanently remove 140 individual host plants (*E. calcareum* and *P. pedunculata*) for the Mariana eight spot butterfly on 187 ac (76 ha) within the proposed MPMG and Non-Standard Small Arms (NSSA) ranges at the LFTRC.

The Ritidian Point area is an important site for the Mariana eight spot butterfly due to interconnected patches of host plants within primary and secondary limestone forest habitat. Mariana eight spot butterflies have consistently been observed occupying this area. For example, during surveys, seven of the 140 individual host plants within the proposed project footprint were found to be occupied by Mariana eight spot butterfly larvae or chrysalis (DON 2017a, pp. 121-122). Permanent removal of host plants would decrease the number of suitable egg-laying sites by female Mariana eight spot butterflies. In addition, larvae of the Mariana eight spot butterfly will have a reduced amount of available food resources. The permanent removal of 350 ac (142 ha) of limestone forest habitat in this portion of the butterfly's range is likely to decrease the carrying capacity of the Ritidian Point area for the butterfly and cause a temporal decrease in the use of the area by Mariana eight spot butterflies.

However, this loss of habitat will be partially offset by the permanent fencing and removal of ungulates within an area of 284.7 ac (115.2 ha) of existing primary limestone and secondary limestone forest adjacent to the LFTRC in the Ritidian Point area. It is likely that with the installation of fencing and removal of ungulates, the host plants for the Mariana eight spot butterfly will be able to establish and thrive and Mariana eight spot butterflies will expand into this protected area.

Habitat Fragmentation

Many butterfly species exhibit metapopulation structure in which populations colonize new patches as previously occupied patches are vacated, leading to an on-off temporal patchwork of localized occupation and extirpation during certain times of the year or over several years (Rubinoff 2016, pp. 4-5). Connectivity of host plants and patch sizes are expected to influence the suitability of habitat for the Mariana eight spot butterfly. Given what we know about butterflies in this family, we suspect that on Guam, as habitat has been lost, the remaining patches have become smaller and more isolated. As habitat patches have become more isolated, the amount of intervening unsuitable areas between the suitable habitat patches have likely exceeded an individual's movement or dispersal capability and heighten vulnerability to the overall metapopulation.

Based on vegetation and butterfly surveys, our current understanding of the distribution and connectivity of suitable butterfly habitat on Guam, while not optimum, has allowed the Mariana eight spot butterfly metapopulation to persist within the action area. We believe the current distribution of butterfly habitat is a result, in part, of ungulates not being able to reach butterfly host plants due to the rugged terrain along cliff faces and the loss of habitat from other sources (e.g., development). As such, controlling existing threats such as ungulates is necessary in order to preserve existing locations of and expand habitat for Mariana eight spot butterfly host plant species.

The construction of the LFTRC will convert a portion of the limestone forest where Mariana eight spot butterflies occur from contiguous primary limestone karst forest to fragmented habitat. Habitat fragmentation may be one of the most challenging ecological issues to address (Dobson et al 1999). For example, Warren (1993) found that key butterfly species have been disappearing even from protected areas and concluded that, if site protection alone is not enough to maintain butterfly populations in the long-term, more emphasis should be placed on creating and maintaining habitat links at a landscape scale. In the absence of functioning habitat links, habitat fragmentation leads to isolation of populations, loss of genetic heterozygosity within populations, disruption of metapopulation, and local extinctions (Wilson et al. 2009, p. 1421). The long-term conservation of most butterfly species requires the protection of its metapopulation in a closely linked network of high quality habitat patches (Thomas et al. 2001, p. 1791).

Under the proposed action, conservation measures involving ungulate-proof fencing and ungulate removal as well as development of a focused fire management plan to minimize the frequency and size of fires caused by live-fire exercises are likely to provide for butterfly habitat in the Ritidian Point area that is better quality than is currently available.

Maintenance of the suitable habitat in a particular landscape is the most fundamental factor determining the presence of a species in a particular area (Thomas et al. 2001). In this context, stepping-stone habitat patches are important for butterflies. Maintaining habitat patches can help ensure and speed up the re-colonization of unoccupied sites that contain suitable habitat. The more isolated a habitat patch is, the less likely it is to be occupied, similarly the greater the gap between habitat patches the longer it takes for the vacant patch to be colonized. In general, the smaller the gap between habitat patches the quicker the vacant patch can be colonized (Thomas et al. 1992).

The network of host plant habitat patches at Ritidian Point is not currently contiguous and is situated between two occupied Mariana eight spot butterfly areas at Haputo and Tarague. As a result of the proposed action, areas of butterfly habitat will be permanently removed, potentially fragmenting habitat by creating gaps that could limit butterfly movement or dispersal between habitat patches within the Ritidian Point area and potentially between the two neighboring areas. Furthermore, because host plants for the Mariana eight spot butterfly are restricted in distribution, occurring in tower karst (Rubinoff 2016, 9 pp), populations of the Mariana eight spot butterfly could easily become isolated, since many tropical forest butterflies are unlikely to fly through open terrain (Laurance et al. 2002).

However, the permanent protection and maintenance of the proposed ungulate-proof fenced area discussed above is likely to provide the Mariana eight spot butterfly with a large block of suitable habitat that when restored, will provide better quality habitat than is currently available in the area. We also note, that while the firing range will not have a durable conservation easement per se, there would be no development or construction in adjacent areas of suitable butterfly habitat due to safety concerns (e.g., live fire exercises). Additionally, the mandatory development of a fire management plan (i.e., implementation of fire prevention measures) will minimize the impact of fires that may ignite within the areas adjacent to the firing range from the use of live munitions. This land use configuration will ensure that the areas of suitable butterfly habitat adjacent to the LFTRC are permanently protected from direct (development) and indirect (fire) loss of habitat, which would effectively benefit the Mariana eight spot butterfly.

Human Disturbance

Although we did not find any studies that evaluated the specific effects of construction activity and the operation of an active firing range on butterflies, a study on the effects of human recreational activities on butterflies found that oviposition events were concentrated on host plants furthest from the trail, suggesting that breeding habitat was constrained by recreational activities (Bennett et al. 2013, pp. 1783-1798). Minimum breeding areas or habitat patches for various butterflies have been calculated and range from 1.2 ac (0.5 ha) to over 123 ac (50 ha), but these areas should be considered within the metapopulation structure (Spalding 2005, p. 4). It is unknown what the minimum breeding area is for the Mariana eight spot butterfly.

Construction activity and firing range operation would disturb Mariana eight spot butterflies using host plants that remain on the edge of the clearing of the MPMG range, and in the absence of adequate buffers, may no longer provide suitable habitat for egg-laying female butterflies. While we do not know the extent of disturbance caused by the proposed action on the Mariana eight spot butterfly, we estimate the exposure of some, small areas adjacent to the LFTRC to human disturbance would be tempered by the beneficial effect of permanently protecting suitable butterfly habitat adjacent to the LFTRC from development or other land use activities due to firing range safety concerns.

In addition to the Ritidian Point area, the proposed action will also affect two subpopulations of Mariana eight spot butterflies located in the Finegayan-Haputo ERA and NMS. The Haputo ERA is an important site for Mariana eight spot butterflies because of the amount of high-quality host plants available. The proposed action includes construction and operation of a 1,213 ac (492 ha) Main Cantonment on the upper plateau above the Haputo ERA. The DON has addressed the potential for increased military and civilian access to the shoreline and into Haputo ERA by fencing the Haputo ERA and providing for educational signage and materials, as part of the proposed action. The NMS, Southern Land Navigation Area contains a single site where the Mariana eight spot butterfly was observed over multiple occasions in the last 10 years in primary limestone forest habitat. Ground maneuvers planned for the Southern Land Navigation Area may disturb this subpopulation of Mariana eight spot butterflies. The NMS, Northern Land Navigation Area also contains eight butterfly-unoccupied locations of individual host plants (*E. calcareum* and *P. pendunculata*).

Habitat Conservation and Minimization Measures

The adverse effects of the proposed action discussed above to the Mariana eight spot butterfly would be minimized, in part, by the DON's proposed conservation measures. The following is a summary of those conservation measures that may affect the Mariana eight spot butterfly:

- Implementation of fire prevention measures will decrease the risk of wildfire and destruction of habitat for the Mariana eight spot butterfly located adjacent to the LFTRC and within the Naval Munitions Site.
- Pre-construction surveys within a project footprint will be conducted to identify all stages of the Mariana eight spot butterfly, prior to construction. If any life stage of the Mariana eight spot butterfly (e.g., eggs, caterpillar, and chrysalis) is located within a project footprint during pre-construction surveys, it will be relocated onto an appropriate host plant (e.g., relocate pre-diapause larvae to *Procris pedunculata* or *Elatostema calcareum*) in similar sites away from the project footprint. This can be conducted by clipping the host plant and grafting the plant to another plant outside the project footprint (Cook and Delisle 2010), but within an occupied area of Mariana eight spot butterflies. The translocation of butterflies using the host plant grafting method in not likely to be 100 percent successful; however, if translocation is done in accordance with accepted protocols (Cook and Delisle 2010) and harm resulting from the relocation would be exempted from take prohibitions. The objective of this conservation measure is to minimize the amount of impact to the species by re-locating individuals out of harm's way and into existing suitable habitat. Movement of the individuals is better for the species than leaving them in habitat that will be destroyed by construction actions as long as actions are sensitive enough to protect the various different life stages.
- The DON will out-plant a minimum of 140 individual host plants of either *P. pedunculata* or *E. calcareum*, commensurate with the amount of each plant species that is removed as a result of construction activities associated with the proposed action. Out-planted host plants will be located in protected areas, including the two Forest Enhancement Sites at Finegayan and within the new ungulate exclusion fence surrounding the LFTRC.
- In addition to the 140 host plants to be out-planted in protected areas, the DON will out-plant host plants of either *P. pedunculata* or *E. calcareum* on the backside of LFTRC range berms that have no likelihood of encountering munitions. This conservation measure will enhance the suspected habitat corridor along the cliff face to ensure connectivity of nearby locations of Mariana eight spot butterflies. When feasible, but no less than annually, the DON will document the status of Mariana eight spot butterfly host plants on the backside of the earthen berms and any presence of the Mariana eight spot butterfly, in order to evaluate the efficacy of this conservation measure.
- The DON will construct an ungulate exclusion fence and remove ungulates within the NWF Ungulate Control Area, surrounding the LFTRC. This conservation measure will protect and enhance 284.7 ac (115.2 ha) of existing primary limestone and secondary limestone forest habitat that is occupied by the Mariana eight spot butterfly.

The planting of butterfly host plants at the Finegayan Forest Enhancement Sites will increase the number of host plants available for the Mariana eight spot butterfly. However, it is unknown

whether this site would be naturally colonized by Mariana eight spot butterflies or whether there would be suitable conditions to allow breeding at this site. The Finegayan Forest Enhancement Sites include mostly *Vitex* sparse canopy and mixed limestone plateau/secondary limestone forest which is a different vegetation community than the vegetation community found in the Haputo ERA and Ritidian Point area where Mariana eight spot butterflies have been observed. Though rearing of Mariana eight spot butterflies in captivity has been successful, successful full-scale propagation or breeding the species in captivity and subsequent reintroduction into previously unoccupied areas, requires additional research and refinement (C. Cobb, DON, pers. Comm 2017). The DAWR has funded a captive breeding project at the University of Guam, with planning underway (D. Vice, DAWR, pers. Comm. 2016).

Although butterfly habitat is limited within the NWF Ungulate Control Area, fencing and removal of ungulates will protect and enhance 284.7 ac (115.2 ha) of existing primary limestone and secondary limestone forest habitat for the Mariana eight spot butterfly. Once ungulates are removed, this permanent protection will greatly assist in improving butterfly habitat and connectivity. Habitat connectivity and patch sizes influence the suitability of habitat. When habitat is lost, the remaining patches become smaller and more isolated. As habitat patches become more isolated, the amount of intervening unsuitable areas between the suitable habitat patches can exceed an individual's movement or dispersal capability and heighten its vulnerability. Therefore, connectivity between patches of suitable habitat is necessary to facilitate daily and seasonal movements, and dispersal to increase the likelihood of long-term viability of Mariana eight spot butterfly populations. Because of long-term commitments to habitat protection through fencing and removal of ungulates, this conservation measure is likely to effectively expand the amount of suitable butterfly habitat beyond its current distribution along the cliff faces. As a result of the proposed fencing and removal of ungulates, host plants and other associated forest plants are expected to develop and be maintained within the 284.7 ac (115.2 ha) area for the foreseeable future.

Summary

The known distribution of Mariana eight spot butterfly populations is disjunct. This suggests that, historically, butterfly habitat was likely less fragmented and provided much greater connectivity to facilitate butterfly movement and dispersal. The proposed action will remove 350 ac (142 ha) of butterfly habitat, including approximately 140 host plants of *P. pedunculata* or *E. calcareum*, which represents 6.1 percent of all currently known host plants range-wide. However, the conservation measures proposed as part of the action (e.g., out-planting of 140 host plants, installation of ungulate-proof fencing, ungulate removal, fire management, and translocation of individual butterflies) in conjunction with natural expansion of host plants within the fenced area will not only minimize impacts of the action, but also restore additional butterfly habitat within areas that are currently unsuitable.

The Ritidian Point area includes occupied habitat and other suitable habitat that is important for sheltering, breeding, and foraging Mariana eight spot butterflies. The restoration of habitat under the proposed action is likely to allow for butterfly population expansion and provide additional habitat connectivity above what is currently available. In addition, this area includes a network of host plant patches with consistent observations of Mariana eight spot butterfly occupancy that

will be retained with implementation of the proposed action. The area is situated between two other Mariana eight spot butterfly habitat areas, and is therefore likely important in maintaining the connectivity of populations for this species.

Implementation of the proposed action, inclusive of the conservation measures, is likely to result in a net loss of limestone forest habitat and adverse impacts to the Mariana eight spot butterfly and its habitat, but will ultimately assist in the restoration of butterfly food plants that will benefit the metapopulation by increasing habitat connectivity. When the fencing in the Ritidian Point area is complete and ungulates are removed, we anticipate these actions will be effective in facilitating the establishment and maintenance of butterfly host plants and other associated forest vegetation within the 284.7 ac (115.2 ha) fenced area for the foreseeable future. Collectively, these conservation actions are likely to temper the loss and fragmentation of limestone forest and butterfly habitat caused by the proposed action to an extent that does not deepen the current degraded baseline for the Mariana eight spot butterfly on Guam.

**Direct and Indirect Effects of the Action on the Partulid Snails: Humped Tree Snail, Guam tree snail, and Fragile tree snail**

In addition to the general effects of the action discussed above, a species-specific effects analysis for the Partulid snails is provided below.

For partulid snails, the analysis considers the number of known snails within project footprints, existing vegetation cover, historical records of partulid snails within the action area, and mark-recapture survey data from long-surveyed populations of endemic tree snails elsewhere in the Pacific. The most severe impact to listed partulid snails is expected to occur within Anderson South, where up to 212 ac (86 ha) of disturbed secondary limestone forest snail habitat is expected to be permanently removed. In 2016, the DON opportunistically found a site of Guam tree snails within this 212 ac (86 ha) area at Anderson South that had not been known previously. In 2016 and 2017, the DON conducted transect surveys to count the number of listed partulid snails within the project site. The DON focused survey efforts on the most suitable and likely habitat to be occupied by partulid snails and expanded survey efforts outwards from that area. Due to the vegetation and substrate, not all vegetation within the 212 ac (86 ha) area at AAFB South could be surveyed. Based on the survey method we estimated a conservative transect buffer area of 9.8 ft (3 m), to represent the area searched along a transect. Based on the transect buffer area, a total of 153 ac (62 ha) were surveyed within the area of suitable snail habitat in AAFB South. Within the area surveyed, the DON found 38 live Guam tree snails, along with 51 dead Guam tree snail shells (DON 2017a, p. 45).

No other species of listed partulid snails were found at Anderson South. At the time of listing in 2015, the humped tree snail on Guam declined to approximately 100 individuals and was only found at one location, Haputo Beach, alongside the Guam tree snail and fragile tree snail (Smith et al. 2008). The DON will construct an ungulate fence and limit military and civilian recreational activities within the Haputo Beach ERA in order to minimize effects to listed partulid snails, as part of the proposed action. The entire Haputo ERA ungulate fence will be approximately 2.8 mi (4.6 km) in length, tying into steep cliffs on each end. Since 1989, the fragile tree snail was found only in the presence of the Guam tree snail (Hopper & Smith 1992),

and adult fragile tree snails are often mistaken for juvenile Guam tree snails. Based on the co-occuring nature of these species and the inability to accurately differentiate fragile tree snails from Guam tree snails, the effects analyses for the listed partulid snails are evaluated collectively.

While suitable habitat exists within the Main Cantonment and LFTRC areas proposed for clearing, the DON surveys have resulted in no sightings of listed partulid snails in these areas. No historical sites of listed partulid snails are known within the Main Cantonment and LFTRC areas proposed for clearing.

Partulid snails are found on the tops and undersides of various types of vegetation and do not exhibit a preference for a particular host plant species, rather they can be found in beach back strand vegetation and primary and seconday limestone forest habitat. Their cryptic nature can make detection challenging. Based on a 5-year dataset surveying listed Hawaiian tree snails of similar shape and size in a forested habitat enclosure where a known number of snails were translocated into the enclosure, timed-count monitoring efforts found that during subsequent surveys for tree snails on average only 30 percent of the actual number of tree snails present, are detected by human observers (U.S. Army 2015, Appendix 3-1; US Army 2016, p. 167; Hall et al. 2010, pp. 67-80).

Based on listed partulid surveys conducted within the action area, with consistent one-person hour searches in over 15 different sites, oberservers were able to detect and count 433 Guam tree snails or fragile tree snails (DON 2017a, p. 45; Lindstrom and Benedict 2014). Due to similar color patterns, surveyors were unable to reliably distinguish fragile tree snails from juvenile Guam tree snails (DON 2017a, p. 45; Lindstrom and Benedict 2014). Based on an average detection rate of 30 percent, the Guam tree snail and fragile tree snail population within the action area is approximately 1,400 snails. Approximately 100 humped tree snails were detected in the Haputo ERA, which is the only location in which they are known to occur. However, all three listed partulid snail species co-occur in similar habitat.

However, because the tree snails are located in terrain that is difficult to survey and the individuals are small and cryptic and can easily be missed during a survey, the Service is using the amount of impacted habitat (212 ac {86 ha}) as a surrogate to evaluate the effects to the Guam, fragile, and humped tree snails.

Habitat Conservation and Minimization Measures

In order to reduce effects to partulid snails, the DON has committed to conduct pre-construction surveys to locate partulid snails within the project footprint, prior to construction or any vegetation clearing activities. The pre-construction surveys will be conducted with the objective of locating, removing, and translocating listed snails out of the project footprint and into suitable protected habitat. Snails would be moved to similar suitable, protected habitat (i.e., habitat not subject to further anthropogenic effects or ungulate damage) and alongside other conspecifics.

In addition, the DON has committed to protect and enhance a total of 1,393 ac (564 ha) of suitable partulid snail habitat in primary and seconday limestone forest in the Finegayan and Ritidian areas.

Summary

The proposed action will adversely affect the Guam tree snail and possibly the fragile tree snail. While the humped tree snail and fragile tree snail are not known to occur within the project footprint, all three species co-occur and are found within the Haputo ERA. The DON will fence the Haputo ERA to reduce civilian and military access and minimize degradation to sensitive snail habitat. Historically, all three species shared similar habitat throughout the action area. Therefore, the likelihood that DON pre-construction surveys may detect individuals of the humped or fragile tree snail in the future cannot be discounted.

The proposed action will result in harm or harass of all Guam tree snails, fragile tree snails or humped tree snails in the 212 ac (86 ha) of limestone forest habitat to be impacted at Anderson South. The DON will conduct pre-construction surveys within the 212 ac (86 ha) of habitat and move all tree snails found to host plants in suitable tree snail habitat outside of the construction footprint. Pacific tree snail translocation techniques have been successful when conducted on similar species (U.S. Army 2015, Appendix 3-1). As long as the DON follows these translocation techniques, any effects to individual snails that occur as a result of translocation from the project footprint to protected habitat will be exempt from take prohibitions. In addition, the DON has committed to protect and enhance a total of 1,393 ac (564 ha) of suitable partulid snail habitat in primary and seconday limestone forest in the Finegayan and Ritidian areas. Therefore, the effect of the DON's action is qualitative, where the relocation of tree snails is considered in context of the amount of habitat impacted within the project footprint and the importance of this habitat to overall snail recovery. Based on the full implementation of the DON's proposed conservation measures, we expect the populations of Guam tree snail, humped tree snail and fragile tree snail to be maintained within the action area.

**Direct and Indirect Effects of the Action on the Orchids (Orchidacea): *Bulbophyllum guamense*, *Dendrobium guamense*, and *Tuberolabium guamense***

In addition to the general effects of the action discussed above, a species-specific effects analysis for the affected listed orchids is provided below.

Direct and Indirect Effects on *Bulbophyllum guamense*

The proposed project will result in the removal of three individuals of *B. guamense* in order to clear forests to construct utilities, buildings, structures, and the LFTRC. The DON has proposed to conduct pre-construction surveys for *B. guamense* within the project construction footprint. After pre-construction surveys are completed and if individuals of *B. guamense* are present within the construction footprint and cannot be avoided, the DON has proposed to salvage healthy individuals of *B. guamense* and relocate individuals to other protected areas away from the project footprint or temporarily house the *B. guamense* individuals at the DON Nursery until a suitable translocation site can be found. Individuals would be relocated by a qualified biologist

and into protected forest habitat or the forest enhancement sites at Finegayan. Please refer to the conservation measures section for more detail.

The DON's conservation measures, to salvage and relocate orchids, are intended to prevent the mortality of individuals of *B. guamense* as a result of the proposed construction activities. However, removing orchids from the wild may result in injuries to the plants. Salvaged individuals may sustain injury from the uprooting, bruising, broken bulbs and leaves (William 1894, p. 15). The DON's measure to hire a qualified biologist would minimize this effect.

Translocation programs, which include moving orchids into new sites (assisted migration) or augmenting wild populations, have been used as tools for orchid conservation (Zettler and McInnis 1992). However, in devising conservation strategies, particularly assisted migration to new safe sites, it is important to consider the orchid's life history traits that may have an impact on long-term survival (Dixon et al. 2003, p. 4). In addition, effective conservation of orchids includes understanding natural migration routes and the functionality of biotic partners (mycorrhizas and pollinators). Orchids are also acutely susceptible to changes in ecosystem equilibria involving organic content, light availability, hydrology and competition that can affect both adult survival and the ability of seedlings to germinate and survive to maturity. We expect the DON will consider these factors in choosing adequate recipient sites for *B. guamense*.

Genetic differences between and among populations also should be considered in the relocation of orchids (Swarts and Sinclair 2008, Duffy et al. 2009). Because little is known about the life history traits of *B. guamense*, the success of relocating individuals of *B. guamense* back into the wild is unknown. However the DON is committed to ensure that a minimum of two *B. guamense* individuals survive and exhibit new root growth at a new protected site. If the DON is unable to successfully salvage all three *B. guamense* individuals then the DON will seek sources outside the project footprint for tissue culture and propagation of *B. guamense*. Since orchids are relatively slow-growing plants, it will require anywhere from several months to more than a year for a newly planted specimen on the tree to become securely attached. The DON has committed to monitoring the success of *B. guamense* translocations that will allow for appropriate adaptive management measures to be implemented in order to reach success targets, defined in **Table 6**.

In addition to the three *B. guamense* individuals known to occur within the project footprint, if any other *B. guamense* individuals are found during pre-construction surveys the DON will seek to translocate all healthy *B. guamense* individuals found.

*Habitat Conservation and Minimization Measures*

The largest concentration of *B. guamense* occurs within the NMS, which contains at least 127 *B. guamense* individuals within primary and secondary limestone forest habitat. The DON will implement avoidance measures including signage restricting access into sensitive areas of orchid habitat and minimization measures to reduce the risk of fire from training activities that would severely impact *B. guamense* habitat. By adhering to all conservation measures, effects to *B. guamense* will be minimized significantly.

The DON will also protect and enhance a minimum of 1,000 ac (405 ha) of occupied suitable *B. guamense* habitat, according to the schedule described in the Conservation Measures section, with the goal of ungulate eradication within the fenced areas; invasive plant removal; and the propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats. In addition, the DON will protect 285 ac (115 ha) of existing primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam.

*Summary*

The proposed action will adversely affect *B. guamense*. The proposed action will result in harm, injury, or mortality to three *B. guamense* individuals that occur in the Finegayan and Ritidian areas. In consideration of the DON's commitment to insure that of the three individuals of *B. guamense* removed, at least two *B. guamense* will survive; the proposed action will result in the loss of 0.2 percent (1 of 407) of the known range-wide population of *B. guamense* and 0.6 percent (1 of 148) of the known population within the action area. Although surveys within the construction footprint have been conducted, surveys may have missed *B. guamense*. The DON has proposed pre-construction surveys. Because *B. guamense* are confined to limited areas and their distribution is not uniform across the landscape, we expect a few additional *B. guamense* to be located near the individuals found in the Finegayan area and the seven occurrences within and surrounding the LFTRC. In addition, as detailed above and in the General Effects section, the proposed action will result in the fragmentation of habitat and will cause ecological degradation that extends beyond the proposed vegetation clearing due to edge effects.

We estimate that that the proposed action would negatively impact less than one percent of the known *B. guamense* population range-wide. Although edge effects, and most notably fragmentation, of forest habitat would occur within the action area in northern Guam, the majority of the population of *B. guamense* occurs at the NMS in southern Guam and these individuals and habitat would be avoided. In addition, if orchids are salvaged, kept in captivity and relocated back into the wild successfully, these methods coupled with the current research being conducted to propagate *B. guamense*, potentially could be used for augmenting existing populations in efforts to recover the species. Based on the full implementation of the DON's conservation measures, we expect the population of *B. guamense* to be maintained within the action area.

Direct and Indirect Effects on *Dendrobium guamense*

In addition to the general effects of the action discussed above, a species-specific effects analysis for *D. guamense* is provided below.

The proposed project will result in the removal of 18 individuals of *D. guamense* in order to clear areas of vegetation to construct utilities, buildings, structures, and the LFTRC. The DON has proposed to conduct pre-construction surveys for *D. guamense* within the project construction footprint. After pre-construction surveys are completed and if individuals of *D. guamense* are present within the construction footprint and cannot be avoided, the DON has proposed to salvage all healthy individuals of *D. guamense* that are feasible to relocate to other protected areas away from the project footprint or temporarily house the *D. guamense* individuals at the

DON Nursery until a suitable translocation site can be found. Individuals would be relocated by a qualified biologist and into protected forest habitat or the forest enhancement sites at Finegayan. Please refer to the conservation measures section for more detail.

The DON's conservation measures, to salvage and relocate orchids, are intended to prevent the mortality of individuals of *D. guamense* as a result of the proposed construction activities. However, removing orchids from the wild may result in injuries to the plants. Salvaged individuals may sustain injury from the uprooting, bruising, broken bulbs and leaves (William 1894, p. 15). The DON's measure to hire a qualified authorized biologist would minimize this effect. As stated in the Effects of the Action for *B. guamense*, translocation programs have been used as tools for orchid conservation (Zettler and McInnis 1992). However, in devising conservation strategies, it is important for biologist and conservation planners to be fully aware of the orchid's life history traits that may have an impact on long-term survival (Dixon et al. 2003, p. 4). In addition, effective conservation of orchids includes understanding natural migration routes and the functionality of biotic partners (mycorrhizas and pollinators). Orchids are also acutely susceptible to changes in microclimate; including humidity, temperature and moisture, as well as organic content, and the presence of other competitors that can affect both adult survival and the ability of seedlings to germinate and survive to maturity. We expect the DON will consider these factors in choosing adequate recipient sites for *D. guamense*. Genetic differences between and among populations also should be considered in the relocation of orchids (Swarts and Sinclair 2008, Duffy et al. 2009).

Because little is known about the life history of *D. guamense*, the likelihood of success of relocating individuals of *D. guamense* back into the wild is unknown. However, the DON is committed to ensure that at a minimum nine *D. guamense* individuals survive and exhibit new root growth at a new protected site. If the DON is unable to successfully salvage all nine *D. guamense* individuals then the DON will seek sources outside the project footprint for tissue culture and propagation of *D. guamense*. The DON has committed to monitoring the success of *D. guamense* translocations that will allow for appropriate adaptive management measures to be implemented in order to reach success targets, defined in **Table 6**.

In addition, to the 18 *D. guamense* individuals known to occur within the project footprint, if any other *D. guamense* individuals are found during pre-construction surveys the DON will seek to translocate all healthy *D. guamense* individuals found.

*Habitat Conservation and Minimization Measures*

The largest concentration of *D. guamense* occurs within the Naval Munitions Site (NMS), which contains at least 201 *D. guamense* individuals within primary and secondary limestone forest habitat. The DON will implement avoidance measures including signage restricting access into sensitive areas of orchid habitat and minimization measures to reduce the risk of fire from training activities that would severely impact *D. guamense* habitat in the NMS. By adhering to all conservation measures, effects to *D. guamense* will be minimized significantly.

The DON will also protect and enhance a minimum of 1,000 ac (405 ha) of occupied suitable *D. guamense* habitat, according to the schedule described in the Conservation Measures section,

with the goal of ungulate eradication within the fenced areas; invasive plant removal; and the propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats. In addition, the DON will protect 285 ac (115 ha) of occupied primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam.

*Summary*

The proposed action will adversely affect *D. guamense*. The proposed action will result in impacts to 18 *D. guamense* individuals that occur in the Finegayan, LFTRC, and Anderson South areas. In consideration of the DON's commitment to insure that nine of the 18 individuals of the relocated *D. guamense* will survive; the proposed action will result in the loss of one percent (9 of 837) of the known range-wide population of *D. guamense* and 3.4 percent (9 of 264) of the known population within the action area. Because *D. guamense* are confined to limited areas and their distribution is not uniform across the landscape, we expect a few additional *D. guamense* to be located near the individuals found in the Finegayan area and the 41 occurrences within and surrounding the LFTRC.

We estimate that that the proposed action would negatively impact less than three percent of the known *D. guamense* population range-wide. Although edge effects, and most notably fragmentation, of forest habitat would occur within the action area in northern Guam, the majority of the population of *D. guamense* occurs at the NMS in southern Guam and these individuals and habitat would be avoided. In addition, if orchids are salvaged, kept in captivity and relocated back into the wild successfully, these methods coupled with the current research being conducted to propagate *D. guamense*, potentially could be used for augmenting existing populations in efforts to recover the species. Based on the full implementation of the DON's conservation measures, we expect the population of *D. guamense* to be maintained within the action area.

Direct and Indirect Effects on *Tuberolabium guamense*

In addition to the general effects of the action discussed above, a species-specific effects analysis for *T. guamense* is provided below.

The proposed action will result in adverse effects to *T. guamense* as a result of the removal of 4,922 individuals of *T. guamense* in order to clear areas of forest for the construction of buildings, structures, utilities and roads in the Finegayan and Ritidian areas. The 4,922 individuals of *T. guamense* represent 39 percent (4,922 of 12,607) of the known population on Guam, and 38.3 percent (4,922 of 12,846) of the total known population of *T. guamense* range-wide.

The DON has proposed to conduct pre-construction surveys for *T. guamense* within the project construction footprint. After pre-construction surveys are completed and if individuals of *T. guamense* are present within the construction footprint and cannot be avoided, the DON has proposed to salvage healthy individuals of *T. guamense* and relocate individuals to other protected areas away from the project footprint or temporarily house the *T. guamense* individuals at the DON Nursery until a suitable translocation site can be found. Individuals would be

relocated by a qualified biologist and into protected forest habitat or the forest enhancement sites at Finegayan. Please refer to the conservation measures for more detail.

The DON's conservation measures, to salvage and relocate orchids, are intended to prevent the mortality of individuals of *T. guamense* as a result of the proposed construction activities. However, removing orchids from the wild may result in injuries to the plants. Salvaged individuals may sustain injury from the uprooting, bruising, broken bulbs and leaves (William 1894, p. 15). The DON's measure to hire a qualified authorized biologist would minimize this effect.

As stated in the Status of the Species section of this BO, *T. guamense* does not occur uniformly within the forest; but instead grows in more humid areas where moss is present on trees and other epiphytic growth including ferns and other native orchids occur. Local site conditions may have a large impact on population dynamics of orchid species, and differences in populations may be due to variables relating to seed germination, such as availability of suitable fungi to promote seed germination, or suitable organic content, moisture, and temperature levels (Perkins 1995, Jersakova and Malinova 2007, Jacquemyn 2010). Therefore, it is important to conserve habitats in which remaining large populations of rare orchids occur, in order to save such species from extirpation (Cozzolino et al. 2003).

The Finegayan area contains the largest and most robust known population of *T. guamense*; the majority or 56 percent of the known range-wide population occurs within the proposed Main Cantonment at Finegayan. The proposed action would negatively impact the Finegayan population by reducing it by at least 70 percent (from 6,924 to 2,070 orchids) and by removing the largest known cluster of this orchid species in the wild. However, this reduced population is not expected to be more vulnerable to extirpation because nearly all remaining *T. guamense* orchids would be contained within the two Forest Enhancement Sites. The DON will enclose these areas with ungulate-proof fences and eradicate ungulates within these enclosures, as well as conduct common native and listed species out-planting efforts to enhance these areas for protection of limestone forest habitat. These measures taken together are expected to protect and allow natural augmentation of the remaining Finegayan population of *T. guamense*.

The area within and adjacent to the proposed LFTRC at Ritidian represents the best remaining primary limestone forest habitat on Guam. Approximately 3,078 individuals of *T. guamense* are present within the Ritidian area. Based on current surveys, the proposed action will result in the removal of 68 *T. guamense* individuals as a result of construction of the LFTRC. The proposed action is also expected to result in fragmentation of *T. guamense* habitat within the Ritidian area.

*Habitat Conservation and Minimization Measures*

As a conservation measure to minimize the above adverse effects, the DON will salvage all healthy *T. guamense* found during pre-construction surveys where feasible, with the objective of translocating the *T. guamense* individuals to protected areas or temporarily house the specimens at the DON's Nursery until a suitable site can be found. The DON has committed to ensure that a minimum of 1,000 *T. guamense* individuals are translocated or outplanted successfully into protected areas. Because little is known about the life history of *T. guamense*, the likelihood of

success of relocating individuals of *T. guamense* back into the wild is unknown. If the DON is unable to successfully salvage at least 1,000 *T. guamense* individuals from within the project footprint, then the DON will seek sources outside the project footprint for tissue culture and propagation of *T. guamense*. The DON has committed to monitoring the success of *T. guamense* translocations that will allow for appropriate adaptive management measures to be implemented in order to reach success targets, defined in **Table 6**.

The salvaging and relocation of *T. guamense* are intended to prevent the mortality of *T. guamense*. However, in devising conservation strategies, it is important for biologist and conservation planners to be fully aware of the orchid's life history traits that may have an impact on long-term survival (Dixon et al. 2003, p. 4). In addition, effective conservation of orchids includes understanding natural colonization routes and the functionality of biotic partners (mycorrhizas and pollinators). Orchids are also acutely susceptible to changes in microclimate; including humidity, temperature and moisture, as well as organic content, and the presence of other competitors that can affect both adult survival and the ability of seedlings to germinate and survive to maturity. We expect the DON will consider these factors in choosing adequate recipient sites for *T. guamense*. Genetic differences between and among populations also should be considered in the relocation of orchids (Swarts and Sinclair 2008, Duffy et al. 2009).

The DON will also protect and enhance a minimum of 1,000 ac (405 ha) of occupied suitable *T. guamense* habitat, according to the schedule described in the Conservation Measures section, with the goal of ungulate eradication within the fenced areas; invasive plant removal; and the propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats. In addition, the DON will protect 285 ac (115 ha) of occupied primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam.

*Summary*

The proposed action will adversely affect *T. guamense*. The proposed action will result in adverse affects to at least 4,922 individuals of *T. guamense* that occur in the Finegayan and LFTRC areas. In consideration of the DON's commitment to insure that of the amount removed, at least 1,000 *T. guamense* will survive; the proposed action will result in the loss of 30.5 percent (3,922 of 12,846) of the known range-wide population of *T. guamense* and 31.1 percent (3,922 of 12,607) of the known population within the action area. In view of the fact that comprehensive *T. guamense* surveys were focused only within and adjacent to the proposed project footprints, the proposed project's impact to the range-wide population of *T. guamense* is a conservative estimate. Based on the status of Guam's remaining forest habitat and current botanical surveys, it is likely that the Finegayan and Ritidian areas constitute the best habitat for *T. guamense* range-wide.

The proposed action will negatively impact the Finegayan subpopulation by reducing it by at least 70 percent (from 6,924 to 2,070 orchids) and by removing the largest known cluster of this orchid species in the wild. However, this reduced population is not expected to be more vulnerable to extirpation because nearly all remaining known *T. guamense* orchids would be contained within the two Forest Enhancement Sites. The DON will enclose these areas with ungulate-proof fences and eradicate ungulates within these enclosures, as well as conduct

common native and listed species out-planting efforts to restore these areas for protection of limestone forest habitat. These measures taken together are expected to provide 1,000 ac (405 ha) of protected occupied *T. guamense* habitat and allow natural augmentation of the remaining Finegayan population of *T. guamense*. In addition, the DON will also control and eradicate ungulates within the Ungulate Control Area in the NWF, surrounding the LFTRC. The Ungulate Control Area will provide 285 ac (115 ha) of occupied primary limestone forest habitat for *T. guamense*. Overall restoration efforts are likely to offset the loss of 30 percent of the *T. guamense* population range-wide. With conservation measures in place, we expect the *T. guamense* population to increase within the Finegayan Forest Enhancement Sites and within the Ungulate Control Area at Ritidian within 10 years.

**Direct and Indirect Effects of the Action on *Cycas micronesica***

In addition to the general effects of the action discussed above, a species-specific effects analysis for *C. micronesica* is provided below.

The proposed project will result in the removal of 3,191 individuals of *C. micronesica* in order to clear forest to construct the LFTRC ranges at Ritidian Point and the Main Cantonment at Finegayan. The remaining 3,177 individuals within the Ritidian Point area will be subject to edge effects, habitat fragmentation, and increased susceptibility to the introduced cycad scale insect, *A. yasumatsui*. Once infected with the cycad scale insect, *C. micronesica* plants monitored have had a 90 percent mortality rate over several years, especially in heavily degraded habitat (JRM 2016).

The largest concentration of *C. micronesica* (18,620 in total) occurs within primary limestone forest habitat within the Ritidian area. *Cycas micronesica* relies on a healthy limestone forest; therefore the loss of 1,219 ac (493 ha) of limestone forest habitat will adversely affect the population of *C. micronesica* on Guam.

Habitat Conservation and Minimization Measures

The DON has proposed to conduct pre-construction surveys for *C. micronesica* within the project construction footprint. After pre-construction surveys are completed and if individuals of *C. micronesica* are present within the construction footprint and cannot be avoided, the DON attempt to translocate any healthy mature individuals and basal suckers (i.e., cycad pups) found. Healthy basal suckers of *C. micronesica* found during pre-construction surveys would be temporarily housed at the DON Nursery until a suitable translocation site can be found. Any cycad pups salvaged may need to be hardened and grown to a suitable size prior to translocation. Individuals of *C. micronesica* would be relocated by an authorized biologist into protected forest habitat (e.g., NWF Ungulate Control Area or lands within the MOA). Refer to the conservation measures section for more detail.

The DON's conservation measures are intended to reduce effects to *C. micronesica* as a result of the proposed construction activities. The relocation of basal suckers of *C. micronesica* has been successful (USFWS 2016, in litt.). Of the 3,191 known *C. micronesica* individuals within the construction footprint, the DON has committed to insuring that 1,596 *C. micronesica* individuals

are maintained and survive into maturity. However, due to predation by invasive insect species, detailed in the Environmental Baseline section, the number of extant individuals that can successfully reproduce is unknown. These 1,596 *C. micronesica* individuals that the DON commits to manage will either be translocated as a whole plant, a basal sucker from the impacted mature plant, or sourced from stock outside the project footprint and propagated in the DON Nursery. The priority is to salvage the maximum amount of genetic stock from the impacted mature *C. micronesica* plants in the Ritidian area. Prior to out-planting into a protected area, the DON will ensure that the *C. micronesica* individual is of sufficient size and durability to withstand the change in environment and will likely need to be hardened off in a temporary location close to the out-planting site. The DON understands the time commitment involved in the growth of cycad plants from basal suckers.

Although the remaining 3,177 mature *C. micronesica* indivduals in the vicinity of the LFTRC would be subject to habitat fragmentation, 34 of these mature trees would be enclosed within the Ungulate Control Area surrounding the LFTRC, and as a result these plants and their offspring would be protected from ungulate damage.

Summary

The proposed action will adversely affect *C. micronesica*. The proposed action will result in harm, injury, or mortality to 3,191 *C. micronesica* individuals that occur in the Finegayan and LFTRC areas. In consideration of the DON's commitment to insure that of the 3,191 individuals of *C. micronesica* removed, at least 1,596 *C. micronesica* will survive; the proposed action will result in the loss of 0.4 percent (1,595 of 421,802) of the minimum known range-wide population of *C. micronesica* and 0.8 percent (1,595 of 19,852) of the known population within the action area.

We estimate that the proposed action would negatively impact less than one percent of the known *C. micronesica* population range-wide. At Ritidian, the loss and fragmentation of high quality limestone forest habitat will have immediate adverse impacts to *C. micronesica*, as well as other native and listed species that rely on *C. micronesica*. However, based on the full implementation of the DON's conservation measures, including translocation and propagation efforts of *C. micronesica* beginning concurrently or prior to forest clearing activities, we expect the population of *C. micronesica* to be temporarily reduced within the action area.

**Direct and Indirect Effects of the Action on *Heritiera longipetiolata***

In addition to the general effects of the action discussed above, a species-specific effects analysis for *H. longipetiolata* is provided below.

The proposed project will result in the removal of seven individuals of *H. longipetiolata* in order to clear forest to construct the Multi-Purpose Machine Gun (MPMG) and Non-Standard Small Arms (NSSA) ranges for the LFTRC at Ritidian. The remaining 21 mature trees in the vicinity of the LFTRC will be subject to edge effects and habitat fragmentation. In addition, in the event of a severe wind storm, with the removal of forest vegetation that would otherwise have acted as a buffer from strong winds or typhoons, structural damage or injury to the remaining *H.*

*longipetiolata* mature trees are likely, especially since *H. longipetiolata* trees are the tallest canopy trees in the area (JRM 2016, pp. 5-6).

The largest concentration of *H. longipetiolata* (223 in total) occurs within remnant coastal plateau secondary limestone forest habitat at Naval Base Guam and AAFB. These areas are outside the construction project footprints and are not expected to be impacted.

Habitat Conservation and Minimization Measures

The DON has proposed to conduct pre-construction surveys for *H. longipetiolata* within the project construction footprint. After pre-construction surveys are completed and if individuals of *H. longipetiolata* are present within the construction footprint and cannot be avoided, the DON would record any mature trees. If any mature trees within the project footprint are found to be seeding, the DON would make every attempt to collect viable seeds from a mature *H. longipetiolata* tree prior to removal. Please refer to the conservation measures section for more detail.

The DON's conservation measures are intended to reduce effects to *H. longipetiolata* as a result of the proposed construction activities. Of the seven known *H. longipetiolata* trees within the construction footprint, the DON has committed to insuring that four *H. longipetiolata* plants are maintained and survive into maturity. These four *H. longipetiolata* individuals will be propagated from seed collected from the seven impacted mature trees, or sourced from seed outside the project footprint and propagated from seed. The priority is to salvage the genetic stock from the impacted mature trees. Prior to out-planting into a protected area, the DON will ensure that the *H. longipetiolata* individual is of sufficient size and durability to withstand the change in environment and will likely need to be hardened off in a temporary location close to the out-planting site. The DON understands the time commitment involved in the growth of hardwood trees from seed. The DON will construct an ungulate fence enclosing 285 ac (115 ha) of occupied primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam. This area and other areas on GMK MOA designated land will be used as *H. longipetiolata* outplanting sites.

Although the remaining 21 mature trees outside the LFTRC footprint at Ritidian would be subject to habitat fragmentation, 18 of these mature trees would also be enclosed within the Ungulate Control Area surrounding the LFTRC, and as a result these trees and their saplings would be protected from ungulate damage.

Summary

The proposed action will adversely affect *H. longipetiolata*. The proposed action will result in harm, injury, or mortality to 7 *H. longipetiolata* mature trees that occur in the LFTRC area. In consideration of the DON's commitment to insure that of the 7 individuals of *H. longipetiolata* removed, at least four *H. longipetiolata* individuals will be propagated from seed and maintained to maturity; the proposed action will result in the loss of 0.6 percent (3 of 488) of the minimum known range-wide population of *H. longipetiolata* and 0.7 percent (3 of 404) of the known population within the action area.

Considering the temporal delay, resulting from the DON's proposal to collect only *H. longipetiolata* seed and propagate to maturity, we estimate that that the proposed action will negatively impact 1.4 percent of the known *H. longipetiolata* population range-wide. The largest concentration of *H. longipetiolata* (223 in total) occuring within remnant coastal plateau secondary limestone forest habitat at Naval Base Guam will not be affected by the proposed action. Based on the full implementation of the DON's conservation measures, we expect the population of *H. longipetiolata* to be maintained within the action area.

**Direct and Indirect Effects of the Action on *Tabernaemontana rotensis***

In addition to the General effects of the action discussed above, a species-specific effects analysis for *T. rotensis* is provided below.

The proposed project will result in the removal of 217 individuals of *T. rotensis* in order to clear forest to construct utilities, buildings, and structures, within AAFB Main and AAFB South, including the LFTRC at Ritidian. The remaining 189 mature trees in the vicinity of the LFTRC area will be subject to edge effects and habitat fragmentation. In addition, in the event of a severe wind storm, with the removal of forest vegetation that would otherwise have acted as a buffer from strong winds or typhoons, structural damage or injury to the remaining *T. rotensis* trees is likely.

The largest concentration of *T. rotensis* (16,366 in total) occurs within limestone forest habitat at AAFB in northeast Guam. The majority of these trees are outside the construction project footprints, however these trees occur adjacent to areas proposed for roads or utility infrastructure and therefore are expected to be indirectly impacted by project effects in the form of edge effects and habitat fragmentation.

Habitat Conservation and Minimization Measures

The DON has proposed to conduct pre-construction surveys for *T. rotensis* within the project construction footprint. After pre-construction surveys are completed and if individuals of *T. rotensis* are present within the construction footprint and cannot be avoided, the DON would record any mature trees. If any mature trees within the project footprint are found to be seeding, the DON would make every attempt to collect viable seeds from a mature *T. rotensis* tree prior to removal. Refer to the conservation measures section for more detail.

The DON's conservation measures are intended to reduce effects to *T. rotensis* as a result of the proposed construction activities. Of the 217 known *T. rotensis* trees within the construction footprint, the DON has committed to insuring that 109 *T. rotensis* trees are maintained and survive into maturity. These 109 *T. rotensis* trees that the DON commits to manage will be propagated from seed collected from the impacted mature tree, or sourced from seed outside the project footprint and propagated from seed. The priority is to salvage the genetic stock from the impacted mature tree. Prior to out-planting into a protected area, the DON will ensure that the *T. rotensis* individual is of sufficient size and durability to withstand the change in environment and will likely need to be hardened off in a temporary location close to the out-planting site. The

DON understands the time commitment involved in the growth of hardwood trees from saplings or seed. The DON has committed to monitoring the success of *T. rotensis* outplanted individuals to allow for appropriate adaptive management measures to be implemented in order to reach success targets, defined in **Table 6**. The DON will construct an ungulate fence enclosing 285 ac (115 ha) of occupied primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam and protect and enhance two Forest Enhancement Sites in Finegayan totaling 1,108 ac (448 ha) of occupied limestone forest habitat. This area and other areas on GMK MOA designated land will be used as *T. rotensis* outplanting sites.

Although the remaining 189 mature trees outside the LFTRC footprint at Ritidian would be subject to habitat fragmentation, 34 of these mature trees would be enclosed within the Ungulate Control Area surrounding the LFTRC, and as a result these trees and their saplings would be protected from ungulate damage.

Summary

The proposed action will adversely affect *T. rotensis*. The proposed action will result in harm, injury, or mortality to 217 *T. rotensis* individuals that occur in the LFTRC and AAFB South areas. In consideration of the DON's commitment to insure that of the 217 individuals of *T. rotensis* removed, 109 *T. rotensis* individuals will be propagated from seed and maintained to maturity; the proposed action will result in the loss of 0.5 percent (108 of 22,422) of the known range-wide population of *T. rotensis* and 0.5 percent (108 of 22,413) of the known population within the action area.

Considering the temporal delay, resulting from the DON's proposal to collect only *T. rotensis* seed and propagate to maturity, we estimate that that the proposed action will negatively impact one percent of the known *T. rotensis* population range-wide. The largest concentration of *T. rotensis* trees (19,319 in total) occur in secondary limestone and primary limestone forest habitat suounding Andersen Air Force Base, and will not be affected by the proposed action. Based on the full implementation of the DON's conservation measures, we expect the population of *T. rotensis* to be maintained within the action area.

## CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. 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 Act.

The extent to which future development is addressed as a cumulative effect in the following analysis excludes any such future development that will have a federal nexus, such as federally-funded roads, or is likely to be caused by other Federal actions. Such actions will be addressed in future section 7 consultations.

Future state, local, or private actions that are reasonably certain to occur in the action area are listed below.

- A private developer has initiated steps to build the Pago Bay Ocean Resort, residential condominiums. The planned footprint of the resort is three ac (1.2 ha) on the southern side of Pago Bay. Surveys for listed partulid tree snails have not been conducted within the project footprint; however, one ac (0.4 ha) of the project footprint may be suitable habitat for any of the federally listed tree snail species.
- Guam Waterworks Authority will be upgrading the Northern District Wastewater Treatment Plant in Dededo. The upgrade will consist of increasing the capacity of the current plant and provide for secondary treatment of wastewater. The upgrade will impact approximately 10 ac (4 ha). Surveys for listed partulid tree snails have not been conducted on this land, however based on tree snail habitat preferences, the species may be present.
- The Guam International Raceway Park in Yigo will be completing site improvements and a raceway expansion. The current footprint of the raceway is 253 ac (102 ha) and the improvements and expansion are anticipated to impact an additional 70 ac (28 ha). There is a potential to impact the following listed species that may be present in the area based on habitat suitability: Mariana eight spot butterfly, *C. micronesica*, and *H. longipetiolata*.

**Natural Resource Management Projects**

Most natural resource management projects that would benefit the listed species covered in this BO will be federally funded. However, small scale projects may occur funded by the territorial or local governments. These projects may benefit listed species; however, their scale is likely to be insignificant compared to the loss of habitat from the proposed action.

**Species-Specific Cumulative Effects**

In northern Guam, habitat for these species may be lost as a result of cumulative effects from civilian development. Because we are still learning about the life histories and habitat requirements of the newly listed species addressed in this consultation, we are unable to estimate the specific number of acres that would be lost as a result of cumulate effects from civilian development. However, many of the newly listed species addressed in this consultation occur in limestone forest habitat. We anticipate at least a few hundred acres would be developed in the absence of the proposed action by 2035.

In southern Guam, habitat for the listed orchids at issue in this consultation may be lost as a result of cumulative effects from wildfire. However, since the trend in annual area burned has been declining, and we anticipate it will continue to decline as a result of ongoing and future Federal support of the development of local fire suppression resources, the amount of habitat lost to wildfire should decline. In addition, the listed orchids are present in ravine forests in southern Guam and the threat of wildfire may not be as high for ravine forests, which are located closer or adjacent to rivers.

**CONCLUSION**

After reviewing the current status of the listed species addressed in this BO, the environmental baseline, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the action, as proposed is not likely to jeopardize the continued existence of the Mariana fruit bat, Mariana eight spot butterfly, the humped tree snail, Guam tree snail, fragile tree snail, *B. guamense*, *D. guamense*, *T. guamense*, *C. micronesica*, *H. longipetiolata*, and *T. rotensis*; and is not likely to destroy or adversely modify Mariana fruit bat critical habitat. The Service reached these conclusions based on the findings for each species presented below.

**Mariana Fruit Bat**

The proposed action will adversely affect the Mariana fruit bat on Guam due to increased noise and human disturbance. Approximately 1,817 ac (735 ha) in the LFTRC and AAFB in northern Guam and 319 ac (129 ha) at the NMS in southern Guam will be affected by increased disturbance to the level that would result take in the form of harm or harass that may preclude successful breeding, foraging and sheltering by the Mariana fruit bat. About 7.8 percent of the Mariana fruit bat habitat on the island will be degraded as a result of the proposed action, and although this impact will not preclude the recovery of the Mariana fruit bat, it may reduce the total number of bats that the island can support. The noise and disturbance to the Mariana fruit bats from construction and operation of project facilities will generally be intermittent and of short duration.

The DON's protection and management of 5,234 ac (2,118 ha) of Mariana fruit bat habitat in northern Guam, including the protection and enhancement of 3,271 ac (1,324 ha) of occupied and suitable Mariana fruit bat habitat away from noise effects will help off-set the disturbance of Mariana fruit bat habitat from the proposed action, and will help insure that Mariana fruit bat habitat in the near term, will be available for survival and recovery of the species on Guam. In addition, the DON's biosecurity conservation measures including landscape-level BTS eradication/control, recommendations from the Regional Biosecurity Plan, HACCP planning, and BTS interdiction program, will be beneficial to the Mariana fruit bat because it will reduce the snake population on Guam and also help prevent spread of the BTS to Rota and other Mariana islands. Based on the full implementation of the DON's proposed conservation measures, including pre-construction surveys, protection and enhancement of 3,271 ac (1,324 ha) of occupied and suitable Mariana fruit bat habitat, and BTS control, we expect the population of Mariana fruit bats to be maintained in the action area. In addition, the DON's two Forest Enhancement Sites at Finegayan, including the creation of 460 ac (162 ha) of BTS-free habitat will facilitate future recolonization or reintroduction of the Mariana fruit bat into Finegayan. Furthermore, the DON's BTS interdiction and control work will help prevent the spread of BTS to other Mariana Islands that support the Mariana fruit bat.

On the basis of these findings, the Service concludes that the effects of the subject action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of the Mariana fruit bat in the wild because sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

<u>Mariana fruit bat critical habitat</u>

The Guam critical habitat unit for the Mariana fruit bat consists of approximately 376 ac (152) ha of land in the fee simple portion of the GNWR. The critical habitat unit is currently occupied, and is located at the base of the cliff below the LFTRC. Upon operation of the LFTRC, noise from gunshots will reach a small portion (approximately two acres) of the critical habitat unit. This noise may preclude the Mariana fruit bat from using this area for roosting as a remote place free of human disturbance. However, because only two acres will be affected, this noise is unlikely to diminish the value of the critical habitat for the conservation of the species in the long-term. Therefore, we determine that the proposed action will not result in the destruction or adverse modification of the Guam critical habitat unit for the Mariana fruit bat.

**Mariana Eight Spot Butterfly**

The range-wide population of the Mariana eight spot butterfly is comprised of at least 10 known local populations. All of these local populations are small, geographically restricted, and subject to further decline due to loss of their native host plants, habitat degradation, and mortality caused by two genera of parasitic wasps (*Ooencyrtus* spp. and *Telenomus* spp.), which predate on Mariana eight spot butterfly eggs. The likelihood of this species surviving and recovering is dependent on restoring a functional metapopulation of Mariana eight spot butterfly. Given the current status of this species, avoiding or effectively offsetting adverse effects to butterfly-occupied habitat is critical to maintaining the resiliency of the Mariana eight spot butterfly metapopulation in the action area.

The proposed action will result in the removal of 350 ac (142 ha) of butterfly habitat, including 140 host plants of *P. pedunculata* or *E. calcareum*, which represents 6.1 percent of all known host plants range-wide. The proposed action will also result in habitat fragmentation and edge effects to limestone forest habitat within the action area, which may reduce its potential to be used by the Mariana eight spot butterfly in the future.

The DON has proposed conservation measures to minimize, the adverse effects of the proposed action on the butterfly in the form of forest habitat restoration, propagation and out-planting efforts to augment existing habitat of *P. pedunculata* and *E. calcareum* host plants, and the commitment to conduct pre-construction surveys to identify all stages of the Mariana eight spot butterfly, prior to construction. If any life stage of the Mariana eight spot butterfly (e.g., eggs, caterpillar, and chrysalis) is located within a project footprint during pre-construction surveys, it will be relocated onto an appropriate host plant (e.g., relocate pre-diapause larvae to *P. pedunculata* or *E. calcareum*) in similar sites away from the project footprint. This has been successfully carried out by clipping the host plant and grafting the plant to another plant outside the project footprint (Cook and Delisle 2010) but within an occupied area of butterfly habitat. These conservation measures will not preclude effects to the species but will minimize effects as a result of vegetation clearing activities. Overall, implementation of the proposed action is likely to temporarily degrade the quality of habitat for the survival of the Mariana eight spot butterfly. In order to prevent permanent degradation of Mariana eight spot butterfly habitat, the DON will place a high priority on creating and protecting quality butterfly habitat in the Haputo ERA and remaining locations within the Ritidian Point area, but outside LFTRC range operations. The

creation and protection of this high quality Mariana eight spot butterfly habitat should occur without delay.

On the basis of these findings, the Service concludes that the effects of the proposed action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of the Mariana eight spot butterfly in the wild because effects of the action will be minimized significantly and sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

**Partulid Snails: Guam tree snail, humped tree snail, and the fragile tree snail**

The proposed action will adversely affect Guam tree snail and possibly the fragile tree snail. While humped tree snail and fragile tree snail are not known to occur within the project footprint, all three species occur within the Haputo ERA. The DON will fence the Haputo ERA to reduce civilian and military access and minimize degradation to sensitive snail habitat. Historically, all three species co-occurred and shared similar habitat throughout Guam. Therefore, the likelihood that DON pre-construction surveys will detect individuals of humped tree snail and fragile tree snail cannot be discounted.

The proposed action will result in harm or harass to all Guam, fragile, or humped tree snails located in the 212 ac (86 ha) of occupied Partulid snail habitat in Anderson South that will be permanently removed. Not all vegetation within the 212 acres has been surveyed. The area that will be cleared is disturbed secondary limestone forest habitat. The DON will conduct a biological survey of a minimum of two-person hours (e.g., 4-persons at 30 minutes each or 2-persons at one hour) at least three days prior to construction at Anderson South for the purpose of locating and removing listed snails within the project footprint that would be impacted by construction activities. The DON will work with the Service and experienced malacologists for appropriate refinement of translocation methods and selection of receiving sites. All detected Partulid snails will be translocated into a protected area with suitable habitat which would allow the translocated Partulid snails to thrive. In addition, the DON will protect and enhance 1,393 ac (564 ha) of suitable Partulid snail habitat in primary and seconday limestone forest in the Finegayan and Ritidian areas. The DON will also fence the Haputo ERA to reduce civilian and military access and minimize degradation to sensitive snail habitat.

On the basis of these findings, the Service concludes that the effects of the subject action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of Guam tree snail, humped tree snail and fragile tree snail in the wild because effects of the action will be minimized significantly and sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

**Orchids*: Bulbophyllum guamense, Dendrobium guamense,* and *Tuberolabium guamense***

The proposed action will adversely affect three *B. guamense* individuals that occur in the Finegayan and Ritidian areas. In consideration of the DON's commitment to insure that of the three individuals of *B. guamense* relocated, at least two *B. guamense* will survive; the proposed

action will result in the loss of 0.5 percent of the known range-wide population of *B. guamense*. The majority of the population of *B. guamense* occurs at the NMS in southern Guam and these individuals and habitat would be avoided.

The proposed action will result in relocation of 18 individuals of *D. guamense* that occur in the Finegayan, LFTRC, and Anderson South areas. Translocation efforts will require at least nine *D. guamense* to survive and exhibit new root growth at a new protected site. Therefore, the proposed action will result in the impacts to 2.2 percent of the known range-wide population of *D. guamense*.

The population of *T. guamense* on Guam comprises 98 percent of its known range-wide population. The loss of 4,922 individuals of *T. guamense* as a result of the proposed action would represent a decrease of the Guam population by 39 percent (4,922/12,607) and in the range-wide population by 38.3 percent, and reduce the largest known subpopulation of this species on Guam. In consideration of the DON's commitment to insure that of the amount removed, at least 1,000 *T. guamense* will survive and exhibit new root growth at a new protected site; the proposed action will result in the loss of 30 percent of the known range-wide population of *T. guamense*.

With the listed orchids being salvaged, kept in captivity and relocated back into the wild, instead of being destroyed, these methods coupled with the current research being conducted to propagate *B. guamense*, *D. guamense,* and *T. guamense* could potentially be used for augmenting existing populations in efforts to recover the species. The DON will protect and enhance a minimum of 1,000 ac (405 ha) of suitable limestone forest habitat in the Forest Enhancement Sites, with the goal of ungulate eradication within the fenced areas; invasive plant removal; and the propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats. These protected areas will provide suitable habitat for translocation efforts and future recovery efforts for *B. guamense, D. guamense,* and *T. guamense*. In addition, the DON will protect 285 ac (115 ha) of existing primary limestone and secondary limestone forest habitat surrounding the LFTRC in northern Guam.

On the basis of these findings, the Service concludes that the effects of the subject action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of *B. guamense, D. guamense,* and *T. guamense* in the wild because effects of the action will be minimized significantly and sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

***Cycas micronesica***

The proposed action would result in adverse effects to *C. micronesica* and loss of over 1,000 acres of occupied habitat for this species. The proposed action will result in adverse effects to at least 3,191 individuals of *C. micronesica* that occur in the Ritidian and Finegayan areas.

Range-wide, the total population of *C. micronesica* is approximately 420,000 individuals and the 3,191 individuals represent 0.8 percent of the known population. Of the total individuals affected, the DON will insure that at least 50 percent, or 1,596 *C. micronesica* will survive relocation efforts, initially as basal suckers and then be out-planted into protected areas to allow

survival into maturity. Based on this conservation measure, the proposed action will result in the loss of 0.4 percent of the known range-wide population of *C. micronesica*. The largest concentration of *C. micronesica* (18,620 in total) occurs within primary limestone forest habitat throughout northern Guam.

Considering the status and environmental baseline of *C. micronesica*, and the effects of the action, taken together with cumulative effects, the proposed action is not likely to reduce appreciably the likelihood of the survival and recovery of *C. micronesica* in the wild.

***Heritiera longipetiolata***

The proposed action would result in adverse effects to at least seven individuals of *H. longipetiolata* and loss of over 1,000 acres of unoccupied habitat that occurs in the Ritidian Point area. The range-wide population of *H. longipetiolata* is approximately 339 individuals and the seven individuals at Ritidian represent two percent of the known population. In consideration of the DON's commitment to insure that at least four *H. longipetiolata* will survive to maturity; the proposed action will result in the loss of one percent of the known range-wide population of *H. longipetiolata*.

On the basis of these findings, the Service concludes that the effects of the subject action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of *H. longipetiolata* in the wild because effects of the action will be minimized significantly and sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

***Tabernaemontana rotensis***

The proposed action would result in adverse effects to at least 217 individuals of *T. rotensis* and loss of over 1,000 acres of occupied habitat for this species in the Ritidian Point area. The range-wide population of *T. rotensis* is approximately 21,000 individuals and the 217 individuals to be impacted at AAFB and Anderson South represent one percent of the known population. In consideration of the DON's commitment to insure that at least 109 *T. rotensis* will survive to maturity; the proposed action will result in the loss of 0.5 percent of the known range-wide population of *T. rotensis*.

On the basis of these findings, the Service concludes that the effects of the subject action, taken together with cumulative effects, is not likely to appreciably reduce the likelihood of both the survival and recovery of *T. rotensis* in the wild because effects of the action will be minimized significantly and sufficient habitat and populations are likely to persist throughout its range at levels that retain the potential for recovery of this species.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in

any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including, breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. 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 a prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by DON for the exemption in section 7(o)(2) to apply. The DON has a continuing duty to regulate the activity covered by this incidental take statement. If DON (1) fails to assume and implement the terms and conditions or (2) fails to require contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to contract documents, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, DON must report the progress of the action and its impact on the species to the Service as specified in this incidental take statement [50 CFR 402.14(i)(3)].

Take of listed plants are not covered under this incidental take statement because sections 7(b)(4) and 7(o)(2) of the Act do not apply to listed plant species. The Act provides protection for endangered plants by prohibiting removal and reduction to possession or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law. Exceptions to these prohibitions are described in 50 C.F.R. 17.61, 17.62, 17.71, and 17.72.

**Amount or Extent of Take Anticipated**

Determining with accuracy the anticipated incidental take for a specific number of individuals of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, and fragile tree snail is difficult because the subject species are small, cryptic in nature (butterfly and snails), two species are similar in appearance in their juvenile forms (Guam and fragile tree snail), definitive population estimates are lacking (all species), and the natural population fluctuations of these species remain undescribed (all species).

Under these circumstances, monitoring of take impacts in terms of individuals of the affected listed species is problematic. As a consequence of these compounded uncertainties, the Service finds that a habitat surrogate is a practical alternative to expressing and monitoring the anticipated extent of take of these five species because (1) the causal link between the surrogate and take is described above in the *Effects of the Action* section of this BO; (2) we have also explained above why it is not practical to express the amount or extent of take or monitor take impacts in terms of individuals; and (3) below we provide a clear standard for determining when the level of anticipated take has been exceeded. The habitat surrogate represents the area of habitat in which

the listed species is known occur, or where suitable habitat exists but has not been surveyed, within the construction and operation footprint of the proposed action and where the biological impacts of the action on the species are likely to conform to the statutory and regulatory definition of take.

Based on the analysis presented in this BO, the Service anticipates the following take is likely to occur as a result of the proposed action:

1. Over the term of the proposed action, all Mariana fruit bats using 2,136 ac (864 ha) of suitable roosting and foraging habitat surrounding the construction and operation footprint of the proposed action (**Figure 13**) are likely to be taken in the form of harm or harass due to exposure to loud aircraft noise, and to noise, light, and human disturbance associated with construction and operation of the LFTRC. This includes approximately 1,817 ac (735 ha) in northern Guam and approximately 319 ac (129 ha) in southern Guam due to noise effects from military aircraft flights and training exercises. The biological impact of the taking on the fruit bat is likely to cause a significant disruption of their breeding, feeding, and sheltering behavior to an extent that creates the likelihood of injury, but not death, of the affected bats. This take level is based on the analyses presented in the *Effects of the Action* section above, which included consideration of the following factors:
    a. The population of the Mariana fruit bat on Guam fluctuates due to periodic migrations of Mariana fruit bats between Guam and Rota;
    b. The Mariana fruit bat population within the action area has been concentrated in northern Guam within AAFB and Finegayan;
    c. Mariana fruit bats have also been noted using the NMS in southern Guam;
    d. In the last 17 years, Mariana fruit bat breeding colony survey counts have reported an average of 113.75 Mariana fruit bats in total on Guam (119 and 179 Mariana fruit bats reported from two separate island-wide efforts in 2000; 40 Mariana fruit bats in 2008; and 112 Mariana fruit bats in 2016);
    e. When Mariana fruit bats are forced to disperse from colonies as a result of human disturbance, infant mortality may increase because dependent, non-volant pups that are too big for the mother to carry are likely abandoned. Forced dispersal may also negatively affect the reproductive potential of the population because access to mates is compromised (CNMI 2010, p. 7). Even without dispersal, high levels of stress from any disturbance can disrupt reproductive cycles and/or lead to miscarriage;
    f. The action area contains approximately 27,096 ac (10,965 ha) of suitable Mariana fruit bat habitat. The proposed action will result in the loss or degradation of 7.9 percent of Mariana fruit bat habitat due to noise disturbance; and,
    g. Mariana fruit bats traverse large areas in search of food and shelter and therefore are likely to be exposed to stressors caused by the proposed action (aircraft noise, construction and operation of the proposed action) multiple times during their life-span;
2. The Service anticipates that, over the term of the proposed action, all life stages of the Mariana eight spot butterfly (i.e., egg cluster, caterpillar, chrysalis, and butterfly) found on identified host plants within 350 ac (142 ha) of occupied habitat within the

LFTRC construction footprint are likely to be subject to take in the form of capture and re-location out of "harm's" way. In addition, all Mariana eight spot butterfly life stages that remain within the 350 ac (142 ha) after host plant translocation occurs are likely to be taken in the form of harm or harass caused by vegetation clearing activities during construction of the LFTRC. The biological impact of the taking on the Mariana eight spot butterfly is likely to be negligible due to the relocation of all identified host plants. Any hram occurring to any Mariana eight spot butterfly life stage during the relocation process would be exempted from take prohibitions as long as translocation protocols are being followed. This take level is based on the analyses presented in the *Effects of the Action* section above, which included consideration of the following factors:

a. The locations of Mariana eight spot butterflies (of all life stages) are closely associated with the occurrence of their host plants, *E. calcareum* or *P. pedunculata*. Both of these plant species are rare within the action area;
b. Due to the cryptic nature of Mariana eight spot butterfly larvae, eggs, and chrysalides and their dependence on these host plants, it is reasonable to use Mariana eight spot butterfly host plants as a surrogate for Mariana eight spot butterfly presence; and
c. The DON has identified 140 individual host plants for the Mariana eight spot butterfly on 187 ac (76 ha) within the LFTRC construction footprint. Of these host plant locations, 11 were documented to contain Mariana eight spot butterfly larvae.

3. The Service anticipates that, based on the pre-development estimate of 176 listed tree snails occurring within the 212 acres of occupied, or potentially occupied, habitat in the Anserson South area, that about 53 Guam tree snail are likely to be detected, based on a 30 percent searcher efficiency, and subject to take in the form of capture and relocation out of harm's way. Although not found within the 212 acres on previous surveys, take in the form of capture and relocation out of harm's way may also occur to any individuals of the humped tree snail or fragile tree snail. Any hram occurring to tree snails during the relocation process would be exempted from take prohibitions as long as translocation protocols are being followed. In addition, all individuals of the Guam tree snail, humped tree snail, or the fragile tree snail remaining on the 212 ac of suitable habitat after removal and relocation efforts are completed may be taken in the form of harm or harass as a result of vegetation clearing activities during construction, operation, and military training activities at AAFB South. This take level is based on the analyses presented in the *Effects of the Action* section above, which included consideration of the following factors:

a. Guam's listed partulid snails are found on the tops and undersides of various types of vegetation and do not exhibit a preference for a particular host plant species, rather they can be found in coastal strand vegetation and primary and secondary limestone forest habitat;
b. Due to their habitat and behavior, listed partulid snails are difficult to detect. Based on a 5-year dataset surveying listed Hawaiian tree snails of similar shape and size in a forested habitat enclosure where a known number of snails were translocated into the enclosure, timed-count monitoring efforts found that during subsequent surveys for tree snails, on average only 30 percent of the

actual number of tree snails present, are detected by human observers (U.S. Army 2015, Appendix 3-1);

c. While the DON has documented only the Guam tree snail within the construction footprint at Anderson South, all three federally listed species (the Guam tree snail, humped tree snail, and the fragile tree snail) co-occur, share similar habitat, and have similar appearances in their juvenile stages; and
d. The DON has detected 38 Guam tree snail individuals within the AAFB South construction footprint; this number reflects 0.83 snails per acre. Based on this information, we expect that up to a total of 127 listed partulid snails are likely present within the 153 ac (62 ha; 0.83 snails per ac x 153 ac = 127 snails) surveyed area. A total of approximately 59 ac (24 ha) of suitable snail habitat at AAFB South was not surveyed. Based on the density of 0.83 snails per acre, calculated from the surrounding surveyed area at AAFB South, we expect that up to 49 snails occur within the unsurveyed 59 ac (24 ha) area of disturbed secondary limestone forest habitat. Therefore, we estimate a total of 176 snails (127 snails + 49 snails) occur within the AAFB South area proposed for construction and operation. While we expect that listed partulid snail density is not uniform in a habitat area, incorporating the highest density estimate to calculate the number of snails likely to be impacted provides a conservative estimate to describe the maximum amount of impact to these species as a result of construction and operation activities at AAFB South.

**Effect of the Take**

As described in the accompanying BO,the Service determined that this level of anticipated take is not likely to result in jeopardy to the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, or the fragile tree snail.

**Reasonable and Prudent Measures**

Reasonable and Prudent Measures serve to minimize the impacts of anticipated take on listed species, and to establish (through terms and conditions) the requirements for the monitoring of take levels to ensure timely reinitiation of consultation if anticipated take levels are exceeded. The Service believes the following Reasonable and Prudent Measures are necessary and appropriate to minimize and monitor the impacts of incidental take on the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, and the fragile tree snail:

1) The DON shall monitor the level of incidental take of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, fragile tree snail, and the humped tree snail using a habitat-based surrogate because it is not practical to detect or monitor the take of individuals that are: (1) exposed to excessive noise levels or other human disturbance; and (2) small and cryptic. The amount of habitat subject to excessive noise levels and to clearing for project construction can be monitored to ensure that these amounts are not exceeded as the proposed action is implemented. The causal link between the habitat surrogate and take of listed species was established for each of these species in the *Effects of the Action* section of the biological opinion.
2) The DON shall prioritize the enhancement and protection of high quality Mariana eight spot butterfly habitat (e.g., forest enhancement areas, Haputo ERA trail and

NWF Ungulate Control Area), including outplanting of *P. pedunculata* and *E. calcareum* host plants into these protected areas prior to or commensurate with vegetation clearing activities that remove butterfly habitat.

**Terms and Conditions**

In order to be exempt from the prohibitions of section 9 of the Act, the DON must comply with the following Terms and Conditions, which implement the Reasonable and Prudent Measures, described above and specify reporting requirements. These terms and conditions are non-discretionary.

In order to implement the reasonable and prudent measures above, the following terms and conditions apply:

1) The DON shall implement the Conservation Measures in the Project Description of this BO. We reiterate this requirement here for convenience and clarity.
2) To minimize the level of incidental take of the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, and the fragile tree snail, the DON shall:
    a. Halt construction if a Mariana fruit bat is present within 492 ft (150 m) of a construction site, at any point during the construction cycle, until the bat leaves the area of its own accord.
    b. Use hooded lighting within 482 ft (150 m) of all potential Mariana fruit bat roost habitat.
    c. Provide educational materials regarding Mariana fruit bat appearance, behavior, and biology to all pertinent DON personnel so that they can correctly identify any Mariana fruit bats near or within the proposed action. If a Mariana fruit bat is sighted down range, in the line of fire, during operation of the LFTRC, all use of the range shall cease until the Mariana fruit bat has left the area of its own accord.
    d. Implement systematic searches for Mariana fruit bat maternity colonies, on a semi-annual basis, in all areas of suitable habitat within AAFB that could be affected by the proposed action including; 1) all Mariana fruit bat habitat within the 65 dB noise contour surrounding the LFTRC and AAFB shown on **Figure 13**; and 2) all Mariana fruit bat habitat that will be subject to increased noise levels from aircraft overflights. Searches shall begin one year prior to the operation of the LFTRC and one year prior to the proposed overflight increases. Surveys shall proceed on a semi-annual bases for the first five years, then conducted annually for the length of the project. If a Mariana fruit bat maternity colony is found the Service shall be notified within one week of the finding.
    e. Monitor all known Mariana fruit bat roost sites, in all areas of AAFB that could be affected by the proposed action including; 1) all Mariana fruit bat habitat within the 65 dB noise contour surrounding the LFTRC and AAFB shown on **Figure 13**; and 2) all Mariana fruit bat habitat that will be subject to increased noise levels from aircraft overflights at a minimum of once a quarter, from one year prior to and one year after the proposed overflight increases are fully

implemented and during all years in which operation of the LFTRC is active. The monitoring methodology shall, at a minimum, include direct counts of Mariana fruit bats using a spotting scope at an appropriate distance to avoid disturbance impacts to the bats.

f. Conduct a noise study at the GNWR and at Ritidian Point upon operation of the MPMG range at the LFTRC. The noise study shall occur during the first year of operation of the LFTRC. Multiple stations shall record noise levels during operation of the MPMG at the GNWR and at Ritidian Point. The monitoring stations shall be approved by the Service in coordination with the DON. Noise monitoring shall occur during day and night activities over multiple days (minimum of 10 days) at least once a quarter to address seasonal and climatic changes. Weather conditions during monitoring shall be closely recorded including temperature, humidity, and wind direction. Results of the after-action noise study, combined with Mariana fruit bat survey data, will continue to inform analyses of noise effects on Mariana fruit bats and assist in refinement of minimization measures, if needed.

g. Conduct a biological survey, involving a minimum of one-person hour, at least three days prior to construction at AAFB South, for the purpose of locating and removing listed partulid snails (Guam tree snail, humped tree snail, and fragile tree snail) within the project footprint or that would be impacted by construction activities, and translocate any listed snails to protected, suitable habitat. The DON shall work with the Service for appropriate refinement of translocation methods and selection of receiving sites.

h. Conduct a biological survey, no less than annually, for the purpose of evaluating the use of sites where host plants with life stages of the Mariana eight spot butterfly (e.g., eggs, caterpillar, and chrysalis) were relocated onto an appropriate host plant (e.g., relocate pre-diapause larvae to *Procris pedunculata* or *Elatostema calcareum*) away from the project footprint.

3) DON shall complete the NWF Ungulate Control Fence within two years of awarding the contract for construction of the portion of LFTRC that removes the existing Ritidian Ungulate Fence.
4) DON shall remove all ungulates from the NWF Ungulate Control Area within six months after completing the NWF Ungulate Fence.
5) In order to monitor the impact of incidental take, the DON shall annually report the progress of the action and its impact on the species, to the Service. A Take Monitoring Plan (Plan) for the Mariana fruit bat, Mariana eight spot butterfly, Guam tree snail, humped tree snail, and the fragile tree snail shall be prepared by the DON in close coordination with and the approval of the Service within 60 days of the date of issuance of the BO accompanying this incidental take statement. The Plan shall include a schedule for the submittal of reports detailing the extent of listed species habitat subject to excessive noise levels or clearing for construction and operation activities to ensure the limits of take exemption have not been exceeded during implementation of the proposed action.

If, during the course of the action, the extent of incidental take is exceeded or occurs for reasons other than described in the BO (above) or the project description or timing changes, such

incidental take represents new information requiring reinitiation of consultation and a new determination(s) of compliance with section 7(a)(2) of the Act. The DON must immediately provide an explanation of the causes of the taking and review with the Service the need for reinitiation of formal consultation.

In summary, the Service anticipates that, over the term of the proposed action, all Mariana fruit bats using 2,136 ac (864 ha) of suitable roosting and foraging habitat surrounding the construction and operation footprint within the action area (**Figure 13**) are likely to be subject to take in the form of harass due to their exposure to noise levels above 65 decibels caused by the proposed action. The Service anticipates that, over the construction phase of the proposed action, all Mariana eight spot butterflies of different life stages (i.e., egg cluster, caterpillar, chrysalis, and butterfly) found on identified host plants in 350 ac (142 ha) of occupied habitat within the LFTRC construction footprint are likely to be subject to take in the form of capture and re-location. The Service anticipates that, over the construction phase of the proposed action, all individuals of the Guam tree snail, humped tree snail, or the fragile tree snail on 212 ac (86 ha) of occupied or potentially occupied habitat (187 ac sureveyd + 59 ac that has not been surveyed), are likely to be subject to take in the form of capture due to capture and relocation and harm due to project clearing and construction.

The incidental take exempted under this incidental take statement will be exceeded if:

1) Effects of the action cause take of the Mariana fruit bat in the form of harm (involving actual death or injury) due to habitat modification (i.e., excessive noise levels) within the 2,136 (864 ha) acres of bat roosting and foraging habitat; or any effects of the action are likely to cause take of the bat in the form of harm or harass outside of the 2,136 ac (864 ha) acres of roosting and foraging habitat discussed above; and/or
2) Mariana eight spot butterfly host plants are found in areas outside of the 350 ac (142 ha) discussed above, and these additional areas would be impacted by the project construction to an extent likely to cause take of the butterfly; and/or
3) Listed tree snails are found in habitat outside of the 212 ac (86 ha) discussed above and subject to project construction impacts causing take in the form of harm.

**Conservation Recommendations**

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species, to help implement recovery plans, or to develop information. The recommendations provided relate only to the proposed action and do not necessarily represent complete fulfillment of the DON's section 7(a)(1) responsibilities for the species. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

*Conservation Recommendations for the Mariana fruit bat*

Our conservation recommendations for the Mariana fruit bat include (adapted from USFWS 2014, pp. 5-6):

- Ungulate monitoring and control:
    - Decrease habitat loss by eradicating feral ungulates on islands where ungulates exist, and prevent their introduction on other islands where Mariana fruit bat recovery is desired.
    - Decrease habitat loss by controlling feral deer in areas of high-quality Mariana fruit bat habitat.
- Habitat and natural process management and restoration:
    - Improve habitat through support of native forest restoration, especially on Guam, Saipan, and Tinian.
    - Set aside enough high-quality habitat areas, including in-perpetuity protection of conservation areas that support the recovery of Mariana fruit bat populations on three of the five southern islands.
- Human interaction monitoring and management:
    - Limit military training in areas occupied by Mariana fruit bats to activities that will not disturb Mariana fruit bats or their habitat.
    - Limit urban development in areas occupied by or potentially used for roosting and foraging by Mariana fruit bats.
- Continue and increase efforts to prevent introduction of BTS on other Mariana Islands.
- Predator / herbivore monitoring and control:
    - Develop and implement large-scale, long-term methods for BTS control that will reduce the BTS population on a landscape level on Guam.

*Conservation Recommendations for the Mariana eight spot butterfly*

Future conservation actions needed for the Mariana eight spot butterfly are listed below. The following actions reflect findings presented in Lindstrom and Benedict (2014, pp. 34-35), Moore (2014, pp. B21-21), and Rubinoff (2016, p.4):

- Develop and implement standardized surveys for the Mariana eight spot butterfly within suitable habitat across Guam.
    - Survey results and location information should be kept current and compiled (i.e., stored in an electronic database) and available to our conservation partners.
- Eradicate or control feral ungulates to allow Mariana eight spot butterfly host plants to expand their range onto less rugged karst, consequently increasing their availability to the butterfly.
- Determine seasonal habitat use, movement, and population dynamics of the butterfly.
    - Identify nectar plants for adult Mariana eight spot butterflies.
- Research the basis for host plant use and possible oviposition preferences of female Mariana eight spot butterflies.
- Augment existing subpopulations or populations of the Mariana eight spot butterfly, provided that studies or data indicate such augmentation is likely to be effective. Augmentation should be conducted under a plan that fully considers the principles of metapopulation and conservation biology principles.

- Reintroduce captive-reared Mariana eight spot butterflies within suitable, but currently unoccupied, habitat to bolster the function and viability of the metapopulation. Female Mariana eight spot butterflies would be collected from an existing local population(s) and allowed to oviposition in captivity. The larvae would then be reared in captivity, and larvae or pupae would be returned back into the wild at new, protected sites.
- Designate Mariana eight spot butterfly reserves or conservation areas that provide host and nectar plants within contiguous habitat at spatial scales that reflect the metapopulation behavior of the overall Mariana eight spot butterfly population.
- Propagate host plants in a nursery and out-plant host plants in protected areas.
    - Conduct research to determine optimal conditions for out-planted host plants and to determine ideal location of out-plantings that increases the likelihood of butterfly use and occupancy.
- Remove invasive vines that are encroaching on Mariana eight spot butterfly host plants.
- Develop standard operating procedures for the proper collection and relocation of eggs and larvae that may be at risk due to projects, including potential future development.
- Develop and initiate an effective public education and outreach focused on the conservation of the Mariana eight spot butterfly.

*Conservation Recommendations for B. guamense, D. guamense, and T. guamense*

Future management actions which would benefit *B. guamense D. guamense, and T. guamense* include:

- Ungulate control throughout *B. guamense, D. guamense, and T. guamense* range would contribute to the protection of the species and habitat.
- Monitoring the status of *B. guamense, D. guamense, and T. guamense* to determine rate of population change and determine population threshold that triggers additional conservation action
- Determine life history and habitat preferences, including conditions that support healthier and more reproductively viable individuals.
- Identify areas that if protected, could provide additional habitat for the conservation of *B. guamense, D. guamense, and T. guamense*.
- Determine the best methods in augmenting populations and relocating and/or reintroducing *B. guamense, D. guamense, and T. guamense* into protected areas within its historic range.

*Conservation Recommendations for Cycas micronesica*

Recommended management actions to help recover the species include:

- Conduct bio-control trials to control damage by insect pests such as the native beetle *D. marianarum* and the invasive *A. yasumatsui*
- Protection from predation and damage by invasive ungulates by use of fencing and population control measures
- Prevention of new invasive pest species which may further threaten the status of *C. micronesica*
- Protection of existing habitat, primarily existing limestone forest

*Conservation Recommendations for Heritiera longipetiolata*

The following recommendations (adapted from DAWR 2006, p. 120) include future management actions to help recover *H. longipetiolata*. This includes:

- Collect seeds from fruiting trees and develop a nursery of seedlings for outplanting in protected areas throughout its range.
- Outplant or relocate wild seedlings/saplings to increase the species distribution.
- The eradication of ungulates from current and potential habitat will serve both to enhance conditions for populations already present, and contribute to promoting additional habitat that may become occupied naturally or via outplanting.
- Install enclosures around trees to protect seeds and seedlings from ungulate.

*Conservation Recommendations for Tabernaemontana rotensis*

The following are recommended conservation actions that would assist in reaching recovery of *T. rotensis*:

- Continue monitoring and survey efforts for *T. rotensis*. Information about the health and reproductive status of individuals will create a more complete understanding of the species on these islands and will inform conservation actions to protect the species.
- Collect seeds from fruiting trees and develop a nursery of seedlings for outplanting in protected areas throughout its range.
    - *Tabernaemontana rotensis* responds to typhoons with a synchronized flowering pulse (UOG 2007, p. 6). Conservation efforts should ensure harvest of the mast seeding that occurs about four months after the passage of a typhoon (UOG 2007, pp. 22, 29).
- Outplant or relocate wild seedlings to increase their distribution.
    - *Tabernaemontana rotensis* seedlings typically occur in a cluster near the parent tree. The seedlings compete with one another for light and other resources, and not all seedlings survive. Resource managers would benefit from transplanting some of these seedlings prior to their death (UOG 2007, p. 22). This approach also would thin out crowded seedlings and possibly ensure more of them remain alive (UOG 2007, p. 23).
- The eradication of ungulates from current and potential habitat will serve both to enhance conditions for populations already present, and contribute to promoting additional habitat that may become occupied naturally or via outplanting.
- Prevent establishment of introduced invasive species (*e.g.*, insect pests).
- Install enclosures around trees to protect seeds and seedlings from ungulate.

**Reinitiation – Closing Statement**

This concludes the Service's formal consultation on the action outlined in the DON's formal consultation request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of incidental take is exceeded; (2) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (4) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological

opinion; or (5) If a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease immediately pending reinitiation.

Thank you for your ongoing efforts to conserve listed species. If you have questions, please contact Jacqueline Flores, Mariana Islands Team Manager, at (671) 989-6744 or via email at jacqueline_flores@fws.gov or Darren LeBlanc, Planning and Consultation Team Manager, at (808) 792-9403 or via email at darren_leblanc@fws.gov . In future communications with us regarding this project, please refer to this project by these reference numbers, 01EPIF00-2015-F-0025 and 01EPIF00-2016-F-0185.

Sincerely,

Mary Abrams
Field Supervisor
Pacific Islands Fish and Wildlife Office

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**Appendix A** - List of Acronyms

| | |
|---|---|
| AAFB | Andersen Air Force Base |
| ac | acre |
| ACE | Air Combat Element |
| ADNL | Average Daily Noise Level |
| APHIS | Animal Plant Health Inspection Service |
| BA | Biological Assessment |
| BEQ | Bachelor Enlisted Quarters |
| BMPs | Best Management Practices |
| BO | Biological Opinion |
| BOQ | Bachelor Officer Quarters |
| BTS | Brown Tree Snake |
| CATM | Combat Arms Training and Maintenance |
| CM | Conservation Measures |
| cm | centimeters |
| CNMI | Commonwealth of the Northern Marianas |
| DAWR | Division of Aquatic and Wildlife Resources |
| dB | decibel |
| dBc | decibels relative to the carrier |
| DFW | Division of Fish and Wildlife |
| DNL | Day-Night Average Sound Level |
| DoD | Department of Defense |
| DON | Department of the Navy |
| EI&E | Energy, Installations and Environment |
| ERA | Ecological Reserve Area |
| ESS | Explosive Safety Standard |
| FDM | Farallon de Medinilla |
| ft | foot |
| GEPA | Guam Environmental Protection Agency |
| GMK | Guam Micronesian Kingfisher |
| GNWR | Guam National Wildlife Refuge |
| GPEPP | Guam Plant Extinction Prevention Program |
| GPS | Global Positioning System |
| GRN | Guam Road Network |
| GWA | Guam Waterworks Authority |
| ha | hectare |
| HACCP | Hazard Analysis Critical Control Point |
| HG | Hand Grenade |
| HMU | Habitat Management Unit |
| HVT | High Value Trees |

| | |
|---|---|
| INRMP | Integrated Natural Resources Management Plan |
| ISR Strike | Intelligence Surveillance Reconnaissance Stirke |
| IUCN | International Union for the Conservation of Nature |
| JGPO | Joint Guam Program Office |
| JRM | Joint Region Marianas |
| KD | Known Distance |
| kHz | Kilohertz |
| km | kilometer |
| kV | kilovolt |
| LFTRC | Live Fire Training Range Complex |
| m | meter |
| $m^3$ | cubic meter |
| MA,NLAA | May affect, not likely to adversely affect |
| MCAG | Marine Corps Activity Guam |
| MCB Hawaii | Marine Corps Base |
| MEC | Munitions and Explosives of Concern |
| MGd | million gallons per day |
| mi | mile |
| MITT | Mariana Islands Training and Testing |
| mm | millimeter |
| MOA | Memorandum of Agreement |
| MPMG | Multipurpose Machine Gun |
| MRF | Modified Record of Fire |
| MSA | Munitions Storage Area |
| MW | Megawatt |
| NCN | No Common Name |
| NAVFAC | Naval Facilities |
| NBG | Naval Base Guam |
| NGLA | Northern Guam Lens Aquifer |
| NMS | Naval Munitions Site |
| NSSA | Non-Standard Small Arms |
| NWD | No Wildlife Disturbance |
| NWF | Northwest Field |
| OASN | Office of the Assistant Secretary of the Navy |
| PBF | Physical or biological features |
| PCE | Primary Constituent Elements |
| PIFWO | Pacific Islands Fish and Wildlife Office |
| PSS | Public School Systems |
| RBP | Regional Biosecurity Plan |
| RFMP | Range Fire Management Plan |

| | |
|---|---|
| RSS | Range Safety Specialist |
| SDZ | Surface Danger Zone |
| SOP | Standard Operating Procedure |
| U&SI | Utilities and Site Improvements |
| UN | United Nations |
| UOG | University of Guam |
| USAF | United States Air Force |
| USCG | United States Coast Guard |
| USDA | United States Department of Agriculture |
| USFWS | United States Fish and Wildlife Service |
| USMC | United States Marine Corps |
| UXO | Unexploded Ordnance |
| VCO | Volunteer Conservation Officer |
| WWTP | Wastewater Treatment Plant |
| yd | Yard |
| $yd^3$ | Cubic yard |

**Appendix B** – Informal consultation for the Department of the Navy's Marine Corps Relocation from Okinawato Guam Affects to *Maesa walkeri*, *Nervilia jacksoniae*, and *Eugenia bryanii*.

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawaii 96850

In Reply Refer To:
01EPIF00-2015-F-0025
01EPIF00-2016-F-0185

Commander Jeffrey S. Powell
Director, Pacific Programs Office
Office of the Assistant Secretary of the Navy (OASN)
Energy, Installations and Environment (EI&E)
1000 Navy Pentagon
Washington, DC 20350-1000

Dear Commander Powell:

The U.S. Fish and Wildlife Service (Service) received your request on May 18, 2017, requesting our concurrence with your determination that the Marine Corps relocation from Okinawa to Guam, including the construction of the Live Fire Training Range Complex (LFTRC), the Marine Cantonment, and use of lands within the Naval Munitions Site (collectively known as Project) may affect, but is not likely to adversely affect three newly listed plant species pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C 1531 et seq.). This consultation addresses the impact of the project on the federally threatened plants *Maesa walkeri* and *Eugenia bryanii*, and the federally endangered plant *Nervilia jacksoniae*.

The DON's proposed Project includes the relocation of 5,000 USMC personnel and 1,300 dependents from Okinawa to Guam. To support this relocation effort, the DON plans to construct and operate a main cantonment area, including family housing; construct and operate an LFTRC; and conduct training activities on Guam. Project activities will occur on land administered by the Department of Defense and the Government of Guam (for road and bridge work). This consultation addresses actions that will take place within the Northwest Field (NW Field) for the construction of the LFTRC and within the Naval Munitions Site (NMS), in both the Northern Land Navigation Area and the Southern Land Navigation Areas. For a complete description of the Project, along with maps of the action area, please see the Description of the Proposed Action section of the accompanying 2017 USMC Relocation BO.

*Maesa walkeri* (no common name) is a shrub in the primrose family (Primulaceae) found only in the Mariana Islands within the forest ecosystem (USFWS, 2015). At the time of listing, *M.*

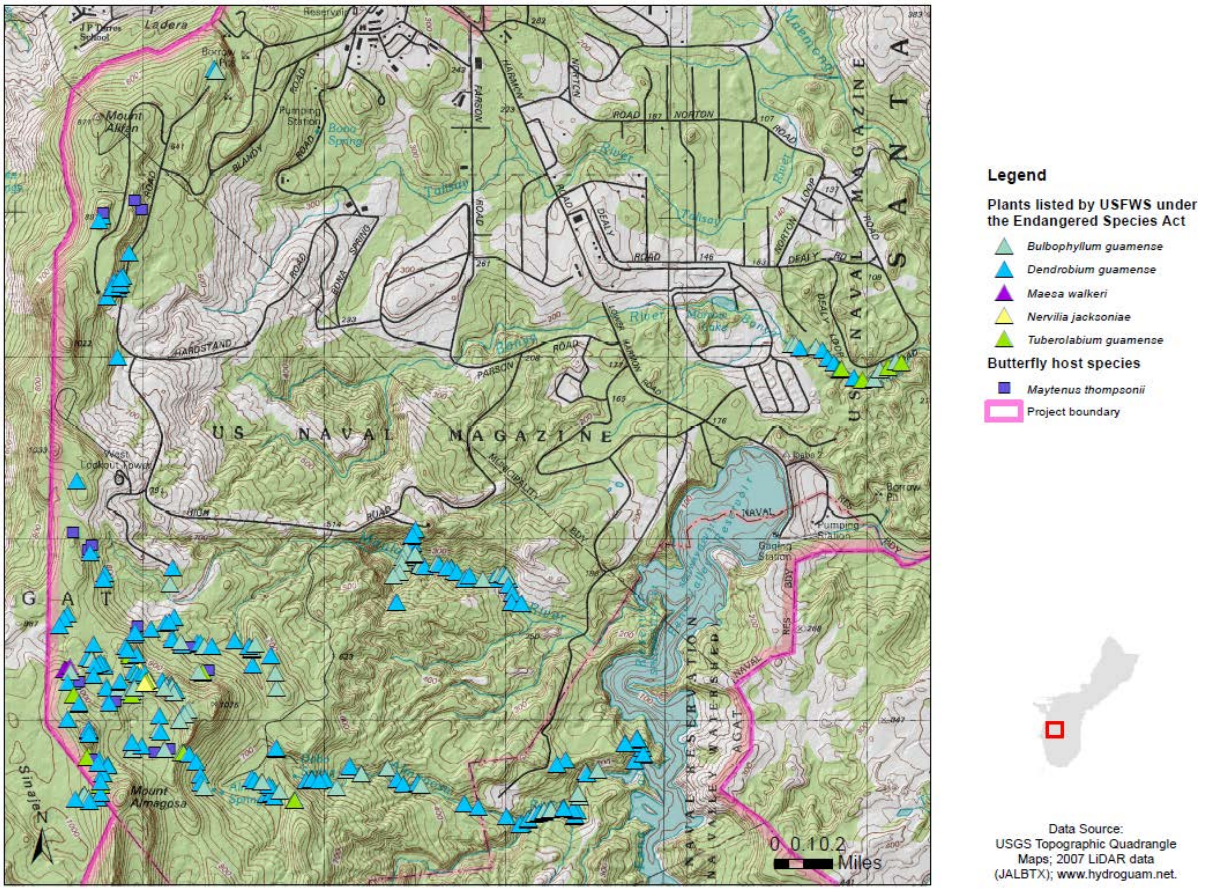
*walkeri* was known from five occurrences on Guam and Rota, totaling at least 686 individuals. On Rota, there are 684 individuals spread out across the Sabana with a population structure consisting of seedlings, juveniles, and adults (USFWS, 2015) and only two individuals were known on Guam. Subsequent surveys on Mt. Lamlam discovered 45 individuals (GPEPP, 2015). Recent surveys in the Naval Munitions have discovered a total of seven mature adults, but no recruitment was noted (JRM, 2016). **Figure 1** shows the known distribution of *M. walkeri* within the NMS.

*Nervilia jacksoniae* (no common name) is a small herb in the orchid family (Orchidaceae), and is found only in the Mariana Islands. It typically grows in shady areas from a small subterranean tuber. It remains dormant for a portion of the dry season. Flowers open in June or July and only remain open for a short period. The seed capsule takes a month to mature. Leaves are small (about 5 x 3 centimeters), kidney-shaped, and emerge as the seed capsule is developing (Raulerson and Rinehart, 1992). Threats to *N. jacksoniae* include habitat loss and destruction from development as well as damage due to ungulates (wallows, digging, and browsing) as well as predation from invasive slugs, and damage from fire events. At the time of listing, it was known from two occurrences totaling fewer than 200 individuals on Guam and 13 occurrences of 320 individuals on Rota (USFWS, 2015). Recent surveys on NMS have discovered 204 mature individuals within the river valleys (JRM, 2016). Surveys of the limestone forest in the NMS to determine the full extent of the species have not been completed. **Figure 1** shows the known distribution of *N. jacksoniae* within the NMS.

*Eugenia bryanii* (no common name) is a small perennial shrub in the Myrtle family (Myrtaceae), and is known only from Guam. *E. byranii* is a multi-stemmed shrub with small elliptical leaves. Flowers are short with four white petals and numerous stamens. Fruits are round and bright red, with edible pulp surrounding one or two seeds (Raulerson and Rinehart, 1991). *Eugenia bryanii* primarily occurs on limestone clifflines along the west and east coasts of Guam (Raulerson and Rinehart, 1991). At the time of listing only five occurrences were known with approximately 420 individuals (USFWS, 2015). Surveys by DOD have since discovered large numbers of individuals along the cliffline at Ritidian Point. Approximately 2,000 individuals were discovered within the ungulate fenced area along the cliffline (JRM, 2016). Threats to *E. bryanii* include habitat loss and destruction from development as well as damage due to ungulates (browsing) as well as predation from invasive slugs, and damage from fire events. **Figure 2** shows the distribution of *E. bryanii* within the proposed LFTRC lands on the island of Guam.

*Maesa walkeri* and *N. jacksoniae* populations occur within the NMS. Potential physical disturbance includes trampling by soldiers or vehicles, destruction by the creation of roads and trails, or placement of bivouacs. DON will ensure that military training units work in close coordination with Joint Region Mariana's Mariana Island Range Complex (MIRC) to clearly define authorized training restrictions, and where appropriate, designate No Wildlife Disturbance (NWD) areas or other designations to prohibit training in sensitive areas. DON will work closely with DON Biologists to identify new NWD areas, consistent with USMC combat readiness and training requirements. Proper designation of NWD areas will ensure that bivouacs do not cause additional disturbance to endangered species (USFWS, 2017).

**Figure 1:** Locations of M. walkeri and N. jacksoniae within the NMS (JRM, 2016)

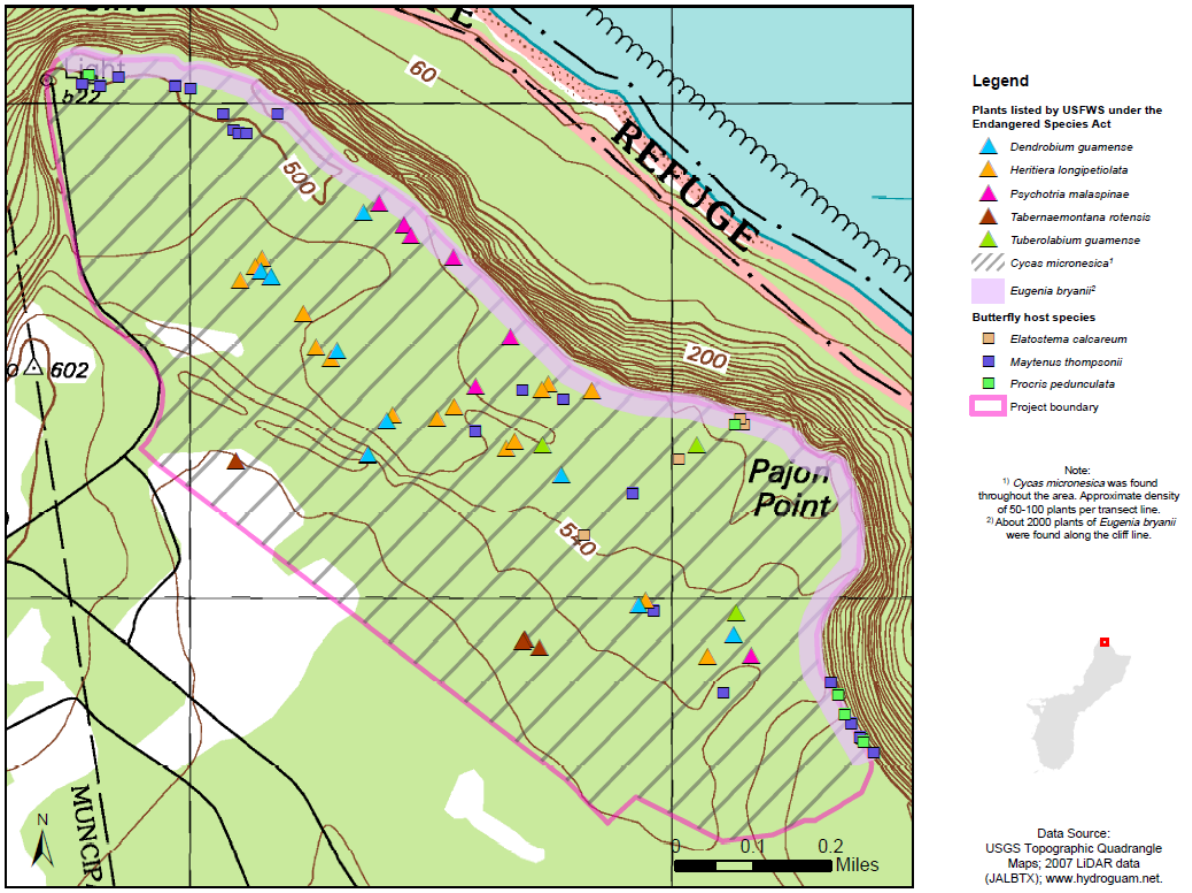



*Eugenia bryanii* occurs along the cliffline at the northernmost edge of the LFTRC complex footprint. As all individuals occur within 50 meters of the cliffline no direct loss is expected from the construction of the LFTRC. One individual plant occurs within the footprint of the LFTRC, but occurs over the cliff edge and is not expected to be affected by construction (DON, 2017). Habitat fragmentation is expected to be minimal. The primary benefit to the species will be the removal and restriction of ungulates from the area to relieve browsing pressure (DON, 2017). Specific measures to enhance the conservation of *E. bryanii* are listed in the DON BA (2017). These measures include prioritization of fire suppression activities in areas known to contain ESA-listed species; creation of an ungulate management fence and removal of ungulates; as well as translocation and propagation of individuals. These conservation measures are expected to provide a beneficial effect by primarily removing ungulate herbivory as a constraint to recovery.

Based on the information and analysis above, we agree with your determination that the proposed projects effects to the three listed plant species would not exceed insignificant or discountable levels. Therefore, we concur with your determination that the proposed project may affect, but is not likely to adversely affect the three listed plant species *E. bryani, M. walkeri* and *N. jacksoniae* pursuant to section 7 of the ESA. Our basis for this conclusion is that the DON will implement the proposed actions and conservation measures specified in the accompanying 2017 USMC Relocation BO, and herein. Actions other than those specified in the Marine

Relocation BO and in this informal consultation have the potential to result in harm to listed species and therefore may require reinitiation of section 7 consultation. In addition, if new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, reinitiation of consultation pursuant to section 7 of the ESA may be necessary.

**Figure 2:** Distribution of E. bryanii along the cliffline within NW Field (DON, 2017).




Thank you for your ongoing efforts to conserve listed species. If you have questions, please contact Jacqueline Flores, Mariana Islands Team Manager (phone: (671) 989-6744, email: jacqueline_flores@fws.gov). In future communications with us regarding this project, please refer to this project by these reference numbers, 01EPIF00-2015-F-0025 and 01EPIF00-2016-F-0185.

Sincerely,

Mary Abrams
Field Supervisor
Pacific Islands Fish and Wildlife Office

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APPENDIX C **- Figures**