3.2.2 Marine Species of Interest

A remarkable 941 species of marine macrofauna (taxa usually > 1 cm in size) have been recorded in the shallow marine habitats of the HERA, including 204 species of fish, 154 species of coral, and 757 species of other invertebrates (Amesbury et al. 2001). Amesbury et al. (2001) and SWCA (2009) found the coral communities in the ERA are unusually diverse and healthy. Reef scleractinians, for example, represent around at least 60 percent of the known coral fauna of Guam (Amesbury et al. 2001, SWCA 2009). Species richness appeared to increase from 154 species in 2000 to 193 in 2008 (SWCA 2009).

3.2.2.1 Algae and Corals

The algal cover at Haputo-Double Reef sites was high with well developed coral-curstose coralline algae assemblages. A distinctive feature at many of the sites was the relatively high cover of Cyanobacteria. The abundance in Cyanobacteria could be linked to (i) *Acanthaster* outbreaks which resulted in large patches of degraded reef and (ii) nutrient input from the aquifer and terrestrial run-off.

A total of 163 scleratinian coral species have been recorded at HERA (SWCA 2009). Common corals are the lobe corals *Porites rus, P. vaughani, P. lutea* and the encrusting coral *Laptastrea purpurea*. Coral cover at HERA ranges from 20 – 80 % depending on location and has not changed significantly since the last survey in 2001. Colony sizes were also consistent between study periods and shows healthy recruitment with small coral colonies well represented.

3.2.2.2 Macroinvertebrates

The most common macroinvertebrates at HERA comprise mainly of high densities (an average of more than 20 individuals per 100 m^2) of sea urchins of the species *Echinostrephus aciculatus* and *Echinometra mathaei*, followed by the small giant clam *Tridacna maxima* and the sea cucumber *Stichopus chloronotus* .

The crown of thorns starfish (*Acanthaster planci*) has been an indigenous but periodically invasive species on Guam's reefs in recent times. The species was not common until 1967 when the species became abundant on reefs on the northwestern side of the island. Within two years, more than 90 percent of corals between Ritidian Point in the north and Orote Peninsular in the south were destroyed by the starfish (Chesher 1969). The starfish preys on a variety of stony corals by feeding on the polyps. There have been several outbreaks of the crown of thorns starfish on Guam over the past four decades (Birkeland 1997). Control methods at the time resulted in the destruction of over 12,000 starfish (Randall 1972). It has been reported in large concentrations in the Indo-Pacific region in recent years. Although infestations occur naturally, they are considered very rare, estimated to occur naturally once

every 400 years (Randall 1972).

During a 2001 assessment of the HERA's marine diversity, the crown of thorns starfish was detected at nine of 31 survey sites, primarily within the deep fore-reef macrohabitat, but also within the shallow fore-reef and back-reef macrohabitats (Amesbury et al. 2001). This species was also detected in four of six surveyed zones during the most recent survey of the HERA (SWCA 2009) with densities ranging from 0 to 1.6 individuals/100m^2 (not in zone 2 and 4). These densities of crown of thorns starfish at HERA are high, as densities are typically less than 1 individual/ha (Pratchett 2005), and is a cause for concern. Within the Haputo reef front microhabitat, slow-growing head corals (e.g., faviids and mussids) tend to be more vulnerable to crown of thorns starfish predation (Amesbury et al. 2001), lobe corals such as *Porites* tend to recover better from predation.

3.2.2.3 Fish

Amesbury, et al (2001) indicated a decline in reef fish abundance and diversity in the mid to late 1980's, likely a result of overfishing. In 1986, USFWS (1986) recorded 214 marine fish species, representing 115 genera and 40 families. In 2000, Amesbury et al. (2001) reported 204 species and the total number of fish species increased to 339 species by 2008 (SWCA 2009). At Haputo the 2008 survey recorded higher total density, more families and higher diversity than the 2001 survey. However, the composition of the fish assemblage and relative abundances of the major families stayed the same. Damsel fishes (Pomacentridae) were the most abundant family (more than 70% of all fish observed) followed by surgeon fishes (Acanthurids) and wrasses (Labrids). Most of the fishes observed in 2008 and not in 2000 were mid-water schooling fishes and cryptic, nocturnal or cave dwelling fishes which may not have been well documented previously. Taking all these factors into consideration, there is no indication that fish abundance or composition at Haputo have changed or declined. *Labroides dimidiatus, Acanthurus nigrofuscus Naso literatus, Parupeneus multifasciata, Cephalopholis urodeta, Chlorurus sordidus, Zanclus cornutus, Chlorurus frontalis*, and *Melichthys vidua* are considered widely distributed and well represented across the ERA (USFWS 1988, Amesbury et al. 2001, SWCA 2009).

Large parrotfishes, grouper and wrasses were heavily targeted by scuba spearfishermen in the 1990s, and with the depletion of these species, shifted to faster growing acanthurids (Burdick et al. 2008). The main families fished targeted by boat and shore fishermen from 2004 to 2006 include fish in the families Acanthuridae, Carangidae, Lutjanidae, Lethrinidae, Mullidae, Siganidae, Kyphosidae, Scaridae, Scombridae and Sphyraenidae (Burdick et al. 2008). Large-sized species tended to be rare at Haputo and were limited to certain species of emperors (Lethrinidae; *Lethrinus olivaceus*), parrotfishes (Scaridae; *Chlororus microrhinos*, mostly juveniles or young immature-phase females, and *Scarus rubrioviolaceus*) and surgeonfishes

(Acanthuridae; *Naso brachycentron*, primarily juveniles).

3.2.2.4 Marine Mammals

Spinner dolphins are often seen in the areas surrounding Double Reef. Anecdotal information suggests that a pod moves up and down the west coast of Guam between Double Reef and Agat. NOAA Environmental Sensitivity Index (ESI) Maps indicate that Bottle nose dolphins and Spinner dolphins are frequently found in the HERA MU (NOAA 2009).

3.2.3 Introduced and Invasive Species

A non-native invasive marine species that has been recorded at Apra Harbor is the Atlantic barnacle (*Chthamalus proteus*). This species threatens natural substrates through dense colonization (IUCN/SSG 2007). Despite not being mentioned in the final reports documenting findings of 2001 marine diversity surveys of the HERA and surrounding waters, it is unknown whether the Atlantic barnacle occurs in this ERA (Amesbury et al. 2001).

Crown of thorns starfish (see section 3.2.2.2 for discussion) is indigenous but has the potential to be invasive and therefore harmful to the HERA MU. It has been reported in large concentrations in the Indo-Pacific region in recent years. Although infestations occur naturally, they are considered very rare, estimated to occur naturally once every 400 years (Randall 1972). Outbreaks of crown of thorns starfish have caused serious harm to coral reefs in Guam (Wilkinson 2008). Increased nutrient levels in the water as a result of agriculture or other land use practices that enhance soil erosion are considered the major cause (GDAWR 2006). Since crown of thorns are attracted to the metabolytes released by damaged or broken corals, walking on, anchoring, mining or storm damage to reefs could trigger a bloom. There are very few natural predators of the crown of thorns starfish. Triton (Genus *Charonia*) is one such predator but because of their highly desirable shell, these animals are over-collected in most Pacific areas.

3.3 Terrestrial Environment

The HERA TU includes steep limestone cliffs, which abuts a narrow limestone shoreline bench and two unconsolidated white sand beached occur (USFWS 1986). Predominately native limestone forest characterizes the limestone cliff area while the limestone shoreline bench comprises a band of strand vegetation comprised of pan-tropical species. Haputo Beach has a well developed strand community with a large coconut plantation forest (Figure 11). The area was described as "forest on elevated limestone" by H. I. Manner in 1995 (an update to F.R. Fosberg's 1954 mapping efforts) (Mueller-Dombois and Fosberg 1998). The "forest on elevated limestone" habitat community is typically a moist, broad-leaved evergreen forest, of

primarily *Artocarpus mariannensis* and *Ficus prolixa* (Mueller-Dombois and Fosberg 1998). During island-wide avian surveys in 1981, five habitat types were classified along a Haputo Point transect close to the existing HERA (Engbring and Ramsey 1984). Primary limestone forest (28.1%), "broken" forest (16.4%), scrub forest (21.2%), open field (23.2%), and urban (11.1%) represented most of the vegetation in the terrestrial unit of the reserve at the time (Engbring and Ramsey 1984).

Figure 11. Haputo beach area of the Haputo Ecological Reserve Area is a well developed coastal strand community with a large coconut forest.

The 1986 HERA Management Plan mentioned that the reserve contained a decent stand of remnant native limestone forest (U.S. Navy 1986). A 2005 draft feasibility study for potential expansion of the HERA classified four vegetation types that occur in the HERA: halophytic-xerophytic scrub, coconut forest, limestone forest, and disturbed limestone forest (Helber Hastert and Fee 2005).

USFWS (1986) listed at least 161 plant species in the HERA found during the 1986 survey. Of these, the majority were found in the limestone forest (n = 93 species, 10 of which were non-native) and included *Pandanus dubius, Pandanus tectorius, Artocarpus altilus, Ficus,* and *Aglaia mariannensis.*

3.3.1 Federally Listed and Candidate Endangered and Threatened Species

3.3.1.1 Plants

The only federally endangered plant species on Guam is the fire tree (*Serianthes nelsonii*). Of the six mature fire trees ever found on Guam, the majority were located in the north, on or near the GNWR (Wiles et al. 1996). Currently, only one mature, naturally occurring fire tree is present on Guam, located on the GNWR Air Force overlay, and not within the HERA (USFWS 1994b, Wiles et al. 1995).

Six plants on Guam are considered by USFWS to be species of concern: *Coelogyne guamensis, Lycopodium phlegmaria* var*., Nervilia jacksoniae, Tabernaemontana rotensis, Thelypteris warburgii,* and *Tinosperma homosepala* (USFWS 2005) (Appendix 4). There are more than 200 *T. rotensis* trees found in various regions of northern and southern Guam (GDAWR 2006). It is unknown whether *T. rotensis* or the five other species of concern are present in the HERA; none have thus far been observed in recent ongoing vegetation surveys (SWCA, unpublished data).

3.3.1.2 Invertebrates

Although none of Guam's native partulid tree snails are currently federally listed as threatened or endangered, all are drastically declining or extirpated. As a consequence, three species are candidates for federal listing; Mariana Islands tree snail (*Partula gibba*), Pacific tree snail (*P. radiolata*), and Mariana Islands fragile tree snail (*Samoana fragilis*). The Guam tree snail (*Partula salifana*) is considered a species of concern; however, this species is possibly extirpated from Guam (USFWS 2005), B. Smith, University of Guam, personal communication). Hopper and Smith (1992) found Mariana Islands tree snail*,* Pacific tree snail, and Mariana Islands fragile tree snail present at Haputo Beach, within the HERA. Smith et al. (2008) found Mariana Islands tree snails and Pacific tree snails at Haputo beach. In the same study, Mariana Islands fragile tree snails and Pacific tree snails were found at Pugua Point, NCTS (Smith et al. 2008). In July 2009, a juvenile Pacific tree snail was found north of Haputo Beach (Figure 12; SWCA, unpublished data). The forest habitat of the reserve supports the last known colony of Mariana Islands tree snail (Hopper and Smith 1992, Helber Hastert and Fee 2005, Smith et al. 2008).

Figure 12. A juvenile Pacific tree snail (*P. radiolata*) was found in the Haputo Ecological Reserve Area in 2009. Photo: SWCA.

Two Guam butterfly species are candidates for federal listing: Marianas eight spot butterfly (*Hypolymnus octicula*) and Marianas wandering butterfly (*Vagrans egestina*). Marianas eight spot butterfly, endemic to Guam and Saipan, is known to occupy karst limestone forest habitats and its larvae have been reared on *Procris pedunculata* and Tupon Ayayu (*Elatostema calcareum*) (Schreiner and Nafus 1997). *Procris pedunculata* and Tupon Ayayu are common in the limestone forest of the HERA (USFWS 1986). The Marianas eight spot butterfly was recently observed in HERA (September 2010) during vegetation surveys (SWCA, unpublished data). Marianas eight spot butterfly has also been observed at nearby Hilaan Point, less than 2 mi (3.2 km) south of the HERA (Schreiner and Nafus 1997). The Marianas wandering butterfly, endemic to Guam and Rota, has not been detected on Guam recently, but several were collected in the early 1970s (Schreiner and Nafus 1997). The Marianas wandering butterfly has never been recorded from the HERA. The only known host tree for the butterfly, *Maytenus thompsonii* (Figure 14), is present but uncommon in the HERA limestone forest (USFWS 1986).

Figure 13. Marianas eight spot butterfly (*Hypolymnus octicula*) observed at Haputo Ecological Reserve Area in September 2010.

Figure 14. *Maytenus thompsonii,* the only known host tree Marianas wandering butterfly, is present but uncommon in the Haputo Ecological Reserve Area limestone forest. Photo: SWCA.

3.3.1.3 Herpetofauna

There are currently no federally listed threatened or endangered reptiles or amphibians on Guam.

3.3.1.4 Birds

The HERA historically supported at least five of the seven federally endangered avian species: the Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*), Guam rail (*Rallus owstoni*), bridled white-eye (*Zosterops conspicillatus*), Mariana crow (*Corvus kubaryi*), and Guam broadbill (*Myiagra freycineti*) (Jenkins 1983, Engbring and Ramsey 1984) (Appendix 4). The Micronesian kingfisher and Guam rail are now extirpated from the wild, but are maintained in captivity (Wiles 2005). The Mariana common moorhen (*Gallinula chloropus guami*) and Mariana swiftlet (*Aerodramus bartschi*) are Guam's only other extant federally endangered avian species. However, these species are unlikely to utilize the HERA because of lack of suitable habitat (Marshall 1949, Baker 1951, Jenkins 1983, USFWS 1991, Takano and Haig 2004). While the bridled white-eye is considered possibly extirpated from Guam (USFWS 2005), the Guam broadbill is officially extinct (USFWS 2004).

The Mariana crow numbers less than five individuals and are recently known to occupy the Munitions Storage Area (MSA) on AAFB (SWCA 2008a). With suitable habitat present in the

HERA, Mariana crows (Figure 15) likely utilized the reserve for foraging and nesting activities. Suitable habitat within the reserve may be used by Guam rails if they were to be successfully re-released on Guam. Since the HERA contains *Pisonia grandis*, a soft-wooded tree that may be appropriate for cavity-nesting Micronesian kingfishers.

Figure 15. The Haputo Ecological Reserve Area historically supported the Mariana crow (*Corvus kubaryi*). Photo: N. Johnson, SWCA.

3.3.1.5 Mammals

The only federally listed terrestrial mammal documented and likely to still occur in the HERA is the threatened Mariana fruit bat (Figure 16: *Pteropus mariannus mariannus*). The HERA has been described as a potentially important feeding area for Mariana fruit bats and they are known to occur in this reserve (USFWS 1986, Helber Hastert and Fee 2005). Although the Mariana fruit bat has been previously observed in the HERA (Morton and Wiles 2002), and less than 1.6 km (1 mi) north of reserve's northern border (SWCA 2008a), there are currently no known roost sites present on in the HERA. However, there are suitable native canopy and understory trees present in the HERA, critical for fruit bat foraging and roosting activities.

Figure 16. Mariana fruit bats (*Pteropus mariannus mariannus*) are known to utilize the Haputo Ecological Reserve Area for foraging. Photo: N. Johnson, SWCA.

3.3.2 Other Species of Interest

3.3.2.1 Plants

Along with the fire tree, the Government of Guam lists two other plant species as endangered and threatened: Ufa-halomtano (*Heritiera longipetiolata*) and tree fern (*Cyathea lunulata*) (GDAWR 2006). Ufa-halomtano is primarily found in northern Guam, restricted to limestone cliffs and plateaus, almost always within 330 to 660 ft (100 to 200 m) of coastal limestone cliffs. A few isolated trees have been identified along the north and east coasts from Ritidian Point to Pagat point (Wiles et al. 1995); however, the species' presence in the HERA is unknown. Tree ferns are considered rare and have only

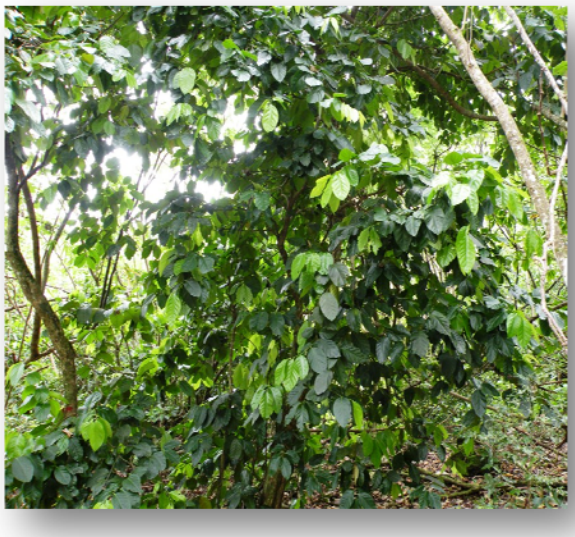

Figure 17. Faniok trees (*Merrilliodendron megacarpum*) are known from the Haputo Ecological Reserve Area. Photo: SWCA.

been found in the southern hills of Guam, including hilly banks of Fena Lake and a wet ravine at Mt. Tenjo. They are not likely to be present in the HERA (Stone 1970, GDAWR 2006).

Figure 18. Fadang (*Cycas micronesica*) is relatively common in the Haputo Ecological Reserve Area. Photo: SWCA.

Two plant species, Faniok (*Merrilliodendron megacarpum*) and Fadang (*Cycas micronesica*), are locally listed as species of greatest conservation need (GDAWR 2006). Faniok is found in limestone forest habitat and is considered rare (Stone 1970). Faniok are known from the HERA (Figure 17) and has also been documented at Hilaan Point, Mt. Lam Lam, Mt. Tenjo, the Agana Spring area, and Naval Munitions Site (GDAWR 2006; SWCA, unpublished data). Fadang is relatively common in the HERA (Figure 18). The University of Guam determined that this species is a major player in ecosystem processes (T. Marler, University of Guam, personal communication). Historically, Fadang was common throughout Guam's undisturbed limestone forests and coastal regions, but since the introduction of the cycad scale (*Aulacaspis yasumatsui*) in 2003, significant mortality has occurred in the population (GDAWR 2006). Although Fadang is known to occur on HERA, the impact of cycad scale on those plants is largely unknown.

3.3.2.2 Invertebrates

A 2001 survey of coconut crabs (*Birgus latro*) at the Communications Annex Finegayan resulted in an estimate of 964 individuals, almost all of which were found in the HERA (USFWS 2001). The population comprised of mainly young, small crabs, 11 percent of which were within the GDAWR-mandated legal size for harvest. Coconut crabs still appear to be relatively common in the HERA (Figure 19: JGPO 2009, SWCA

Figure 19. Relatively large coconut crabs (*Birgus latro*) are present in the Haputo Ecological Reserve Area. Photo: SWCA.

unpublished data), probably due to large inaccessible areas and restrictive access. Coconut crabs are culturally important to the people of Guam.

3.3.2.3 Herpetofauna

There are presently 11 native reptile species in Guam (Rodda et al. 1991). These include six skinks: oceanic snake-eyed skink (*Cryptoblepharis poecilopleurus*), littoral skink (*Emoia atrocostata*), azure-tailed skink (*Emoia cyanura*), Mariana skink (*Emoia slevini*), moth skink (*Lipinia noctua*), Pacific blue-tailed skink (*Emoia caeruleocauda*); and five geckos: oceanic gecko (*Gehyra oceanica*), Pacific slender-toed gecko (*Nactus pelagicus*), Micronesian gecko (*Perochirus ateles*), mutilating gecko (*Gehyra mutilata*), and mourning gecko (*Lepidodactylus lugubris*). Although none are federally listed, eight (five skinks and three geckos) are considered locally endangered or threatened (GDAWR 2006, Appendix 5). These include the oceanic snake-eyed skink, littoral skink, azure-tailed skink, Mariana skink, oceanic gecko, moth skink, Pacific slender-toed gecko, and Micronesian gecko.

Figure 20. Moth skink (*Lipinia noctua*) found on Andersen Air Force Base in 2009. Photo: SWCA.

Wiles et al. (1995) recorded moth skinks at Haputo beach. During surveys in 2008, Pacific blue tailed skink, mourning gecko, and mutilating gecko were captured and/or observed in the HERA (SWCA 2010). Moth skink (Figure 20) and Pacific slender-toed gecko (Figure 21) were found in the same surveys on AAFB adjacent to the HERA.

Figure 21. Pacific slender-toed gecko (*Nactus pelagicus*) found on Andersen Air Force Base in 2009. Photo: SWCA.

3.3.2.4 Birds

The Micronesian starling (*Aplonis opaca*) although not federally listed, is considered a species of conservation need by the Government of Guam (GDAWR 2006, Appendix 5). Jenkins (1983) considered starlings to be uncommon in Guam including the HERA. Micronesian starlings are currently found in the housing area of AAFB, Mount Santa Rosa, and Cocos Island (GDAWR 2006). Although suitable habitat for the starling exists within HERA, there have been no recent sightings of the bird within this area. An observation of one Micronesian starling flying north-northwest over the intersection that leads to the MSA and HSC-25 on AAFB (approximately 8 km or 5 mi from the HERA) occurred in 2007 (N. Johnson, SWCA, personal observation).

Two resident breeding waterbirds, the yellow bittern (*Ixobrychus sinensis*) and Pacific reef heron (*Egretta sacra*) are usually detected in forest edge and exposed coral reef habitats (Pratt et al. 1987). Jenkins (1983) considered yellow bitterns to be uncommon in the HERA. The yellow bittern is considered to be the only native land bird still common on Guam. It is probable that the yellow bittern and Pacific reef-heron utilize parts of the HERA.

Marine waters near the HERA likely serve as important flyways for breeding and non-breeding seabirds. The brown noddy (*Anous stolidus*) and white tern (*Gygis alba*) are Guam's only resident breeding seabirds and likely occur within the boundaries of the HERA.

Some seabirds may not breed on Guam but use the island to roost. Species that are frequently detected in Guam's near-shore waters (possibly including the waters near the HERA), include the wedge-tailed shearwater (*Puffinus pacificus*), white-tailed tropicbird (*Phaethon lepturus*), red-tailed tropicbird (*Phaethon rubricauda*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*), great frigatebird (*Fregata minor*), black noddy (*Anous minutus*), black-naped tern (*Sterna sumatrana*), and sooty tern (*Sterna fuscata*) (Wiles 2005).

Guam serves as an important stop-over location for migratory shorebirds during the non-breeding season, and more than 80 migratory birds have been recorded on Guam (Wiles 2005). Shorebirds are likely to be observed within the HERA on shorelines and exposed coral reef habitats. Frequent sightings during the fall migration have been recorded on Guam for the following species: Pacific golden plover (*Pluvialis fulva*), wandering tattler (*Heteroscelus incanus*), gray-tailed tattler (*Heteroscelus brevipes*), whimbrel (*Numenius phaeopus*), ruddy turnstone (*Arenaria interpres*), and common sandpiper (*Actitis hypoleucos*) (National Audubon Society 1989-2006).

3.3.2.5 Mammals

There are currently no additional mammal species of special interest on Guam.