Hawaiian Green Turtle Nesting Marine Corps Base Hawaii 2023

Environmental Compliance & Protection Division, Natural Resources Office

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1.0 Summary

The Hawaiian green turtle, also known as the honu, are a distinct population segment of the pacific and are designated as threatened under the Endangered Species Act (ESA). Honu nesting occurs annually between April-November. Although only one breeding female was believed to have used Marine Corps Base Hawaii (MCBH) during the 2023 season, all of her nests were successful with an average emergence success rate of 91%.

Clutch sizes in 2023 ranged from 57 to 79 eggs with the average being 66.5 eggs to a clutch. Due to the close monitoring of our volunteers we know that 266 eggs hatched aboard. Highlights include strides in light mitigation and no major disorientation events observed in 2023. Recent literature from Florida published this year supports project development toward nest detection using dogs. Challenges facing nesting honu aboard MCBH consist of extensive light pollution, erosion of the shoreline due to sea level rise, nest inundation, direct conflict with humans and indirect impacts of coastal development from populations of people. MCBH will continue to improve its honu nesting program by working closely with the Malama I Na Honu, United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) as well as other partners.

2.0 Acknowledgments

MCBH has many dedicated volunteers both on and off base as well as support from USFWS, NOAA, and Hawaii Marine Animal Response (HMAR). Volunteers walked the MCBH shorelines multiple times a week monitoring for sign of turtle activity. This work benefits from many caring hands.

A special thanks to all Malama I Na Honu volunteers who dedicated their time to collect the data contained in this report. We especially thank Debbie Herrera, Malama I Na Honu's volunteer coordinator for orchestrating this past season's volunteer effort. She played a critical role in organizing volunteer efforts and directing nest excavations, which will contribute to an overall better understanding of sea turtle species and improved management practices. We thank the USFWS, NOAA and HMAR members for their collaboration on this project. We thank all personnel at S-3 Range Control for working with us and our volunteers.

3.0 Background

Five of the seven sea turtle species can be found in Hawaiian waters. Of the five, the Hawaiian green turtle (*Chelonia mydas*) nests the most often aboard MCBH. The Hawaiian distinct population segment (Figure 1) is considered threatened under the Endangered Species Act (Seminoff et al. 2015).

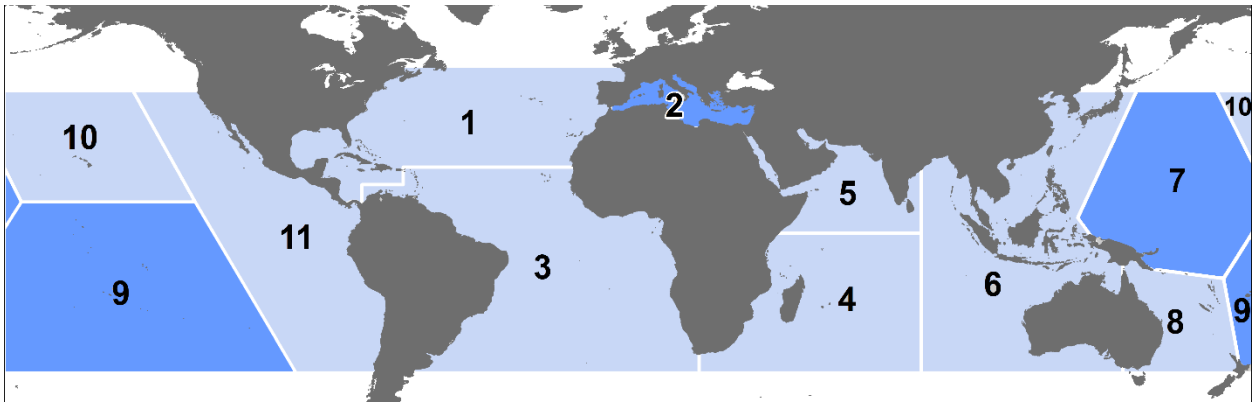

Figure 1: Distinct Population Segments of the Green Turtle (*C. mydas*). **Light blue** represents threatened populations and **dark blue** represents endangered populations. 1. North Atlantic, 2. Mediterranean, 3. South Atlantic, 4. Southwest Indian, 5. North Indian, 6. East Indian-West Pacific, 7. Central West Pacific, 8. Southwest Pacific, 9. Central South Pacific, 10. Central North Pacific, and 11. East Pacific (https://www.fisheries.noaa.gov/resource/map/green-turtle-distinct-population-segments-map).

The Hawaiian green turtle, also known as honu and referenced as such hereafter, typically nests from April to November with the peak hatchling emergences between July and August. Females typically lay between four to six nests in a season but do not lay eggs every year but rather every 2-9 years with the average being every 4 years (Balazs et al. 2015). Clutch sizes vary from 50-150 with nests averaging ~92 eggs per clutch. Incubation takes 50-90 days with an average of 66 days in the Hawaiian Archipelago. Sex ratio is temperature dependent with a pivotal temperature of 29.22° C (84.6° F). Females will develop if temperatures are above the pivotal threshold and males will develop if the temperature cooler. It is unclear how climate change will shift these patterns, if at all. Hatchlings usually emerge at night, queued by temperature. Major ongoing threats to the honu include illegal harvest, incidental take from entanglement in commercial fishing gear, vessel strikes, loss of nesting habitat, artificial lighting, and ingestion of plastics. These threats are compounded by the low survivorship of hatchlings and the many years (25+) it takes for a hatchling to reach sexual maturity. These factors make it crucial to maximize nesting success through protective measures in order to reach species recovery. Although we are required by law to protect these threatened species, protecting them also contributes to Marine Corps overall mission readiness by preserving ecosystem services and improving community relations, as well as remaining compliant with federal regulations. Further details on the nesting ecology of sea turtles can be found in the supplemental documents.

Marine Corps Base Hawaii (MCBH) is responsible for stewarding nearly 14 miles (22.5km) of shoreline. Honu nesting aboard MCBH has been documented at Pyramid Rock, North Beach, Fort Hase, and at Marine Corps Training Area Bellows (MCTAB). Other suitable nesting habitat aboard MCBH may include other locations listed in Table 1 and depicted in Figure 2.

Table 1. Names and codes of delineated beaches aboard MCBH.

#	CODE	NAME
1	HASE_R	Fort Hase WMA (Restricted)
2	HASE_P	Fort Hase (Public area)
3	FOBE	Fossil Beach
4	PORO	Pond Road Cove Beach
5	NOBE	North Beach
6	PYRO	Pyramid Rock
7	PAKI	Pali Kilo
8	HAKO	Hale Koa/Cabanas beaches
9	MCTA	Marine Corps Training Area Bellows (MCTAB)
10	PRTF	Puuloa Range Training Facility

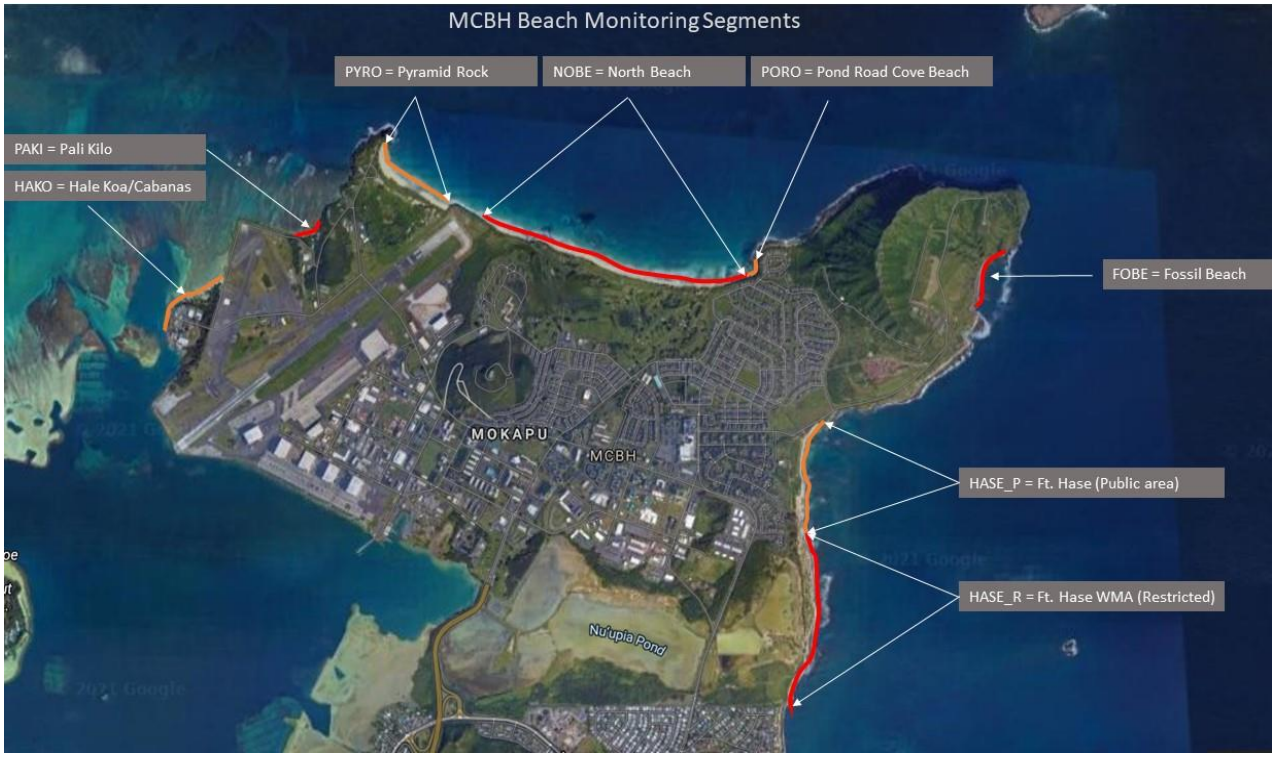

Figure 2: Beach segments at MCBH Kaneohe Bay. MCTAB and Pu'uloa RTF are not depicted above.

3.1 Seasonal Preparations

Seasonal preparations included a MCBH volunteer orientation hosted at the Environmental Compliance & Protection Division office Building 1359. This orientation guides volunteers with specific requirements and procedures for work on base. We also worked with the City & County of Honolulu Parks and Recreation to close overnight camping at MCTAB May 16th – August 31st in anticipation of nesting.

A nest was designated a "presumed nest" when there was adequate evidence to suggest a nest such as a body pit, mound and/or tracks. Presumed nests were marked with GPS, cordoned off to protect the site, and later excavated with USFWS, sub-permittees and MCBH Natural Resources staff (USFWS excavation permit FWSPIFW0-26, TE-039990-26). A nest was designated a "confirmed nest" when a nest chamber was found

during the excavation. If a presumed nest is excavated and no chamber is found, it is then deemed a 'false crawl', which are not uncommon. Egg chambers were located and emergence data was successfully collected for four confirmed nests. The other three presumed nests were deemed 'false-crawls.'

3.2 Partnerships

During the 2023 season, the Natural Resources office enhanced its partnership with the volunteer organization, Malama I Na Honu and hosted a MCBH specific orientation with volunteers on April 13th. We also worked closely with experts from University of Hawaii, USFWS, and NOAA. Guided by the experts, volunteers logged 785 hours while assisting with monitoring shorelines, collecting data, documenting changes, and excavating presumed nests. Volunteers walked MCBH beaches 2-3 times a week, often late at night, early in the morning, and during the heat of the day to attain high resolution data, identify nests, and report on-site conditions. Natural Resources staff and the most dedicated volunteers excavated the majority of nests. Excavation data was shared via the ESRI Fieldmaps application with our partner agencies to better understand nesting sea turtles broadly.

3.3 Light Mitigations

Many of the lighting mitigations measures from 2020 and 2021 were implemented again in the spring of 2022. These include 36 bollard lights covered with plastic shrouds along the Fort Hase running path, the exterior wall lights on building 1551 being de-energized, and continued relations with key stakeholders such as base Facilities, Hunt Housing, Base Safety, and the Provost Marshall's Office. The recent renovation of the back gate entry control point completed in July 2022 presented many challenges and resulted in re-opening consultation with USFWS. However, working with our partners almost all challenges have been overcome including the vehicle search area (Figure 3). A NAVFAC project is still being developed to plant a vegetative barrier between the housing and beach along Fort Hase to mitigate lights coming from residential homes.

Most notably, the Environmental Compliance & Protection Division (ECPD) successfully purchased 25 Amber LED lights from Alpha Electric of which 19 have been installed since January 2023 in the Pa Honua neighborhood as part of an agreement with Hunt Housing. Furthermore, at the time of writing, ECPD has secured $100k dollars earmarked for purchase of additional amber LEDs and has passed that money to base Facilities who will then seek out and retrofit problematic streetlights such as those depicted in Figure 4.

At MCTAB, although we did not document any nesting, bathhouse lights were de-energized and camping was prohibited during the bulk of the nesting season. Prior to the emergence window, if a known nests was susceptible to light pollution, it is protocol for Natural Resources staff to construct a barrier of silt construction fabric to mitigate light disorientation. The barriers were U shaped and directed hatchlings towards the ocean. Since all of our nesting was confined to Fort Hase Restricted WMA, this technique was not needed due to the short beach and dark remote area.

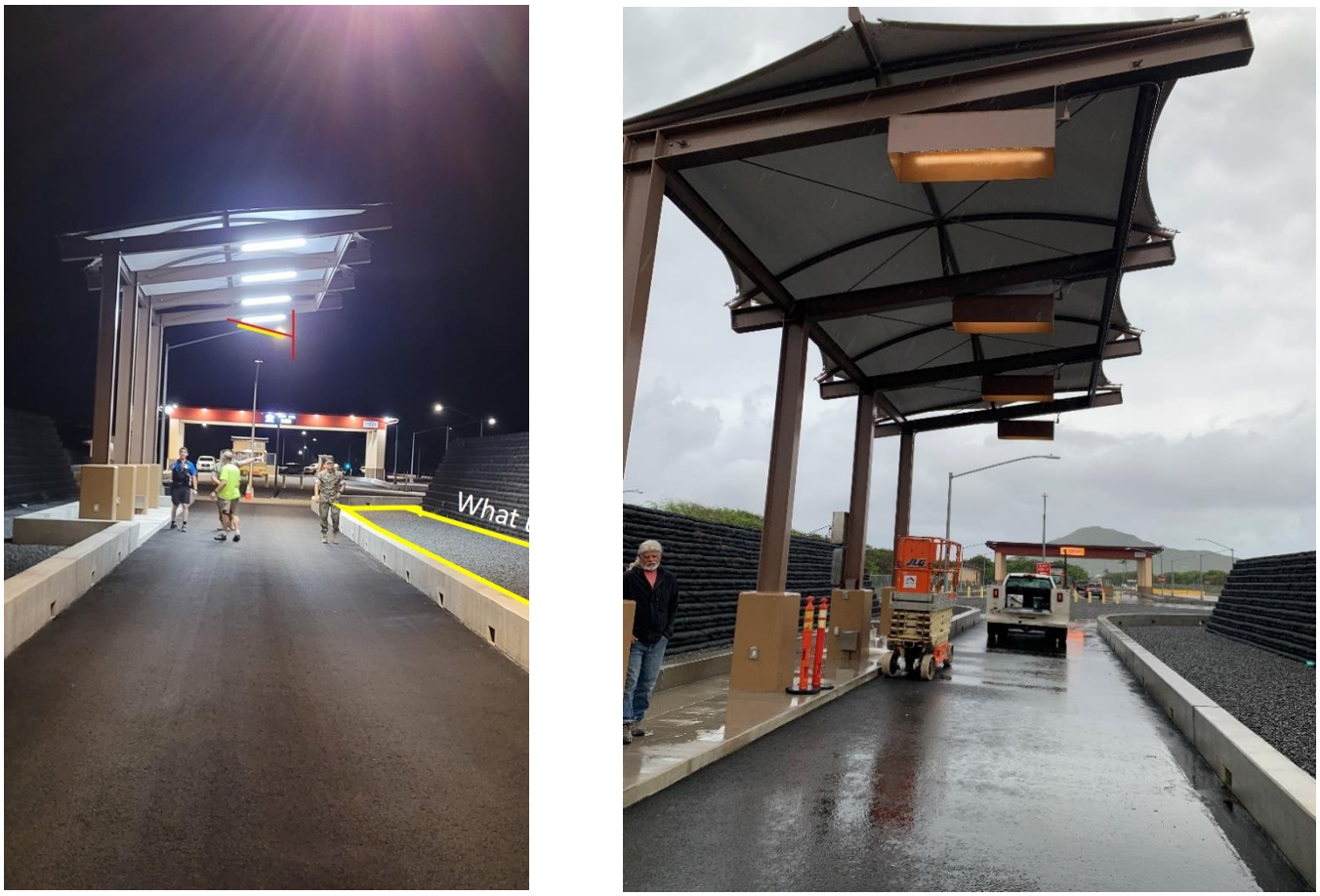

Figure 3: Before (left) and after (right) photos of the back gate entry control point. The warmer amber lighting and shrouds will help to prevent light trespass into the wildlife management area. Photos taken by Lance Bookless.

Figure 4: A problematic streetlight in the neighborhood overlooking Fort Hase at the base of Ulu‘pau crater. Note how the light scatters all directions including into the street side neighbor’s windows.

3.4 Outreach Actions

No outreach events during excavations were performed due to location of all nests. Had nests been laid along Pyramid Rock beach, North Beach or Fort Hase Public, events offer participants a chance to witness real time sea turtle conservation in action complete with USFWS and volunteers. Events emphasized threats, actions taken by MCBH to mitigate threats, and how sea turtle conservation fits into overall military readiness as well as specific biology of the species.

MCBH purchased $3,700 in materials needed for managing nesting sites in 2020 and much of those materials continue to pay dividends. Natural Resources staff designed and commissioned the production of 90 metal signs to be used at marked nests and in the general area of any turtle nesting activity. Each presumed nest in 2023 was cordoned off with corrosion resistant light chain and signs mounted. Additionally, MCBH conducted outreach and education through social media, beach signs, delivered internal notifications to residents and routine interactions with the public.

4.0 2023 Results

4.1 Nesting success

During the 2023 nesting season MCBH identified only seven presumed nests on MCBH beaches. All seven presumed nests detected were along the Fort Hase Restricted beach inside the wildlife management area (WMA). MCBH confirmed and collected data from four nests, likely from a single female (Table 2). All other MCBH beaches including MCTAB did not have any detected nests during the 2023 season. Walks began early April and the first nest was detected April 18th. The last nest detected was laid June 21st. However, volunteers continued to walk beaches until the last day of September in order to catch any late nesters. MCBH had an average nesting success rate of 91.06% in 2023. Clutch sizes ranged from 57 to 79 eggs with the average being 67 eggs to a clutch. Due to the close monitoring of our volunteers we know that 243 eggs hatched aboard MCBH.

Table 2: Summary table of all confirmed nests excavated in 2023. Nests 4-6 were deemed false crawls.

Site ID	Date Found (MM/DD/YYYY)	Excavation Date	Total Clutch Size	Emergence Success %
HASE_R_1	4/18/2023	7/24/2023	79	89.87
HASE_R_2	5/2/2023	7/24/2023	66	89.39
HASE_R_3	5/16/2023	7/24/2023	64	93.75
HASE_R_7	6/21/2023	9/8/2023	57	91.23
		Average	66.5	91.06
		Total	266	N/A

4.2 MCBH Nests Compared to O‘ahu’s

O‘ahu had a total of 32 confirmed nests on island in 2023 with four of them (12.5%) being aboard MCBH. Mean clutch size on island was Mean emergence success across the island is ~84% (n=27). Comparatively, MCBH had a mean emergence success of 91% (n=4) in 2023. In the past we have had nests along Fort Hase restricted with 23% emergence success due to wash over from rising tides, demonstrating the clear threat of sea level rise in the wake of human induced climate change and runaway emissions.

USFWS conservatively estimates between 2020-2022 O‘ahu’s nesting population totals 26 females (pers. comm). Using some of the same calculations for same years, the Natural Resources Office estimates five to six females are using MCBH habitat. There were 2,877 eggs laid between 2020-2022 aboard MCBH. Divided by a

island mean clutch size of 80±15 yields approximately 36 nests. Further divided by a conservative estimate of six clutches per female, it becomes reasonable to assume MCBH had five to six nesting females for those years. For 2023, we are confident all four nests aboard MCBH came from a single female.

4.3 Nesting aboard MCBH: Current year vs Historical years

a) 2019 = 7 presumed nests / 4 confirmed nests

b) 2020 = 17 presumed nests / 7 confirmed nests

c) 2021 = 31 presumed nests / 18 confirmed nests

d) 2022 = 33 presumed nests / 13 confirmed nests

e) 2023 = 7 presumed nests / 4 confirmed nests

4.4 Outreach Success

No formal education & outreach events were hosted during excavations in 2023. However, we continued awareness efforts via email, social media, and face to face communication when possible.

5.0 Factors Impacting Nest Success/Failure

5.1 Sea Level Rise and Storm Surges

In 2023, no major storms or cyclones made landfall on O‘ahu. However, as the human race continues to generate additional greenhouse gases, the warming of the oceans from climate change will drive further sea level rise and potentially impact future nests by inundating eggs. Increased intensity and frequency of storm surges from climate change along with sea level rise will also erode away future nesting habitat, potentially posing a long-term risk to the species.

5.2 Light Disorientation

Light disorientation occurs when hatchlings emerge from the nest and struggle to find the ocean due to the glow of inland light pollution. Once turtles emerge from the egg chamber, honu hatchlings rely partially on the moon light and horizon as natural ques or indicators to navigate to the water. They can confuse manmade sources of light, such as streetlamps, with these natural indicators and migrate inland, away from the sea. Because they have limited energy stores, light disorientation impacts survival and can result in incidental take. Artificial light sources may also deter adult females exiting the water to lay eggs. In 2023, we did not detect any evidence of light disorientation aboard MCBH. This is largely due to the short beach and the regular tides that wash away hatchling tracks before they can be detected and followed.

MCBH has made significant cuts to its coastal light signature since 2020 but will continue to work hard to reduce light pollution further. In general, all non-essential lighting near the shoreline should be turned off to avoid incidental take and harm to wildlife. International Dark Sky standards are techniques and/or methods that reduce light pollution while maintaining essential lighting. A rule of thumb for essential lighting is to keep lights “long, shielded, and low.” Using lights with ‘longer’ wavelengths (≥560nm) should reduce the risk of disorienting honu. However, there is some evidence that even ‘turtle safe’ lighting can disorient hatchlings, especially when closer than four meters or on a moonless nights (Robertson et al. 2016). Keeping lights shielded ensures light is directed where needed while preventing light glare where it is not needed. Keeping lights ‘low’ refers to low lumens and wattage as well as physically lower to the ground (Figure 5).

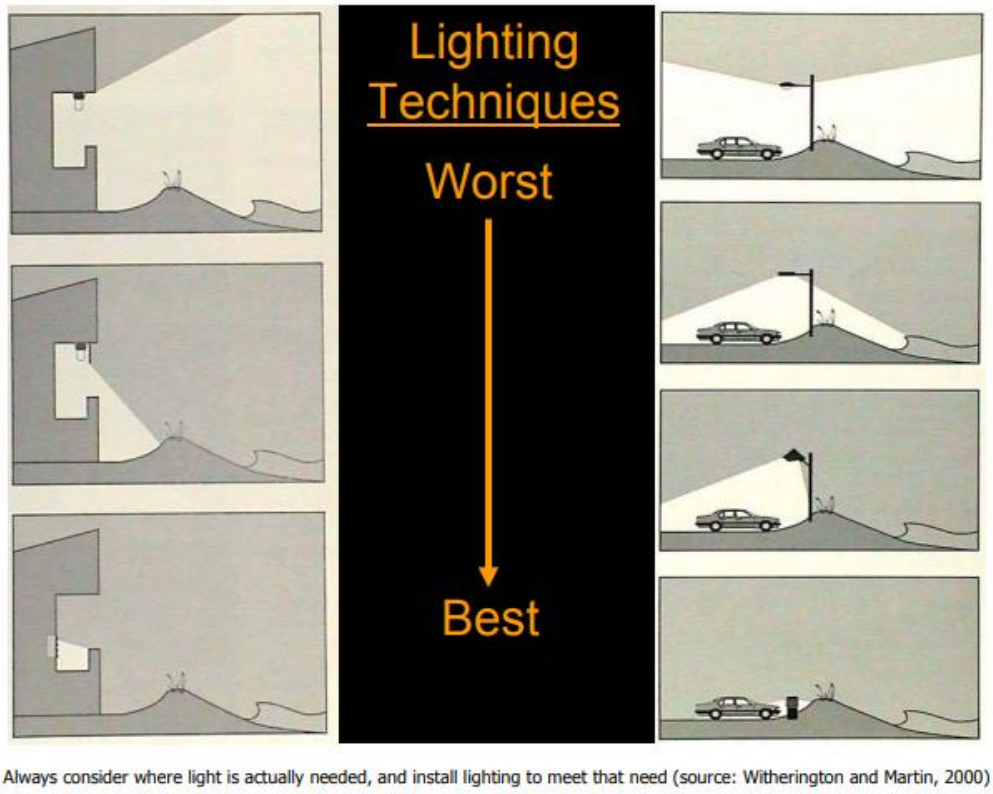

Figure 5: Illustrative methods from worst (top) to best (bottom) lighting techniques.

5.3 Education & Outreach

Outreach and education efforts may also impact nesting success. Community awareness enables and encourages individuals to keep their spaces darker by turning off unneeded lights, closing shades/blinds, and lighting beach fires. Outreach and education may also boost reports forwarded to law enforcement and encourages a self-policing community.

There may be other unknown impacts to nesting success not addressed here. However, we will continue to monitor nesting aboard MCBH, implement adaptive management techniques, and improve best management practices to the honu program.

6.0 Depleted Volunteer Contingency Plan

High resolution data collection is made possible by a small group of dedicated volunteers. Should our relationship wane, collection of high resolution may not be possible, inhibiting our capacity to manage this endangered species effectively. The Natural Resources Office cannot foresee a time when monitoring wouldn't be needed as it is a critical necessity to adaptive management of the natural resources. Nonetheless, should volunteers be lacking, the ECPD Bioscience Tech and Natural Resource Managers will have to use the ATV to monitor North Beach and Pyramid Rock during the season. The full length of Fort Hase (Public & Restricted) would still have to be walked regularly. All beaches should be monitored a minimum of once a week with a emphasis on beaches historically used by nesting females. The Natural Resources Office would have to lean heavily on the detection methods discussed below and an additional support position would be strongly advised.

7.0 Detecting Active Nests

If MCBH continues to receive increased nesting along its shoreline, honu nests may have the potential to impede training, depending on the density of nesting. Being able to detect active nests will allow Natural

Resources staff to minimize the area protected to just 'confirmed active nests.' Using multiple methods to eliminate false crawls will be especially useful during large training operations such as RIMPAC, which occurs every two years. Natural Resources staff is in close communication with USFWS during all phases of the projects including design to ensure the success of the research and approvals. This research will be a valuable contribution to the scientific community while enhancing MCBH's overall mission readiness.

7.1 Ground Penetrating RaDAR (GPR)

Ground penetrating RaDAR (GPR) may be a feasible option to detect active nests and can be applied to presumed nests or possibly to a small area on the beach essential for training. Natural Resources staff members have reviewed the scant research available on the use of GPR to identify active turtle nests (Ermakov et al. 2021; Korczak, Bruder, & Spisani 2016). Natural resources staff have determined a research project specific to Hawai'i will have to be conducted to analyze the use of GPR in detecting active honu nests. Natural Resources staff, USFWS, and GPR contractors have collaborated on a basic study design and have a project slated for 2023. Under the supervision of USFWS, on July 7th 2021 contractors visited several HASP nests to see if a signature could be picked up (Figure 6, Section 9.0). While preliminary testing was promising, Nest IDs will need to be associated with scans and a scientific analysis conducted.

7.2 Detection Dogs

The use of detection canines could be used to distinguish active nests from false crawls after locating presumed nests. Detection dogs could also be applied to identify active nests not previously identified by volunteers (Witherington et al. 2017). Lindborg, Peruyero, and Witherington demonstrated in 2023 a canine is more accurate and efficient at locating deposited eggs. The Natural Resources office has engaged in preliminary discussions with Conservation Dogs Hawai'i LLC. Natural Resources Staff, USFWS, and the dog handlers will collaborate on a study design and pilot project. USFWS has confirmed no permit is needed to train the dog using eggs post excavation and that a letter of transfer would allow the handlers to retain eggs to train the dogs, if needed.

Interestingly, dogs have already been used on Maui to detect Hawksbill nests. The dog's name was Tauzer and was trained in Florida using cloacal mucus fluid under a USFWS Permit. Dogs were on call. Although, that research was very limited, unpublished, and unfinished. In 2022, Conservation Dogs Hawai'i LLC initiated a pilot study with two dogs using empty eggs shells collected early in the season from North Beach, Fort Hase, and other island locations not aboard MCBH. As a control, sand adjacent to the egg chamber was also collected. After a series of trials and various methods. Egg shells were found to be ultimately ineffective. The pilot study demonstrated the need for good timing of surveys. Calm mornings with low winds will increase accuracy.

8.0 Conclusions and Recommendations

MCBH is becoming regular nesting habitat for these species and it is reasonable to assume nesting will continue as habitat in the northwestern Hawaiian islands erode away due to more frequent and intense storm surges. With a significant portion of O'ahu's nesting, the Natural Resources office will continue to improve its honu nesting program by working closely with regulatory entities and collaborators.

Immediate efforts should be targeted towards detecting active nests, outreach & education, and lighting mitigations. Accurately detecting active nests with high fidelity allows Natural Resources staff to manage the species more effectively, while minimizing impacts to training. Additionally, projects contracting GPR and detection dogs to detect active nests would be scientifically valuable and would benefit the species as a whole. Bolstering outreach and education would raise on-base and off-base awareness of the species and its threats. Greater community awareness could have direct impacts such as individual residents mitigating the light pollution on their property, but could also take the form of indirect impacts such as a self-policing community that reports violations of base policy and take. To prevent disorienting honu hatchlings, Natural Resources staff will continue work with base Facilities to implement lighting mitigations with long-term goals aimed towards converting all essential lighting to fit International Dark Sky standards following the core principles of 'long, low, and shielded.'

Mitigating on base light pollution will require active participation from base Facilities as well as base Planning but will benefit other wildlife species such as seabirds as well as the honu, effectively solving multiple problems simultaneously. It is also recommended that MCBH continue to enforce federal endangered species laws and base orders with veracity.

Long-term efforts should target shoreline restoration efforts to reduce sediment runoff and beach erosion. Out planting vegetation along the crest of the beach dune should retain more sand for current and future marine units to train on as well as preserving valuable nesting habitat for the honu. These efforts will become even more critical over the coming decades as worsening climate change threatens national security (DoD 2015 & 2019).

MCBH is committed to the protection and preservation of sea turtles and their habitats. MCBH recognizes the value of these natural resources and the role they play in the overall mission readiness of the installation. Natural Resources staff will continue to strengthen partnerships with USFWS, NOAA, HMAR, and Malama Na Honu to better manage sea turtle species, collectively. The Natural Resources staff looks forward to future successful seasons and is committed to implementing adaptive best management practices supported by the latest science.

9.0 Additional Figures

Figure 6: Contractors move GPR scanners over several 2021 nests at the public side of Fort Hase.

Figure 7: Overview of presumed nests aboard MCBH Kaneohe Bay in 2023. Imagery includes the cluster of seven presumed nests (orange dots; Figure 8) in the WMA, one false crawl on Fort Hase Public (orange dot), and one basking male Green Turtle (*C. Mydas*) on North Beach (green dot; Figure 9) documented July 20th around 1045am. The sea turtle re-entered the water soon after seeing the volunteer from 50-100 feet.

Figure 8: Zoomed in aerial of all seven 2023 presumed nests on Fort Hase Restricted. Only nests 2, 4, 6, and 7 are visible with the ESRI software.

Figure 9: Photos taken of tracks (left) and adult male Green Turtle (*C. Mydas;* right) at North Beach on July 20th 2023. Photos taken by Sadie Hausman.

10.0 References

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11.0 List of Supplemental Documents (available upon request)

1. Sea Turtle Ecology_CONDENSED
2. MCBH turtle nest protocol
3. USFWS Emergence Guidelines
4. USFWS Permit (TE-039990-26)
5. Section 106