Action Plan for Research and Management of Hawksbill Sea Turtles (*Eretmochelys imbricata*) in Hawai‘i: 2018-2022

National Marine Fisheries Service
Pacific Islands Region

Pacific Islands
Fish and Wildlife Office

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Cover photo credit: D. McLeish. #MUI40 (“Barnacle Billie”), Maui

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I. Background on Hawksbill Turtle Research and Management in Hawai‘i

Introduction and Statement of Need

Hawksbill sea turtles (*Eretmochelys imbricata*) were listed as endangered throughout their range on June 2, 1970 (35 FR 8491) under the Endangered Species Act (ESA). Globally, hawksbill populations are estimated to have declined >80%, leading to inclusion of the species as Critically Endangered (CR) on the Red List of the International Union for the Conservation of Nature (IUCN) (Mortimer & Donnelly, 2008). In Hawai‘i, hawksbill turtles are present predominantly in nearshore waters, along with the much more abundant green turtle (*Chelonia mydas*), which is classified as threatened under the ESA occurring within the Central North Pacific DPS (81 FR 20057). Preliminary genetic research suggests that hawksbill turtles in Hawai‘i represent a distinct genetic stock (Dutton 2008) and evidence indicates the species may spend most, if not all of its life cycle within nearshore waters of the Main Hawaiian Islands (MHI) (Parker et al. 2009; Van Houtan et al. 2016), potentially after a pelagic post-hatchling development phase.

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibility for management and recovery of sea turtle species listed under the ESA that are found in waters and on lands under U.S. jurisdiction. NMFS is responsible for addressing activities that affect sea turtles in the marine environment, while USFWS is responsible for addressing activities that affect sea turtles in the terrestrial environment. As sea turtles used both of these environments for resting, migrating, foraging, nesting and basking, the agencies must work together to establish research and management priorities, and to implement actions for recovery of listed species.

Several past efforts have been undertaken to develop research and management recommendations for hawksbill turtles in Hawai‘i. In the late 1980s, an Interim Recovery Plan for Hawaiian Sea Turtles (hereon referred to simply as HI Interim Recovery Plan) was written by an officially appointed Recovery Team, which included members from federal and state agencies (Balazs et al. 1992). In 1992, this Plan was issued as an Administrative Report, while a new team was appointed to address all Pacific sea turtles and develop official U.S. Recovery Plans for each species. In 1994, representatives from NMFS, USFWS, and the Hawai‘i Volcanoes National Park Service (NPS) came together and developed a summary of recommendations, agreed upon at an informal interagency planning meeting, on issues related to the endangered hawksbill turtle in Hawai‘i (Katahira et al. 1994). Nonetheless, as research and management has advanced substantially since that time, many of those recommendations are now outdated (see Appendix I). Many recommendations have been implemented, some actions are still ongoing, and several are no longer viable or necessary. The recommendations also largely focused on one particular nesting beach (Kamehame), however other beaches with important levels of nesting have been identified since that time (e.g., Pōhue Bay).

Assessing hawksbills in their marine habitats has also gradually become more common, increasing the scope of research and management in these areas.

The final Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle was published in 1998 (NMFS and USFWS 1998; Hereon referred to simply as U.S. Recovery Plan). The geographic scope of the U.S. Recovery Plan extends from the Pacific coast of the United States moving westward across the Pacific Ocean to encompass all U.S. Territories, the state of Hawai‘i, and U.S. affiliated but independent nations as far west as Palau.[1] Five-year reviews for the hawksbill turtle were completed in 1985 (Mager 1985; 50 FR 29901), 1991 (56 FR 56882), 1995 (Plotkin 1995), 2007 (NMFS and USFWS 2007) and 2013 (NMFS and USFWS 2013). The purpose of a five year-review is to evaluate the listing status of a species and determine whether a change in listing is warranted given the new body of knowledge that has accumulated since the last status review, as well as to define/update recovery goals and actions. The most recent review determined that the current listing of endangered is still appropriate for hawksbill turtles throughout its range (NMFS & USFWS 2013). However, the review also indicated that additional recovery actions could be identified and that hawksbills should be evaluated to determine whether the application of the Distinct Population Segment (DPS) policy is appropriate. While the U.S. Recovery Plan includes a list of primary threats for Pacific hawksbill turtles, the recovery criteria and actions outlined in the plan are directed at the species as a whole across the U.S. Pacific Islands, Territories and affiliated nations, thus a plan outlining specific actions for hawksbills in Hawai‘i is warranted.

This Hawai‘i Hawksbill Turtle Action Plan (hereon referred to simply as HI Action Plan) meets this need by detailing previous, current and future research and management actions needed for hawksbill turtle protection and recovery in Hawai‘i. Future objectives and actions are guided by identified gaps in knowledge or actions, which translate into research or management priorities for the population, and set feasible recovery goals. In doing so, this HI Action Plan provides comprehensive information for hawksbill turtles in Hawai‘i, which can be applied to future status reviews, ESA Section 7 consultations, and help set funding or program priorities. Although some of the previously mentioned plans and recommendations are outdated, or identify priorities over a much broader geographic scale, they provide the framework upon which this updated HI Action Plan has been developed. Given this context, this HI Action Plan incorporates suggestions and actions identified in the U.S. Recovery Plan and the HI Interim Recovery Plan, while also relying heavily upon recommended actions and needs identified by USFWS, NOAA and partners over the past 25+ years. Additionally, this Plan incorporates recommendations from the National Resource Council’s Review of Sea Turtle Assessment Methods (NRC 2010) and NOAA’s Research Plan for Marine Turtle Stock Assessments (NMFS 2013). This HI Action Plan is intended to span five years (2018-2022), and will be reviewed and updated as needed every five years (i.e., next update/revision due in 2022).

[1] Hawai‘i, U.S. Territories (Guam, Commonwealth of Northern Mariana Islands, and American Samoa), U.S. Pacific Island Areas (Howland, Baker, Wake Jarvis, Midway Islands, Johnston Atoll, Palmyra Atoll and Kingman Reef), and U.S.-affiliated but independent nations (republic of the Marshall Islands, federated States of Micronesia, and Republic of Palau).

Cultural Significance

Green and hawksbill sea turtles are indigenous to Hawai‘i and have historically played an important role in Hawaiian culture. Sea turtles appear throughout Hawaiian lore and legends, in hula, petroglyphs, chants and tattoos, and were utilized in traditional ceremonies, with their use controlled by the kapu (‘taboo’ or prohibition) system. Some families continue to highly revere sea turtles as their ‘aumakua or personal gods. ‘Ea or honu‘ea (Hawaiian name for the hawksbill turtle) is mentioned in the 4th verse of the Kumulipo, the Hawaiian creation chant. Historically, ‘ea meat was consumed, although not as highly esteemed for food as the honu (green turtle), possibly due to the fact that hawksbill meat is sometimes poisonous, which is suspected to be a result of their diet, which can include toxic sponges. ‘Ea shells were prized for the making of fish hooks, tools, medicine and jewelry (‘tortoiseshell’).

Geographic Distribution

Globally, hawksbill turtles have a circumtropical distribution, generally occurring between 30°N and 30°S latitudes. In Hawai‘i, hawksbill nesting and foraging has primarily been documented in the MHI. While no direct monitoring efforts are in place in the Northwest Hawaiian Islands (NWHI), there are at least six recorded observations of hawksbills and two potential historic nesting records from the area (Van Houtan et al., 2012).

Nesting Females and Population Trends

Monitoring the number of females that come ashore to nest is the most logistically and economically feasible method to evaluate sea turtle populations (Balazs & Chaloupka, 2004). Despite the fact that hawksbill turtles in Hawai‘i have been afforded the same protections as the threatened Hawaiian green turtle (i.e., Central North Pacific DPS; 81 FR 20057), they have not experienced a similar recovery trend (Figure 1). This is a significant management issue and represents a primary focus for future research attention. Further, a better understanding of the current and historical abundance and distribution of hawksbill turtle nesting in Hawai‘i is needed. While it appears that only a small number of hawksbill turtles currently nest in Hawai‘i, it is unclear whether the species has suffered a major decline compared to historical numbers, or if it has always persisted at relatively low levels in the region (albeit perhaps higher than current levels).

The majority of the nesting and demographic information currently available for hawksbills in Hawai‘i has been collected via nesting beach monitoring projects carried out on the Island of Hawai‘i[2] and on Maui[3], where monitoring efforts began in the early 1990s. However, despite the long timespan of these projects, significant gaps remain in the scientific understanding of nesting by the species on the Hawaiian archipelago. This

[2] Hawksbill turtle nesting beach monitoring activities on the Island of Hawai‘i have been undertaken by the NPS Hawaii Volcanoes National Park (HAVO), Hawai‘i Island Hawksbill Turtle Recovery Project (HIHTRP).

[3] Hawksbill turtle nesting beach monitoring activities on Maui have been undertaken via a consortium of partners including the USFWS, State of Hawaii Department of Land and Natural Resources (DLNR), Hawaii Wildlife Fund (HWF), and community-based volunteers (e.g., USFWS coordinated Dawn Patrol).

is due in large part to the diffuse and less colonial nesting habits of this species, as well as the tendency to use remote nesting beaches (Gaos et al. 2010, 2017a), characteristics that are especially prevalent in Hawai‘i.

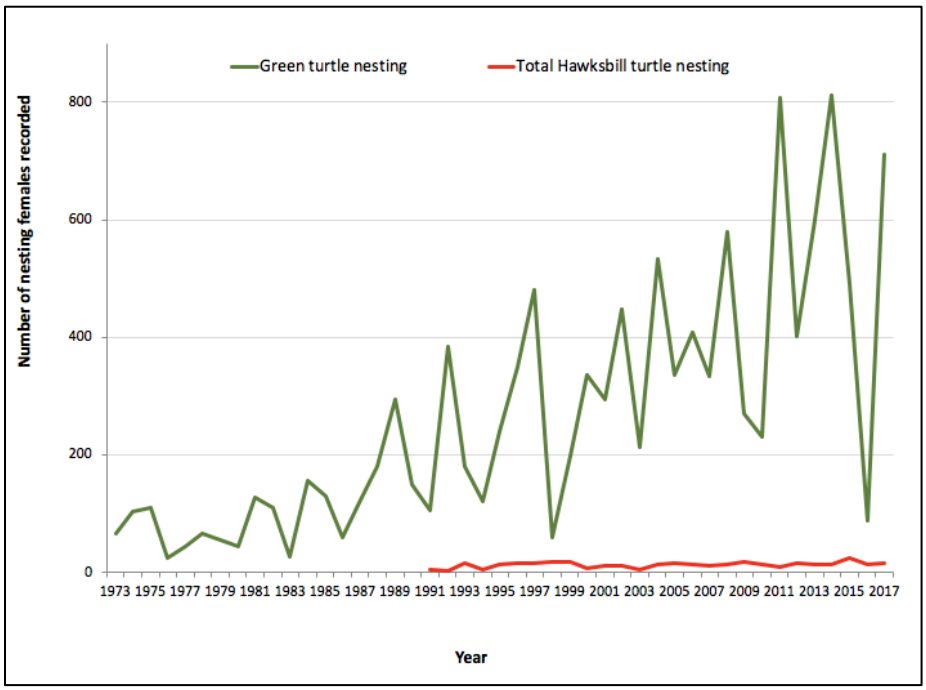

Figure 1. The increasing nesting trend for green turtles (green line) contrasts with lack of increase for hawksbills (red line) in Hawai‘i (PIFSC MTBAP unpublished).

Over 90% of documented hawksbill turtle nesting activity in the Hawaiian archipelago has been recorded along the Ka‘ū Coast (southeast shoreline) of the Island of Hawai‘i.[4] The remaining nesting has been documented primarily on other parts of the Island of Hawai‘i and on southern Maui, as well as limited nesting along the eastern coast of Moloka‘i (i.e., Halawa beach) and eastern Maui (Figure 2). There is speculation that occasional nesting may occur on the northern coast of Lāna‘i (e.g., Shipwreck Beach) and the windward (eastern) coast of O‘ahu as several hawksbill hatchlings strand almost annually along that coast, typically during September and October (see Appendix II), but no nests have been documented to date on the island. Not all sites are active every year and the annual level of nesting activity for each site can fluctuate substantially (Seitz et al. 2012; Kurpita 2015).

Between 1991 and 2017, 160 individual nesting females have been tagged on the Island of Hawai‘i and ten on Maui. Approximately 10 to 25 females may nest on Hawai‘i’s beaches annually, yet this may be an underestimate due to the innate difficulties in monitoring the species (see details below). The average hawksbill clutch in Hawai‘i

[4] As of the 2017 nesting season, hawksbill turtle nesting activity has been documented at a total of 23 individual beaches, including 13 on the Island of Hawai‘i, nine on Maui, and one on Moloka‘i.

contains 175.2 (±1.5) eggs, incubates for approximately two months (62.5 days ± 0.4) and experiences a hatching success rate of 71.9% (± 1.0) (Seitz et al. 2012). The nesting season typically spans from May to December, with peak nesting occurring between late-July and mid-September (Seitz et al. 2012).

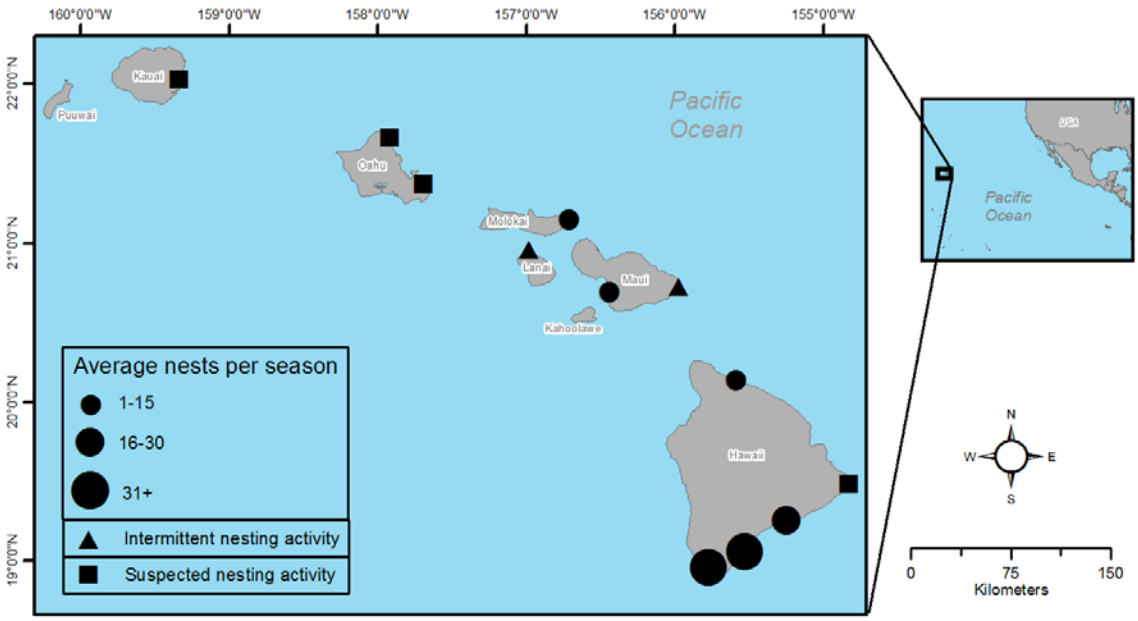

Figure 2. Map of confirmed and suspected hawksbill nesting on the Main Hawaiian Islands.

In Hawai‘i, hawksbill turtles nest in a variety of habitats, including extensive black and white sand beaches. Typical nesting beaches on Hawai‘i Island are located in small pocket coves and are covered in crushed coral substrates. Females often lay eggs under dense beach vegetation, although nesting along bare beach-berms is also common. The combination of substrate types and vegetation cover often make it difficult to detect tracks and evidence of nesting, thus complicating the quantification of nesting activity and identification of new nesting beaches. When coupled with the low numbers of hawksbill turtles in the Hawaiian archipelago, these factors complicate detection, monitoring and quantification of nesting hawksbills and their nesting habitats. Anecdotal reports suggest that multiple undiscovered hawksbill rookeries may exist on remote pocket beaches around the island chain. Identifying these “missing” rookeries and implementing monitoring at priority sites will be critical to better understanding the status and management needs of hawksbills in the region.

Even on the Island of Hawai‘i, where the bulk of monitoring and nesting has been carried out and documented to date, respectively, many beaches have yet to be evaluated. Here too the lack of monitoring is due to the remote and inaccessible nature of beaches, as well

as extreme weather conditions, lack of funding, inadequate vehicles/equipment, and other logistical complications. To illustrate the impact of these challenges, in 2015 at total of 67 nests were documented on the Island of Hawai‘i, but 30 (45%) of those nests were laid by unidentified/unobserved females. Hawksbill tracks were also seen at four additional beaches, but observation and identification of the nesting female was not possible (Kurpita 2015). Additionally, each season more than 50% of the nesting females represent neophyte nesters. Although this may bode well for the future of the population as these turtles represent new recruits to the nesting population and indicate at least some females are surviving to reach sexual maturity, the fact that so few remigrants from previous years are returning to nest indicates these individuals are likely using unidentified or unmonitored nesting beaches (or are no longer reproducing). These results highlight the need to identify and increase monitoring at primary and secondary nesting sites in order to support robust assessment and management efforts.

Age to Maturity

Results from skeletochronology work indicate an approximate age to maturity of 17-22 years for hawksbills in Hawai‘i (Snover et al. 2012). However, a recent study using bomb radiocarbon dating to estimate growth and maturity, estimated average age of first breeding at 29 years (range 23-36) (Van Houtan et al. 2016). The disparity between these two studies demonstrates the uncertainty in this key life-history parameter and highlights the ongoing need to conduct more rigorous research on growth and maturity.

Foraging Habitat, Diet and Movement Ecology

Limited data on growth rates, diet and habitat use exist for hawksbill turtles in Hawai‘i, and no information exists on metabolic rates or energetics (i.e., energy budgets), which are essential elements to understanding population dynamics and critical for population assessments and modeling. Further, the identification of hawksbill foraging sites remains an important management need in order to better protect the species and their key habitats.

Juvenile and adult hawksbills have been sighted in marine habitats throughout the state, including in harbors (e.g., three juveniles sighted in Ko‘olina harbor in April 2017) and more commonly, along the open coast. Numerous sightings have been reported at foraging habitats along west Maui, specifically, likely due in large part to directed efforts by conservation organizations and collaborators in the area (King 2015; see www.HIhawksbills.org).

In 2015, three adult females were captured and satellite tagged in foraging habitats off Kahekili, Maui. One turtle (ID# MUI24 “Misty”) had recently nested on the Island of Hawai‘i, but the other two were untagged. All three tracks indicated highly restricted foraging home ranges, and none of the turtles undertook nesting migrations during the two years the transmitters were active (Figure 3; PIFSC unpublished data).

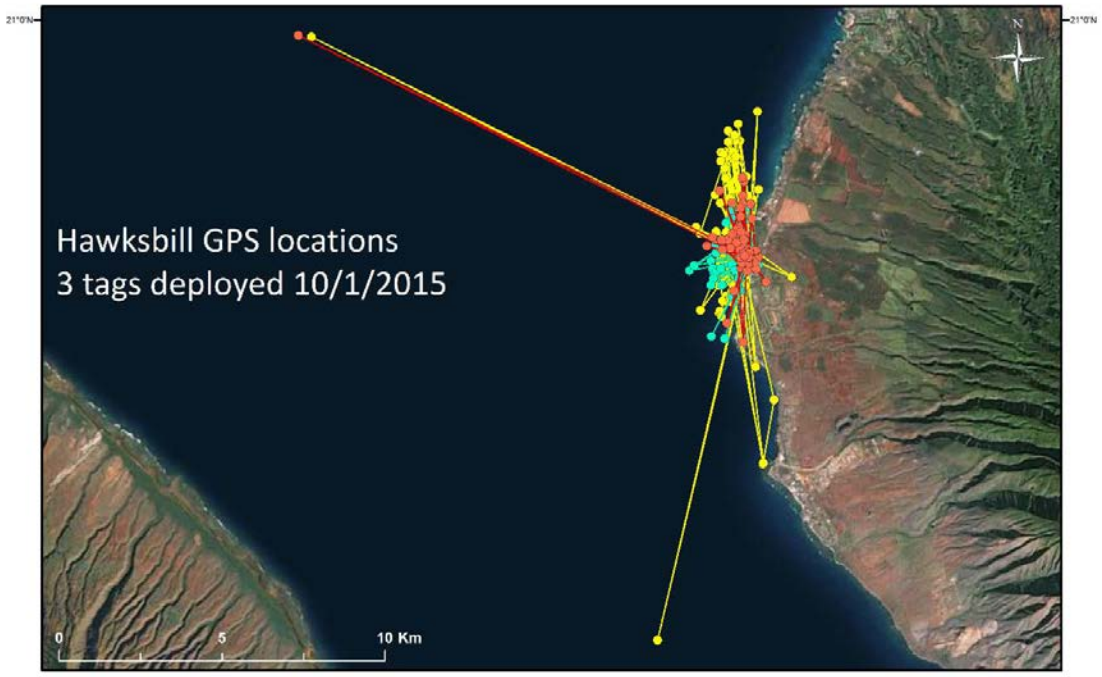

Figure 3. Satellite tracks of three adult female hawksbill turtles captured at Kahekili, Maui foraging habitat [Turtle IDs: #MUI23 ("Rocket Girl"), #MUI24 ("Misty"), and #MUI40 ("Barnacle Billie"); PIFSC unpublished].

Through December 2017, a total of 132 individual hawksbills had been observed and catalogued throughout the state (Table 1).[5] While snorkel-based surveys have yielded many sightings of hawksbill turtles, the majority of reports have been received from tour operators and the public (King 2015).[6] Given observer effort, the reefs at Kahekili appear to serve as important foraging and resting habitat as 23 of the 41 West Maui individuals have been documented at Kahekili specifically (see www.HIhawksbills.org; Table 2). Sightings have been accompanied by photos and/or videos, revealing valuable information about hawksbill in-water behaviors, foraging preferences and threats (King 2015; King and McLeish 2016; King et al. 2017). Importantly, observations highlight the importance of soliciting hawksbill sightings through advertisements, websites, social media, and outreach to community members and dive/snorkel operators. Hence focusing efforts to encourage public reports of sightings (via citizen science efforts) is warranted and may be the most cost/effort effective means by which to receive information to help document foraging habitats, foraging ecology, and individuals.

[5] An additional 6 turtles have been identified through April 2018 (C.King pers comm.).

[6] Between 2013 and 2014, HWF systematically surveyed new habitats on Maui covering 47 transect hours. Unfortunately no hawksbill observations were made, although 17 reports of 9 individuals was received during this time period from tour operators and the public (King 2015).

Table 1. Photo-ID catalog summary over the past 20 years: 1998-2017 (www.HIhawksbills.org).			
Island	Confirmed Sightings	Year Span	Total Individuals
Kaua‘i	8	2009-2017	8
O‘ahu	44	2009-2017	32
Moloka‘i	4	2015-2017	2
Lāna‘i	13	2011-2017	7
Maui	1,030	1998-2017	64
Kaho‘olawe	3	2007-2009	1
Hawai‘i Island	32	2003-2017	20
		Total	132

Table 2. The number of individual hawksbill turtles identified in Maui waters (www.HIhawksbills.org).	
West Maui (Ma'alaea to Kapalua)	41
South Maui (Kealia to Keone‘ō‘io, Makena)	13
Molokini	3
North and East Maui (Kapalua to Makena)	0
Unknown	1
Total	64

Note: two individuals originally sighted around West Maui have been more recently sighted around the South Maui area, and one individual who was originally sighted at Molokini has been more recently sighted around West Maui.

Hawksbill diet can vary substantially by location. In the Caribbean, hawksbills were historically described as feeding primarily on sponges (Meylan 1988; Hill 1998), but were later also documented feeding on corals and algae (Leon and Bjorndal 2002; Pemberton et al. 2002). Studies in the western Pacific have demonstrated diets consisting largely of algae (Bell 2013), while in the eastern Pacific the species has been documented feeding on tunicates, sponges, mangrove shoots and various invertebrates (Carrión-Cortez et al. 2013; Rivas 2017). In Hawai‘i, hawksbills have been observed foraging on a variety of prey including octopus, algae, fire worms, black sponges, urchins, frogfish, and more (King 2011, 2015; King and McLeish 2016). Additional research on hawksbill turtle diet is needed to quantify foraging resource requirements.

Post-nesting migrations

A total of 15 post-nesting individual hawksbill turtles have been equipped with satellite telemetry tags in order to investigate the migrations and foraging habitats of adult females in Hawai‘i. Parker et al. (2009) tracked nine post-nesting hawksbills from nesting beaches on the Island of Hawai‘i (n=4) and Maui (n=5), six (66.7%) of which migrated to foraging habitat off the Hāmākua Coast (northern shoreline) of the Island of Hawai‘i (Figure 4). An additional six post-nesting hawksbills have been tagged since that time, two of which also migrated to the Hāmākua Coast (PIFSC unpublished data). One of the six more recent post-nesting females tagged on the Island of Hawai‘i migrated to

foraging habitats in Ma‘alaea, Maui, while another off the coast of Kaunakakai on southern Moloka‘i (Graham 2009). Another undertook a surprising migration, first heading north of the Main Hawaiian Islands, then travelling southwest approximately 2,000 km, before transmissions ceased west of Johnston Atoll (Figure 5). Hawai‘i Wildlife Fund (HWF) together with PIFSC satellite tagged one post-nesting females at Oneloa beach, Makena, Maui in 2011. After nesting, this turtle used pelagic habitats following a week in Kaua‘i’s nearshore waters (Figure 6), with tracking data indicating the track likely ended due to turtle fatality (Parker et al. 2014).

Given the predominance of adult female post-nesting migrations to Hāmākua coast (53.3% of all females), directed research to characterize this coastline, evaluate threats and further understand the importance of the area for hawksbill turtles is needed. With the exception of two post-nesting females, the majority (86.7%) of hawksbill turtles equipped with satellite tags have remained within the Hawaiian archipelago. This suggests that Hawai‘i’s hawksbill turtles have limited connectivity to other ocean regions and may be a discrete population, but research on post-hatchling dispersal and genetic stock analysis (see details on both of these themes below) is needed to corroborate this theory.

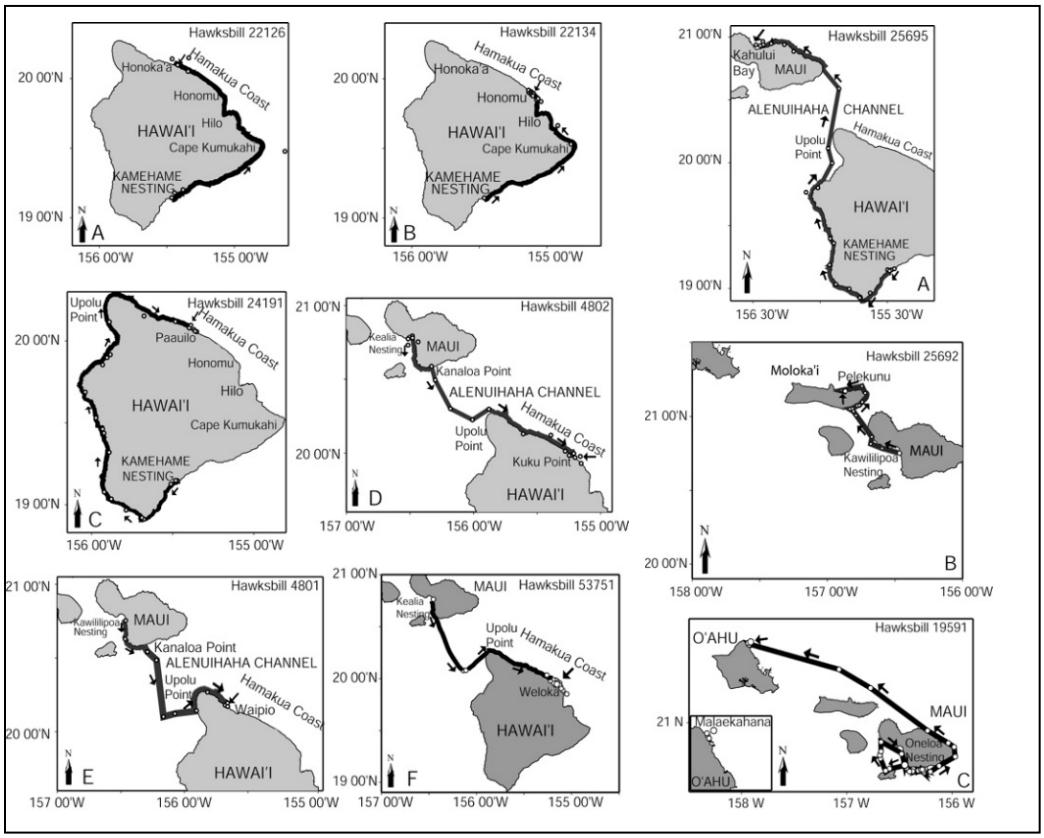

Figure 4. Satellite tracked migrations of nine post-nesting female hawksbills from Maui and the Island of Hawai‘i (Parker et al. 2009).

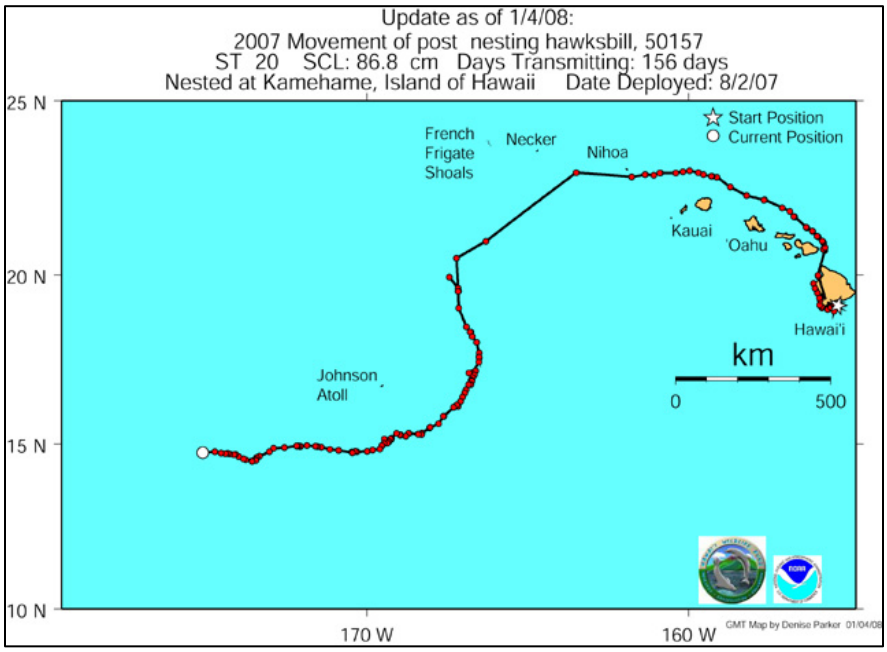

Figure 5. 2007 Satellite track of post-nesting female tagged at Kamehame, Island of Hawai‘i **(**Graham (2009).

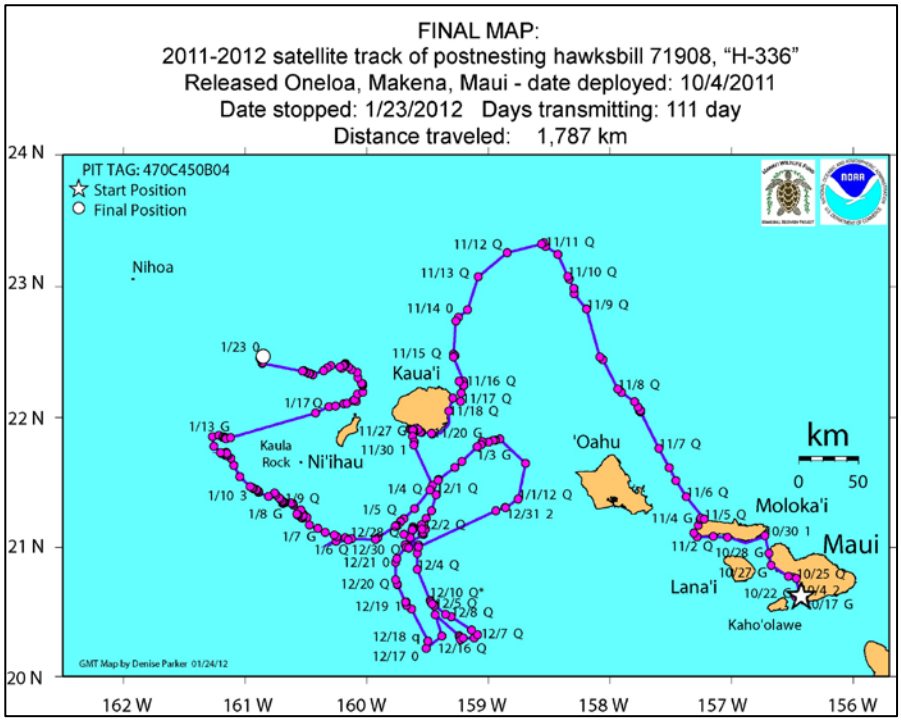

Figure 6. 2011 Satellite track of post-nesting female tagged at Mākena, Oneloa beach, Maui. Turtle undertook a pelagic migration, spent one week in Kauai waters, and then met some type of debilitating fate (or mortality) around Dec 10, 2011 (Parker et al. 2014).

Hatchling Dispersal

High seas oceanic ecosystems are considered important developmental habitat for post-hatchlings (i.e., the "lost years"; Carr 1966) of many sea turtle species/stocks, and most demonstrate clear patterns of early pelagic development. However, direct evidence of a pelagic post-hatchling development phase for hawksbill turtles in Hawai‘i remains lacking. Of the limited sightings of hawksbill turtles measuring 8–34 cm straight carapace length, corresponding to individuals 0-4 years of age, all came from the coastal waters surrounding Hawai‘i, suggesting that Hawaiian hawksbills may lack a pelagic post-hatchling phase (Van Houtan et al. 2016), a life-history pattern that has also been suggested for hawksbills in the eastern Pacific Ocean (Gaos et al. 2017b). Further research combining particle modeling (e.g., Blumenthal et al. 2009), tracking of post-hatchlings (e.g., Thums et al. 2013) and satellite telemetry of young life-stage (8-12 months old) juveniles (e.g., Mansfield et al. 2013; Putnam and Mansfield 2015), would help elucidate the movements and dispersal of Hawaiian hawksbills during this cryptic life-history phase.

Genetic Diversity and Stock Structure

A large genetic data gap remains for hawksbills in the Hawaiian archipelago and much of the Indo-Pacific, in large part due to the innate difficulties in obtaining samples from the remote nesting beaches where hawksbill nest in these ocean regions (see section on Nesting Females and Population Trends). The most recent 2013 status review re-iterated this information gap for Pacific hawksbills (NMFS & USFWS 2013), and this HI Action Plan prioritizes sample collection and genetic stock assessment of Hawaiian hawksbills, particularly nesting females.

Recently published genetic studies implementing mitochondrial DNA (mtDNA) markers for hawksbills in the western and eastern Pacific Oceans (Vargas et al. 2016; Gaos et al. 2016) have identified various Management Units (Moritz 1994) in those regions. Through 2016 in Hawai‘i, skin samples (for genetic analysis) were been collected from nesting females (n = 9) and in-water animals (i.e., strandings, foraging, fisheries bycatch) (n = 41), as well as from hatchlings (n = 1,639). A preliminary mtDNA analysis of the limited samples available for nesting female hawksbills and unique offspring (i.e., a single hatchling from a known mother) from the Island of Hawai‘i and Maui has led to the discovery of two new haplotypes that appear exclusive to the archipelago. Although still preliminary, these findings, combined with other haplotype frequencies found in the region, suggest that there is a minimum of at least one distinct Management Unit (MU) for hawksbills in Hawai‘i. However, samples from nesting females are required to accurately assess nesting stock structure and thus efforts are needed to increase the sample size from these individuals and increase our power to detect genetic differences. Fortunately, increased efforts were undertaken during the 2017 nesting season at beaches monitored by Hawai‘i Volcanoes National Park (HAVO) staff, resulting in the collection of 14 samples from nesting females (L. Kurpita, pers. comm). Genetic samples collected to date (as per 2017) have been accounted for within the PIFSC database. Similar efforts to observe and sample nesting females at other sites are necessary as doing so may reveal that the delineation of multiple MUs in the Hawaiian archipelago is warranted. Preliminary results of samples collected from in-water animals have also indicated the

presence of the endemic Hawaiian haplotypes, suggesting that local beaches likely serve as the primary source for hawksbills at local foraging grounds, a concept supported by hawksbill natal foraging philopatry (NFP) patterns documented in the East Pacific Ocean (Gaos et al. 2017b).

Since mtDNA only provides information on female lineages, using nuclear markers (in addition to mtDNA markers) will also be important to provide a more comprehensive understanding of stock structure and connectivity (NRC 2010; Jensen et al. 2013). It is important to recognize that the results from mtDNA and nDNA markers do not represent conflicting schemes, but rather reflect geographic structuring differences on distinct DNA lineages, which together can provide a more complete understanding of genetic structure (Gaos et al. 2016).

Climate and Temperature Effects

The sex of marine turtles is determined by nest incubation temperatures (i.e., temperature-dependent sex determination), with temperatures above the pivotal temperature skewing ratios in favor of females (Bollmer et al. 1999). Many studies report highly female-biased hatchling, juvenile and adult sex ratios in marine turtle populations, and temperature increases at nesting beaches due to ongoing climate change have the potential to drive further feminization of populations (Hawkes et al. 2009; Eckert et al. 2012). In Hawai‘i, less than 2% of marine turtle strandings correspond to hawksbill turtles,[7] and data suggest that the hawksbill population is highly female biased, with females comprising 82.4% of stranded turtles (female = 42, male = 9; Brunson et al. *in prep*). Additionally, in-water surveys at foraging areas around Maui and sightings submitted to the statewide photo-ID catalog (www.HIhawksbills.org) have yielded only 11 adult males (King 2011, 2015; King and McLeish 2016). The apparent lack of male hawksbills in Hawai‘i is of concern and raises questions as to the potential role the male deficiency may be playing in the lack of recovery of the species (see Figure 1). Given the predicted ongoing increases in global ocean temperatures (IPCC 2013), establishing baseline data on hatchling and adult hawksbill sex ratios, male population size and beach/nest temperature profiles, represent urgent research needs.

Threats & Management

The primary historical threat and cause of global population declines has been the unsustainable harvest of hawksbills for their shells (NMFS and USFWS 1998). The high value of their shells and resulting international trade focused on its exploitation, largely led to the listing of the species in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975. Protection measures such as CITES and listing of hawksbill turtles under the ESA has greatly reduced the threat of direct human take. Hawksbills are highly neritic (Witzell 1983; Gaos et al. 2012), especially in the Hawaiian archipelago (Van Houtan et al. 2016; PIFSC unpublished data). Hawaiian hawksbills therefore face increased risk of mortality and injury due to their prolonged lifespan in coastal ecosystems in close proximity to human activities.

[7] Strandings in the Hawaiian Archipelago between 1982 and 2014 totaled 6,711 turtles of which 1.3% (n=87) were hawksbills and 97% were greens.

Currently, the primary threats to hawksbill turtles in Hawai‘i include (Seitz et al. 2012; King 2015; Kurpita 2015; King et al. 2017; Brunson et al. 2017; Appendix II):

- Entanglement in marine debris and bycatch in nearshore fisheries (hook-and-line fisheries, nets and crab/lobster traps);
- Human interactions related to beach use (e.g., night camping/fishing activities, light pollution, off road vehicles, etc.);
- Egg/hatchling loss due to predators (see below); and
- Loss of nests and nesting habitats due to storms (i.e., erosion), climate change (temperature impacts), and sea level rise.

Additional threats may include: boat/watercraft strikes, foraging and nesting habitat degradation (e.g., habitat alteration/conversion, coastal development, etc.), and beach vegetation (NMFS and USFWS 1998, 2013). Additionally, hatching success at Kealia, Maui has been variable (often 0%)[8] for reasons that remain unknown (King et al. 2007; King et al., *in press*).

Mongooses, feral cats, rats, dogs, and pigs prey on hawksbill eggs and hatchlings, in addition to native predators like seabirds, crabs, fish and sharks. Introduced (i.e., non-native) vegetation with thick, dense root systems (certain species of palms, buffel grass, fountain grass, haole koa, kiawe, etc.) in the beach environment can make it difficult for females to dig nests chambers and for hatchlings to emerge. Foot traffic or off road vehicles on beaches can damage nests or compact sand to make it difficult for hatchlings to emerge. Increased coastal development continues to occur and some hawksbill nesting areas are already affected by artificial lighting, which can deter nesting females and disorient hatchlings (Witherington and Martin 2000). Nests are subject to inundation by high tides, which is of growing concern with predicted increases in average global ocean levels and extreme climactic events (IPCC 2013), which may lead to more frequent nest inundation and mortality events. On the Island of Hawai‘i especially, the lack of (or reduced) monitoring efforts at remote nesting beaches due to staff safety concerns, poor weather (storms, hurricanes or high surf events) can result in loss of hatchlings or females if project staff are not present to assist animals that may get trapped in volcanic rock habitats or hatchlings being predated (Kurpita 2015).

Management & Conservation Actions

Numerous management and conservation actions have been implemented to date and many are ongoing. However, additional stakeholder-specific materials or actions can (and should) be pursued to reduce and mitigate anthropogenic threats and environmental impacts to hawksbill turtles in Hawai‘i.

[8] Since 2000, at least 4 females have nested on Kealia for a total of 19 nests. Two females, Lele and Hapa, laid 11 nests with 0% hatching success, including 2 nests that were relocated to Kawililipoa. Another turtle, Kolohe, has had varying hatching success from 0% in 2002 and 97.9% in 2009. An unobserved female also laid 2 nests in 2015, with 89% and 43.1% hatching success. The westernmost nests, closer to the mouth of Kealia Pond, tend to have 0% hatching success.

Starting in 2007, the NMFS Pacific Islands Regional Office (PIRO) and the USFWS Pacific Islands Fish and Wildlife Office (PIFWO) have attempted to convene annual team/partner meetings to facilitate networking, communication, track progress and develop recommendations for on-going and future activities to support hawksbill turtle recovery in Hawai‘i.[9] Also starting in 2007, the PIRO began hosting an annual federal funding opportunity (FFO) to support priority research and conservation activities consistent with the ESA and regional management obligations. Programs may submit single year or multi-year applications for consideration, and are recommended for funding following a comprehensive competitive technical review and National Environmental Policy Act (NEPA) clearance. Several Hawai‘i hawksbill turtle projects have received partial programmatic funding via this FFO, although funding and equipment needs persist (e.g., the repair and purchase of four-wheel drive vehicles is critical to access remote nesting beaches on the Island of Hawai‘i).

Nearshore fishery interactions, particularly hook-and-line, are a primary threat to sea turtles in Hawai‘i (Appendix II; Brunson et al. 2007; King et al. 2017; PIFSC unpublished). Coastal fisheries result in the incidental hooking or entanglement of approximately 4 to 5 hawksbill turtles (juveniles and adults) annually, thus representing a primary threat to this small and isolated population (Brunson et al. 2017). In an effort to address or mitigate this threat, the PIRO spearheaded a multi-agency Fishing Around Sea Turtles (FAST) program.[10] The FAST program has developed messaging and materials to promote increased awareness and best-practice guidance to reduce sea turtle bycatch and mortality in coastal hook-and-line fisheries. FAST guidance is disseminated by NOAA, the State of Hawai‘i’s Marine Wildlife Program, Hawai‘i Fishermen’s Alliance for Conservation and Tradition (HFACT) and other partners, at fishing tournaments and marine related events in order to build local capacity to reduce and mitigate fishery interactions.

Brochures have been produced for the general public and tourism industry about hawksbill turtle biology, status and threats, including cultural relevance, species identification, reporting, and actions the general public can take to promote conservation of the species.[11] Materials are distributed at community outreach events and other educational venues. HWF and HAVO actively work to involve local communities in nest excavations when/where possible to build awareness and provide outreach, as well as to reduce intentional and unintentional disturbance of hawksbill turtles on nesting beaches and at foraging grounds. Some nesting beaches on the Island of Hawai‘i and Maui have had signs installed but may need to be replaced. The Kealia Wildlife Refuge, on Maui, are marked with signage informing beach users of the presence and status of hawksbill turtles in the area.

Some direct management and protection actions include the following:

- Nesting beach programs on Maui and the Island of Hawai‘i actively work to bolster reproductive success (funding/staff dependent) by:

[9] Meetings were held in 2007, 2008, 2009, 2010, 2012, 2015, 2016 and 2017.
[10] http://www.fpir.noaa.gov/PRD/prd_fishing_around_sea_turtles.html
[11] http://www.fpir.noaa.gov/Library/PRD/Sea%20Turtles/Hawksbills/2016_hawksbill_brochure.pdf

1. Reducing predation via trapping/removing/deterring predators and installing predator proof cages/fences around nests,
2. Relocating nests laid in erosion prone areas,
3. Excavating nests to collect data on reproductive success and release any trapped hatchlings, and
4. Removing marine debris plus land-based trash from nesting habitats.

- In 1997, partners (spearheaded by HWF and USFWS) installed a semi-permanent 2 mile fence along North Kihei Road fronting the Kealia Wildlife Refuge to prevent nesting females from wandering onto the road (which has led to mortality in previous seasons).[12] The fence was eventually replaced with a more permanent/durable plastic fence in 2010, however, fence repair and maintenance (including purchase of materials and volunteer workforce coordination) remains an ongoing challenge with yearly upkeep necessary.

- As of 2017, four nesting females have fallen into the deep volcanic crack at Humuhumu point, on the Island of Hawai‘i.[13] The HAVO monitors the area frequently and has organized rescue/recovery efforts of turtles that have fallen into the crevice, however, this is a major threat to nesting females that must be addressed.

Partnerships in Hawai‘i Hawksbill Turtle Recovery

A long history of involvement by federal and state institutions, non-governmental organizations (NGOs) and community members exists in Hawai‘i hawksbill turtle research and conservation, dating back to the early 1990s (for a summary see Appendix III). Key partners have included: the USFWS - Pacific Islands Fish and Wildlife Office (PIFWO) and USFWS Kealia Wildlife Refuge, NMFS Pacific Islands Regional Office (PIRO) and Pacific Islands Fisheries Science Center (PIFSC), the State of Hawai‘i Department of Land and Natural Resources (DLNR), the National Park Service’s Hawai‘i Volcanoes National Park (HAVO), Hawai‘i Wildlife Fund (HWF), Hawaiian Hawksbill Conservation (i.e., www.HIhawsbills.org), various community members, and numerous volunteers (e.g., USFWS Dawn Patrol). This collective partnership – working under relevant USFWS and NMFS research permits – are critical in maintaining momentum and progressing research, conservation and management in Hawai‘i. Annual team/partner meetings (aka. the Hawai‘i Hawksbill Turtle Network), convened by PIFWO and PIRO, facilitate communication, review and track progress, and develop recommendations for on-going and future activities. The reports of these meetings become addendums to this

[12] In 1993 and 1996, two gravid females wandered onto the road and were struck by cars, and 88 hatchlings were also run over in 2009. While the fence may protect and prevent females from accessing the road, volunteers and project staff must monitor nesting activity to ensure that hatchlings are not disoriented.
[13] At Humuhumu point 3 adult females have fallen into a deep volcanic crack: 2008 – turtle recovered dead; 2014 – turtle released alive; 2016 – turtle released but injured (non-lethal crack in shell); and 2017 – turtle released with minor injuries. HAVO is in discussion with the County of Hawai‘i and seeking funding to establish temporary and ultimately permanent structure/barrier to prevent turtles from falling into the crevice again. They are also working to educate campers in the area to address light pollution, and seeking legislative support.

Action Plan and are incorporated via reference (Browning, Maison & Van Houtan, 2012; Browning, Kelly & Van Houtan, 2015; PIRO and PIFWO 2007, 2008, 2009, 2010, 2016, 2017).

II. Actions to Recover Hawksbills in Hawai‘i

ESA Recovery Goals

As stated in the U.S. Recovery Plan, the recovery goal is to delist the species (NMFS and USFWS, 1998). Based on updated information, the most recent five-year review for hawksbills recommended the species be evaluated for application of the DPS policy (NMFS and USFWS, 2013), which would have important implications for hawksbills in Hawai‘i.

Recovery criteria listed in the U.S. Recovery Plan include: stable or increasing nesting populations at source beaches for 25 years, foraging habitats maintained as healthy environments, and the development of a management plan to maintain sustained populations, among others. The U.S. Recovery Plan identifies eight major Actions (see below) needed in order to achieve recovery of hawksbill turtles in U.S. waters, and these actions form the basis for this HI Action Plan. If these Actions are met in Hawai‘i, this HI Action Plan will actively contribute to recovery of hawksbill turtles in U.S. waters. Thus, in addition to summarizing known information on hawksbills in Hawai‘i, the primary aim of this HI Action Plan is to outline activities necessary to implement these eight major ESA Actions in the Hawaiian Archipelago. The eight major actions, along with their current (2017) status (completed, ongoing, needed, or not applicable) for hawksbill turtles in Hawai‘i, are as follows (not presented in order of priority):

1. Stop the direct harvest of hawksbill turtles and eggs, through education and law enforcement actions.
   Status: Direct harvest – completed; Outreach and enforcement – ongoing

2. Reduce incidental mortalities of hawksbills by commercial and artisanal fisheries.
   Status: Commercial fisheries – not applicable for hawksbills in Hawai‘i; Artisanal fisheries – on-going [via PIRO’s Fishing Around Sea Turtle (FAST) program]

3. Determine population size, status and trends through long-term regular nesting beach and in-water censuses.
   Status: needed, ongoing

4. Evaluate genetic stocks and diversity using DNA analyses.
   Status: needed, ongoing

5. Support conservation and management of hawksbill populations in countries that share U.S. hawksbills.
   Status: pending, potentially not applicable in Hawai‘i

6. Identify and protect primary hawksbill nesting and foraging areas.
   Status: Nesting – needed, ongoing; Foraging – needed, ongoing

7. Eliminate adverse effects of development on hawksbill nesting and foraging habitats.
   Status: needed, ongoing, strict HAVO & HWF protocol exist regarding social media and photography, and limited/no public reporting of nesting locations

8. Control non-native predators of eggs and hatchlings, e.g., mongoose, feral cats, and pigs, in the Hawaiian population.
   Status: needed, ongoing

Top Research and Management Priorities for Hawksbills in Hawai‘i

Given that many of the actions needed to achieve ESA recovery are still ongoing or needed, this HI Action Plan identifies a list of priority activities necessary to advance ESA recovery criteria for hawksbills, as defined by the U.S. Recovery Plan (NMFS/USFWS 1998). However, an exhaustive list is not practical for implementation so a number of long-term goals of highest priority, as well as the short-term actions needed to achieve those goals, are listed for implementation over the next five years (2018-2022). The following research and management actions are listed in random order; the numbers listed do not represent levels of priority, but do represent the long-term goals for the life of the Action Plan with near-term actions identified.

Research Priorities

1. **Long-term goal:** Strengthen population assessments through robust quantification of nesting activity and nesting females. Because understanding the number of nesting female turtles is the fundamental parameter used to estimate sea turtle populations sizes, having a more holistic understanding of the number of nesting females and their nesting habitats is central to understanding the state of populations in the MHIs.

Short-term actions to achieve goal #1:

- Conduct ongoing/increased monitoring and conservation at known nesting beaches on the islands of Hawai‘i and Maui.
- Develop and execute a plan to initiate nesting beach surveys/monitoring at Halawa, Moloka‘i.
- In lesser known/documented areas, such as on Lāna‘i, use traditional methods (e.g., foot patrols) or innovate technologies (e.g., drones, helicopters, small planes) to conduct surveys/monitoring in an effort to identify new hawksbill nesting sites (and develop/execute monitoring if new sites are identified).
- Maximize observance of nesting females and equip them with flipper and PIT tags to ensure ongoing identification. Photograph them for inclusion in the statewide photo-ID catalog, which can reveal their foraging areas.
- Collect tissue samples from nesting females to conduct rookery stock structure analysis.

- Protect nests and maximize hatchling production.
- Determine the cause(s) of poor hatchling development/survival at Kealia Beach.
- Identify creative way to provide monitoring coverage at Kamehame beach (e.g., NMFS/FWS summer camping adventures).

2. **Long-term goal:** Evaluate genetic diversity and stock structure of hawksbills at nesting beaches and foraging grounds. Understanding stock structure is a necessary to identify the appropriate scales of management.

Short-term actions to achieve goal #2:

- Prioritize collection of skin samples from nesting females across the MHIs.[14]
- Ensure collection of skin samples from all hawksbills encountered via strandings and in-water monitoring.
- Use mtDNA markers to establish a baseline genetic profile for rookeries in the region, which will set the stage for additional genetic analyses.
- Evaluate rookery contributions to hawksbills in the waters of the MHIs and to evaluate connectivity across the Pacific Ocean.
- Once mtDNA studies have been carried out, implement studies using nDNA markers (e.g., SNPs or microsatellites) to further characterize genetic structure at nesting and in-water areas.

3. **Long-term goal:** Understand movement and marine habitat use of hawksbills. Identifying core habitat, migratory pathways and general movement behaviour is necessary to protect hawksbills and their habitats. Opportunistic sightings of hawksbills in nearshore waters throughout the state have been occurring for decades, but a more systematic approach is needed to holistically assess movements and habitat use around the archipelago.

Short-term actions to achieve goal #3:

- Use photo-ID, moto-tool (dremel), citizen science, and satellite telemetry to track post-nesting females and understand inter-nesting movements and post-nesting migrations.
- Satellite track juvenile and adult hawksbills to identify foraging hotspots, characterize home ranges and dive behavior, and understand general movements.
- Evaluate, characterize and quantify substrates in hawksbill foraging hotspots to understand habitat requirements.
- Generate data on post-hatching hawksbill dispersal via: 1) acoustic tracking of hatchlings and 2) rearing of hatchling to an age of 8-12 months and equipping/releasing them with mini satellite tags.
- Conduct in-water monitoring using hand capture and/or tangle-nets at foraging sites to evaluate hawksbill densities and prioritize site importance for the species (as well as to determine growth rates and survivorship).

[14] SAIP FY17 grant application submitted and funded, project entitled: Population genetics and demographic assessment of central Pacific hawksbill turtles: Project period April 2018 - May 2020. Principal Investigators: Dr. P. Dutton (SWFSC), Drs. T.T. Jones and A. Gaos (PIFSC), I. Kelly (PIRO).

    - Directed research and in-water surveys along the Hāmākua coast to characterize this coastline and evaluate threats.
    - Investigate and better understand hawksbills living in/near harbors and marinas.
- Use genetic results (see Long Term Goal #2) to understand connectivity among habitat types.
- Increase hawksbill sighting reports by community members and tour operators.
    - Develop/disseminate outreach materials to encourage reporting of sightings (i.e., "Wanted Honu'ea" fliers).
- Mine the www.HIhawkbills.org in-water observations and PIFSC stranding databases to elucidate information regarding habitat use.

4. **Long-term goal:** Understand age to neritic recruitment and first reproduction. Producing information on age to recruitment and reproduction is needed for accurate population modeling.

Short-term actions to achieve goal #4:

- Use skeletochronology to determine the age of stranded hawksbill in the smallest size classes to estimate age to recruitment. Determine priority level for such research while continuing to increase sample size.
- Collect samples from the trailing edge of the flippers from a predetermined number of live hatchlings for use as "living genetic tag".
    - Genotype in-water samples from small juveniles encountered at foraging grounds in an attempt to identify those originally sampled as hatchlings to understand age at recruitment to foraging grounds.
    - Long-term (10+ years): genotype neophyte nesting females in an attempt to identify those originally sampled as hatchlings to understand age at first reproduction.

5. **Long-term goal:** Evaluate juvenile and male hawksbill population sizes. Determining the number of juveniles in the population will assist with future population projections by assisting us in evaluating how many hawksbills are "in the pipleline" and will reach mature status in the future. By understanding the number of males in the population will assist in population modeling and allow for assessment of potential role in the lack of population recovery.

Short-term actions to achieve goal #5:

- Conduct in-water monitoring at foraging sites (see long term goal #3) to quantify males and juveniles.
- Collect tissue samples from all hatchlings that fail to emerge from nests (i.e., embryos or dead hatchlings), a proportion of live hatchlings (as per specific project protocols and permitting), and from nesting females. Use genetics to estimate breeding sex ratios and the number of reproductive males in the population.

6. **Long-term goal:** Understand diet-requirements and habitat needs of hawksbills. By evaluating diet we will better understand the habitats where protection and restoration efforts should be directed in order to best support population recovery.

Short-term actions to achieve goal #6:

- Apply camera tags to hawksbills to observe, characterize and quantify feeding behavior and diet preferences.
- Conduct diet analysis of gastrointestinal tracts of all stranded hawksbills.
- Use stable isotope analysis to understand trophic levels.

7. **Long-term goal:** Evaluate temperature parameters and the potential impacts of climate change. Temperature, both current and future, has the potential to negatively impact population growth, so establishing a baseline on current temperature profiles is needed to monitor future changes.

Short-term actions to achieve goal #7:

- Place temperature loggers within nests (during egg laying) and along beach transects to generate baseline temperature profiles for nests and beaches, respectively.
- Collect eggs from various nests and incubate them in a controlled laboratory setting to evaluate pivotal temperature and understand how temperature impacts sex ratios of hatchlings. Hormone analysis (via blood sample) and laparoscopy will be used to verify sex of hatchlings.

Management Priorities

1. **Long-term goal:** Increase hawksbill overall population size by reducing nesting beach impacts, maximizing hatchling production and protecting nesting females at nesting beaches. Overall population sizes of wildlife populations is the essential parameter to survival, thus ensuring the maximum number of hawksbill hatchlings reach the sea and nesting females safely return to the ocean are primary management measures that can be undertaken to facilitate recovery. While on-going nesting beach monitoring projects have reported on the threats at individual nesting beaches, a comprehensive assessment of threats at all nesting sites is needed.

Short-term actions to achieve management goal #1:

- PIFWO to lead a comprehensive nesting beach threat assessment to catalogue/ inventory threats at nesting beaches, then identify and prioritize actions.
- Continue predator eradication and protection of nests from cat, mongoose and rat predation in order to optimize successful hatchling incubation and emergence (Kamehame is of specific concern given lack of recent volunteer presence which has resulted in high predation pressure).
- Relocate nests deemed to be located in areas highly vulnerable to inundation or erosion (i.e., “doomed” nests) to areas with a higher likelihood of survival.

- Protect nesting females from threats that may cause mortality [i.e., falls into volcanic crevices (e.g., Humuhumu point), wandering onto roads, etc.].
- Reduce/prevent light pollution (i.e., turtle "safe" lighting, shielding) from shoreline development, pavilions, campgrounds, fishing activity, roads, harbors, military installations, and other sources.
- Remove marine debris from nesting beaches.
- Ensure signage is installed and maintained at nesting beaches.

2. **Long-term goal:** Understand why hawksbills in Hawai'i are not increasing despite being afforded the same ESA protections as green turtles. Determining what factors may be limiting hawksbill population growth (e.g., energetic limitations, environmental variables, fishery interactions, currently undocumented threats leading to mortality, etc.) will enable managers to tailor conservation initiatives accordingly.

Short-term actions to achieve management goal #2:

- Continue to identify and assess threats in marine habitats via stranding data and community-based reporting.
- Expand NOAA's sea turtle stranding program and FAST program, especially as it pertains to hawksbill turtles.[15]
- Develop a systematic process to reach out and disseminate information to the fishing community.
- PIFSC to implement research to better understand sea turtle population dynamics through a study that will estimate food intake, energetics and growth rates of hawksbill turtle hatchling(s) (likely reared at participating marine park facility).
- Develop/distribute outreach materials to encourage reporting of sightings (i.e., "Wanted Honu'ea").

3. **Long-term goal:** Pursue stable funding sources for nesting beach and in-water monitoring projects. Currently, existing hawksbill turtle monitoring projects do not have stable sources of funding beyond a single year. This precarious financial situation hinders continuity of staff and deters long-term investments (e.g., of research and field equipment, etc.). Identifying sources of permanent funding will ensure continued data collection, maintain/expand protection efforts, and facilitate project expansion.

Short-term actions to achieve management goal #3:

- Maintain PIRO and USFWS grant support as funding allows.
    - Primary focus on observing/tagging/sampling nesting females, maximizing nest protection/hatchling production, protecting nesting females, identifying and monitoring new or understudied nesting beaches.
    - Genetics research.

[15] The *Fishing Around Sea Turtles* (FAST) steering committee met in early 2017 to discuss development of hawksbill-specific guidelines for fishermen. The team concluded that specific hawksbill guidance does not exist, but had suggestions regarding increased awareness materials that have since been developed and implemented.

    - In-water research & monitoring.
    - Citizen science: reporting of sightings and maintaining the state-wide photo-ID catalogue.
- Encourage application of ESA Section 7(a)(1) (PIRO/PIFWO).
- Pursue and widely promote web-based donations to partner NGOs.
- Assist with issues related to trucks and field logistics to support the HAVO project and infrastructure improvements (e.g., fence maintenance along North Kihei Road, mitigate light pollution, etc.).
- Investigate innovative strategies to raise funds such as the Florida license plate program (i.e., replicate this program in Hawai‘i).

4. **Long-term goal:** Increase public awareness and educational outreach to island communities about the presence and status of the Hawaiian hawksbill population, their cultural significance, and actions the public can take to promote information gathering, conservation and recovery of the species.

Short-term actions to achieve management goal #4:

- Continue existing outreach efforts (all partners).
- Maintain, repair and install signage at nesting sites.
- Promote community-based reporting (i.e., advertisements, fliers, social media, websites, community connections, tour operators, etc.).

5. **Long-term goal:** Compile and collate literature for Hawai‘i hawksbills (PIRO/PIFWO), and facilitate analysis and publication of existing data from all monitoring projects (PIFSC). Data on Hawai‘i hawksbills have been collected for over twenty years and exists in various program databases. Analysis of this existing data will help to identify research gaps and management options, and support ongoing stock assessment mandates.

Short-term actions to achieve management goal #5:

- Collate existing literature – Ongoing/needs constant updating, but large archive of literature has been compiled and shared via Google drive and on www.HIhawksbills.org. [16]
- Work with partners to analyse (and publish) existing data to lay the foundation and direction for future work.

6. **Long-term goal:** Continue inter/intra agency coordination and partnering with NGOs. The annual Hawai‘i Hawksbill Turtle Network meetings convened by PIRO and PIFWO are invaluable to review progress, develop new/additional actions and recommendations, and to ensure implementation of this HI Action Plan. The annual meetings and resulting reports become addendums to this Plan to help guide activities.

[16] http://www.hihawksbills.org/hawaiian-hawksbill-publications.html.

Short-term actions to achieve management goal #6:

- Convene Hawai‘i Hawksbill Turtle Network meetings annually.
- Facilitate continued communication among members of the ‘hawksbill network’ (also referenced as the Hawai‘i Hawksbill Recovery Implementation Group) via email and other tools/outlets.

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APPENDIX I: Summary of 1994 Informal Interagency Recommendations for the Endangered Hawksbill Turtle in Hawai‘i

Informal interagency planning meeting held February 3, 1994 which resulted in action items related to protection of the endangered hawksbill turtle in Hawai‘i. Held at Hawai‘i Volcanoes National Park.

Participants:

Larry Katahira and Charlotte Forbes
Resource Management Division
Hawai‘i Volcanoes National Park

Susan Pultz
Pacific Islands Office
U.S. Fish and Wildlife Service

George Balazs
Marine Turtle Research Program
Honolulu Laboratory
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Note: The following recommended actions were not prioritized. They are presented here in the order they were discussed. In most cases the appropriate agencies, organizations, and/or individuals responsible for accomplishing these tasks were not specifically identified. This summary constitutes the opinions of the participants, and does not necessarily reflect the official views of the agencies represented. The current status of each recommendation is provided with a short explanation (completed, ongoing, needed, or no longer applicable). **Activity “status” has been reviewed & updated as per 2018.**

1. A need exists for appropriately worded informational signs at key hawksbill nesting areas to alert beach visitors and ocean users of the protected status and conservation needs of sea turtles (such as undisturbed habitats, absence of disorienting light, etc.).

Status: ongoing; signs have been placed at major nesting areas that are impacted by human activities but they require routine replacement and maintenance due to vandalism and environmental damage. Additional signage at newly identified nesting habitat may be necessary in the future.

2. A comprehensive management and research plan is needed for the Kamehame nesting site. This should include an evaluation of the potential for designating the beach as a sea turtle “sanctuary” or “refuge”, as well as eliminating detrimental fishing activities.

Status: needed; Kamehame is currently owned by The Nature Conservancy and designated as a 'preserve' but is otherwise unprotected. Current impacts at this site include fishing, artificial lights, trash on the beach, disturbance from cattle and pigs from adjacent ranch lands, predation by feral cats and rats, and safety concerns to HIHRP personnel which restricts monitoring presence. This recommendation is no longer a priority for Kamehame given that predator management is an ongoing need at all hawksbill turtle nesting areas (see #7 below).

3. Ecotourism enterprises currently using, and possibly negatively impacting the Kamehame nesting area and nearshore waters should be contacted in order to develop positive lines of communication and exchange relevant information on sea turtle conservation and biology.

Status: completed; ecotourism enterprises no longer access Kamehame

4. Hawksbill nests deposited low to the water (within the intertidal zone) at Kamehame and other beaches under close surveillance by authorized researchers should be skillfully relocated at the earliest possible time to a safe and suitable site a short distance away.

Status: ongoing; HIHRP personnel relocate nests if necessary as a regular part of beach monitoring activities at Kamehame and other nesting beaches.

5. Authorized researchers should continue to carefully document and quantify all negative impacts to the successful incubation, hatching, and overall productivity of nests, and the survival of hatchlings in reaching the sea. Particular attention should be given to documenting the scope and magnitude of density-dependent nest destruction at Kamehame.

Status: ongoing; HIHRP personnel document threats and impacts to nests when possible.

6. Comprehensive training programs must be conducted for all volunteers and other personnel assigned to monitor, tag, and study hawksbills at nesting beaches. Efforts should be made to recruit volunteers that can commit to the study for a major portion of the nesting season.

Status: completed/ongoing; the HIHRP is now well-established and recruits and trains groups of volunteers annually.

7. Mammalian predators of eggs and hatchlings should continue to be controlled at key nesting beaches. Periodic consultations should be made with a professional veterinarian and/or a recognized humane society with regard to acceptable capture and euthanasia procedures.

Status: ongoing; the HIHRP sets traps for mammalian predators and humanely euthanizes them using methods approved by the American Veterinary Association Panel on Euthanasia as a regular part of nesting beach monitoring.

8. An investigation is warranted to determine ownership and the possibility of permanent closure of the unimproved roadway infringing upon the sand dunes bordering Punalu‘u beach. Exact ownership of land associated with the pavilion at Punalu‘u should also be determined in order to more effectively address hawksbill conservation issues.

Status: Completed; The County beach park and pavilion are on land leased by the County. The road across Punalu‘u Black Sand Beach has been closed since 2005. While County councilmen have tried to reopen the road, as per 2017, the road remains closed.

9. The County of Hawai‘i should be commended for steps it has taken to accommodate nesting hawksbills and hatchlings by reducing the intensity and wavelength of artificial lighting associated with the parking lot at Punalu‘u Beach Park. Additional modifications along these same lines are warranted with regard to lighting within the pavilion.

Status: ongoing; Improvements have been made although hatchlings are still disoriented by parking lot and pavilion lights, as well as lights from vacation rentals, campers, and fishermen. A timer to control the light at the pavilion would be helpful.

10. The U.S. Fish and Wildlife Service and the National Park Service Office of Research and Resources Management should liaison with regard to the research and management of nesting hawksbills and nest productivity in Hawai‘i.

Status: ongoing; USFWS was (currently NMFS is) a major funding source for HIHRP and they work in collaboration on hawksbill nesting beach issues.

11. The appropriate federal and state regulatory agencies need to be contacted by resort developers at the earliest time possible in order to ensure compatibility of their project with regard to hawksbill recovery and conservation goals.

Status: ongoing/not applicable; for any action carried out, permitted, or funded by the Federal government USFWS and NMFS must be consulted to ensure listed species are not jeopardized. NMFS and USFWS have no jurisdiction if there is no Federal action (permit, funding, etc.). NMFS and USFWS can and do provide comments during the public comment period for Environmental Impact Statements addressing development projects.

12. Research needs to be conducted to determine the species and possible predatory role of ants on hawksbill eggs and hatchlings noted at local nesting beaches.

Status: no longer applicable; ants have not been observed as a major impact to nests in recent years.

13. Research needs to be conducted to determine why green turtles are nocturnally resting ("basking") at Kamehame beach in proximity to where hawksbill nesting occurs.

Status: not applicable; there are higher priority research questions to be addressed for hawksbills.

14. As existing personnel and funds permit, reports of turtle nesting at previously unstudied locations should be promptly followed up with an on-site assessment. Assistance should be obtained from appropriate agencies and owners to gain access to nesting sites situated on private property.

Status: ongoing; HIHRP actively monitors potential nesting habitat and responds to reports of nesting activity at new locations.

15. Satellite telemetry is needed to identify the resident foraging pastures used by hawksbills nesting along the east coast of the island of Hawai‘i. Oceanic migrations to locations outside of the Hawaiian Islands are a possibility.

Status: ongoing; Tracking should be done to document in-water movements and behaviors.

16. Private conservation organizations in Hawai‘i should be encouraged to carry out additional public education programs about Hawaiian sea turtles.

Status: ongoing; All partners of the Hawai‘i hawksbill turtle network encourage public education about hawksbills and promote species conservation.

17. Research and management programs focused on the hawksbill turtle need to be initiated at known nesting sites on the islands of Moloka‘i and Maui.

Status: ongoing; HWF, USFWS, and DLNR monitor and document hawksbill nesting events on Maui. A monitoring program has not yet been established on Moloka‘i. Monitoring efforts have been initiated on Lāna‘i.

18. The need exists for additional cooperation among federal, state and county agencies, along with private land owners, in order to effectively manage hawksbills nesting areas.

Status: ongoing; representatives from these entities gather on an annual basis for a meeting to discuss issues specific to hawksbills in Hawai‘i and collaborate on various projects throughout the year.

19. Research is needed on adult male hawksbills due to their critical contribution to the reproductive process and the current absence of any data on their status and ecology.

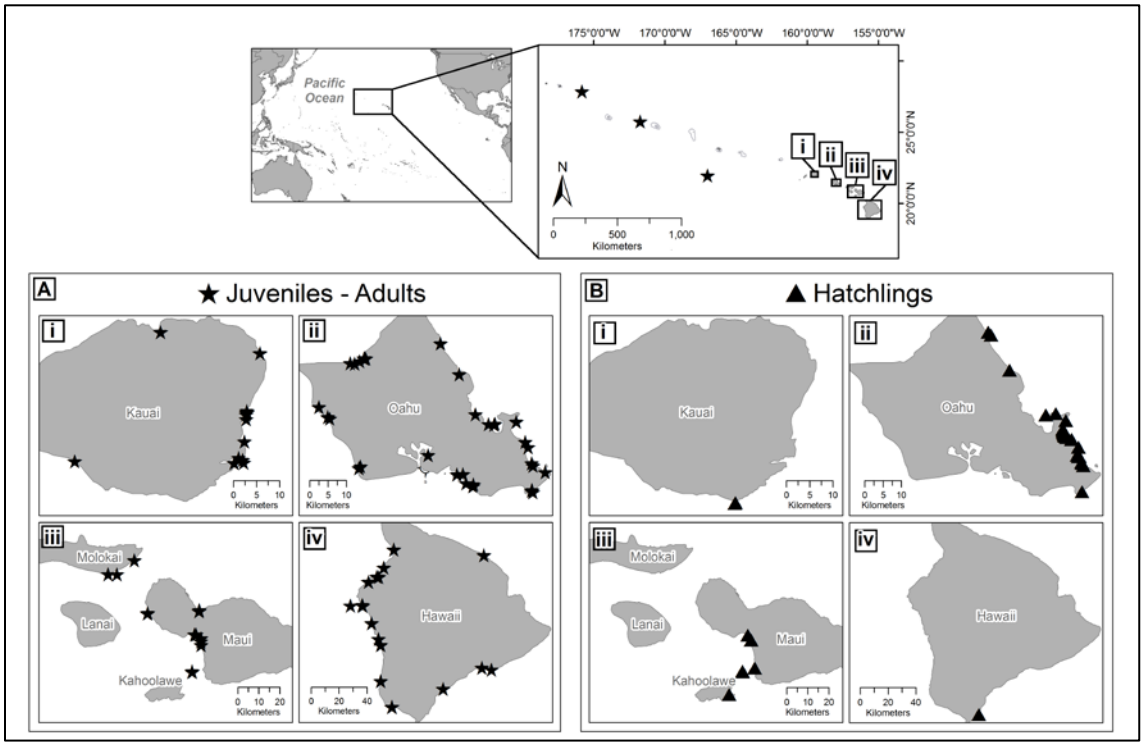
Status: needed/ongoing; Planned via hatchling genetics research to identify breeding males.

APPENDIX II: Hawksbill Turtle Strandings and Threats in Hawai‘i

Abstract: *Population threats to Hawaiian hawksbill sea turtles revealed from three decades of strandings*[17]

Hawksbill turtles (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) are the most common species of marine turtles in nearshore Hawaiian waters; however, green turtles outnumber hawksbills by over an order of magnitude. The low population numbers has led researchers to suggest that the Hawaiian hawksbill population is one of the smallest known marine turtle populations. While greens were historically plentiful throughout the archipelago, little is known about the historic abundance and distribution of hawksbills. To gain a better understanding of the magnitude and distribution of threats facing hawksbills, we analyzed stranding data collected in the Hawaiian Islands between 1984 and 2014. Strandings of sick, injured, or dead turtles on all islands were reported to the NOAA Marine Turtle Research Program, presently known as the Marine Turtle Biology and Assessment Program. In this study, we synthesize these records to evaluate the basic trends in time, demographic composition, and distinguish the type and mortality of various threats. In doing so, we present a comprehensive description of the population across developmental stages and rank threats that may be impeding the successful recovery of the population. Over the 33 years, there were 88 hawksbill sea turtle strandings in the Hawaiian Islands ranging in size class from juvenile to adult (15-89 cm SCL). We classified threats into categories representing typical injuries facing Hawaiian hawksbills. Wounds related to fishing gear were by far the most prevalent threat and cause of death. The second prevalent cause of death was emaciation. Stranded turtles of known sex were female biased (female = 36; male = 5) suggesting sex-specific threats or possibly nesting location and sand temperatures are affecting sex-ratios. It is evident there is a particularly small hawksbill population in the Hawaiian Islands from the small number of strandings and in comparison with the number of green turtle strandings over the same time span. Future studies are needed to focus on the foraging ecology of hawksbills to understand possible resource limitations as well as conservation and research efforts to mitigate anthropogenic threats in Hawai‘i.

[17] Brunson, S., Van Houtan, K.S., Hargrove, S., Balazs, G.H. and T. Work. 2017. Population threats to Hawaiian hawksbill sea turtles revealed from three decades of strandings. 37th Annual Symposium on Sea Turtle Conservation and Biology. Las Vegas, NV. 15-20 April 2017.


175°0'0"W
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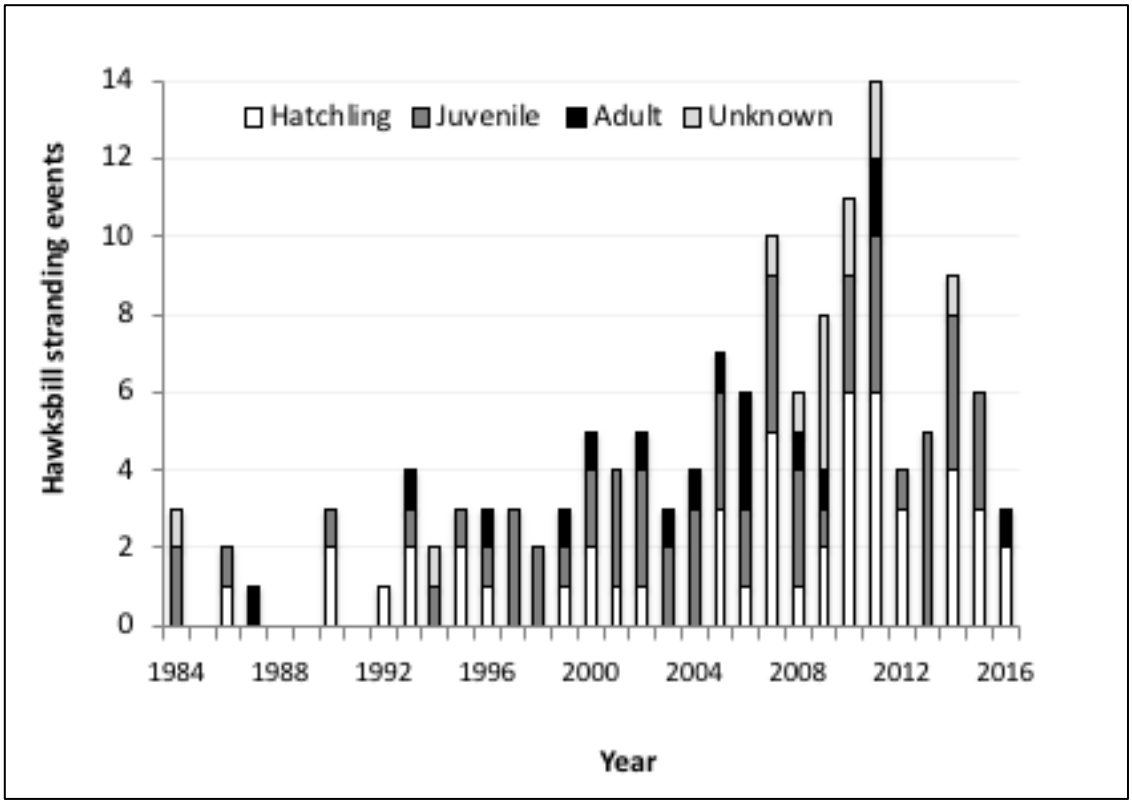
Pacific Ocean
N
0
500
1,000
Kilometers
i
ii
iii
iv
A
★ Juveniles - Adults
B
▲ Hatchlings
Kauai
Oahu
Molokai
Lanai
Maui
Kahoolawe
Hawaii
0 5 10
Kilometers
0 10 20
0 20 40


Hatchling
Juvenile
Adult
Unknown
Hawksbill stranding events
0
2
4
6
8
10
12
14
1984
1988
1992
1996
2000
2004
2008
2012
2016
Year

APPENDIX III: Partnerships in Research, Monitoring, and Management in Hawai‘i

Hawai‘i Volcano National Park

The National Park Service Hawai‘i Volcano National Park (HAVO) has implemented the Hawai‘i Island Hawksbill Turtle Recovery Project (HIHTRP) since 1989. The staff primarily monitors and manages nesting beaches along the Ka`ū coast of the Island of Hawai‘i. HAVO began documenting and monitoring nesting beaches within the National Park boundaries and has since expanded activities to include sites outside the park where nesting activity has been confirmed. Staff monitor nesting beaches from May through January or until the final confirmed nests have hatched for the season. They address threats to nesting females, nests, and hatchlings and provide continuous coverage at multiple nesting sites to ensure hatchlings safely reach the ocean. Staff collect data on nesting events, biometrics of nesting females, hatching success, and hatchling sizes in addition to flipper tagging new nesting individuals and collect genetic samples. Staff also implement predator control measures in the form of traps and predator fences, non-native plant control, as well as outreach and education efforts within the local community. The project is primarily supported by various federal grants and non-permanent sources of funding and volunteer efforts, this project has collected the bulk of current information about nesting hawksbills in Hawai‘i.

Hawai‘i Wildlife Fund, Maui

The Hawai‘i Wildlife Fund (HWF) implements the Maui Hawksbill Turtle Nesting & Foraging Ecology Project to monitor nesting activity by surveying beaches for nesting females, documenting and protecting nests, tagging, and collecting biometrics and biological samples whenever possible. HWF identifies possible threats and responds to those threats. Near the estimated time of emergence, HWF organizes a nearly 24/7 nest watch to ensure hatchlings make it to the sea safely. During nest excavations, HWF works collaboratively, whenever possible, with USFWS and DAR to release trapped hatchlings, record hatch success data, and collect genetic samples from each nest. HWF also implement in-water surveys to search for foraging hawksbills and their habitats and collects opportunistic in-water sightings of hawksbills around Maui.

USFWS Dawn Patrol

In 1996, the USFWS, with support from HWF, initiated this volunteer beach patrol to assist in identifying nesting activity on select Maui beaches and keeping adult turtles off a nearby highway at night (i.e., North Kihei Road). This volunteer group is currently managed by the USFWS. During the nesting season, volunteers walk beaches every morning and report any turtle tracks observed.

Hawaiian Hawksbill Conservation

This educational site is dedicated to advancing the scientific understanding of the Hawaiian hawksbill sea turtle to aid in its local and global conservation. The statewide photo-ID catalog (1998-present) is posted here: www.HIHawksbills.org, and it is a hub for Hawai‘i hawksbill turtles and other ecosystem-related information.

Pūlama Lānaʻi

Pūlama Lānaʻi joined the Hawaiʻi Hawksbill Turtle Network in late 2016 and since then has been working to characterize sea turtle habitats on the island and survey beaches for nesting activity. Pūlama Lāna'i, in collaboration with the Turtle Island Restoration Network's Hawaiʻi Program, will be further expanding these monitoring efforts starting in 2018.