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Human induced trauma and directed take inhibits sea turtle recovery in the Commonwealth of the Northern Mariana Islands*

TAMMY M. SUMMERS†
Rainbow Connection Research, PO Box 5253, Hagatna, GU 96932 USA
tammymaesummers@yahoo.com

IRENE KINAN KELLY
National Oceanic and Atmospheric Administration, Inouye Regional Center, Pacific Islands Regional, 1845 WASP Boulevard, Building 176, Honolulu, Hawaii 96818 USA

THIERRY M. WORK
U.S. Geological Survey, National Wildlife Health Center, Honolulu Field Station, 300 Ala Moana Boulevard. Room 8-132, Honolulu, Hawaii, 96850 USA

JOSEPH K. RUAK AND JESSY R. HAPDEI
Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources Sea Turtle Program, Lower Base Road, Saipan, Northern Mariana Islands 96950 USA

Abstract— Sea turtle conservation is often hindered by the lack of reliable information on population status and threats due to sampling difficulties of these highly migratory reptiles that live in remote and data-poor locations. This paper summarizes more than a decade of stranding recoveries (live and dead turtles) on the islands of Saipan and Tinian, Commonwealth of the Northern Mariana Islands (CNMI), to obtain baseline information on the primary threats to sea turtles in the CNMI. Gross external examination and necropsy of dead turtles was used to infer primary cause of stranding of 89 sea turtles (92.1% green (*Chelonia mydas*), 5.6% hawksbill (*Eretmochelys imbricata*), 1.1% olive ridley (*Lepidochelys olivacea*), and 1% unknown). Of these stranding recoveries, 80.9% were juveniles, 15.7% were adults, and 3.4% were unknown. Trauma related to illegal human take was the primary cause of stranding and accounted for 79% of CNMI sea turtle injuries and mortalities. The remaining 21% of strandings were attributed to (in rank order): marine debris entanglement, shark bite, boat strike, emaciation, and infectious disease. This study provides the first comprehensive characterization of cause-specific sea turtle injury and mortality in CNMI, described within the unique socio-cultural and historical dynamics of the region. Culturally-relevant suggestions for management are provided that may help address the primary threat to CNMI sea turtles.

Introduction

All sea turtle species occurring in United States (U.S.) territorial waters of the Western Pacific region are protected under the U.S. Endangered Species Act (ESA) of 1973 (16 U.S.C. § 1531 et seq.). Of the five species of sea turtle that occur regionally, only hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles are residents in nearshore waters of Commonwealth of the Northern Mariana Islands (CNMI DLNR 2006-2016, Kolinski et al. 2001, Pritchard 1995, Rodda et

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† Corresponding author

al. 1991, Wiles et al. 1989, Martin et al. 2016, Summers et al. 2017); both species are in decline and of significant recovery and conservation concern (NMFS and USFWS 2013, Seminoff et al. 2015).

Globally, hawksbill populations are estimated to have declined >80% over three generations (Mortimer & Donnelly 2008, NMFS & USFWS 2013). The first reported hawksbill turtle nest in the region was on Guam in November 1991 (Eldredge 2003), however, no confirmed nesting activity has been documented in the CNMI since 2006 (Summers et al. 2018). Green turtles of CNMI are part of the endangered Central West Pacific Distinct Population Segment (CWP DPS; 81 FR 20057, May 6, 2016). The CWP DPS is estimated to consist of roughly 6,500 nesting females distributed throughout a vast geographic range spanning nine countries (Seminoff et al. 2015) and over 22 billion square kilometers. Little historical scientific data exist for this DPS, but the limited information available and anecdotal accounts from locals suggest that nesting populations have decreased over time in numerous locations (Seminoff et al. 2015). This is the case in CNMI where only 14 green turtles are estimated to nest annually (Summers et al. 2018).

The harvest of sea turtles for meat, shells and other products is generally believed to have led to reductions in the numbers of nesting and foraging green and hawksbill turtles throughout Micronesia (Groombridge & Luxmoore 1989, Pritchard 1995, Seminoff et al. 2015, Mortimer & Donnelly 2008). Hunting, facilitated by modern tools, paired with an increased human population and waning traditions that may have once limited numbers of turtles taken by island residents, likely exacerbated declines in local turtle populations (Frazier 2003, Johannes 1978, McCoy 1982, Woodrom Luna 2003, 2010). Despite current prohibitions, exploitation and illegal trade of turtles and their eggs continues to be prevalent throughout the region (Humber et al. 2014, Lam et al. 2011, Maison et al. 2010, Seminoff et al. 2015). Green turtle meat in CNMI is considered a delicacy embedded with a tradition of sharing and consumption (Amesbury & Hunter-Anderson, 2008, McCoy 1997, 2004, Woodrom-Rudrud 2003, 2010). The meat of hawksbills is less prized, however, their shells are sought after and primarily used for ornamental products such as jewelry (Mortimer & Donnelly 2008). While threats attributed to the decline of sea turtles in the CNMI include directed take, reef and seagrass degradation, and coastal construction, a comprehensive analysis of threats has not been undertaken as of 2018 (McCoy 1997, NMFS & USFWS 1998a, b, Work et al. 2015, Seminoff et al. 2015). Directed take is defined as intentionally harming or killing a listed species.

Sea turtle conservation is often hindered by the lack of reliable information on population status and threats (Martin et al. 2016, Seminoff et al. 2015), which is frequently the result of sampling difficulties associated with remote and data-poor locations such as in CNMI. Stranding data are commonly used to infer impacts and threats to populations that are exposed to anthropogenic and environmental hazards, and analysis of these impacts can fill necessary data gaps to complement status assessments and to help guide recovery efforts (Chaloupka et al. 2008, Koch et al. 2006, Shaver & Teas 1999). Given this context, the goal of this study is to analyze over a decade of sea turtle strandings in CNMI to obtain baseline information on impacts to both green and hawksbill turtles and filling data deficiencies/needs in this region of the western Pacific. This study provides the first comprehensive analysis of stranding data to quantify primary threats to sea turtles in CNMI.

Methods

Study Area

The Mariana Islands Archipelago consists of the island of Guam and the 14 islands of CNMI, which are located in the Micronesian region of the western Pacific Ocean. The oldest and most complex reef systems in CNMI are located along the western coastlines of the southern islands of Saipan, Tinian, and Rota. There are 53,883 human residents on these three islands, with the majority (89.0%) of the human population residing on Saipan (CNMI Dept. Of Commerce 2010). This study was conducted on the islands of Saipan and Tinian (14.11°N – 15.29°N and 145.12°E – 145.83°E,

respectively), which are bordered by the Philippine Sea to the west and the western Pacific Ocean to the east (Figure 1).

The CNMI Department of Lands and Natural Resources (DLNR) and Division of Fish and Wildlife (DFW) are responsible for the conservation and protection of listed species under the authority of the ESA, and for the enforcement of local CNMI laws which protect turtles from take (hunt), capture, or harm. The DLNR Sea Turtle Program (STP) and DFW maintain a National Marine Fisheries Service (NMFS) permit to study protected species for scientific purposes. This permit authorizes the retrieval of stranded sea turtles, necropsy of carcasses, and possession of confiscated live and dead turtles in CNMI in order to assess anthropogenic impacts and health status of sea turtles on the islands of Saipan and Tinian.

Data Collection and Survey Effort

Data were collected between April 2005 and September 2016 via: 1) opportunistic capture of debilitated/injured turtles during STP marine surveys, 2) opportunistic recovery of turtles, carcasses, carapaces, or frozen meat by DFW Conservation Officers (COs) in response to public reports and surrenders, and 3) STP staff observations or recovery of turtles during nesting beach surveys. A stranded sea turtle was defined as a dead animal found on land or in the water, and any live animal (on land or in the water) that is unable to return to its natural habitat or resume natural activities due to injury, impediment, immobilization, poor health, or impaired body condition. For nesting females, strandings were those nesters captured for consumption but released as a result of STP staff presence or interruption; recovered dead (females of adult size) on or nearby nesting beaches; or butchered carcasses confiscated during residence searches conducted by DFW Enforcement. A turtle stranding hotline (C-TRTLES/287-8537) was established in 2012 to facilitate and encourage public reporting.

Stranding recovery location data were collected via a handheld Garmin GPSMAP 76 Global Positioning System (GPS) and were mapped using Geographic Information System (GIS) version 10. In cases with no GPS location, we used the coordinates of the beach or village where the stranding occurred.

Determination of Injury and Mortality

The primary cause of stranding, mortality or injury was determined via external examination and necropsy of dead animals or gross assessment of live injured turtles. Strandings were documented on standardized Sea Turtle Stranding and Salvage Network (STSSN) forms (Shaver & Teas 1999). Species identification followed Pritchard and Mortimer (1999) and the "Sea Turtle Identification Key" (www.seaturtle.org 2005). Turtle condition was coded as: 0 (alive), 1 (fresh dead), 2 (moderately decomposed), 3 (severely decomposed), 4 (dried carcass), and 5 (skeleton, bones only). All recovered turtles were checked for flipper tags and scanned (Biomark Pocket Reader©) for Passive Integrated Transponder (PIT) tags; tag numbers, tag positions, and tag type were recorded. Necropsies were performed on turtles recovered in condition one or two, following methods outlined in the Sea Turtle Necropsy Manual for Biologists in Remote Refuges (Work 2000). No severely decomposed turtles were recovered during this study. Butchered carcasses and curio shells were coded as 5 (skeleton, bones only).

Severely injured turtles stranded live were taken for short-term care to a Saipan-based permitted veterinarian and/or held overnight for observation by permitted agency staff. If the turtle survived, it was tagged and released near the site of recovery; if it died, turtle condition was recorded in database as fresh dead and the carcass was necropsied. Mildly injured turtles opportunistically captured during nearshore surveys were treated for impacts (e.g. hook removal) prior to release. Unless injuries prevented tag application, all released turtles were double-marked with Inconel (National Band & Tag Co, 681C) flipper and PIT (Biomark, GPT12 Pre-load sterile) tags.

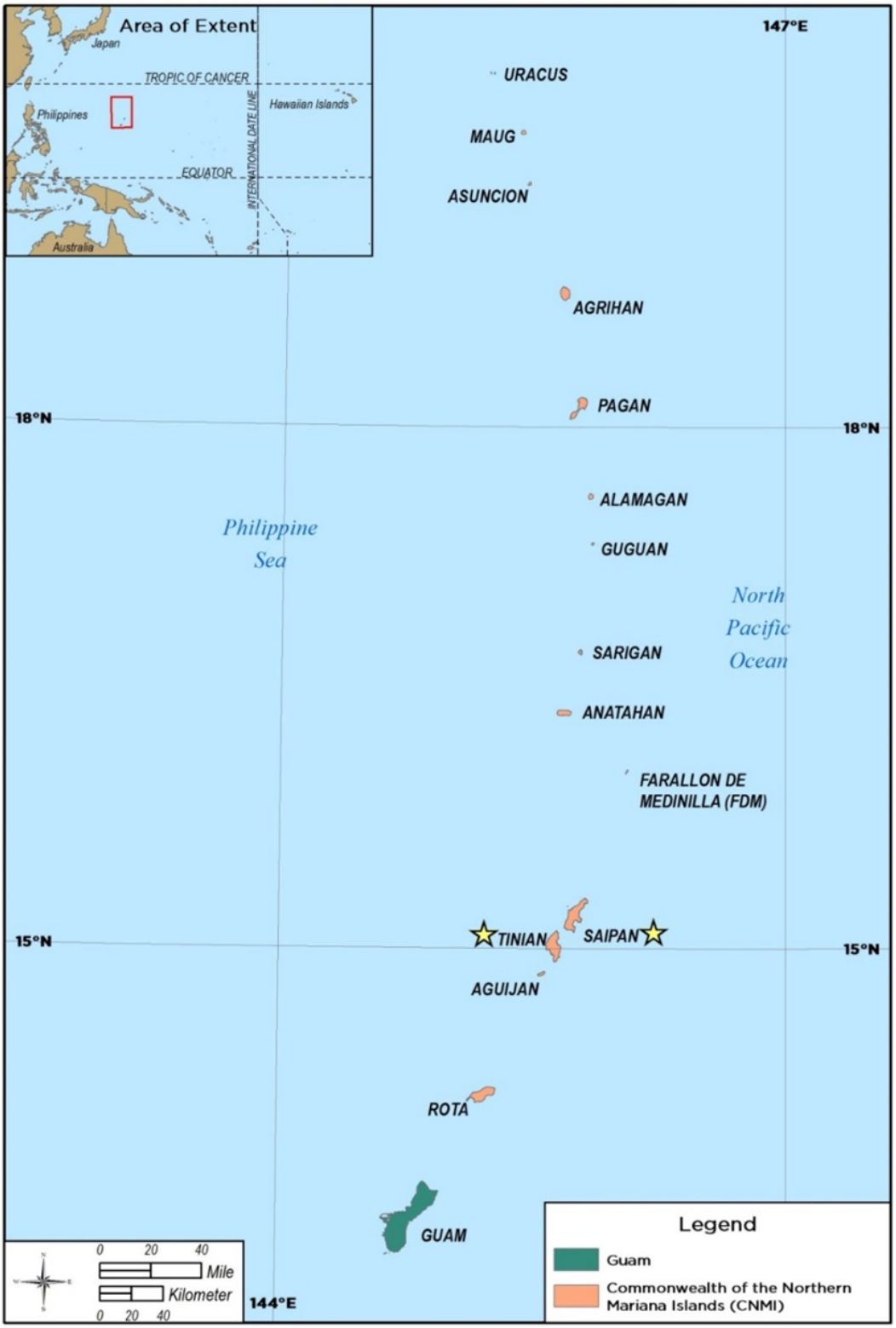

Figure 1. Map of the Mariana Islands Archipelago showing the study site locations (denoted by stars) of the islands of Saipan and Tinian, CNMI.

MEASUREMENTS

Calipers (800 mm and 1270 mm, Haglöf, Sweden) were used to measure straight carapace length (SCL) and width (SCW) of all confiscated turtles, while curved carapace length (CCL) and width (CCW) were measured using a calibrated flexible fiberglass tape consistent with Bolten (1999) to the nearest tenth of a centimeter (cm). Maturity estimates (SCL ≥ 81 cm) were based on the CNMI adult green turtle nesting population (Summers et al. 2018), while those for hawksbill turtles (SCL ≥ 78.6 cm) were taken from van Buskirk and Crowder (1994). Size class data was binned into two categories based on these maturity estimates: adult and juvenile. Carcass body mass was measured to the nearest tenth of a kilogram (kg) using a Salter Brecknell PS 400 digital scale.

NECROPSY

On carcasses where necropsy was likely to yield useful information as to cause of death (decomposition stage one or two), formalin-fixed organ tissues, along with photos and gross necropsy notes were submitted to the U.S. Geological Survey's (USGS) National Wildlife Health Center – Honolulu Field Station, Hawaii. Gross and microscopic lesions were examined in an attempt to determine primary cause of stranding or mortality, which were broadly categorized as: trauma, infectious/inflammatory, nutritional, physiologic, or unknown (Work et al. 2015). Causes of trauma included: 1) direct human take: a) gross evidence of butchery, b) injury from fishing or hunting gear (spears/bullets/hooks), c) flippers immobilized (bound with strips of rubber inner tubing/nylon rope or cord), hatchling retention (improper husbandry); 2) predation (shark bite); 3) boat strike (blunt or acute trauma, or propeller injury); 4) entanglement (in ghost fishing gear, marine debris, or mooring lines); 5) other/unknown.

For carcasses where intact soft tissue was unavailable (i.e., only the carapace, plastron, or scutes/bones were recovered), SCL, SCW, CCL, and CCW were recorded, photos were taken, and remains were examined for evidence of butchery such as presence of parallel linear slashes on bones and charring suggesting cooking. Occasionally, preserved curio shells were confiscated or surrendered, in which case the species was identified and carapace measurements and photos were taken. All carcasses/carapaces displaying evidence of butchery, freshly preserved curio shells, and improper husbandry of hatchling 'pets' were categorized as directed take.

Results

A total of 89 sea turtles, including 22 (24.7%) live and 67 (75.3%) dead, were recorded as stranded between April 2005 and September 2016 (Figure 2). Three different sea turtle species were recovered (Table 1): green (n = 82, 92.1%), hawksbill (n = 5, 5.6%) and olive ridley[1] (*Lepidochelys olivacea*) (n = 1, 1.1%). A single turtle (1.1%) for which species identification was not possible was also encountered. Of the 89 stranded or recovered animals, 20 turtles were confiscated by DFW COs and 14 were recovered during STP nesting beach or nearshore surveys, with the remaining 55 reported by the public (n = 41) or government agency personnel (n = 14).

Of total strandings (n = 89), 86 cases were from Saipan while three were from Tinian. Human induced trauma related to directed take was the primary cause (n= 70; 78.7%) of stranding injury or mortality, including five cases of known (in-year) nesting females (Figure 3). Other causes of strandings included: marine debris entanglement (n = 3), shark bite (n = 3), boat strike (n = 3), nutritional (n = 3), infectious/inflammation (n = 2), or unknown (n = 5).

[1] An additional sighting of a juvenile olive ridley turtle was reported (via cell phone video) on October 2, 2017 by a local fisherman. Turtle was found entangled in a ghost fishing net that was drifting in nearshore waters of Rota, CNMI, and released alive.

Table 1. Number of sea turtle strandings (n = 89), condition, sex, and size class from 2005 to 2016 on Saipan and Tinian, CNMI.

Species	Total Number (% total)	Condition		Sex			Size Class		
		Live	*Dead*	*Female*	*Male*	*Undet.*	*Juvenile*	*Adult*	*Unk.*
Green	82 (92.1)	20	62	16	5	61	65	14	3
Hawksbill	5 (5.6)	2	3	2	0	3	5	0	0
Olive ridley	1 (1.1)	0	1	0	1	0	1	0	0
Unknown	1 (1.1)	0	1	0	0	1	1	0	0

Juvenile size classes (i.e., SCL < 81 cm) accounted for 80.9% (n = 72) of stranded turtles; only 15.7% were adults (n = 14), and 3.4% were unknown (n = 3). The majority (79.3%) of green turtles were juveniles (n = 65), while 17.1% (n = 14) were adults (SCL ≥ 81 cm), and 3.6% unknown (n = 3) (Table 1). All stranded hawksbill and olive ridley turtles were juveniles. Green turtle mean SCL was 55.5 cm ± 17.9 (n = 82), hawksbill turtle mean SCL was 44.0 cm ± 8.3 (n = 5), and the olive ridley turtle was 39.7 cm (n = 1). Of those turtles of known sex (n = 24), 75.0% were female, while 25.0% were male. The majority of strandings could not be sexed.

Of the 20 green turtles recovered live (Table 1), 17 (85.0%) had evidence of directed take due to gross evidence of butchery (Figure 4A), spear gun injuries (Figure 4B), large stainless steel hooks found embedded in the ventral neck region (Figure 4D), and/or were found bound/immobilized (Figure 4E, 4F). Remaining live recovery cases involved fresh boat strike injuries (n = 2) (Figure 4J) and one hatchling that was retained as a pet/improper husbandry (Figure 4G). Cause of death was directed take for 48 (77.4%) of the 62 green turtles recovered dead (Table 1). Four of the five hawksbill turtle strandings were the result of human take, including individuals recovered with spear gun injuries (n = 2), butchered (n = 1), or ornamental decoration (n = 1), with one animal entangled in marine debris (Figure 4I). A single olive ridley carcass was recovered entangled in marine debris (ghost net) floating in Saipan channel near Cross Point, Tinian (Figure 6).

Of the five adult-sized turtles, one was found by STP staff during a rapid nesting beach assessment at Barcinas Cove, Tinian (Figure 6). This animal was originally tagged at the same beach in 1995 (Pultz et al. 1999). One butchered animal was recovered by DFW officers which had been originally tagged as a nesting turtle at Obyan beach (Figure 5) in 2006 and re-emerged in 2012. One nesting female was found flipped over but dead, seemingly abandoned by hunters, at DanDan Pocket Beach on Saipan (Figure 5). Several abandoned egg chambers were also found at this site, and necropsy revealed eggs in her body cavity suggesting that the turtle had been attempting to nest when collected. Two turtles were found incapacitated (flipped over or bound), but alive and subsequently released, during STP nesting beach surveys at Wing and Tank beaches, Saipan (Figure 5).

An additional seven adult size carapaces were also recovered with evidence of butchering and cooking, but sex could not be determined nor could they be identified or correlated with a known (in-year) nesting animal as PIT/flipper tags and other identifying features were not evident. One adult female had evidence of a shark bite, and one adult male turtle was seen floating at sea but was not recovered so cause of death could not be determined.

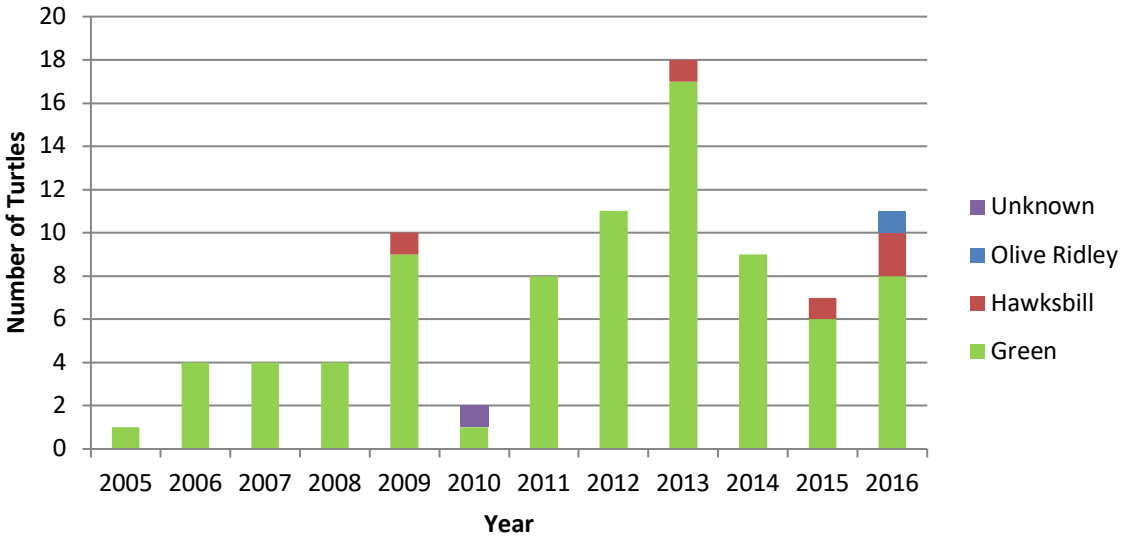

Figure 2. Total number of green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*) and unknown sea turtle recoveries per year represented in the CNMI stranding database 2005 to 2016 (n = 89).

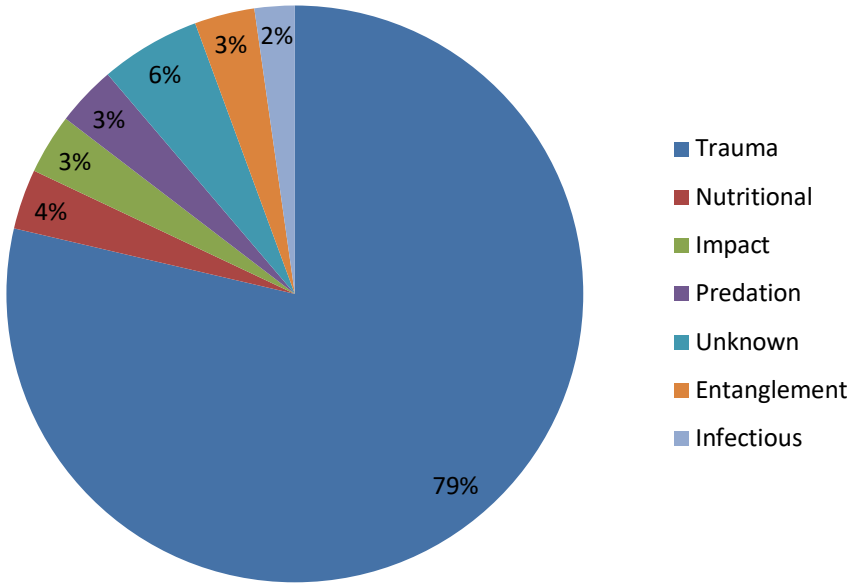

Figure 3. Primary causes of injury and mortality of dead and live stranded sea turtles in Saipan and Tinian from 2005-2016 (n = 89). Trauma includes butchery, spear/bullet damage, rubber inner tube binding & improper husbandry. Nutritional refers to emaciation, predation is from sharks, entanglement sources include marine debris, lines and nets. Infectious damage is evidenced by inflammation.

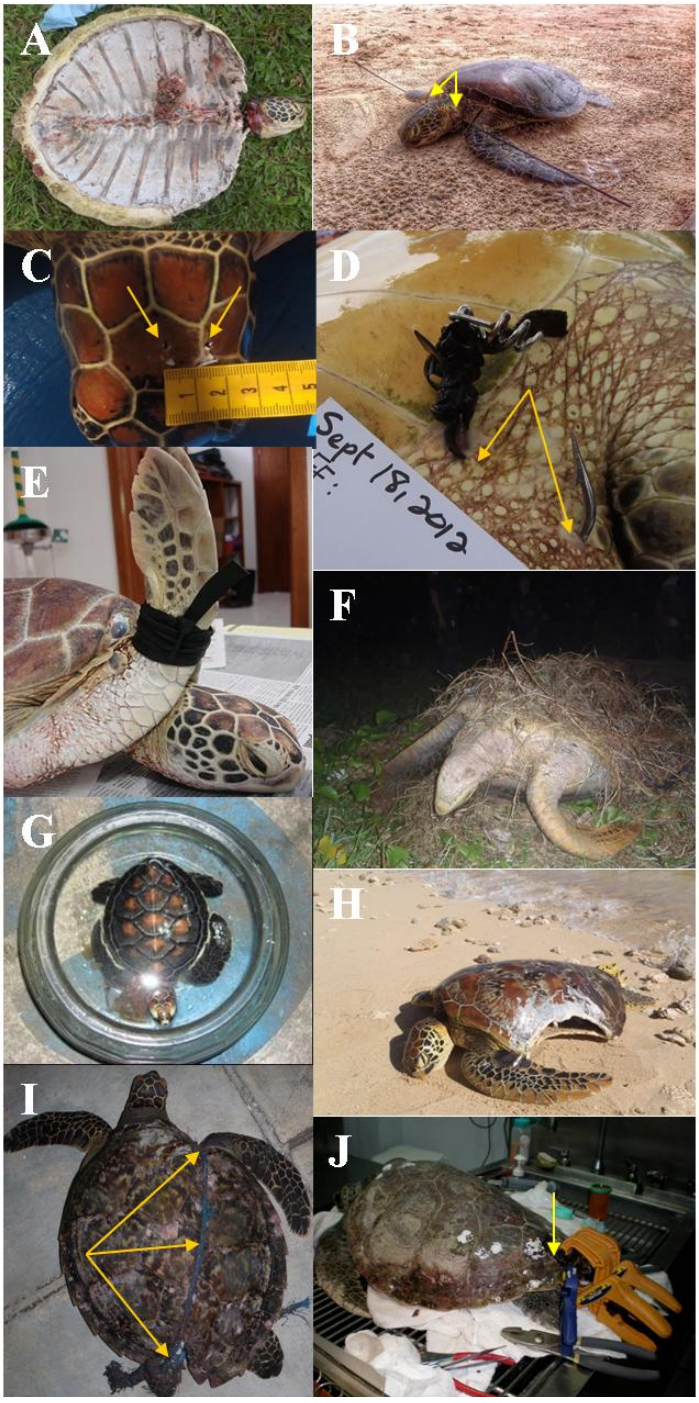

Figure 4. Examples of trauma, predation, impact, and entanglement in CNMI: A) butchered green turtle carapace and head; B) spear piercing neck of live juvenile green turtle; C) three-prong spear impact to cranium; D) large stainless steel hook embedded in ventral neck; E) rubber (inner tube) straps binding front flippers; F) nesting female immobilized by flipping onto carapace; G) hatchling retained as pet; H) shark predation; I) marine debris entanglement (note marked disfigurement due to debris); and J) boat strike (photo depicts carapace repair-arrow). Photos taken under USFWS recovery permit no. TE017352-17.

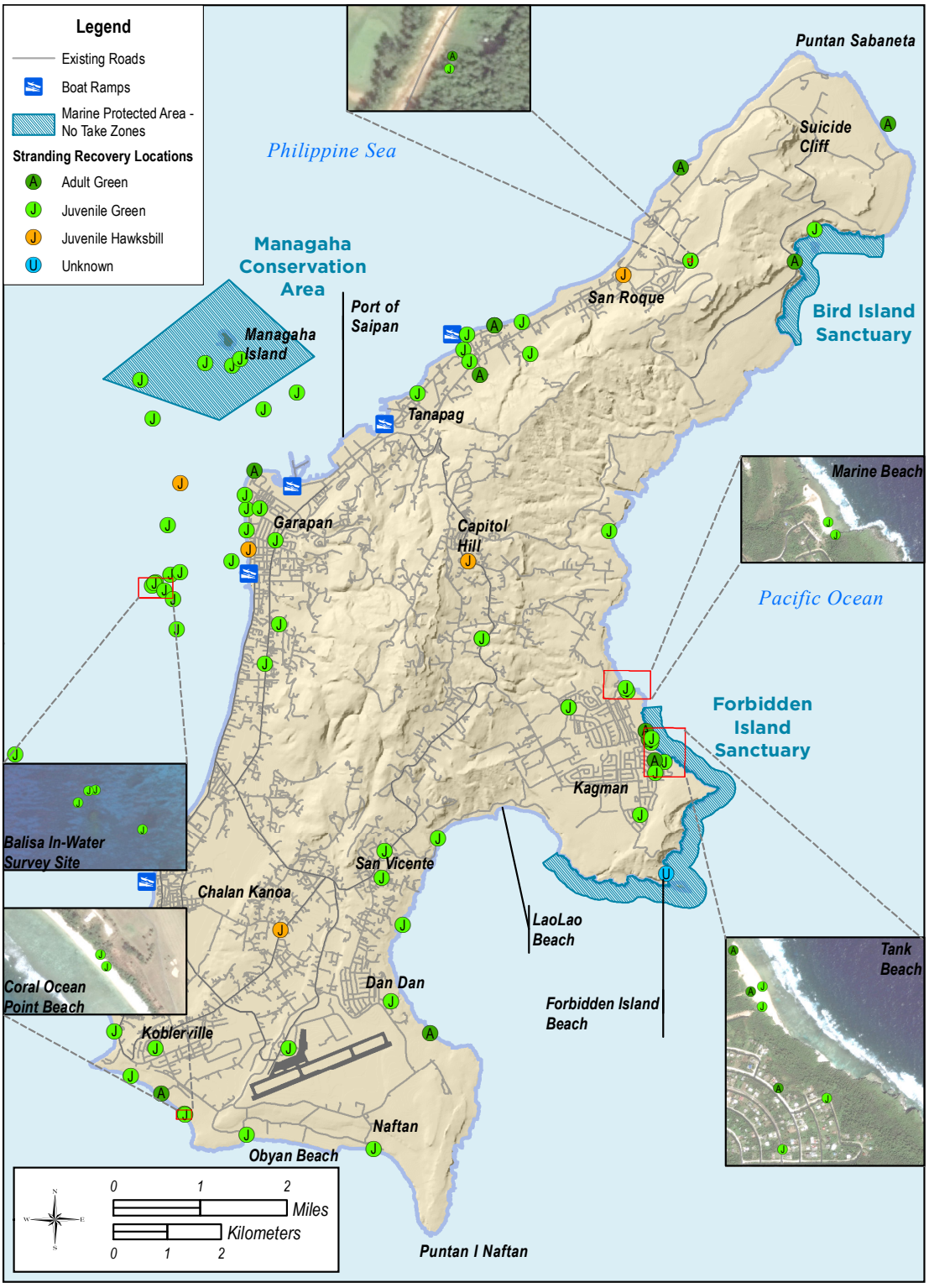

Figure 5. Locations of sea turtle stranding recoveries on Saipan, CNMI from April 2005 to September 2016.

Figure 6. Locations of opportunistic sea turtle stranding recoveries on Tinian, CNMI from July 2009 to July 2016.

Discussion

GENERAL

The primary cause of stranding, injury and mortality to sea turtles in CNMI is direct human take. Of stranded animals, 79% were the result of directed take (or illegal hunting) as evidenced by injuries stemming from three-pronged spears, automatic spear guns, hooking (large stainless steel fish hooks), flippers bound, bullet wounds, butchery, or charring/cooking. Eighty percent of these human take cases involved juvenile turtles which is consistent with the primary size class of foraging marine turtles in CNMI (Summers et al. 2017). Not surprisingly, the bulk of takes (92.1%) involved green turtles as these are the predominant species found in nearshore waters (Summers et al. 2017), and the only species currently known to nest on Saipan (Summers et al. 2018). Other less common causes of mortality or stranding in CNMI included boat strike, predation (shark) and debris entanglement. In general, confiscated and stranded animals were opportunistically recovered and not systematically collected suggesting directed take of sea turtles around CNMI may be more common than our results indicate.

Strandings appeared to increase after 2012 (Figure 2), however this is most likely a result of increased STP monitoring activities combined with increased reporting after a stranding hotline was established in 2012. When systematic surveys aren't feasible, stranding data are typically subject to confounding factors such as frequency of reporting (Chaloupka et al. 2008). To elucidate whether strandings are truly increasing or not requires standardized surveys at index sites. Because of the low numbers reported between 2005 and 2008, detecting true trends may be challenging.

The majority of juvenile strandings attributed to illegal take (77.5%) were confiscated within one mile of reefs with easy access from boat ramps or beaches on the leeward sides of Tinian and Saipan (Figures 5 and 6). These nearshore waters have greater protection from prevailing northeast winds and waves, providing favorable conditions for fishing. Adult female stranding recoveries attributed to take occurred at beaches with easy vehicle and pedestrian access and in close proximity to villages. Evidence of nesting turtle take was never observed at Bird Island beach (but instead as discarded carcasses off the roadside at Bird Island Lookout) likely because this beach is protected by high cliff walls on all sides and is only accessible by foot via a steep, narrow path approximately 200 m in length.

The CNMI resident foraging population of green turtles are estimated to require an average of 17 years to mature (range: 13 – 24 years; Summers et al. 2017), thus allowing ample opportunities for human take before turtles reach adulthood. Anthropogenic impacts to the population are likely exacerbated by the take of adult females (Summers et al. 2018), the loss of which decreases the chance of population recovery (Crouse et al. 1987, Heppell et al. 1996). Summers et al. (2018) concluded that 25 females from Saipan (32%) and at least three from Tinian (12%) were taken between 2006 and 2016 (this estimate included the five nesting females recovered in this study). The removal of nesters from this small population of 65 adult females has likely negatively affected the populations' recovery potential by slowing the annual population growth rate by 4% (Summers et al. 2018). Given the continued hunting pressure in CNMI combined with a very small nesting population, it is reasonable to assume that the continued take of nesting females could further impede recovery of the CNMI component of the Central West Pacific DPS (Seminoff et al. 2015). The take of five juvenile hawksbills documented in this study likely also has the potential to negatively impact local populations given its imperiled status in CNMI (Summers et al. 2017) and the Pacific (Meylan & Donnelly 1999, NMFS & USFWS 2013).

MANAGEMENT IMPLICATIONS

ESA recovery obligations include reducing threats to protected species. While the ESA can provide a foundation for the protection and recovery of listed species (Crouse et al. 2002, NMFS 2004, Suckling 2007); sea turtle protection is challenging to implement in remote locations such as in CNMI, where capacity, funding, enforcement and educational outreach are limited (Johannes 1986, Martin et al. 2016, McCoy 1997, Schwartz 2008). The challenge of sea turtle protection is particularly difficult given that regulatory laws can be perceived to be imposed from "afar" and as contrary to traditional rights (Kinan [Kelly] & Dalzell 2004, McCoy 1974, 1982, 1997). This perception may lead to defiance against ESA regulations (von Essen et al. 2014).

To effectively manage human impacts to sea turtles in CNMI, it is important to consider the history of the place and its people. CNMI has a rich history embedded within a complex sociopolitical story of culture, colonization and war (Atienza 2013). The Micronesians which settled in CNMI were known for their seafaring and fishing skills, and prior to European contact in the 16th century the indigenous people of that time followed clan and lineage relationships manifested in marriage, adoption, visitation, and material exchanges of food and other natural resources, which included sea turtles (Amesbury & Hunter-Anderson 2008, Johannes 1986; Woodrom-Luna 2003). Today, fishing continues to contribute not only to the subsistence needs of the people, but in helping to preserve their history, identity, traditional knowledge, and in maintaining connections to the sea and its resources (Amesbury & Hunter-Anderson 2008, Pickering & Gist 2011). Our results indicate that sea turtle harvest continues, which could be a result of deeply imbedded traditions despite protective U.S. territory and federal regulations, suggesting that laws alone are not enough to deter harvest pressure (Kinan [Kelly] & Dalzell 2004, Liles et al. 2014, von Essen et al. 2014).

Since 2006, numerous management outreach activities have been implemented by the STP in effort to raise community awareness about the need for sea turtle conservation, including educational outreach at schools and community events, public service announcements, ads in newspapers, and a stranding hotline. Additionally, an award winning film, *My Haggan Dream,* was produced and widely disseminated that highlights the shared international connectivity of green turtles within the CWP DPS and the greater western Pacific region (Open Boat Films 2016, Summers & Kinan [Kelly] 2011). An elementary school curriculum is planned to include culturally-relevant outreach recommendations originally proposed by McCoy (1997). Recognizing that engagement of local residents is essential towards achieving conservation objectives, a curriculum which creatively incorporates sea turtles in a non-lethal fashion (i.e., a symbolic gift) in local fiestas and village celebrations, perhaps coupled with traditional canoe sailing practices, may help rebuild cultural awareness and connections with sea turtles and traditions beyond consumption (Basile 2000, Liles et al. 2014, McCoy 1997, Nichols & Safina 2004). In other words, culturally-relevant management and community engagement may help foster a social movement to shift attitudes and future behaviors in CNMI to support sea turtle recovery objectives (Delgado & Nichols 2005, Liles et al. 2016*,* Liles et al. 2014, Schneller 2008, Senko et al. 2011).

However, if efforts to reduce take are to be effective, education must be complimented by increased enforcement presence and a stronger stance in local courts (Mancini et al. 2011, von Essen et al. 2014). In CNMI, arrests are sometimes made, but cases are rarely prosecuted (e.g., tourist in possession of five carapaces in 2013; CNMI DLNR 2014), and sentences typically lenient (McCoy 1997, E. Escudero pers. comm., C. Ratterman pers. comm., Saipan Tribune 2010). Institutional capacity is lacking and the community can receive conflicting guidance if elected officials themselves do not appear supportive of their own laws by promoting continued "traditional," yet illegal, sea turtle take (Bagnol 2016, de la Torre 2016, Dumat-ol Daleno 2016, Todiño 2017). Perceptions are key, hence greater conservation and regulatory buy-in by local government and community leaders would be beneficial (Liles et al. 2016, von Essen et al. 2014). Public acknowledgment that continued take is unsustainable, illegal, and contrary to population recovery efforts and traditional practices could be helpful. Traditional practices (i.e., taboo systems or cultural

rules) encouraged the protection of and responsibility to care for sensitive or depleted resources and were culturally influential in management of Micronesian and Polynesian marine resources in the past (Johannes 1978, Jones et al. 2008, McCoy 1997, 2004, Woodrum-Luna 2003, 2010). Such community-based practices are currently experiencing a renaissance in numerous locations (e.g., Hawaii, Fiji, Vanuatu) and may complement current regulatory marine resource management efforts in the CNMI (Hawai‘i DLNR-DAR 2016, Friedlander et al. 2013, Hickey 2006, Johannes 2002, Johannes & Hickey 2004, Richmond & Levine 2012, Remling & Veitayaki 2016).

Although we present evidence of substantial illegal take of foraging and nesting turtles in the CNMI over the past decade, there may be great promise for sea turtle conservation if programs collaborate, local institutional support exists, and funding is available to support cooperative efforts. Given that more than half of stranding recoveries resulted from voluntary public reports, community support and buy-in for sea turtle protections in CNMI may be increasing. A solid foundation of intensive outreach and monitoring presence by both STP and DFW Enforcement staff could be helpful. Additionally, research to better understand and inform management strategies is encouraged to address the underlying sociopolitical dimensions that may be perpetuating negative attitudes towards regulations and the need for protections. Such efforts are essential to the future health of CNMI sea turtles and could advantageously focus on helping local communities and community leaders embrace protections for future generations.

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