

Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for severely depleted populations of hawksbill turtle *Eretmochelys imbricata*

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Abstract While little is known about hawksbill turtles *Eretmochelys imbricata* in the eastern Pacific Ocean, available information suggests that the population has declined substantially in recent decades and could be near extirpa-

tion in the region. To evaluate the current status of the population more effectively and to determine the feasibility of recovery efforts, a workshop of regional marine turtle specialists was held in June 2008 in Los Cóbano, El Salvador. An international working group, Iniciativa Carey del Pacífico Oriental (ICAPO; Eastern Pacific Hawksbill Initiative in English), was established to consolidate information, promote conservation projects and raise awareness about the species. We present information derived from the workshop and compiled by the ICAPO working group since that time. Considering only records from 1 January 2007 to 31 May 2009 it appears that El Salvador hosts the majority of known hawksbill turtle nesting activity in the eastern Pacific, with 79.6% ($n = 430$) of all nesting observation records, and Mexico hosts the majority of records of hawksbill turtles at sea, with 60.3% ($n = 44$) of all in-water observation records. Although current abundance is very low, the pervasiveness of the species in the region suggests potential for conservation and recovery. Despite a historical paucity of research focusing on this population, the relatively large and steadily increasing number of records as a result of concerted efforts demonstrates the viability of the ICAPO network as an instrument to promote conservation of this species in the eastern Pacific.

Keywords Conservation network, critically endangered, eastern Pacific Ocean, *Eretmochelys imbricata*, hawksbill turtle, recovery, status, tortoiseshell

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Introduction

The hawksbill marine turtle *Eretmochelys imbricata* is distributed circum-tropically and categorized on the IUCN Red List as Critically Endangered (Mortimer & Donnelly, 2008) as a result of the decline of populations throughout its range (Meylan, 1999; Mortimer & Donnelly, 2008). Unique to this species of marine turtle, and one of the principle reasons for its decline, is the collection of its elaborately coloured keratinous shell (tortoiseshell, or bekko as it is referred to in Japan) for fabrication of items

such as rings and pendants (Carr, 1952; Parsons, 1972; King, 1982; Chacón & Arauz, 2002; Mortimer & Donnelly, 2008). Entire individuals are also commonly collected and sold as stuffed curios (King, 1982).

Hawksbill turtles are particularly threatened in the Pacific Ocean where they are approaching regional extirpation (NMFS & USFWS, 1998; Mortimer & Donnelly, 2008). This is especially the case in the eastern Pacific, where the species was once considered common from Mexico to Ecuador (Cliffon et al., 1982) but is now the rarest marine turtle in the region (Cornelius, 1982). As in other parts of the world, the historical reduction in numbers in the eastern Pacific is closely tied to the tortoiseshell trade, as well as to egg harvest and fisheries bycatch (Mortimer & Donnelly, 2008).

The earliest accounts of hawksbill turtles in the eastern Pacific come from the diaries of 18th century pirates and missionaries, who wrote about commercial tortoiseshell industries and important breeding sites for the species in north-west Mexico (see references in Sáenz-Arroyo et al., 2006). Hawksbill turtles were abundant and heavily exploited in the region up to the mid 20th century (Caldwell, 1962; Townsend, 1916, cited in Cliffon et al., 1982; Felger & Moser, 1985; Nichols, 2003), with fishermen recalling how the crew of a single fishing canoe could capture 5–7 hawksbill turtles in one night (Cliffon et al., 1982). Major and sporadic nesting was known to occur along the coasts of El Salvador, Ecuador and Colombia (Mortimer & Donnelly, 2008) but no major nesting sites were thought to persist into contemporary times (Cliffon et al., 1982). After commercial extinction even hawksbill turtles encountered opportunistically were killed for their shell, which became increasingly valuable (Nichols, 2003).

Despite an apparently large reduction in numbers the hawksbill turtles of the eastern Pacific have received little attention; published quantitative data on nesting and foraging are almost non-existent (but see Seminoff et al., 2003; Gaos et al., 2006). Long-term marine turtle conservation strategies, status assessments and recovery plans require reliable quantitative and qualitative information (Taylor, 1995; Brook et al., 1997). Scarcity of data for hawksbill turtles in the eastern Pacific was recognized by the IUCN Marine Turtle Specialist Group as one of the principal barriers to effective conservation of the species (Mast et al., 2004). Individuals and organizations working throughout the eastern Pacific therefore convened a data-gathering meeting (First Workshop of the Hawksbill Turtle in the Eastern Pacific) on 15–16 July 2008 in Los Cóbano, El Salvador (ICAPO, 2008). The objectives of the workshop were to compile current scientific knowledge on the species, identify priority research sites and issues, and identify the main threats.

At the workshop participants collaboratively established an international working group, *Iniciativa Carey del Pacífico*

Oriental (ICAPO; Eastern Pacific Hawksbill Initiative in English), to consolidate information, promote projects and raise awareness about the species. Following the workshop ICAPO has continued to compile information on confirmed observations of hawksbill turtles in the eastern Pacific. Based on this information we present here the most complete set of nesting and in-water sightings, strandings and bycatch observations for hawksbill turtles in the eastern Pacific available to date and use it to make recommendations for future research and management.

Methods

Workshop

At least one participant was invited from each country in the eastern Pacific, from the USA to Peru (Fig. 1), believed to be the northernmost and southernmost limits of the population, respectively (Mortimer & Donnelly, 2008). Participants were asked to serve as representatives for their regions/countries and/or field of expertise and to gather and present information pertaining to hawksbill turtles, including local conservation legislation, principal threats, past, existing and future conservation programmes, and a summary of available biological and ecological data. The latter was summarized in five observation categories: (1) Nesting: any emerging ashore in an attempt to nest, whether successful or not. (2) In-water: any recorded at sea, including fisheries bycatch, in-water monitoring and visual confirmations (e.g. while scuba diving). (3) Stranding: any encountered dead along the shoreline or inland (e.g. on garbage dumps). (4) Curios: any shells or entire (stuffed) individuals on display in homes, restaurants, shops or elsewhere. (5) Captivity: any being held in captivity (e.g. in an aquarium). The data were attained via numerous methods (e.g. directed studies, opportunistic monitoring, random sightings), detailed accounts of which are not presented here.

A threat assessment, following guidelines outlined by the Inter-American Convention for the Conservation and Protection of Marine Turtles (IAC Secretariat, 2004), was conducted. It included: creation of a list of threats, examination of techniques to reduce the effects associated with each threat, and prioritization of the three greatest threats or impacts according to contribution, breadth (having broad, multi-scale impacts), irreversibility and severity.

Ongoing data gathering

Following the workshop members of the ICAPO working group made concerted efforts to increase data collection on hawksbill turtles and to promote and undertake efforts that would lead to increased information on the species. These data were compiled into the ICAPO database. Data

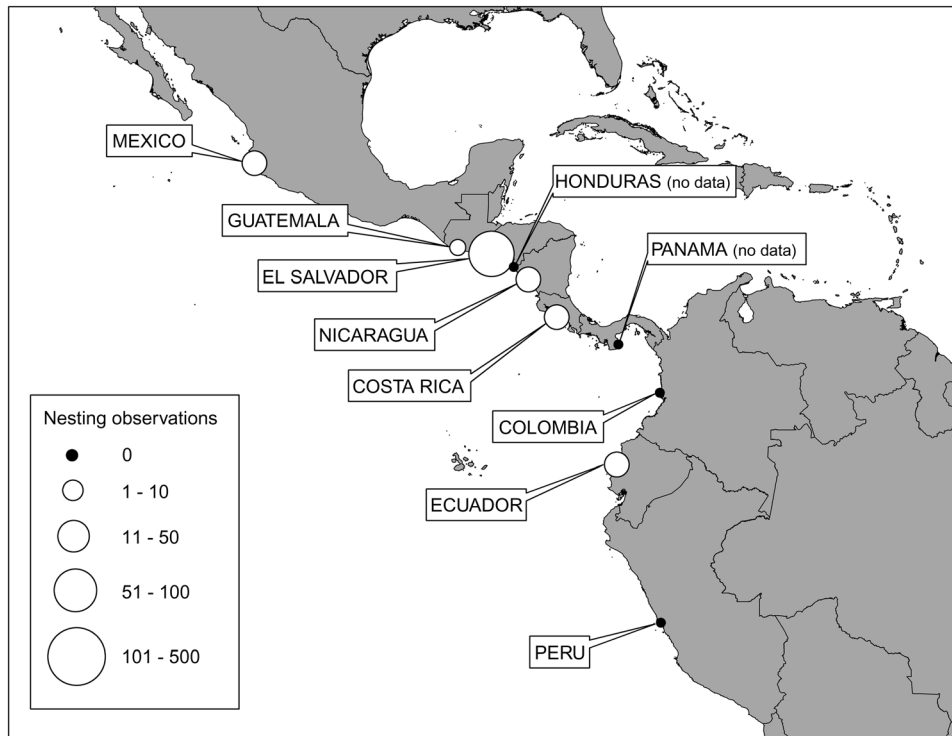


FIG. 1 The study area of the eastern Pacific, with total observations reported, by country, from 1 January 2007 to 31 May 2009, of the hawksbill marine turtle *Eretmochelys imbricata* nesting along the coast from Mexico to Peru.

collection included: (1) Informing local individuals, organizations and networks of the need to collect information on the species and soliciting the delivery of such information to ICAPO members. (2) Conducting in-water monitoring, conservation projects at nesting beaches, bycatch observations, interviews of fishermen, beach carcass surveys, and following up anecdotal information of the presence of the species. (3) Contacting potential members for the working group, particularly in countries not represented or underrepresented at the workshop. (4) Facilitating communications among members of the working group via creation of a listserv. (5) Utilizing the media and presentations at national and international meetings to raise awareness of the situation facing hawksbill turtles in the eastern Pacific and the need for conservation and data collection.

Results

Observations of hawksbill turtles collected by the ICAPO working group up to 31 May 2009 are summarized in Table 1. The table includes all information available on the species irrespective of date.

Based on the knowledge shared at the workshop El Salvador, Ecuador, Mexico and Nicaragua were identified as priority countries in which to begin or expand investigation and conservation of hawksbill turtles. El Salvador was identified as the top priority country because of the relatively large number of observations of hawksbill turtles there and

the severe demographic pressures and other threats. Conducting exploratory activities to identify potentially critical habitat for the species throughout the eastern Pacific was considered a high priority issue. It was also noted that as no representatives from Honduras, Panama or Peru were present at the workshop, the consequent lack of information for these countries might be why they have been excluded as priority areas for investigation and/or research.

The following issues were identified as important action points for conservation and recovery of hawksbill turtles in the eastern Pacific:

- Establish a database on the species' biology and status and conservation actions pertaining to the species and standardize future data collection.
- Protect hawksbill turtles at known nesting and in-water aggregation sites and promote efforts to identify and protect any additional sites.
- Guarantee the protection of hawksbill turtles in El Salvador and in other countries with critical habitat for the species.
- Quantify and reduce mortality from incidental bycatch and implement fisheries mitigation methods when appropriate and feasible.
- Identify the genetic structure of the species in the eastern Pacific.
- Identify migration routes and behaviour in nesting and foraging habitats using techniques such as satellite telemetry and flipper tagging programmes.

TABLE 1 Observations of hawksbill turtles *Eretmochelys imbricata* nesting, at sea, stranded, as curios and in captivity reported from 1 January 1982 to 31 May 2009, and separately for the 25-year period 1982-2006 and for 1 January 2007 to 31 May 2009 (NI, no informant, ND, no data).

Country	Nesting	Marine	Stranding	Curios	Captivity	Total
1 January 1982 to 31 May 2009						
Mexico	73	68	83	61	9	294
Guatemala	2	3	ND	ND	1	6
El Salvador	538	2	33	1	ND	574
Honduras	NI	NI	NI	NI	NI	NI
Nicaragua	36	3	3	ND	ND	42
Costa Rica	48	8	5	ND	ND	61
Panama	NI	NI	NI	NI	NI	NI
Colombia	ND	14	1	10	ND	25
Ecuador	31	14	14	6	4	69
Peru	ND	19	2	ND	ND	21
<i>Total</i>	728	131	141	78	14	1,092
1 January 1982 to 31 December 2006						
Mexico	60	24	55	ND	1	140
Guatemala	1	ND	ND	ND	ND	5
El Salvador	108	ND	8	ND	ND	116
Honduras	NI	NI	NI	NI	NI	NI
Nicaragua	7	ND	ND	ND	ND	7
Costa Rica	12	1	3	ND	ND	16
Panama	NI	NI	NI	NI	NI	NI
Colombia	ND	3	ND	ND	ND	3
Ecuador	ND	11	ND	ND	ND	25
Peru	ND	ND	ND	ND	ND	16
<i>Total</i>	188	58	80	ND	2	328
1 January 2007 to 31 May 2009						
Mexico	13	44	28	61	8	154
Guatemala	1	ND	ND	ND	ND	1
El Salvador	430	2	25	1	ND	458
Honduras	NI	NI	NI	NI	NI	NI
Nicaragua	29	3	3	ND	ND	35
Costa Rica	36	7	2	ND	ND	45
Panama	NI	NI	NI	NI	NI	NI
Colombia	ND	11	1	10	ND	22
Ecuador	31	3	ND	6	4	44
Peru	ND	3	2	ND	ND	5
<i>Total</i>	540	73	61	78	12	764

- Strengthen the participation of key people and bodies, such as fishers, ecotourism operators, local communities and decision makers at various levels of government, and recognize (via distinctions such as awards and prizes) those that contribute to the protection of the species.
- Establish alliances and multinational projects for conservation of the species.
- Develop an education and outreach campaign to raise awareness of the conservation status of the species.
- Generate funding to comply with these recommendations. It was determined that fisheries bycatch, egg harvest and habitat alteration were the most pressing threats to

hawksbill turtles in the eastern Pacific (Table 2). Additional country-specific (north to south) threats identified were: Mexico (ghost nets), Guatemala (lack of information), El Salvador (dynamite fishing), Nicaragua (dynamite fishing and lack of information), Costa Rica (Trawl fisheries), Colombia (ghost nets) and Ecuador (gill-net fisheries and boat collisions).

Discussion

Clifton et al. (1982) concluded that hawksbill turtles had become rare to non-existent in most localities in the eastern Pacific and reported that no nesting had been seen there for some years. In contrast, the data compiled by the ICAPO network present a comparatively optimistic summary of the status of the species in this region. Comparing the number of observations of hawksbill turtles reported for the eastern Pacific prior to 1 January 2007 ($n = 328$; 1 January 1982 to 31 December 2006; 9,131 days; Table 1) with those compiled since that time ($n = 764$; 1 January 2007 to 31 May 2009; 882 days; Table 1) it is clear that a substantially larger percentage of reports (70%) come from the latter period. This does not, however, necessarily indicate recovery of the species, but rather the effectiveness of efforts by ICAPO members to increase data collection and hence provide a more accurate evaluation of the status of the species.

Six countries reported verified hawksbill nesting between 1 January 2007 and 31 May 2009, totalling 540 nests, 430 (79.6%) of which occurred in El Salvador. El Salvador thus hosts the largest known remaining hawksbill turtle rookeries in the eastern Pacific, highlighting the urgent need to consolidate protection, conservation and research for the species there. A major conservation issue that needs to be addressed is the use of explosives for fishing (also known as bomb fishing), which killed several adult-sized hawksbill turtles in El Salvador 2008 and 2009 (M. Liles & M. Vasquez, unpubl. data). Despite pleas to the Salvadoran government actions to stop fishing with explosives remain inadequate. However, given the recent change in the country's political leadership and new laws prohibiting the collection and sale of marine turtle products (Executive Orders 343 and 74, 4 February 2009) the situation may improve.

Nesting in other regions of the eastern Pacific seems to be considerably lower. The 31 nesting observations reported for Ecuador originated predominantly from one beach, La Playita ($-01^{\circ}33' S$, $-80^{\circ}50' S$), 800 m in length, within Machalilla National Park, along the country's central Pacific coast. Significant hawksbill turtle nesting is reported for Nicaragua ($n = 29$) and anecdotal reports are emanating from the Padre Ramos Estuary ($12^{\circ}47' S$, $-87^{\circ}29' W$) and much of the country's Pacific Coast, which remains largely under-investigated. The majority of nesting observations ($n = 36$) reported for Costa Rica during 2007-2009

TABLE 2 Prioritization of threats to hawksbill turtles in the eastern Pacific based on a 1–5 scale following the guidelines outlined by the Inter-American Convention for the Conservation of Marine Turtles (IAC Secretariat, 2004).

Threats ¹	Contribution	Breadth	Irreversibility	Severity	Total
Bycatch (D) ²	5	5	3	5	18
Egg extraction (D)	5	5	3	5	18
Habitat alteration (I) ³	5	4	4	5	18
Lack of basic information (I)	5	4	2	2	13
Lack of or insufficient policy & regulation (I)	4	4	3	2	13
Direct capture & take (D)	3	3	3	3	12
Commercialization of products (I)	3	3	2	3	11

¹D, direct threat; I, indirect threat.

²Dynamite fishing

³Coastal development and solid and liquid wastes

were recorded over 3 weeks in late November of 2008 during a pilot monitoring project in Corcovado National Park (27°12' N, –83°34' W). These findings are particularly surprising considering that Costa Rica probably hosts the most marine turtle monitoring projects of any country in Central America, and much of its Pacific coastline has been well surveyed for marine turtle activity, but reports of hawksbill turtle nesting in the country have previously been scant (Gaos et al., 2006).

Seven countries in the eastern Pacific reported verified in-water observations of hawksbill turtles between 1 January 2007 and 31 May 2009, totalling 73 records, 44 (60.3%) of which were from Mexico, underscoring the importance of the country's waters as a foraging and nursery area for the species (Nichols, 2003; Seminoff et al., 2003). Although hawksbill turtles are known to use distinct nesting and foraging habitats (Trøeng et al., 2005), considering the percentage of reported in-water records that come from Mexico and the fact that other marine turtle species nest abundantly along the country's Pacific coast, the low number of hawksbill turtles reported nesting is puzzling. Whether this is a result of a lack of nesting in the region, that nesting sites remain undocumented, or that Pacific Mexico is an important migratory pathway or developmental area for hawksbill turtles originating from the relatively few nesting colonies, is unknown.

It is important to note that the relatively high number of nesting observations in El Salvador and Ecuador and of in-water observations in Mexico are largely the result of efforts focused on hawksbill turtles and that these are the only countries where such efforts have taken place. Therefore, the potential importance of other countries should not be overlooked and, in addition, little information is available for Panama and Honduras, which do not yet have representatives in the ICAPO working group.

To estimate the abundance of hawksbill turtles in the eastern Pacific an increase in monitoring is required, and this needs to recognize that in this region the species appears to utilize nesting and foraging habitats that are different from those used by the species in other regions.

Adult hawksbill turtles are primarily utilizing mangrove and estuarine habitats for foraging, a behaviour that has been documented via satellite telemetry throughout the region (Gaos et al., unpubl. Data), in contrast with the coral reef habitats utilized by adults in other regions (Carr et al., 1966; Meylan, 1988; van Dam & Diez 1996). In El Salvador adult hawksbill turtles are not only foraging within the mangrove estuary of Bahía Jiquilisco (13°12' S, –88°26' W) but also using its shorelines as their principal nesting sites (M. Liles, pers. comm., 21 January 2008), and similar foraging/nesting is believed to occur in the Padre Ramos Estuary, Nicaragua (L. Manzanares, pers. comm., 23 July 2009). The only other instance of marine turtle nesting in such habitat was recently reported for hawksbill turtles in the Términos Lagoon Protected Area (18°41' S, –91°40' W) on the Caribbean coast of Mexico (Guzmán et al., in press) but both nesting and adult foraging in such habitat appears to be a rare behaviour, possibly exclusive to hawksbill turtles in the eastern Pacific.

Along central Pacific Mexico (19°26' S, –105°01' W) and south-west Nicaragua (11°08' S, –85°47' W) hawksbill turtles have also been documented nesting in low numbers along very short stretches of beach (e.g. < 100 m in length), often hidden within small coves and inlets. This cryptic, low-density nesting probably explains why the species has gone unnoticed in this region and it is possible that remote beaches hosting important numbers of nesting hawksbill turtles remain undocumented. The use of such remote and atypical nesting habitat could also be, in part, a result of the species having been extirpated from more accessible habitats in the region.

The small number of hawksbill turtles and their obscure nesting locations in the eastern Pacific makes the implementation of projects and the documentation of nesting activity logistically challenging and underscores the importance of strong, integrated multi-sector conservation programmes in the region. Sharing and expanding existing research and conservation efforts to include hawksbill turtles in government conservation plans and strategies, and university and NGO programmes, will be key to

generating information on the species. Anecdotal reports of hawksbill turtles nesting and foraging can provide an important guide for more rigorous assessments.

Although information currently available on hawksbill turtles in all subregions of the eastern Pacific remains incomplete, the information collated here is, as far as we are aware, the best available data. Our findings indicate that only a few hundred hawksbill nests are deposited annually along the > 15,000 km of eastern Pacific coastline. Considering the vast area, these numbers are very low and, even if further nesting sites are discovered in remote locations, suggest that hawksbill turtles in the eastern Pacific are highly threatened. However, the conservation effort devoted to the hawksbill turtle in the region is much less than that for other marine turtle species (e.g. olive ridley turtle *Lepidochelys olivacea*; Abreu-Grobois and Plotkin, 2008).

Notwithstanding the relatively low overall numbers, our findings demonstrate the continued presence and geographical pervasiveness of hawksbill turtles throughout the eastern Pacific. Through ICAPO's concerted efforts we have established baseline data and demonstrated that both nesting and foraging areas for the species exist. Researchers have only recently begun to make specific efforts to document hawksbill turtles in the region and are generating valuable data. By raising awareness of the importance of collecting baseline information, promoting research and conservation projects, and assembling data, ICAPO will be able to play a pivotal role in the conservation of hawksbill turtles along the eastern Pacific coast.

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Biographical sketches

The authors work with marine turtles in countries along the eastern Pacific Rim. Sharing a concern regarding the paucity of information and lack of investigation and conservation for the hawksbill turtle in the region, the members of ICAPO collaborate to improve this situation and raise general awareness of the plight of this species. This is achieved through close collaborations with local and international stakeholders, including fishers, coastal community members, government representatives, wildlife managers, scientists and conservationists. There is a shared belief that the hawksbill turtle plays an important, albeit still unclear, role in eastern Pacific marine ecosystems, and existing investigation and conservation efforts are still inadequate to ensure survival of the population.