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BEHAVIORAL CHANGES WITHIN THE RECOVERING HAWAIIAN GREEN TURTLE POPULATION

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Following decades of intensive exploitation, the Hawaiian green turtle (honu), Chelonia mydas, is presently showing some promising signs of population recovery 16 years after becoming protected under the U.S. Endangered Species Act. Green turtles throughout the 2,400 km span of the Hawaiian archipelago migrate to breed at isolated French Frigate Shoals (24°N, 166°W), the mid-point of the island chain (Balazs 1976, 1980, 1983). Systematic monitoring of nesting females at this site for 22 consecutive years has shown a gradual but definite increase (Fig. 1). Considerable interannual fluctuation during this period emphasizes the necessity of long-term studies to reliably ascertain population trends (Wetherall and Balazs, submitted).

An increase has also been seen in the number of immature green turtles residing in foraging pastures of the eight main Hawaiian Islands with human habitation at the southeastern end of the chain (Balazs et al. 1993, 1994a, 1994b). The narrow band of shallow water around these large islands accounts for 96% of the benthic habitat potentially available for recruitment by post-pelagic green turtles. Research at multiple sites in nearshore waters is ongoing to gather baseline data on growth rates, food sources, movements, health status, habitat requirements, and population trends (Balazs 1982, 1991; Balazs et al. 1987; Russell and Balazs 1994; Koga and Balazs, this volume).

Pronounced changes in the behavior of immature and some adult turtles have been documented in the main Hawaiian Islands. These changes include shifts in foraging times, greater tolerance to humans, formation of discrete cleaning stations, terrestrial emergence for resting purposes, utilization of warm-water discharge, and the apparently rapid occupation of certain feeding and resting sites with no historical record of such use. This paper gives short examples of the behavioral changes and highlights several locations where they are known to have occurred. The role of turtle-watching as a form of ecotourism is emphasized, along with the need to ensure this activity is conducted appropriately with the best interests of the turtles in mind.

FINDINGS

Foraging Times-- The most striking change in behavior by green turtles in the Hawaiian Islands involves the time of day when juveniles and subadults actively feed. Several kinds of benthic algae are utilized (e.g., Pterocladia, Gelidium, Acanthopora, Hypnea, Amansia, Codium, Ulva) and, to a much lesser extent, the only sea grass present in Hawaii, Halophila hawaiiensis. All of these food items frequently grow in shallow water close to shore. Prior to the mid-1980's turtles were seldom seen foraging during the daytime, except in very remote areas or at the base of ocean cliffs inaccessible to humans. The common knowledge among local fishermen was that turtles fed principally at night, especially along developed coastlines, when they entered the shallows on high tides. This information was verified when in-water research was initiated by the author during the mid-1970's at such sites as Punalu'u and Kiholo Bay on the island of Hawaii, and Kaneohe Bay on Oahu. Presently, diurnal feeding at these sites, and many others, is exceedingly common and widespread. The turtles now forage during all hours of daylight, whenever and wherever tides provide access to the

desired marine vegetation. However, most of the large adults which comprise only a small segment of the population are not seen feeding during the day. Presumably these turtles continue to be nocturnal and/or feed at greater depths farther from shore.

Tolerance to Humans-- The willingness to forage during the daytime is believed to be closely related to the increased tolerance to humans shown by many (but by no means all) turtles during recent years. Tolerance to humans in the Hawaiian Islands ranges from being virtually tame with no apparent fear (i.e., swimming right up divers even when there is no history of hand-feeding), to turtles exhibiting guarded caution and only swimming away when approached too close. The "normal" behavior previously displayed in the Hawaiian Islands, and which still occurs at most places worldwide, was for green turtles to flee at the first sign of human presence. This does, in fact, still happen in Hawaii but it is no longer prevalent at many of the sites investigated.

The behavior presently exhibited by turtles at Kahalu'u Beach Park on the Kona Coast of the island of Hawaii represents the ultimate in tolerance to people in association with daytime foraging. The small calm bay at this site is visited daily by hundreds of tourists and local residents for snorkeling and swimming in waist-deep water. In spite of the intensive human use, turtles routinely forage in plain view and commonly rest under shallow coral heads not more than 50 m from shore. A remarkable photo showing people standing in the water watching a turtle forage near their feet recently appeared in Sea Frontiers (Parks 1993). During two short study visits to Kahalu'u 11 turtles weighing 11-40 kg were easily captured and tagged. All were healthy and robust. Recently 34 turtles were counted at high tide feeding in plain view inside the bay.

Cleaning Stations-- Green turtles in the Hawaiian Islands have established numerous discrete underwater sites where they aggregate to be cleaned by fish. The turtles exhibit distinctive solicitation postures at these locations, which are most often associated with a specific coral formation. A highly specialized cleaning symbiosis has been recorded in the case of the wrasse, Thalassoma duperry, feeding on barnacles attached to the turtle's skin (Losey et al. 1994). In most instances, however, herbivorous fish graze on and remove algae from the carapace and other body surfaces of the turtle. During the cleaning process turtles and fish are sensitive to being approached by divers and will leave the area if this happens. Prominent cleaning stations are known at Puako (Hawaii), and Waikiki and Kaneohe Bay (Oahu). However, many others have been reported by dive tour operators throughout the islands.

Terrestrial Emergence-- Green turtles in small numbers are exhibiting a basking type of behavior in increasing incidence in the main Hawaiian Islands. The turtles emerge along the shoreline and on the tops of bare coral heads in areas where foraging occurs. In some cases this activity happens in the late afternoon or at night, in the absence of solar radiation. Turtles may be out of water in the same place for hours, if left undisturbed. On sand beaches, such as at Punalu'u and nearby Kamehame, the turtles crawl only as far as the high-tide mark. At Kiholo Bay emergence occurs on lava rock ledges bordering an area used by turtles for resting underwater. Apparently the shoreline constitutes an acceptable, alternate resting location for some turtles. All turtles examined ashore at the various locations appear to be heathy and vigorous. This is in sharp contrast to stranded turtles that crawl or wash ashore in Hawaii when injured or afflicted with fibropapillomas.

Terrestrial basking by green turtles has been known for centuries at French Frigate Shoals and other sites in the remote Northwestern

Hawaiian Islands (Whittow and Balazs 1982). However, until recently emergence of this nature has been exceedingly rare in the main inhabited islands.

Warm-water Bathing-- Since the mid-1980's green turtles have been aggregating each night in increasing numbers in the warm-water discharge of a power plant at Kahului Bay, Maui (Balazs et al. 1987). This is the only location where such behavior is known in Hawaii. Steam turbine generating units discharge cooling water 27-33°C that cascades down a boulder embankment to form a plume about 20 m in diameter. The depth at this site is only 2 m or less. The turtles are mainly large subadults and adults of both sexes. They lie motionless on the bottom or drift back and forth within the plume often stacked one over the other. People can easily view the turtles from a nearby elevated pathway. Entering the water with the turtles causes them to flee, but watching them from shore seems to have no negative impact. The turtles are almost never present during the daytime. They start to arrive in the late afternoon, and most leave before sunrise. No algal or other food sources exist at the discharge site. The sole attraction to the turtles is the thermal bath. Some of the turtles are known to have fibropapillomas. A video made at sunset on March 19, 1994 indicated that 50-80 turtles were present in the plume. The video also documented a copulating pair that remained together for at least 30 min. However, green turtle nesting has never been reported on Maui.

Occupation of New Foraging Sites-- The relatively sudden appearance of numerous green turtles occupying new foraging grounds has recently been documented. This phenomenon happened in waters fronting Pu'uhonua o Honaunau National Historical Park on the Kona Coast of Hawaii. There is no prior record of such use at this location. Honaunau is one of the most sacred sites known in Hawaiian culture. In past centuries sanctuary and forgiveness for offenses were given to all who successfully reached this area. Park personnel witnessed scores of turtles feeding along the rocky shoreline starting in early 1994. During two short study visits 30 turtles weighing 8-50 kg were captured and tagged. Turtles were found resting on the bottom a short distance from shore in depths of 5-15 m. Most of the turtles captured were far larger (>10 kg) than ones known to be recent recruits from pelagic habitats. None had been previously tagged. It is unknown where these turtles formerly resided or why relocation occurred. Presumably they arrived from elsewhere along the 200 km expanse of the island's western coastline. Movements of this scope and magnitude have not been previously recorded for immature green turtles in coastal habitats of the Hawaiian Islands.

Turtle-Watching and Ecotourism-- Turtle-watching in the Hawaiian Islands is becoming an increasingly popular activity for both tourists and residents. Dive tour operators frequently promote sea turtles as the major attraction of underwater sightseeing (see Roberts 1992). Watching turtles from shore is also gaining in popularity, such as from highrise hotels on Waikiki Beach and coastal lookouts around the islands. Children in particular seem to enjoy seeing the turtles surface and dive while foraging close to shore. Clearly the behavioral changes described in this paper substantially increase the number and quality of opportunities to view turtles from both above and beneath the sea. A recent survey of tourists in Hawaii found overwhelming interest in people wanting more information about turtles and how to go about seeing them (Rebelo 1994). At present, sea turtles are probably only second to humpback whales as the most popular marine life attraction in the Hawaiian Islands.

CONCLUSIONS

New and intriguing forms of behavior are being exhibited by some green turtles at certain foraging and resting sites in the main Hawaiian Islands. An increase in the number of turtles, and the turtles' greater tolerance of humans, are believed to be the result of 16 years of protection under the U.S. Endangered Species Act. The positive aspects resulting from this protection now offer unprecedented opportunities for enhancing and expanding the role of turtle-watching in the ecotourism industry. However, the public needs to be better informed and educated about all aspects of sea turtles. Vigorous law enforcement must be continued. Such efforts will ensure that divers and other ocean users don't intentionally harass or inadvertently disrupt the turtles at cleaning stations, sleeping areas, and other sensitive sites. In addition, it must be recognized that many turtles, mainly adults, continue to be disturbed and flee when people approach too close.

Threats that are a continuing concern for green turtles in the Hawaiian Islands include an enigmatic tumorous disease known as fibropapillomatosis, accidental drowning in nearshore gill nets, illegal hunting, vessel collisions, coastal development, and incidental capture by high-seas longline and other fisheries. An interim recovery plan for Hawaiian sea turtles formulated by a recovery team appointed in 1985 continues to successfully serve as a guide for research and management issues (Balazs et al. 1992).

ACKNOWLEDGMENTS

The following individuals and organizations are acknowledged for their valuable contributions to this work: D. Akaka, E. Bakken, C. Bangay, V. Bio, B. Blinski, M. Coelho, J. Coney, W. Dudley, D. Ellis, C. Forbes, W. Gilmartin, L. Hallacher, S. Hau, D. Heacock, B. Heacox, P. Hendricks, R. Hind, L. Hino, A. & J. Howard, L. Katahira, U. & P. Keuper-Bennett, S. K. Koga, E. & D. Medeiros, R. Miya, A. Morita, R. Morris, R. Nishimoto, J. & W. Perry, W. Puleloa, M. Rice, J. Shimoda, R. Silva, B. Tamaye, G. Watson, J. Wetherall, J. Wilson, H. E. Witham, Atlantis Reef Divers, Dive Makai, Hawaii Institute of Marine Biology, Hawaii Preparatory Academy, Lahaina Divers, Makai Animal Clinic, Marine Option Program of the University of Hawaii, Mauna Lani Resort, National Park Service, State of Hawaii Division of Aquatic Resources, The Ocean Recreation Council of Hawaii (Kauai Chapter), and the U.S. Fish and Wildlife Service. I also thank J. Kendig for editorial assistance.

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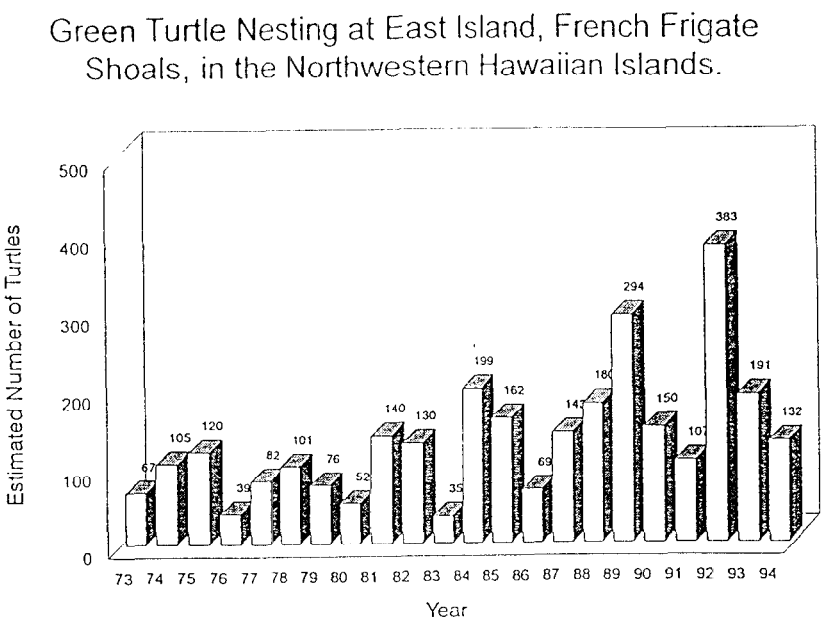

Figure 1. Historical trend for 22 nesting seasons, 1973-94. East Island accounts for 50% or more of all green turtle nesting at French Frigate Shoals.

NOAA Technical Memorandum NMFS-SEFSC-387

PROCEEDINGS OF THE FIFTEENTH ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION

20-25 February 1995
Hilton Head, South Carolina

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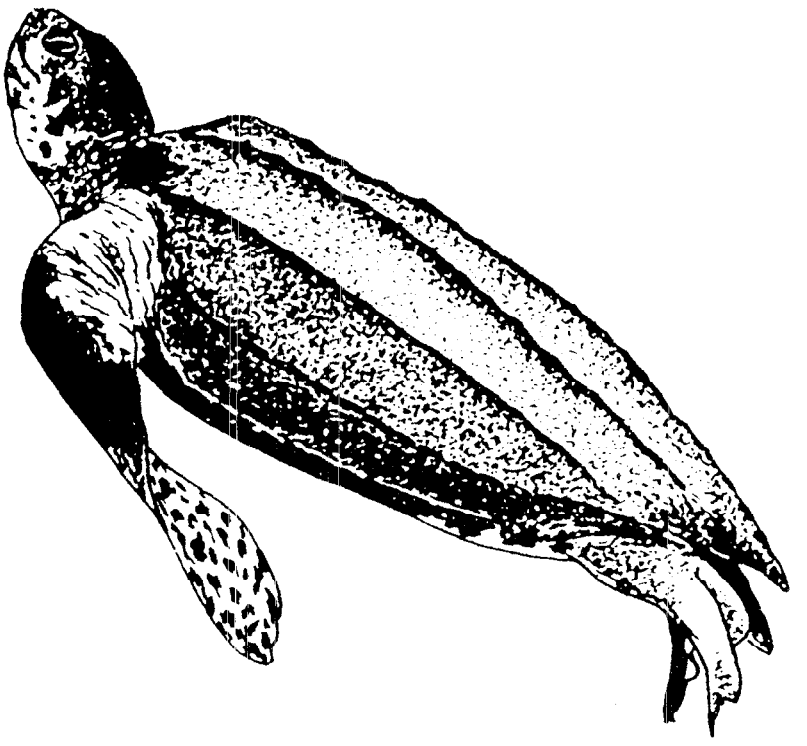

U.S. Department of Commerce
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June 1996