

SEA TURTLE RESEARCH AND CONSERVATION IN OCEANIA

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Sea turtles are designated worldwide as threatened and endangered species. Population declines have been prominent in the Pacific Islands of Oceania as the result of nesting habitat loss and excessive and widespread harvesting for commercial and subsistence purposes. The principal species of concern to Pacific islanders are the green turtle (*Chelonia mydas*) and the hawksbill (*Eretmochelys imbricata*). Both turtles are the focus of considerable conservation efforts by the Regional Marine Turtle Conservation Programme (RMTCP) of the South Pacific Regional Environment Programme (SPREP) based in Apia, Western Samoa. The SPREP is a non-governmental organization providing assistance to the environmental needs of 22 Pacific island nations. The National Marine Fisheries Service Honolulu Laboratory plays an important role in assisting SPREP in the conduction of the RMTCP. There is presently the strong desire by native inhabitants of Oceania to reverse declining trends of sea turtles so as not to lose an acknowledged important part of their cultural, traditional and nutritional way of life. This task will not be easy due to inherent biological constraints of most sea turtles, which include extensive ocean migrations for reproduction, vulnerability to predation, unknown pelagic life stages, and slow growth resulting in delayed sexual maturity of 20 or more years.

There are only two populations of loggerheads (*Caretta caretta*) in the Pacific, one originating in Australia where serious declines are occurring, and the other in southern Japan where numbers of nesting females appear to be stable. Leatherbacks (*Dermochelys coriacea*) inhabiting the Pacific mainly originate from nesting beaches in Mexico and Costa Rica where significant declines have been documented, in Indonesia where their status is uncertain but possibly stable, and Malaysia where the nesting colony is bordering on extinction despite 30 years of conservation measures. Both leatherbacks and loggerheads are the species of principal concern with regard to incidental take in pelagic longline and other commercial fisheries of the Pacific conducted mainly by Japan, Taiwan, Korea and, to a lesser extent, the U.S. A.

Green turtles in the Hawaiian Islands are genetically discrete and geographically isolated. Under the protection of the U.S. Endangered Species Act, this population has responded favorably to 20 years of recovery and research efforts by the National Marine Fisheries Service Honolulu Laboratory working in cooperation with the U.S. Fish and Wildlife Service, the State of Hawaii, and several private conservation organizations. The number of green turtles nesting in Hawaii each year has substantially increased at the index nesting site of East (Hikina) Island, French Frigate Shoals in the Northwestern Hawaiian Islands.

However, the total number of nesting females in the population is still well below historical levels and the fibropapilloma tumor disease continues to be a threat. The number of green turtles observed in waters around the main Hawaiian Islands has also increased significantly. Turtles in these foraging pastures are mostly immature turtles resulting from the increased nesting success. The greater numbers of green turtles in the main Hawaiian Islands have resulted in more opportunities for tourists and local people to view turtles in the water in the same manner that humpback whales are an ecotourism attraction. The successes thus far achieved in the biological recovery of the Hawaiian green turtle population constitute a model example in research and management for the rest of the Pacific islands. The olive ridley (*Lepidochelys olivacea*) nesting in the East Pacific has also shown a significant population increase in recent years under protective management and research by Mexican authorities.

Goal of the NMFS Honolulu Laboratory Sea Turtle Program

The goal of the Marine Turtle Research Program at the Honolulu Laboratory is to achieve the biological recovery and sound long term management of sea turtle populations in Hawaii and other U.S.-affiliated Islands of Oceania, and to assist Pacific Island and Pacific Rim Nations to recover sea turtle populations to the degree possible. To obtain the best scientific information possible to achieve this objective, research efforts at the Honolulu Laboratory emphasize the following:

- Monitoring, assessment and biological investigations at selected sea turtle breeding sites.
- Monitoring, assessment and biological investigations at selected sea turtle foraging pasture aggregations in benthic habitats.
- Development of comprehensive computer simulation models and other quantitative tools to monitor population trends in order to better facilitate sea turtle recovery efforts and to assess impacts of fishery bycatch.
- Assessment of post-hooking survival, movements and ecology in pelagic habitats relating to bycatch of sea turtles in longline fishing.
- Investigations of the pathology, etiology and epidemiology of fibropapilloma disease.
- Conducting cooperative research, technical assistance and research training with Pacific Island and Rim Nations to promote the collection, analysis and sharing of reliable sea turtle data, including fishery bycatch data.

Major Research Activities in the Hawaiian Islands:

Biology, Ecology and Life History Investigations.

Important progress is being made in understanding the biology, ecology, and life history of green turtles through long-term in-water monitoring at study sites throughout the Hawaiian Islands. Growth rates of immature turtles, diets, habitat characteristics and use, daily foraging patterns, and trends in the number of turtles are being determined. For example, an analysis of data collected on 171 green turtles recaptured one or more times (of 1,458 turtles tagged) at Palaau, Molokai yielded a mean growth rate of only 2.1 cm (or 7/8 inch) per year in carapace length. The use of high technology acoustic telemetry and dive recorders is revealing that green turtles undergo exceedingly limited daily movements between underwater resting areas and sites where feeding occurs on selected seaweeds.

The Hawaiian green turtle nesting colony at French Frigate Shoals has been systematically studied since 1973 in a cooperative program with the U.S. Fish and Wildlife Service. Approximately 500 migrant females were present at East Island in 1997, the highest year on record for the 25 consecutive seasons that nesting has been monitored at this vital location.

Fishery Interactions Research.

The National Marine Fisheries Service Honolulu Laboratory plays a central role in the research, monitoring and mitigation of sea turtle interactions with commercial fisheries. In particular, the Laboratory provides critical support to the scientific observer program conducted since 1994 to monitor the interactions with sea turtles of the Hawaii-based pelagic longline fishery. Honolulu Laboratory staff carry out sophisticated statistical analyses of observer data to assess the total magnitude of the fishery's interactions with turtles and identify the oceanographic, biological, or operational factors associated with such interactions. Estimates of the level of interactions and resulting mortality are then combined with computer simulation models to evaluate the impacts of the fishery, and other sources of mortality on sea turtle populations in order to devise mitigation efforts.

Biological studies by the Honolulu laboratory are also being conducted to improve the assessment of fishery impacts on turtles. During monitored longline fishing trips, vessel observers tag turtles, collect life history data, and take small biopsies of turtle tissue. When analyzed at the National Marine Fisheries Service La Jolla Laboratory (by Dr. Peter Dutton), these samples reveal the genetic origins of the turtles and show which nesting colonies, in various parts of the Pacific, are impacted by the Hawaii longline fishery.

Satellite Tracking of International Pacific Marine Turtle Migrations.

NOAA's polar-orbiting satellites are being successfully used to track the movements of sea turtles across Oceania and the Pacific Rim Nations. The information from this unique research is essential in promoting international sea turtle management plans for the Pacific islands. Except for the Hawaiian Islands, sea turtles are an internationally shared resource throughout the Pacific. For example, satellite tracking has discovered that green turtles

nesting in American Samoa migrate to and from Fiji, passing through the waters of Tonga in the process. This technology has also shown that Hawaiian green turtles make migrations back and forth to the Northwestern Hawaiian Islands where they nest at French Frigate Shoals. In addition, vessel observers have been trained to place small satellite transmitters on live turtles released after incidental capture in Hawaii-based pelagic longline fishing. These transmitters provide critical information on the oceanic movements of pelagic turtles and are the only basis available to evaluate post-hooking survival in the wild.

Assistance and Cooperative Research with South Pacific Islands and Pacific Rim Nations. Substantial progress is being made in research activities and information exchange through the RMTCP of SPREP. Important bonds of cooperation have been established and are being strengthened with sea turtle researchers, managers, conservationists and their programs in Tahiti, Fiji, Samoa, CNMI, Japan, Indonesia, the Philippines, Taiwan, Mexico, Costa Rica, and elsewhere throughout the Pacific. The Honolulu Laboratory is also conducting periodic training sessions for Pacific Islanders in the areas of data collection, tagging, satellite tracking, experimental design, necropsies, and procedures for monitoring and assessing sea turtles populations.

Fibropapilloma Tumor Disease Research.

Fibropapilloma (FP) is a tumor-forming, debilitating and often fatal disease of sea turtles that has rapidly emerged in the past decade as a potentially serious threat to populations worldwide. The disease is manifested by the formation of multiple fibrous masses of tissue 1 mm to 30 cm in diameter growing from the eyes, flippers, neck, tail, seams of scutes, and in the mouth. The tumors also form in the internal organs. Although most FP tumors are histologically classified as benign (non-cancerous), they can significantly disrupt the vital life-functions of breathing, feeding, vision and swimming. In advanced stages of the disease, turtles will often be lethargic, emaciated with soft and sunken plastrons, and prone to stranding ashore. Abnormal serum chemistry and blood cell counts are present. In addition, the pathology of FP is often associated with heavy burdens of internal parasites consisting of spirorchid cardio-vascular flukes. FP has been shown to be transmissible in laboratory studies using injected cell-free tumor extracts.

The prevalence of FP is highest in the herbivorous green turtle, *Chelonia mydas*, the species in which the disease was first described in the scientific literature as a rare curiosity from the Florida Keys in the 1930's. In the Hawaiian Islands, the earliest verifiable case of FP dates back to only 1958 when a heavily tumored green turtle was captured (and killed) in Kaneohe Bay, Oahu. At present, green turtles in Hawaii and Florida demonstrate high prevalence of FP ranging up to 90% at certain coastal foraging areas. Elsewhere in the Pacific FP in green turtles is currently limited to a few but potentially significant sites in Australia, Indonesia and the Bonin Islands of Japan where moderate prevalence has been reported, but insufficient research has been conducted. Outside of the Hawaiian Islands, sea turtles at other insular sites of Polynesia, Melanesia and Micronesia are virtually free of the disease. Two cases of the disease in green turtles have recently been found in Taiwan by Dr. I-Jiunn Cheng.

An issue that must be urgently addressed is the emergence of FP within the past few years at elevated levels in sea turtle species other than the green turtle. Olive ridleys, *Lepidochelys olivacea*, nesting in the eastern Pacific in Oaxaca, Mexico and at Ostional, Costa Rica have shown increased FP prevalence. A similar occurrence has taken place in Australian loggerheads, *Caretta caretta*, foraging at Moreton Bay adjacent to Brisbane in Queensland. It is noteworthy that molecular genetics research by the SWFSC has shown that some pelagic-phase olive ridleys and loggerheads from these populations occur in the North Pacific and are incidentally taken in the Hawaii-based longline fishery. Loggerheads foraging in southern Florida have also shown increased FP prevalence, but to date the severity of the cases has not equaled what has been recorded in green turtles.

In 1990 the National Marine Fisheries Service Honolulu Laboratory convened the first expert workshop on FP to exchange information, discuss strategies and formulate a Research Plan to guide studies of the etiology, pathogenesis, virology and epidemiology of the disease (Balazs and Pooley, 1991 "Research Plan for Marine Turtle Fibropapilloma"). Since that time the Honolulu Laboratory has been the leader in FP research through the conduction of epidemiological field studies and collaborative projects created through research partnerships with a worldwide array of outstanding disease specialist. In December 1997 the second expert FP workshop was convened by the Honolulu Laboratory to examine progress and redefine research priorities, in view of advances made in recent years. During the eight years between the two workshops, the number of journal publications and reports dealing with FP soared from 35 to 173. This reflects the intense interest in and concern for sea turtles afflicted with this enigmatic and scientifically challenging disease.

It is essential that the exact cause(s) of FP be determined along with the mode(s) of transmission in wild populations. Based upon the most recent results, the disease has a complex multi-factorial etiology involving two or more viral agents (herpes virus and retrovirus). However, the involvement of undetermined environmental co-factors, somehow predisposing turtles to FP, appears very likely. The identification of the causative viral agent(s) will permit the development of a diagnostic field test that can facilitate collection of vital management-oriented information (i.e. immunity, exposure, infection and recovery rates). Such data are fundamental to formulating disease containment, control and possibly even prevention strategies. In addition, the existence of a reliable diagnostic test will allow for an informed response to any outbreaks of FP that may eventually occur at one or more of the currently unafflicted insular Pacific island and Pacific Rim Nation locations.

The Honolulu Laboratory's role and responsibilities in pursuing FP research are based upon several interrelated factors of significance, as follows: 1) sea turtles are listed as threatened and endangered species mandated for ESA recovery in partnership with FWS and the impacts of FP to population recovery are unknown; 2) the overall health of coastal marine ecosystems at FP locations is in question; 3) mortalities and morbidities from FP are highly visible to the public, especially Hawaii's burgeoning sea turtle ecotourism industry, thereby exacerbating pressures on the agency to find solutions; 4) requests are increasing for international assistance and training in conducting research in areas where

FP has emerged in other sea turtle species; 5) concern by insular Pacific island nations that emergence of the disease in their area will cause already deleted, but culturally important, local sea turtle populations to become inedible or go extinct; and 6) concern over potential human-health issues of diseased turtles.

Summary

The National Marine Fisheries Service Honolulu Laboratory is actively involved in an array of research activities important to the conservation and management of sea turtles in Oceania and the Pacific Rim Nations. We are fully prepared and eager to collaborate with and assist other individuals, agencies and organizations to promote the survival and recovery of sea turtle populations.



Pacific Islanders from Samoa, Fiji, and Mariana Islands participating in training and information exchange on sea turtles at the Honolulu Laboratory.

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