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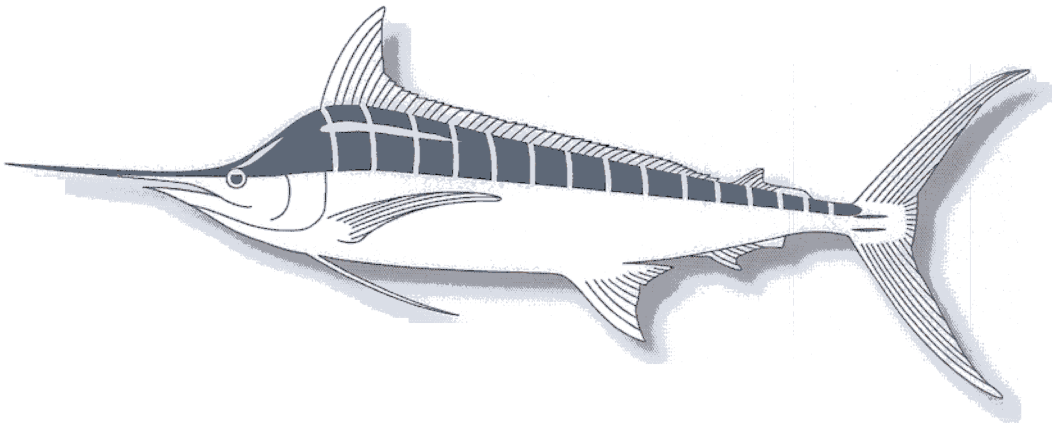
NMFS Honolulu Laboratory Research to Reduce Bycatch of Sea Turtles



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The Honolulu Laboratory is mounting major research efforts related to the reduction of bycatch of Pacific sea turtles by longline fisheries. The rationale for this research is related to the critical need to develop longline fishing gear technologies and fishing strategies for reducing sea turtle capture rates throughout the Pacific. The potential long-term benefits to Pacific sea turtle stocks of developing new fishing strategies that may be adopted by domestic longline fisheries as well as potentially being exportable to other long line fishing nations far outweigh the minimal harm to sea turtle population status caused by the experiments.

The research topics related to longline sea turtle bycatch issues include: 1) research to reduce long line fishery bycatch of sea turtles, 2) research to reduce mortality of sea turtles caught in longline fishing, and 3) research to improve sea turtle population estimates and evaluate management alternatives.

Research to reduce long line fishery bycatch of sea turtles

Much of the research to 'reduce long line fishery bycatch of sea turtles' will be conducted with Hawaii longline fishermen to test and evaluate minor and major changes in longline fishing gear and tactics to reduce bycatch of sea turtles. This is a proposed three-year project with contracts with fishing vessels for approximately 1370 research sets each year. All vessels doing experiments must carry a scientific technician and the research requires a special Endangered Species Act permit. An application for a permit to do this research has been submitted by the Honolulu Laboratory and is pending.

The 'minor' gear and tactics will initially involve testing the use of blue- dyed squid bait and moving all branch lines to more than 40 fathoms away from float lines. It is expected that these experiments will have minor impacts on the catches of target species. Testing will involve alternating between take reduction measures and normal (control) swordfish-style fishing. Blue-dyed squid baits have been shown to reduce the bycatch of seabirds and possibly increase the catch of swordfish. In addition, laboratory experiments have shown that captive green sea turtles avoid blue-dyed squid for periods up to about 8 -10 days (see further discussion below). Data collected by NMFS observers on Hawaii longline fishing vessels indicate that a significantly higher proportion of loggerhead and leatherback sea turtles are taken on the branch line closest to floats than on other branch lines. Whether turtles are attracted to the floats, either visually or

aurally is unknown. A typical distance between branch lines on a set of longline gear targeting swordfish is 40 fathoms, except those nearest to the floats are set much closer. The take reduction technique will require that the branch lines be at least 40 fathoms form the nearest float line.

There are also experiments and tests planned that may have major impacts on the catches of target species. These include: 1) evaluation of using stealth fishing gear, 2) assessment of the effectiveness of deep, daytime fishing for catching swordfish, 3) determination of when and where, e.g., what part of the longline fishing operation and what depths, are sea turtles caught in longline fishing, and 4) tests of different hook designs. The 'stealth' long line fishing gear experiments are designed to test fishing gear that may be less detectable by sea turtles such as counter-shaded floats, dark colored lines, dulled hardware, blue- dyed bait, and downward facing LED light sticks. The tests of deep daytime fishing for swordfish will determine if swordfish can be caught deep during the daytime with low bycatch of turtles. These experiments will require the use of a mainline shooter and will utilize light sticks and squid bait. The stealth fishing gear and deep daytime fishing for swordfish will use the same normal swordfishing controls.

Laboratory physiology and behavior research on sea turtles and pelagic fish, as well as laboratory tests on modified baits and fishing gear, are also being conducted to obtain information that may used to reduce the bycatch of sea turtles. The physiology and behavior research investigations on sea turtles and pelagic fishes are categorized into three topics: 1) odor receptors and olfaction in sea turtles, 2) auditory capabilities of sea turtles and pelagic fishes, and 3) visual capabilities of sea turtles and pelagic fishes. Because sea turtles, which evolved from terrestrial reptiles, and commercially targeted pelagic fishes are so evolutionarily distant, their sensory capabilities should have conclusive differences, and defining these should be achievable. Techniques that exploit the differences, i.e., that are repulsive or make longline gear less attractive to sea turtles without reducing catch rates of targeted tuna and billfish species, could then be developed. Most of these studies are being conducted on contracts with leading academic and private research foundation experts.

The investigation of odor receptors and olfaction in sea turtles involves cloning genes responsible for producing proteins involved in odor detection in order to characterize the ability of turtles to discriminate odors by assessing the relative numbers of functional odor receptor genes versus silenced ones. Early successes include the isolation of several members of the family of genes responsible for producing odor reception molecules in loggerhead sea turtles. This information on odor receptors will be used to evaluate the feasibility of developing baits with odors that may be offensive to sea turtles. The studies of the auditory capabilities of sea turtles and pelagic fishes are using electro- physiological techniques including auditory evoked potentials, to define the auditory capabilities of sea turtles and tunas. This may lead to using sound

sources that will repel turtles away from longline fishing gear, but not detract pelagic fishes. The research on visual capabilities of sea turtles and pelagic fishes includes cloning and sequencing genes responsible for producing visual pigments and determination of spectral sensitivity. Laboratory research on the behavioral responses of sea turtles includes testing the responses of turtles to various point light sources, i.e., chemical light sticks and new LED electronic light sticks, as well as assessment of responses of sea turtles to various sound, chemical, and magnetic stimuli. The research on visual capabilities of sea turtles and pelagic fishes has already yielded some results that may help to reduce bycatch of sea turtles in longline fishing. For exarnple, the research has shown that tunas, and perhaps swordfish, may have eyes much more sensitive to low light levels, especially at night, than previously thought. If the research that is planned shows that the eyes of turtles are less sensitive to very low light levels, then the use of low intensity electronic light sticks may be one key to reducing sea turtle interactions with longline gear.

In an effort to identify a method to directly reduce the incidence and/or severity of hooking, behavioral experiments are currently being conducted on subadult green turtles held in tanks at the Honolulu Laboratory Kewalo Research Facility (KRF). The immediate objective is to obtain information on the relative importance of visual and olfactory cues in turtles' "bite -no bite" decision. 80th treated and untreated food items, usually squid, are presented on a simulated longline, where the baits have received various treatments. Results so far indicate that green turtles will reject blue dyed squid for up to 8-10 days while readily eating untreated squid. Because the frequency at which turtles encounter longline baits in their natural habitat is most likely very low, these results suggest that blue bait may be effective at reducing sea turtie-iongline interactions.
Clearly, more experiments are needed to define better the potential of this bait treatment using both captive turtles and field trials. Additional experiments using captive-reared loggerhead turtles are scheduled for this fall in association with investigators from the NMFS Galveston, Texas, Panama City, Florida and Pascagoula, Mississippi Laboratories. Experiments have also been conducted at the KRF where bait was marinated in a variety of chemical substances to elucidate the importance of olfaction/gustation in the "bite-no bite" decision, and possibly to define a simple repellent substance. Squid were treated with garlic, cilantro, bitter and sour substances, e.g. citric and lactic acid, urea (to simulate a "shark-like" smell), as well as substances that stimulate the trigeminal receptors, e.g., capsaicin and wasabi oil. Turtles were willing to eat the treated squid in all cases. These results suggest that while smell and taste may be important components to bait attraction, a simple repellent substance remains to be discovered. In an attempt to isolate further the relative importance of vision and olfaction, various artificial baits were also tested on captive green turtles at the KRF. Fish and squid-based baits were fabricated using various edible matrices. Baits were dyed the same color and formed into the same shape; they differed only by taste and smell. Results suggest that turtles use a combination of vision and taste in making the decision to bite bait, and that they have a memory.

Turtles that had previously been fed a mixed diet of fish and squid were willing to eat both fish and squid-based artificial baits, whereas turtles fed on a squid-only diet would not eat fish-based baits. Because modified bait must also be effective for swordfish and tuna fishing, all modified and artificial baits also being tested on captive yellowfin tuna maintained in tanks at KRF.

Research to reduce mortality of sea turtles caught in longline fishing

Research to reduce mortality of sea turtles caught in longline fishing is making extensive use of satellite remote sensing technology. For example, Pop- Up Satellite Tags (PSATs) are being deployed on hard-shelled and are planned on leatherback turtles incidentally caught by the Hawaii-based longline fishery. Post-hooking mortality and morbidity (latter obtained from PSAT data) will be correlated with a standardized set of scored observations, such as hook location, severity of injury, and a general health assessment. PSATs are electronic data storage tags that record depth, water temperature and a daily estimate of geolocation. They are carried by the animal, then jettison at a pre-programmed date and transmit their data to the ARGOS satellite system. In contrast to conventional satellite tags, PSATs have a fail-safe/mortality sensor, whereby the link can be set to corrode if the tag is stationary for extended periods or if it exceeds a specified depth. As a result, PSA Ts provide data that can be used to readily differentiate between an animal mortality and a shed tag. Tags can be programmed to release up to two years after the deployment date, thereby providing an opportunity to determine long-term movement patterns and their associated physical environments, i.e., to correlate data on the turtles' movements with information on currents, sea surface temperatures, and forage abundance that is collected simultaneously by orbiting and geostationary satellites.

As PSA Ts are a new technology and have never been deployed on sea turtles, attachment methodologies first had to be developed and tested that were reliable and safe for both the turtles and the observers who would be attaching the devices at sea. As a result, this past year, attachment methods were successfully tested on captive green turtles at KRF. The system involves using a marine epoxy, specifically Marine Fix@ Fast, to hold a Syntactic foam!$> base plate to which the PSAT's tether is attached. Results clearly demonstrated that this method alone is sufficient for a nine-month deployment and most probably longer, and that it is easy, quick, and safe for use by observers at sea. The procedure, and the relevant training manual, have been reviewed and approved by the NMFS Office of Protected Species. Workshops to train observers in attachment procedures have been held and, since mid-March 2001, PSAT tagging kits have been taken to sea on approximately 25 longline fishing trips.
So far only one turtle has been incidentally captured which was tagged and released with a PSA T.

Likewise, a method for attaching PSATs to leatherback turtles at sea also had to be developed. This is a far more difficult goal given that: (1) leatherbacks are generally too large to be brought aboard commercial fishing vessels and therefore PSA TS have to be applied while the turtle remains in the water; (2) the PSA T's tether has to be anchored with a "sub dermal" device as the animal's oily carapace prevents using any sort of base plate and adhesive; (3) there is no ready access to captive leatherbacks on which to test attachment methodologies. HL scientists are collaborating with scientists the New England Aquarium, University of British Columbia, and an orthopedic surgeon to develop and test new methods for attaching PSATs to leatherback sea turtles. New England Aquarium colleagues using a surgical-grade titanium sub dermal anchor that is employed by orthopedic surgeons to reattach torn tendons, recently attached PSATs to ten nesting leatherbacks in Puerto Rico. The data from these tag attachment tests are still being received and analyzed, but early results look promising.

Recent research results from satellite-linked depth recorders attached to two loggerhead and two olive rid ley turtles provide new information on the dive depth distribution of these turtles in the region of the Hawaii longline fishery. The results indicate that loggerheads spend much of their time in shallow water, with 40% of their time at the surface and 90% of their time shallower than 40 m. Olive ridleys are deeper diving. They spend only 20% of their time at the surface and about 50% of their time deeper than 40m with about 5% of their time deeper than 100m These finding provide the first fishery independent confirmation that the current management regulations to prohibit shallow longline sets will significantly reduce incidental catches of loggerhead turtles. These results suggest that a return to fishing in the swordfish grounds without incurring significant loggerhead catches may be possible as long as deep longline sets are used, where gear is set well below 100m. In addition, satellite technology has been used by HL scientists to define the habitat and movement dynamics of several sea turtle species in the North Pacific.

Research to improve sea turtle population estimates and evaluate management alternatives

HL scientists have developed a prototype sea turtle population simulator, TURTSIM, to provide provisional insights into the relative impacts of various human activities, including Hawaii-based longline fishing, on sea turtle populations. Analyses of this sort can provide guidance on comparative effects of various human activities and estimation of maximum net per-capita rates of population increase conditional on assumed scenarios of human activity. This capability should prove helpful in designing procedures to set allowable incidental take levels for fisheries. The TURTSIM research is being augmented with outside contracts that will result in population assessments of Pacific loggerhead, western and eastern Pacific leatherback stocks, and Hawaiian green sea turtles.