JIMAR, PFRP ANNUAL PROGRESS REPORT
FY 2001

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Project Proposal Title: Survivorship, migrations, and diving patterns of sea turtles released from commercial longline fishing gear, determined with pop-up satellite archival transmitters.

Funding Agency: NOAA/NMFS/PFRP

1. Purpose of the project and indicative results.
The main objective of the project is to provide reliable estimates of delayed mortality and morbidity in sea turtles following interactions with longline fishing gear. To do this, we will deploy pop-up satellite archival tags (PSATs) on incidentally-caught turtles. The tags have a fail-safe/mortality sensor, whereby the tag can be set to jettison if the turtle is stationary for extended periods or if it exceeds a specified depth. Rates of post-hooking mortality and morbidity will be correlated with a standardized set of scored observations, such as hook location, severity of injury, and a general assessment of the turtles' health.

As PSATs have never been deployed on sea turtles, our first goal was the development and testing of a simple, safe, and effective attachment methodology. Therefore, during the past year we have developed and successfully tested a method for attaching PSATs to hard-shelled turtles using captive green turtles maintained at the NMFS Honolulu Laboratory's Kewalo Research Facility (KRF). Because these experiments presented a unique opportunity to work with live animals under controlled conditions, we added second objective: to identify a method to reduce or eliminate interactions between longline fishing gear and turtles by developing a bait or bait treatment that makes the gear less attractive, or that is actively repulsive to sea turtles.

2. Progress during FY 2001. Provide a thorough discussion of accomplishments and problems.
We tested several materials for fabrication of a "base plate" that will hold the PSATs' teathers to the turtle carapace and found a syntactic foam manufactured by Syntech Materials, Inc® to be highly suitable. The material is relatively inexpensive, easily fabricated into desired shapes. More important, it will not crush and lose its buoyancy even when exposed to depths of over 1000 m. We have also have found a marine epoxy, specifically Marine Fix® Fast, that alone is sufficient for adhering the foam baseplate to the carapace. During our tests with green turtles in captivity, we found the epoxy will keep the base plates adhered to for up to 10 months. The primary advantage of this epoxy adhesive are its ease and safety of use by observers at sea. Furthermore, we have also found that because epoxy does not result in as permanent an attachment as fiberglass, it has as an addtional advantage. It will allow a turtle to shed its PSAT if the device becomes entangled in marine debris.

After demonstrating the efficacy and saftey of our PSAT attachment method, we applied for and obtained approval from both the NMFS Regional Office and NMFS Office of Protected Resources to proceed with the next phase of the project: having at-sea observers attach PSATs to hard shelled turtles incidentally caught in commercial fishing gear. We have also developed and

gotten approval for an instruction manual (copy attached) that is given to the observers as part of the tagging kit. We have participated in NMFS Regional Office sponsored workshops to train observers in PSAT attachment procedures. Since March 2001, PSATs have been taken to sea on approximately 25 longline fishing trips. As of the end of June, no turtle has been incidentally captured and thus no turtle has been tagged.

In association with colleagues on the mainland (Drs. Molly Lutcavage, Anders Rodin, and Russ Andrews), a method for attaching PSATs to leatherback turtle released from longline gear is also now being tested. The method invovles a subdermal attachment of the PSAT's tether using a medical-grade titanium bone anchor. The device is manufactured by Mitek Inc. (a division of Ethicon Inc.) and they are normally used by orthopedic surgeons for reattaching torn rotator cuff tendons. The device has been tested on a carapce taken from freshly dead leatherbacks and appeared suitable. Field trials of the new attachment device are currently underway in Puetro Rico on nesting leatherback turtles.

A second objective was added to the project to take direct advantage of the turtles being maintained in captivity to test PSAT attachement techniques. In this project, we have been attempts to identify a bait treatment that will repel marine turtles from longline fishing gear, or at least make the baited hook less attactive. During these experiments, we present both treated and untreated food to turtles using a simulated longline gear, whereby bait is lowered into the water on simulated "hooks", and turtles have a choice of baits. In testing the importance of vision in the “bite-no bite” decision, we first treated our squid bait with blue dye. This color was chosen as it has been effective in reducing seabird bycatch during longline fishing operations. Blue squid was initially rejected by all captive turtles. For turtles that had been fed squid (untreated) prior to introduction of blue squid ($n = 2$), the initial rejection of the treated bait was short-lived, and turtles were willing to eat both untreated and blue squid after three days. For turtles that had been presented both blue and untreated squid from their initial feedings ($n = 6$), blue squid was rejected for eight to ten days. Because the frequency that a turtle is likely to encounter blue-dyed bait in the open ocean would be very low (i.e., much less frequent then our daily presentations), our results suggest that this procedure may be effective at reducing sea turtle-longline interactions.

We have also marinated squid in a variety of chemical compositions in a first attempt to find a simple repellent substance. We have soaked squid in garlic, cilantro, bitter and sour substances (citric and lactic acid), and urea; as well as substances that stimulate the trigeminal receptors (capsaicin, wasabi oil). Turtles were willing to eat squid soaked in all substances. Although olfaction may be an important component to bait attraction, discovering a repellent substance will clearly require a more systematic approach.

In an attempt to isolate the relative importance of vision and olfaction in turtles' "bite - no bite" decision, we are also developing various artificial baits. We fabricate fish- and squid-based baits using various edible matrices. Baits are dyed the same color and shaped identically; they differ only by taste/smell. Our results so far suggest that turtles use a combination of vision and olfaction in making the decision to bite. We have also learned that turtles have a memory. Turtles previously been fed a mixed diet of fish and squid are willing to eat both fish and squid-based artificial baits, while turtles fed on a squid-only diet will not eat fish-based baits. Because

modified bait must also be effective for swordfish and tuna fishing, we are also testing all modified baits on captive yellowfin tuna maintained in tanks at KRF.

3. Plans for the next fiscal year.

In accord with our objectives, we plan to continue two projects during the next fiscal year. To expedite the work, we have initiated the processes required to hire 50% FTE employee to assist with the research.

Project 1: Estimate mortality of sea turtles incidentally caught in longline fishing gear.

We will continue working with experienced at-sea observers and to train any new ones in methods to attach PSATs to hard-shelled turtles. For the immediate future, observers will be given PSAT tagging kits suitable for use with hard shelled turtles for each fishing voyage. If the attachment methods for leatherbacks currently being tested prove suitable, and if the requisite permits/permissions can be obtained, we will begin issuing tagging kits also containing PSATs suitable for attachment to leatherbacks.

Tags currently being issued are programmed to pop-off from three to twelve months after deployment. We expect a turtle to be tagged in the near future, and once this occurs, we will begin receiving data on turtle movements post-release. These will allow a better understanding sea turtles' vertical and horizontal movement patterns in relation to oceanographic conditions. More important, as multiple turtles are tagged with differing levels of injury, we will also be able to obtain robust estimates of rates of mortality and morbidity of animals released from longline gear.

Anticipated project period: This work will continue on throughout 2002.

Project 2: Tests of the Efficacy of Modified Baits and Fishing Gear Using Captive Turtles

It is highly likely that differences exist between sea turtles and marine fishes sensory physiology. The key to success (e.g., identifying a chemical substance repellent to turtles, but that is undetectable by the targeted fish species) will be in defining and then exploiting these differences. In next year, research on turtles' reactions to modified baits will continue in an attempt to identify a potentially repellent bait treatment. Likewise, specific hook modifications will be tested with the aim of developing procedures that prevent hooking, reduce the incidence of hooking, or at least reduce the frequency of deeply injested hooks. Specifically, these latter tests will include observations of turtles approaching "hooks" with some modification, such as a "shield" or a "stop". These experiments will be video-recorded and analyzed to determine their potential efficacy for reducing turtle hooking. If successful in the captive conditions, future tests will be conducted in field trials.

These projects complement concurrent NMFS-funded projects on sea turtle and tuna sensory physiology. For example, research conducted on the visual capabilities of turtles will be followed by a bait-color preference study using captive green and loggerhead turtles. Artificial baits will be used to elucidate the relative importance of vision and olfaction in turtles "bite / no bite" decision and to test classes of potentially repellent odors based on

identified “odor receptor” genes. Chemical alterations will include various ratios of amino acids, lipids, etc.

Juvenile/subadult turtles will be brought from the wild and maintained in groups of 2-3 animals per tank. As in previous experiments, turtles will be presented food on simulated longline gear. In order to increase our sample size from this current year's research, we will repeat our experiments on food color preference/aversions with as many turtles as possible. Once again, these studies will be conducted on “naive” green turtles that have not started feeding in captivity. Turtles will be fed both treated (e.g. blue, red) and untreated squid from their initial feeding. All treated baits will also be tested on yellowfin or skipjack tunas also maintained at the KRF. Promising methods will be tested in field trials involving an experimental longline fishery to be conducted by NMFS. Results will indicate the potential value in using dyed bait as a way to reduce turtle-longline interactions while ensuring acceptable catch rates for targeted species.

The artificial/colored bait experiments will also be repeated on “naive” juvenile loggerhead turtles maintained at the NMFS Galveston Laboratory. It is estimated that approximately 20-30 turtles will available by this fall. This aspect of the behavioral research is especially important as the majority of turtles hooked on longline gear are juvenile loggerheads.

Anticipated Project Period:

July 1, 2001 to June 30, 2002: Continue experiments on responses of green and loggerhead turtles to modified baits. Also, continue provide PSAT turtle tagging kits to be taken to sea aboard commercial longline vessles, and to train newly hired observers on attachment procedures. Once data come in, analyse and publish results.

July, 2001 through April, 2002: Test approximately 15 “naive” green turtles at the Kewalo Research Facility and approximately 20-30 loggerhead turtles at the NMFS Galveston Laboratory using colored and artificial baits.

May, 2002 to July, 2002: Summarize results of color preference and artificial bait studies Analyze data and prepare manuscripts for publication.

July, 2001 through March, 2002: Test responses of green and turtles to modified gear. This work will be conducted simultaneously with modified bait studies and it will not require additional permits, access to turtles, etc.

March, 2002 to July, 2002: Summarize results of gear modification. Submit final report on status of all experiments.

4. List of papers published in refereed journals during FY 2001.

Brill, R., Swimmer, Y., Taxboel, C., Cousins, K. and T. Lowe. 2001. Gill and intestinal Na+-K+ ATPase activity and estimated maximal osmoregulatory costs, in three high-energy demand teleost: yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and dolphin fish (*Coryphaena hippurus*). Marine Biology 138: 935-944.

5. Other papers, technical reports, meeting presentations, etc.
We have documented our work in the form of a five minute video entitled: "Bait Selection Study in Marine Turtles". This video has been presented to various government and scientific meetings and highlights our research with captive turtles.

Swimmer, Y. and R. Brill. 2001. Research directed at mitigating sea turtle-longline interactions. [Abstract] . In: Proceedings of the 52nd Annual Tuna Conference. Lake Arrowhead, CA.

Swimmer, Y. and R. Brill. 2001. Methods aimed to reduce marine turtle interactions with longline fishing gear.[Abstract] . In: Proceedings of the 21st Annual Workshop on Sea Turtle Conservation and Biology. In press: NOAA-Tech Memo-NMFS-SEFSC.

6. Names of students graduating with MS or Ph.D. degrees during FY 2001. Include title of thesis or dissertation.

None

7. For multi-year projects, provide budget for the next year on a separate page.

Procedure for Attaching Pop-Up Satellite Archival Tags (PSATs) On Incidentally-Caught Hard-Shelled Marine Turtles

The following is a detailed procedure for the attachment of PSATs on incidentally caught hard-shelled sea turtles. Observers should follow all normal protocols for handling turtles that have been hooked or entangled.

ASSESSMENT:

Once on deck, guide the turtle to a safe area, preferably out of the weather and salt spray. To calm the turtle place its head in a corner or confine it to a large box. Follow the protocols for obtaining information for the *sea turtle life history form* and the *Protected Species Tally Sheet* as well as applying tags, collecting DNA samples, and photographing. In addition, take a photograph showing hook placement. Make sure that the photo includes the I.D. label for the tag (either from tag's base-plate or from stickers enclosed).

PREPARATION:

Identify a good position on the carapace to attach the PSAT. Flat clean scutes toward the back of the carapace generally work best (see arrows in figure 1). Use freshwater to help clean the area on the carapace where the transmitter will be mounted. With a scrub brush, remove barnacles and clean surface as best as you can. Use sandpaper for finer cleaning and finally wipe the area with a dry clean cloth.

ATTACHMENT:

Have all your supplies (including watch) available. Make sure the carapace is clean and dry before beginning attachment procedures. Put on gloves and perform the following steps as quickly as possible.

1.) Open the box of Marine Fix® Fast and put the contents from both containers (A and B) into the large plastic cup. Mix thoroughly for 90 seconds using the large wooden stirrer (figure 2).

2.) Using the same stirrer, apply a thick coat of mixed epoxy onto the flat bottom part of the white base-plate (figure 3).

3.) Place the baseplate on the clean dry carapace. Press down firmly against the carapace for a few minutes to squeeze out any air pockets. Be careful not to press down too hard such that a significant amount of epoxy is displaced from under the baseplate. Smooth out the excess epoxy that oozes out the sides with the stirrer or wet (gloved) fingertip. Wait approximately 30 minutes for the epoxy to harden completely.

4.) Take a photograph showing the transmitter attached to the carapace (figure 4).

5.) Release the turtle into the ocean from a position as close to the water as possible to prevent harm to the turtle and damage to the transmitter. Be sure to record the PSAT number, the position of release, and other required data in the notes section of the *sea turtle life history form* and the *protected Species Tally Sheet*.

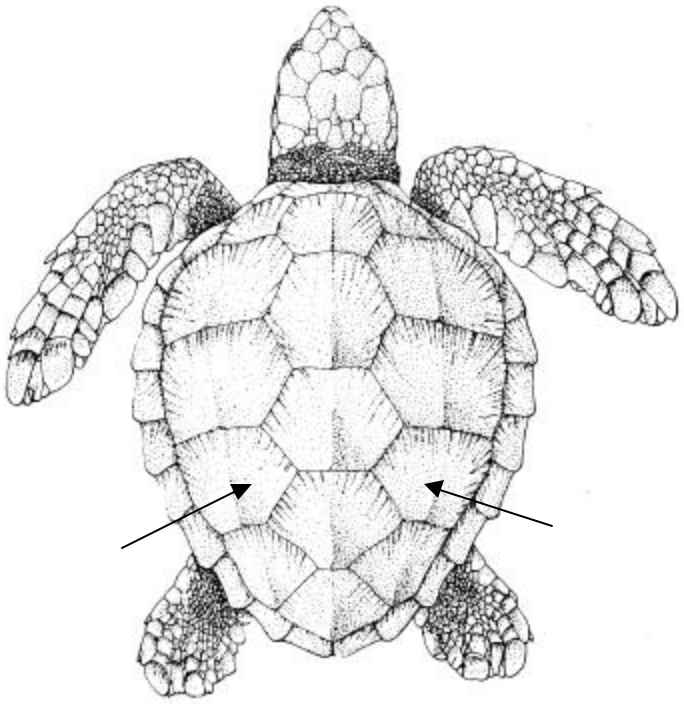

Figure 1.

Figure 2.

Figure 3.

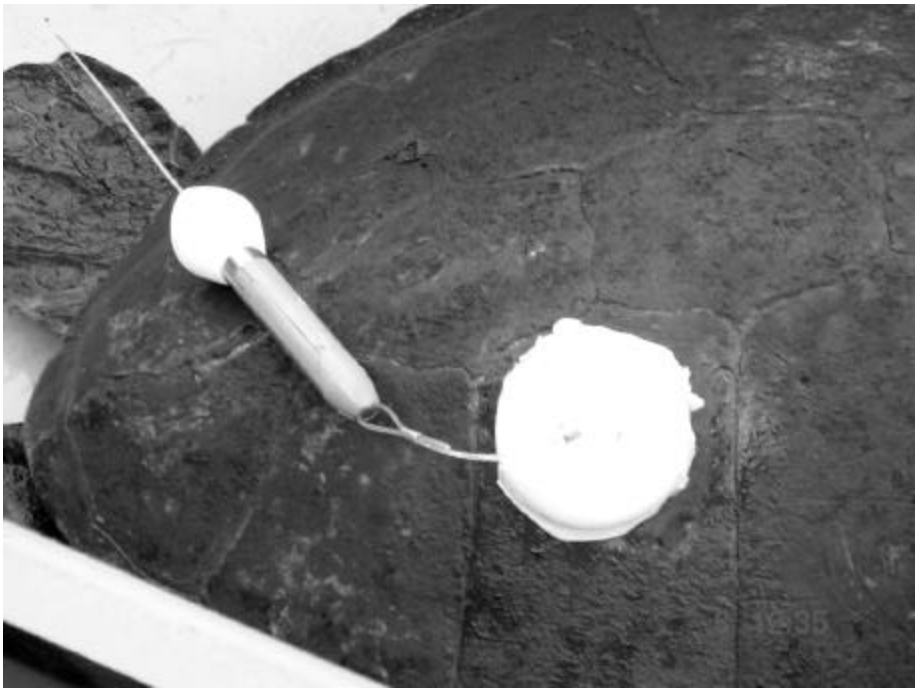

Figure 4.