JIMAR, PFRP ANNUAL REPORT FOR FY 2004

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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: PFRP/NMFS

1. Purpose of the Project and indicative results:

The objectives of this project are two-fold: 1) to provide estimates of delayed mortality and morbidity in sea turtles following interactions with longline fishing gear, and 2) to compare the movements and behaviors of sea turtles caught and released from longline gear to free-swimming controls. To do this, we've deployed pop-up satellite archival tags (PSATs) on longline-caught and free-swimming hard-shelled turtles in the Eastern Tropical Pacific, the North Pacific, and the South Atlantic Oceans.

2. **Progress during FY 2004. Provide a discussion of accomplishments and problems.**

I. **PSATs deployed in Costa Rica**

We have worked in collaboration with local commercial fishermen and an NGO (PRETOMA) on the Pacific Coast of Costa Rica since November 2001 in order to attach PSATs on marine turtles incidentally-captured in longline fishing gear. Despite the use of circle hooks, the incidental capture of juvenile olive ridley turtles (*Lepidochelys olivacea*) in the EEZ of Costa Rica is extremely high—ca. 8 turtles/1,000 hooks. The majority of captured turtles are landed and released alive, however ca. 10% are released with hooks remaining in their gastrointestinal tracts or flippers. We have successfully tagged 10 sea turtles (9 olive ridleys & 1 green, *Chelonia mydas*) incidentally captured in fishing gear, and 5 free-swimming "controls" to which the behaviors of longline-caught turtles could be compared.

Horizontal movements of turtles appear similarly for longline-caught and control turtles (Figures 1 & 2) both in terms of directionality as well minimum distance traveled (4.6 nmi vs. 7.7 nm for longline-caught and control turtles, respectively; $p>0.15$). PSATs were retained on average 56 and 60 days for control- and longline-caught turtles, respectively (range: 35 to 113 days). Three (of 15) PSATs never transmitted data.

Dive behaviors varied considerably among individual turtles, rendering the data (at this point in time) most useful for descriptive rather than statistical analyses. For example, lumping data together resulted in an earlier erroneous conclusion that longline-caught turtles remained deeper than free-swimming controls. This was based on a significantly deeper dive profile of a single turtle. Closer investigations into individual dive behaviors indicated a high degree of individual variation. More recently, we've investigated turtles' dive behavior both as it relates to group (e.g. longline-caught or

controls) as well as incorporating the potential significance of oceanographic conditions (e.g. SST, chlorophyll concentrations) including seasonal and annual variability.

Turtle dive behaviors did not fall out by group. Our results suggest that turtles' median daily depths appear more highly correlated to oceanographic conditions than to turtles' condition (e.g. free-swimming or hooked in longline gear; Figure 2). Turtle dive behaviors did not fall out by group. Our results suggest that turtles' median daily depths appear more highly correlated to oceanographic conditions than to condition (e.g. free-swimming or hooked in longline gear). Specifically, two longline-caught and two control turtles were tracked during the same period of time over two consecutive years. The longline caught turtles had both the deepest and shallowest median depths while the two control turtles were in between. We believe this is due to the fact that the turtle with the deepest distribution was tracked during the 2002/2003 time period as compared to the other turtles that were tagged the previous year. As determined with AVHRR data, the time period in 2002/3 was approximately 3^{o}C warmer in this general area. Chlorophyll concentrations were similarly different from one year to the next, which could likely account for depth distributions noted among tagged turtles. Of particular note, we have found evidence to suggest that turtles apparently compensate their dive behavior in order to maintain within a similar range of ambient temperatures. We will continue to explore the impact of the fisheries interaction in the context of other factors influencing turtles' movements.

Our results indicate that olive ridley turtles apparently survive their encounter with longline fishing gear at least for the first two months post-release. Turtles in our study that were incidentally-captured in longline gear (and for which we received some response from the satellite tag) all survived a minimum of 3.5 weeks, and most survived a minimum of six weeks post-release before the tag was shed.

In the one case for which we have data indicating a mortality (#38604), the turtle was tagged after it had been resting on the ocean surface and thus served as a "control". Perhaps as a result of "natural causes", we speculate that after approximately 5 weeks at liberty, the turtle sank to the bottom and remained on a coastal shelf or on a seamount at approximately 900 m for four days before the PSAT released to the surface (Figure 6). The PSAT performed exactly as programmed which we feel validates the utility of PSATs to identify delayed mortality.

II. PSATs deployed in the North Pacific Ocean

Since September 2002, California-based longline fishery observers have placed 13 PSATs on loggerhead (*Caretta caretta*) turtles in the North Pacific (Figures 7 & 8). Of these, six PSATs have already transmitted recorded data and one failed to report. The remaining tags are presumably still on turtles and should report within the coming months. PSATs retention on N. Pacific loggerheads was significantly longer than on olive ridleys in Costa Rica. Average number of days at liberty for loggerheads was 88.3 (range: 30-192 days). However, we have been disappointed with the quantity data received both regarding geolocation and dive behavior.

Depth data is nearly non-existent for turtles tagged thus far. For one turtle, depth data was only recorded for the first three months after release. However, the last depth

reading recorded three months later was 1,108 m, which would suggest a mortality, or a faulty mechanical release device (RD1,500) designed to jettison the PSAT at 1500 meters. Because no depth data were obtained prior to this one "mortality", we consider these data inconclusive. What little data obtained, however, indicate the turtle spent 75% of time within the top 10m during the day and remained slightly deeper at night, yet never exceeding 50m (Figure 9).

Light-based geolocations as generated from PSATs were run through the Kalman filter model in order to determine turtles' most probable track for three turtles. We will continue to work with Anders Nielsen to refine these estimates based on incorporation of sea surface temperature data.

III. PSATs deployed in the South Atlantic Ocean

In January 2004, while participating in an experimental fishery in Brazil in an attempt to identify a means to reduce sea turtle-longline interactions, we tagged a loggerhead turtle that had been previously caught in commercial longline gear and maintained in captivity in Southern Brazil for two months. A second loggerhead was tagged during a subsequent cruise in March 2004. We expect to receive data from the PSATs after 8 months after their release. We anticipate future opportunities to tag longline-caught turtles in the Brazil longline fishery in the coming year. This work is being conducted in collaboration with Projeto TAMAR/IBAMA.

3. Plans for the next Fiscal Year:

We plan to continue tagging efforts with collaborators in Costa Rica and Brazil. Beginning in May 2004, we plan to train fisheries observers that will accompany Hawaii-based vessels for the required 100% coverage for the "experimental longline fishery". Each observer will be equipped with PSATs for the purpose of tracking hard-shelled turtles post-release. We are also in contact with various organizations in the Central and Western Pacific as well as Southeast Asia that may assist in our efforts to tag turtles after their release from fishing gear. We will likely increase use of conventional satellite tags in an effort to get more accurate estimates of geolocations.

4. List of Papers Published in Referred Journals during FY 2004.

5. Other Papers, Technical Reports, Meeting presentations, etc.

Swimmer, Y., Arauz, R., Musyl, M., Ballestero, J., McNaughton, L. and R. Brill. 2004. Survivorship and behavior of olive ridley turtles off the coast of Costa Rica following interactions with longline fishing gear. Poster presented at the 24th Annual Symposium on Sea Turtle Conservation and Biology22 - 29 February 2004, San Jose, Costa Rica.

Swimmer, Y. and L. Mailloux. 2003. Bait Modification Research: Reducing Incidental Interactions between Sea Turtles and Longline Fishing Gear. 2003. In:

Proceedings of the 54th Annual Tuna Conference. Lake Arrowhead, California, May 13-16. 2003.

Swimmer, Y, Brill, R., Arauz, R., Mailloux, L., Musyl, M., Bigelow, K., Nielsen, A., Sibert, J. 2003. Surivorship and Behaviors of Sea Turtles after their release from Longline Fishing Gear. In: Proceedings of the 54th Annual Tuna Conference. Lake Arrowhead, California, May 13-16. 2003.

Brill, R. and Y. Swimmer. 2003. Laboratory Experiments Aimed at Reducing Pelagic Longline Interactions with Marine Turtles. In: Proceedings of the 54th Annual Tuna Conference. Lake Arrowhead, California, May 13-16. 2003.

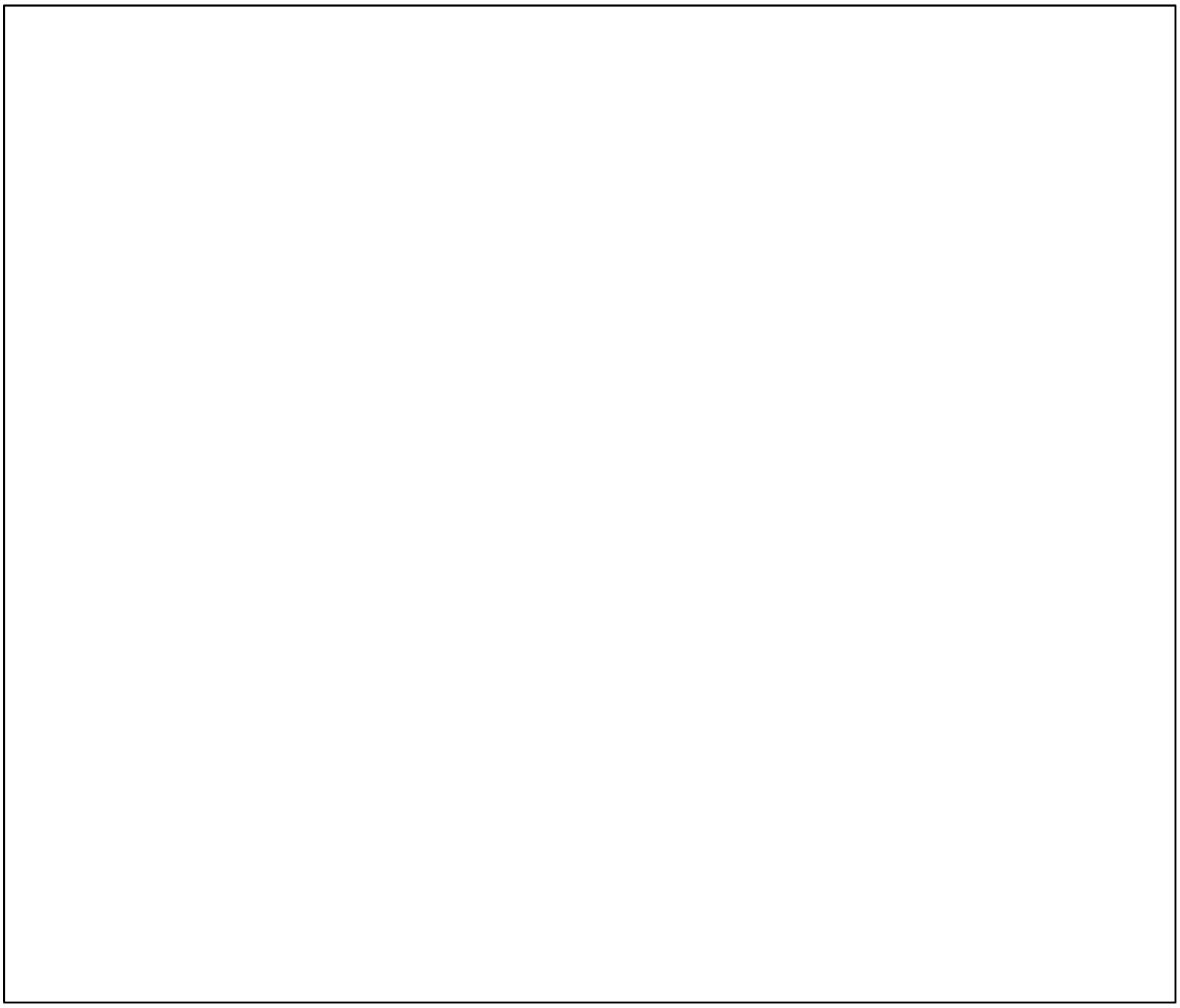
Swimmer, Y., Arauz, R., Musyl, M.., Ballestero, J., McNaughton, L., and Brill, R. 2004. Survivorship and dive behaviour odf olive ridley sea turtles after their release from longline fishing gear off Coasta Rica. (manuscript in preparation).

6. Names of Students Graduating with MS or PhD Degrees during FY 2004 Titles of their Thesis or Dissertation.

n/a

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

Figure 1. Most probable tracks (as based on the Kalman filter model) of 5 longline-caught olive ridley turtles. Average time at liberty was 60 days (SE=9.73, range=35-113).



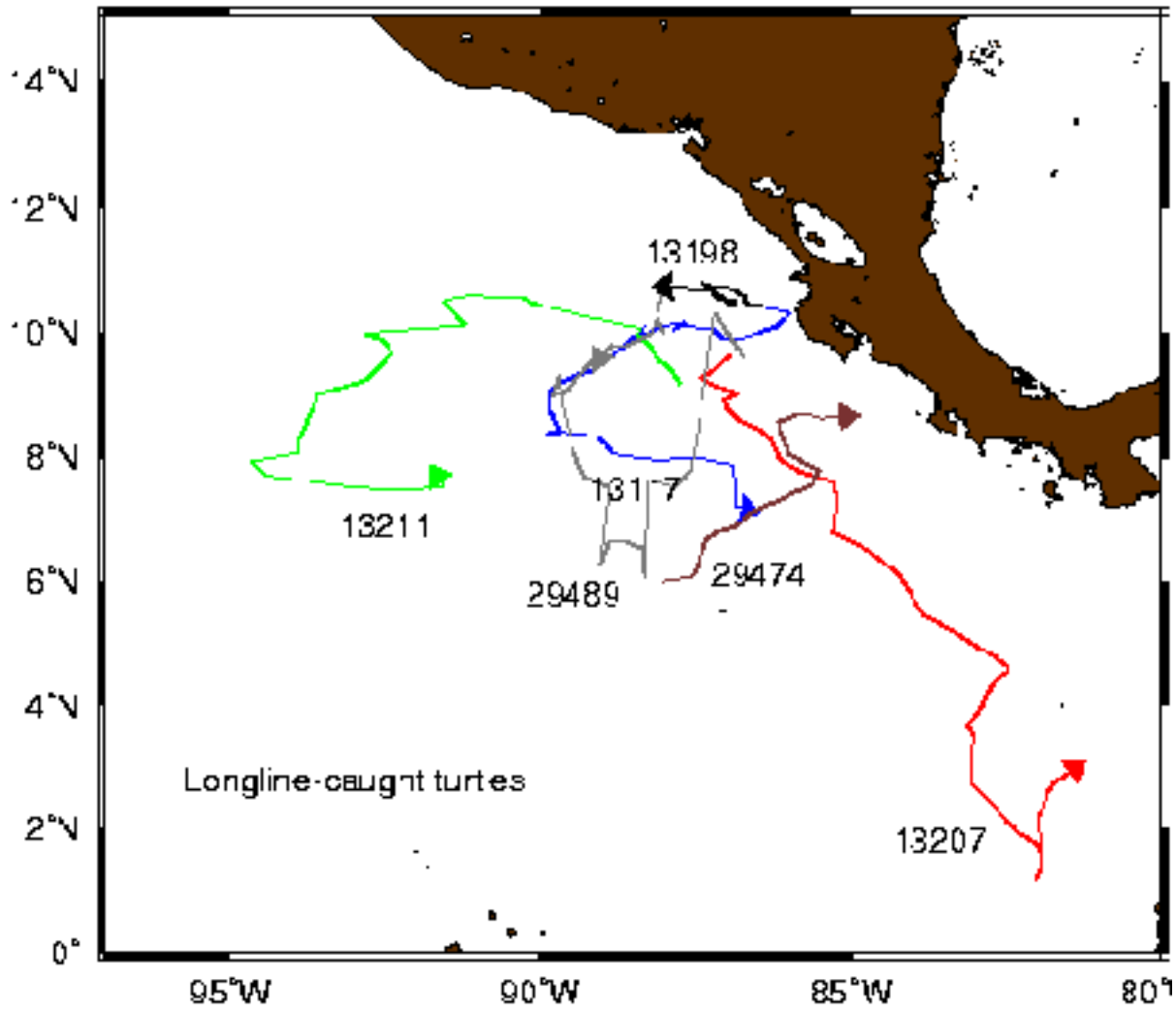
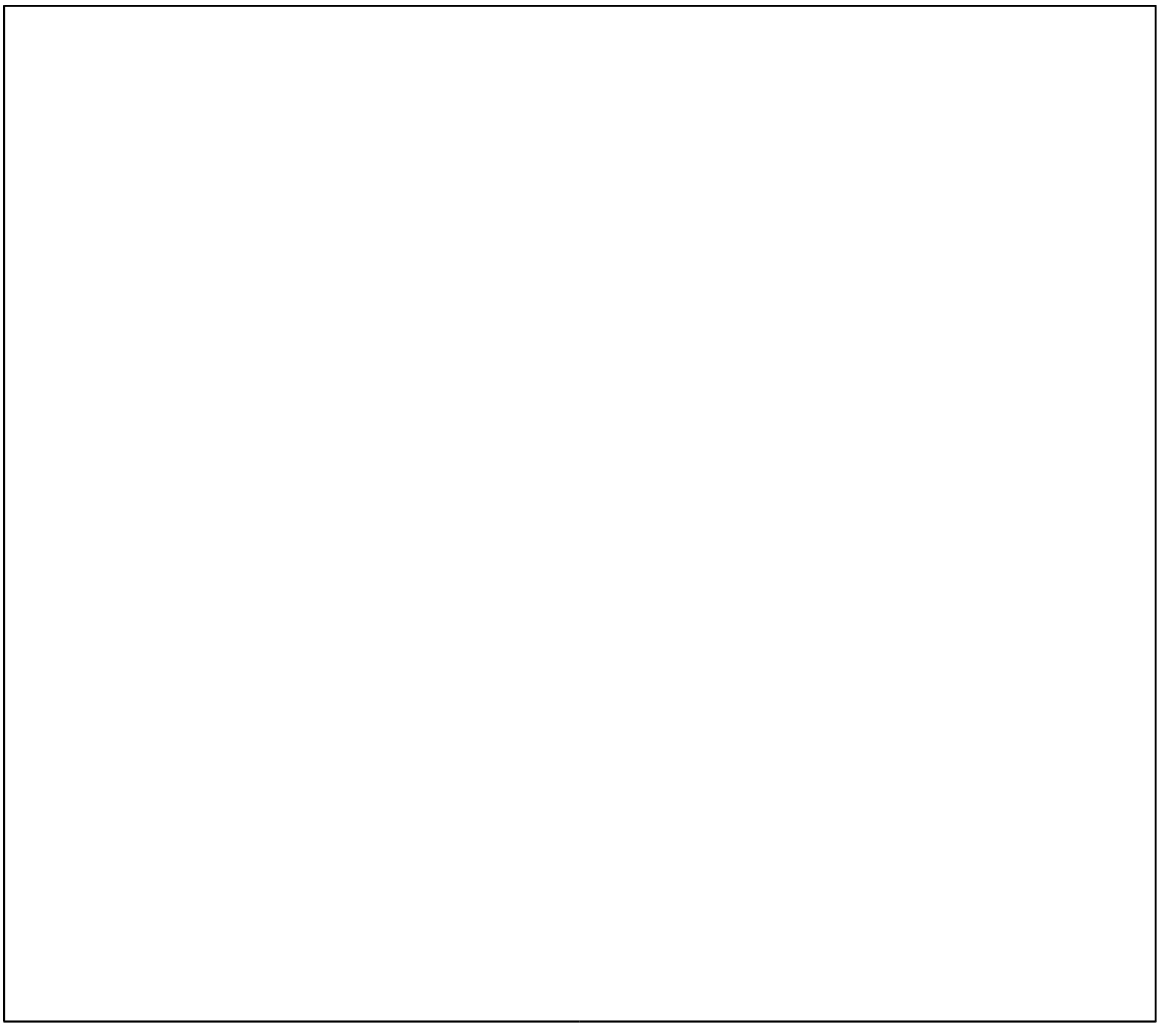

4°N
2°N
0°N
8°N
6°N
4°N
2°N
0°
95°W
90°W
85°W
80°
13198
13211
13177
29489
29474
13207
Longline-caught turtles

Figure 2. Most probable tracks (as based on the Kalman filter model) of 3 “control” olive ridley turtles. Average. time at liberty was 56 days (SE=6.68, range=40-68).



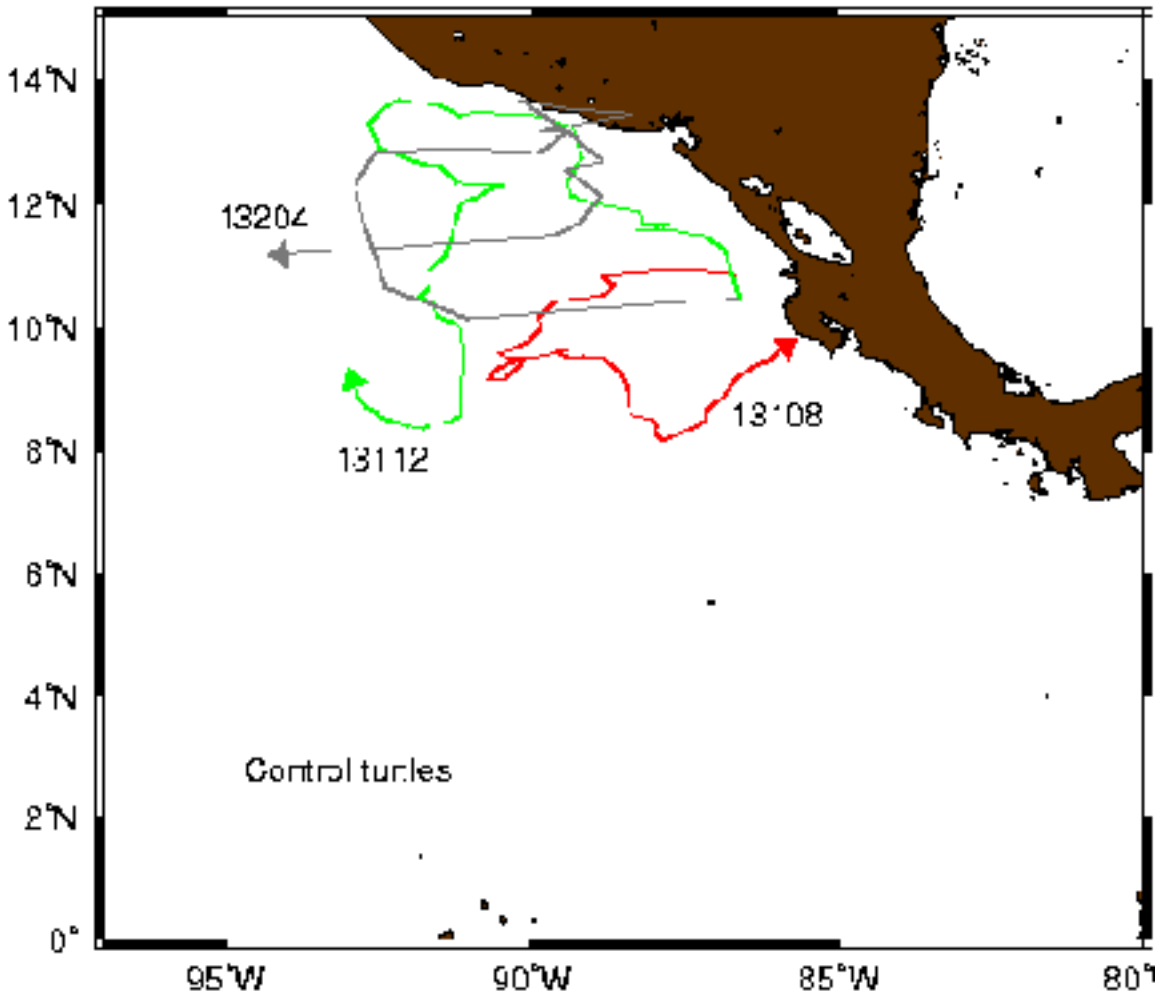

14°N
12°N
10°N
8°N
6°N
4°N
2°N
0°
95°W
90°W
85°W
80°
13204
13112
13108
Control turtles

Figure 3. Daily median depths (m) were graphed for each turtle. Blue lines are turtles that had been incidentally caught in longline gear, red lines are "controls", and the green line is for the green turtle tagged.

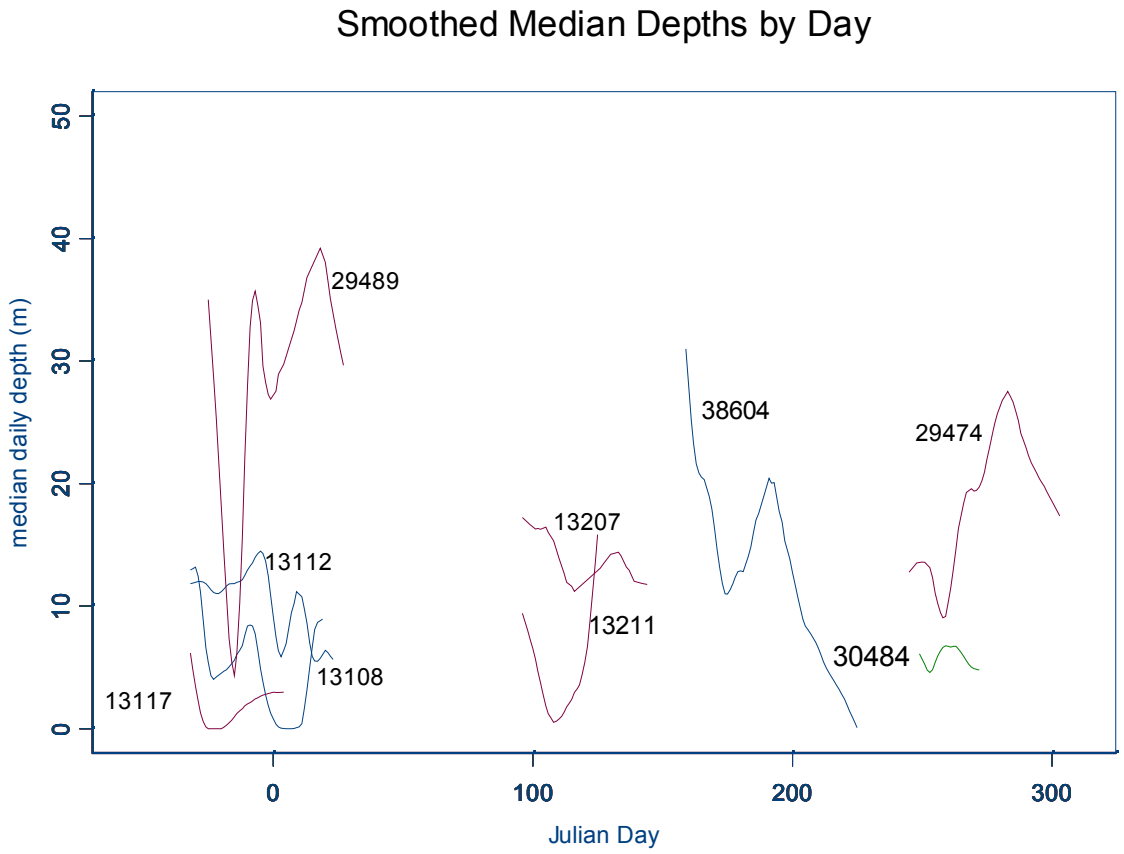


Figure 4. Daily median ambient temperatures (C°) were graphed for each turtle. Blue lines are turtles that had been incidentally caught in longline gear, red lines are "controls", and the green line is for the green turtle tagged.

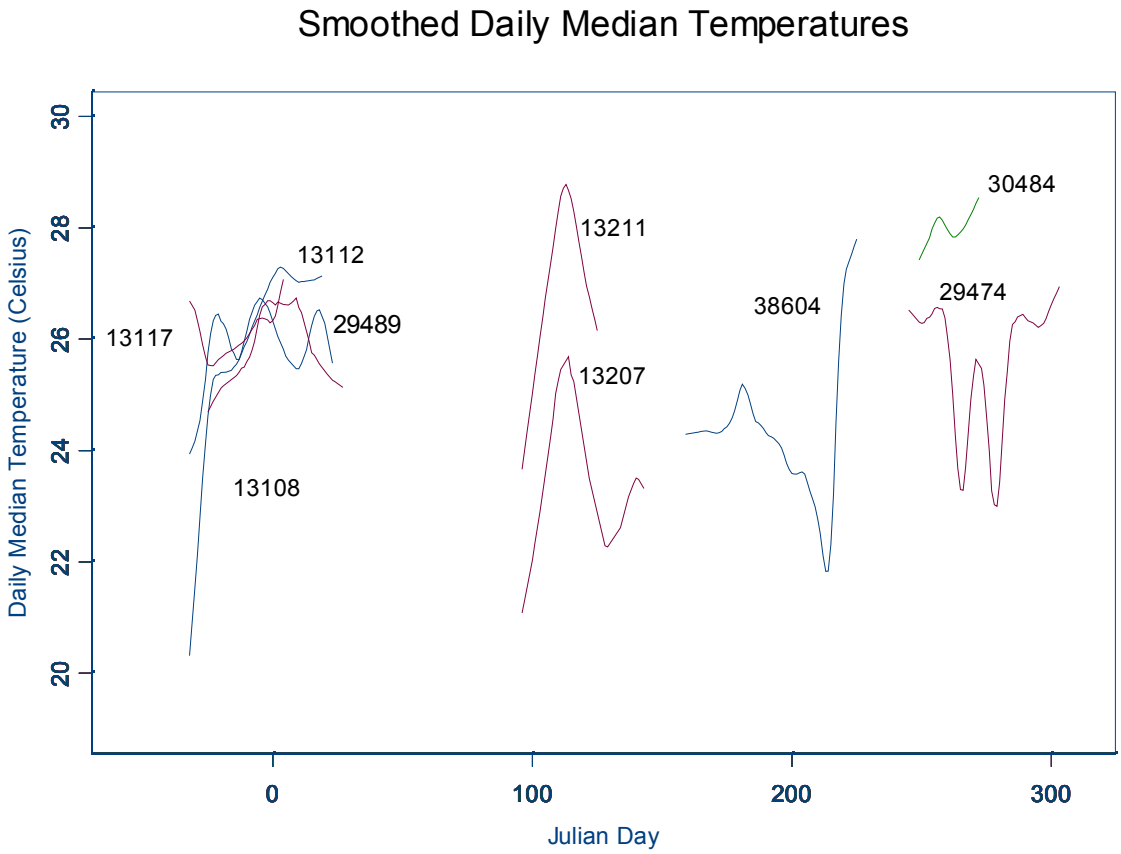


Figure 5. Mean sea surface temperature during 03 Dec 2002 to 24 Jan 2003 as determined by AVHRR with overlayed track of turtle #29489.

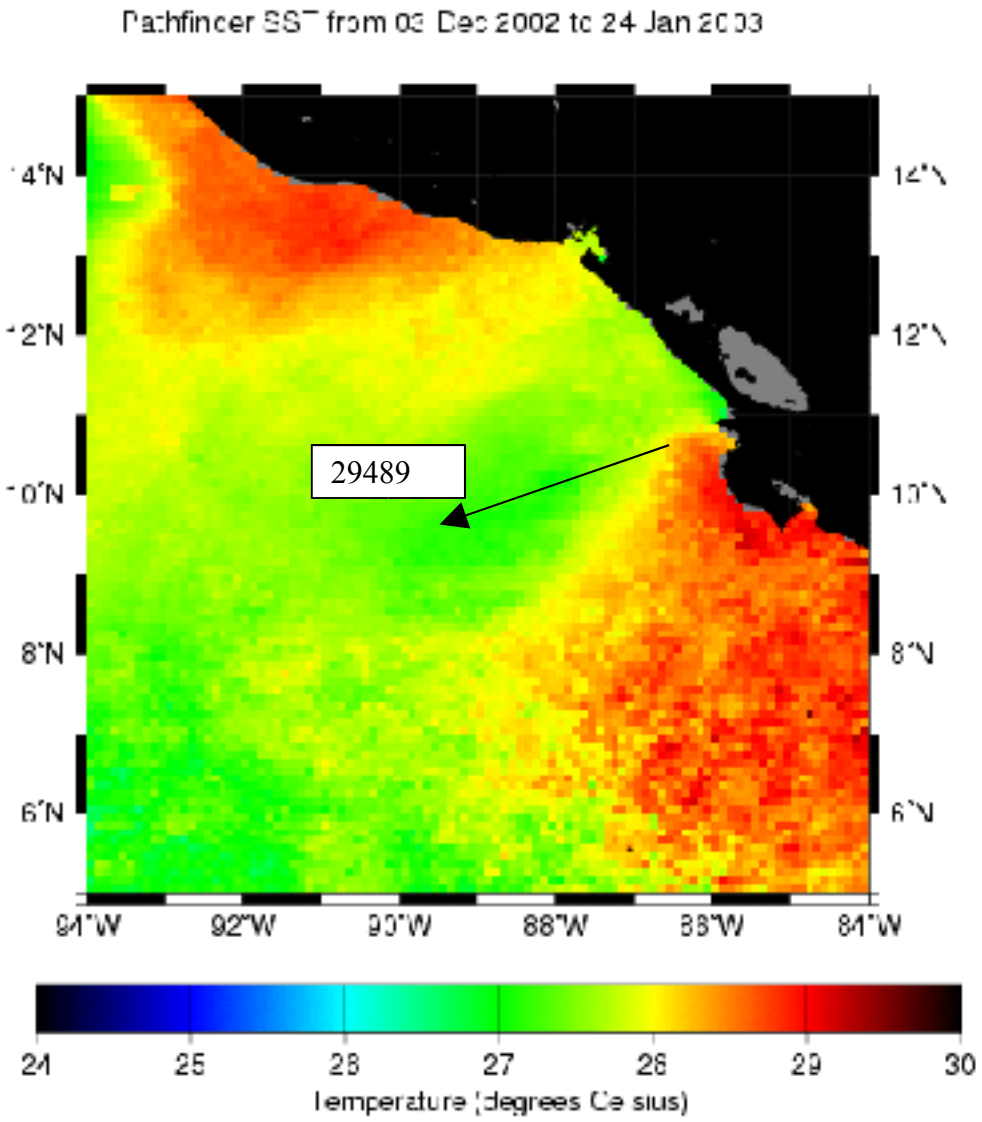


Figure 6. Mean sea surface temperature during 03 Dec 2001 to 24 Jan 2002 as determined by AVHRR with overlayed track of turtles #13112m 13108, 13117.

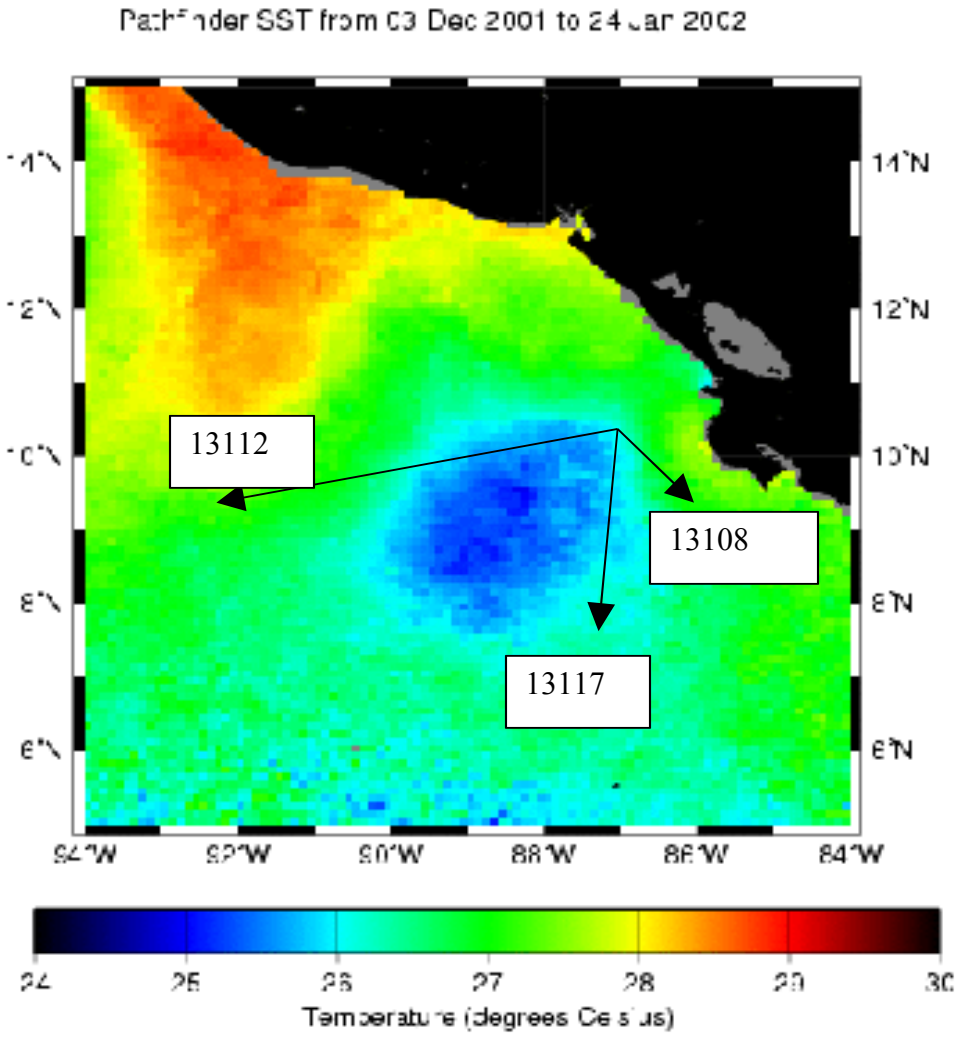


Figure 6. Depth data for olive ridley turtle # 38604 suggesting normal behavior after it was tagged on June 8, 2003, until the turtle apparently died and sunk on Aug. 13, 2003. The turtle and tagged remained on the seafloor for the required four days, then the tag floated to the surface and began to transmit its data to the satellite overhead.

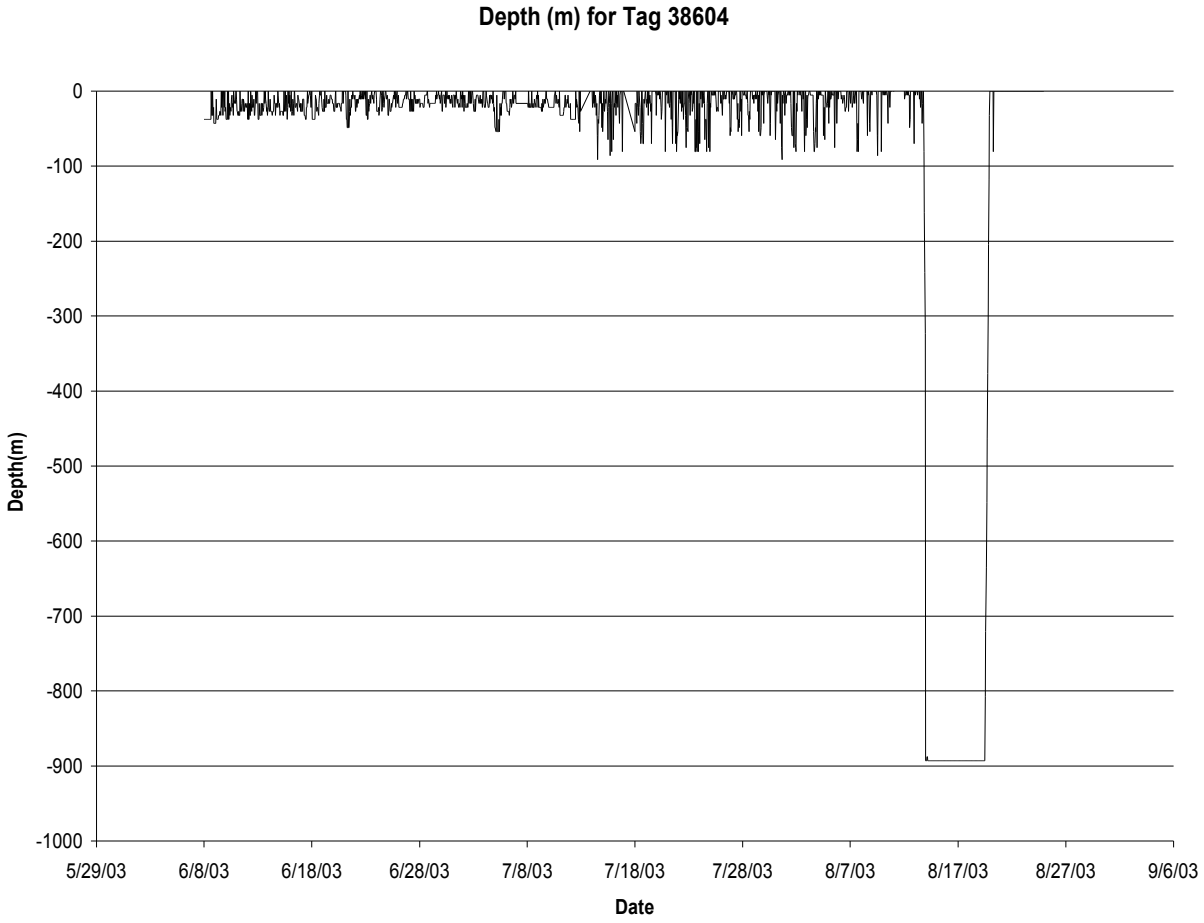
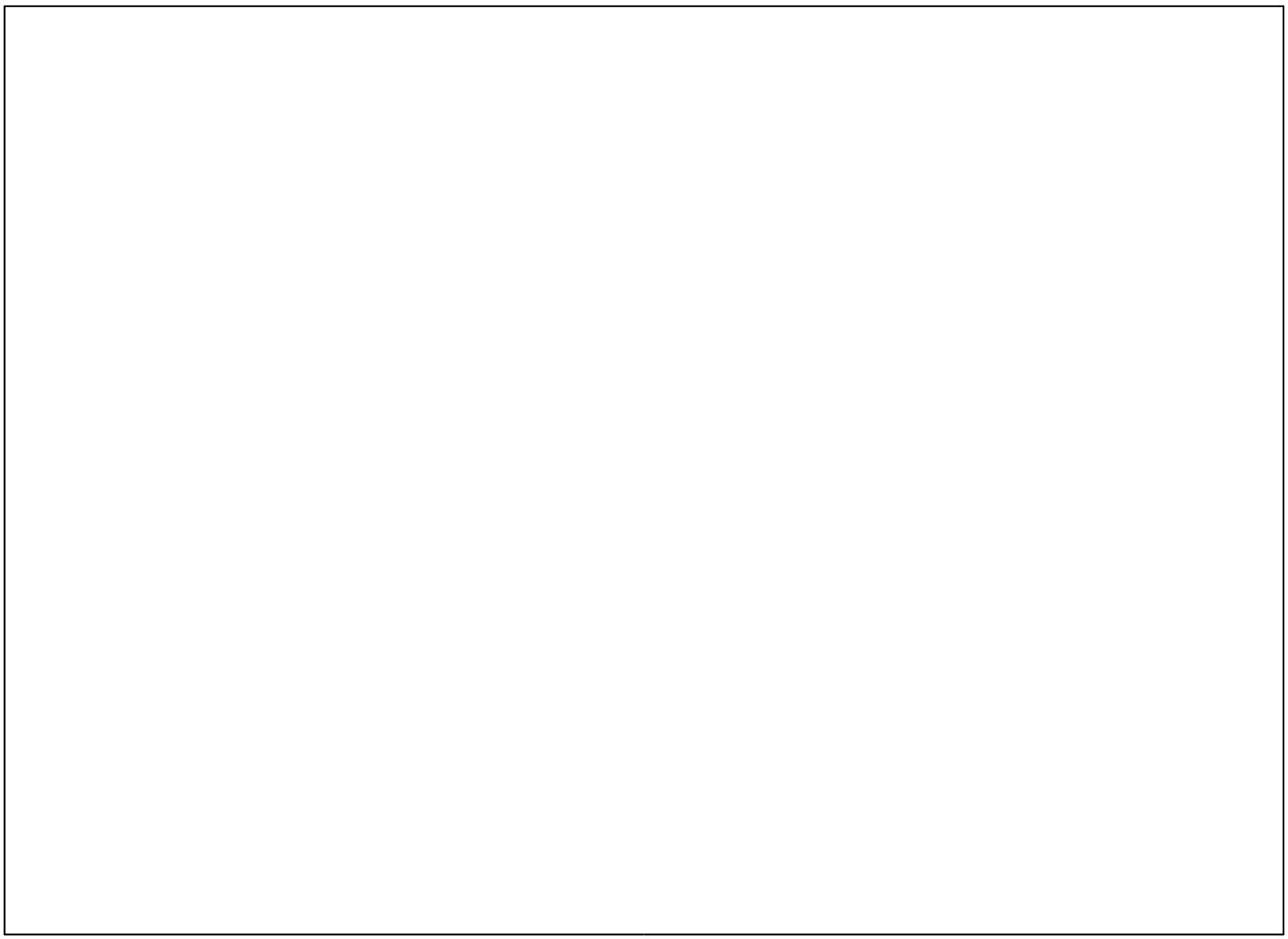


Figure 7. Start and end points of pop-off satellite tags deployed on hard shelled turtles in the North Pacific Ocean. Arrows indicate pop-off location.



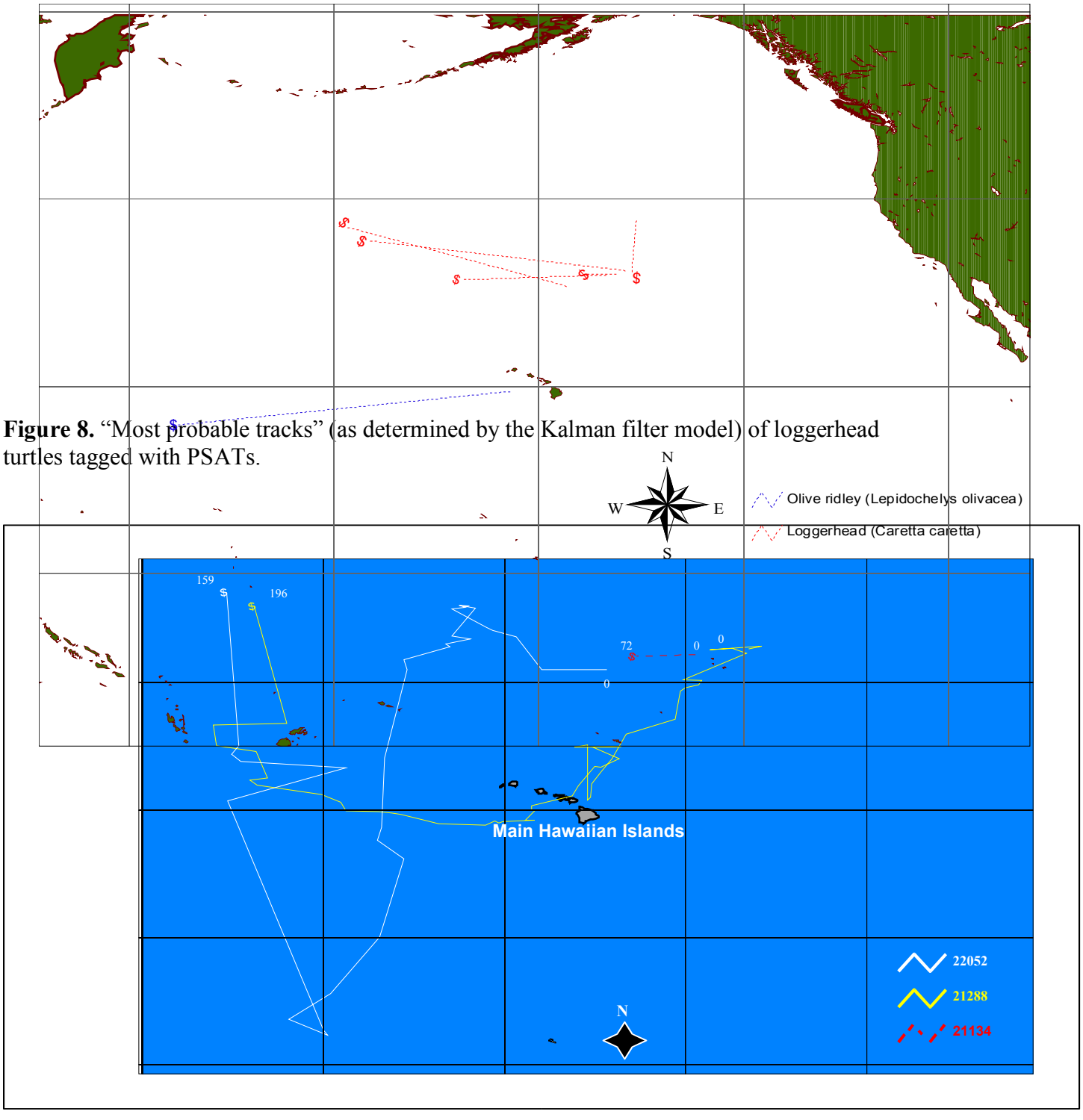


Figure 8. "Most probable tracks" (as determined by the Kalman filter model) of loggerhead turtles tagged with PSATs.

Figure 9. Frequency of time at depth for loggerhead turtle #21288 in the N. Pacific Ocean.