

## **JIMAR ANNUAL REPORT FOR FY 2009**

P.I./SPONSOR NAME: Kevin Weng, Mike Musyl, Christina Larsen, Hans Malte & Richard Brill

NOAA OFFICE (Of the primary technical contract): Pacific Islands Fisheries Science Center

PROJECT PROPOSAL TITLE: Modeling the Eco-physiology of Pelagic Fishes and Sharks with Archival and Pop-up Satellite Archival Tags (PSATs)

FUNDING AGENCY: NOAA

NOAA GOAL (Check those that apply):

- ☒ To protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management
- ☐ To understand climate variability and change to enhance society's ability to plan and respond
- ☒ To serve society's needs for weather and water information
- ☐ To support the nation's commerce with information for safe, efficient, and environmentally sound transportation

PURPOSE OF THE PROJECT (One paragraph):

We propose to use available data from archival and pop-up satellite archival tags (PSAT) to develop IBMs (individual based models) to describe the eco-physiology of different species of large pelagic fishes and sharks. This project will complement data already collected on a number of pelagic species and will be linked to existing PFRP projects by Musyl, Brill, and Moyes. Thus the study will be a collaboration between the University of Hawaii/JIMAR/PFRP, Virginia Institute of Marine Science/ National Marine Fisheries Service, and the Dept. of Zoophysiology, University of Aarhus, Denmark. Our ultimate goal is to develop model(s), which will be applicable to many different pelagic fish and shark species. Using these models we can evaluate the possible importance of specific oceanographic parameters in an unbiased fashion, which will allow for intra- and inter-species comparison. A second purpose of this study is to explore failure (or conversely success) scenarios in PSATs attached to pelagic fish, sharks and turtles. Specifically, this aspect of the study is designed to look for explanatory variables in the context of PSAT retention rates, percentage retrieved satellite data (i.e. depth, temperature, geolocations), and tag failure. By examining several factors and information about PSATs attached to vastly different pelagic species, it is anticipated that certain patterns/commonalities may emerge to help improve our understanding of attachment methodologies, selection of target species and experimental design. Lastly, information derived from this study will allow an unprecedented and critical appraisal of the overall efficacy of the technology.

PROGRESS DURING FY 2009 (One-two paragraphs, including a comparison of the actual accomplishments to the objectives established for the period, and the reasons for the slippage if established objectives were not met):

Although the project was unavoidably delayed due to major knee surgery for PI Musyl in FY2007 and in FY2008 medical problems with other personnel, several manuscripts have been published and submitted by project personnel (outlined below) including a major review manuscript on PSAT performance and reliability. Project personnel have also completed major analyses to correlate movement patterns of PSAT tagged blue shark, silky shark, oceanic white-tip, bigeye thresher and short-fin mako shark with various oceanographic parameters. Another manuscript detailing the post-release survival of pelagic sharks from longline gear is to be submitted soon.

PLANS FOR THE NEXT FISCAL YEAR (One paragraph):

In addition to submitting the manuscripts outline above and revising manuscripts as required, project personnel anticipate two additional manuscripts: 1) post-release survival of marlin (blue, stripe and black) from sports fishing and longline gear, and 2) movements of marlin in relation to oceanographic conditions. Most of the analyses on these papers have already been completed. Next, project personnel will accession PSAT performance data into a public repository housed at the PFRP website (metadata is already available). Lastly, due to the success and inertia of the project, various researchers from many agencies (both domestic and foreign) have expressed an interest in collaboration and/or initiating new projects.

LIST OF PAPERS PUBLISHED IN REFERRED JOURNALS DURING FY 2009, in the following format: (Author or authors with last name and initials, publication year: Article title. *Journal name*, volume, page range.) For example: Charney, J.G., and A. Eliassen, 1964: On the growth of the hurricane depression. *J. Atmos. Sci.*, 21, 68-75.

- 1). Beverly, S., B. Maloney, D. Curran, and M. Musyl. 2009. Effects of eliminating shallow set hooks from tuna longline sets on target and non-target species in the Hawaii-based pelagic tuna fishery. *Fisheries Research*, 96, 281-288.
- 2). Nielsen, A., J. R. Sibert, S. Kohin, and M.K. Musyl. 2009. State space model for light based tracking of marine animals: validation on swimming and diving creatures. In J.L. Nielsen et al. (eds.), *Tagging and Tracking of Marine Animals with Electronic Devices, Reviews: Methods and Technologies in Fish Biology and Fisheries 9*, Springer. (in press)
- 3). Sibert, J., A. Nielsen, M. Musyl, B. Leroy, K. Evans. 2009. Removing Bias in Latitude Estimated from Solar Irradiance Time Series. In J.L. Nielsen et al. (eds.), *Tagging and Tracking of Marine Animals with Electronic Devices, Reviews: Methods and Technologies in Fish Biology and Fisheries 9*, Springer. (in press)

- 4). Boye, J. H. Malte, M. Musyl and R. Brill. Transectional heat transfer in thermoregulating bigeye tuna (*Thunnus obesus*) - a two-dimensional heat flux model. Journal Experimental Biology. (in press)
- 5). Bernal, D., C. Sepulveda, M. Musyl, and R. Brill. 2009. The eco-physiology of swimming and movement patterns of tunas, billfishes and large pelagic sharks. In: Fish locomotion- an etho-ecological approach (P. Domenici and BG Kapoor, eds.). (in press)
- 6). Swimmer, Y., M. Chaloupka, L. McNaughton, M. Musyl, R. Brill. 2009. Bayesian hazard regression modelling of factors affecting post-release mortality of loggerhead sea turtles caught in pelagic longline fisheries. Ecological Applications. (in press)

#### Submitted/finished manuscripts

- 1). M. Musyl, R. Brill, M. Domeier, N. Nasby-Lucas, M. Lutcavage, B. Galuardi, F. Royer, L. McNaughton, Y. Swimmer, S. Wilson and J. Liddle. A Study of Pop-Up Satellite Archival Tag (PSAT) Performance and Reliability in Marine Fisheries Research. Marine Ecology Progress Series (planned submission in July/Aug).
- 2). Humphries, N.E., J.R.M. Dyer, N. Queiroz, N. G. Pade, M.K. Musyl, K. Schaefer, J.M. Brunnschweiler, T.K. Doyle, J.D.R. Houghton, G. C. Hays, C.S. Jones, L.R. Noble, V.J. Wearmouth, E.J. Southall, and D.W. Sims. 2009. Prevalence and diversity of Lévy flight search patterns in open ocean predators. Science (submitted).

#### OTHER PAPERS, TECHNICAL REPORTS, ETC.:

##### PFRP Honolulu Talks 2008

Michael Laurs, Michael Musyl, and David Foley. Identification of Central Pacific Large Pelagic Shark Habitats using PSATs, Satellite Remote Sensing, and SODA Ocean Assimilation Models

##### Expeditionary

Marshall Islands. 2009. At the request of Marshall Is. Visitor Authority and Marine Resources Authority, Musyl advised on blue marlin psat tagging techniques and general biology, ecology and migration of this species in and around Majuro.

##### Outreach

Representative for JIMAR/PFRP and NMFS at 2008 Hawaiian International Billfish Tournament (HIBT), invited to deliver talk to anglers and coordinated “Science Night”

Episode on “Pacific Expeditions” television show on VERSUS network showcasing Musyl and colleagues from the Marshall Islands tagging marlin (June, 2009).

GRADUATES (Names of students graduating with MS or PhD degrees during FY 2008; Titles of their Thesis or Dissertation): None.

AWARDS (List awards given to JIMAR employees or to the project itself during the period): None.

PUBLICATION COUNT (Total count of publications for the reporting period and categorized by NOAA lead author and Institute (or subgrantee) lead author and whether it was peer-reviewed or non peer-reviewed (not including presentations):

	JI Lead Author	NOAA Lead Author	Other Lead Author
Peer Reviewed	3	1	4
Non-Peer Reviewed			1

#### PERSONNEL:

For projects that awarded subcontracts in the fiscal year, please provide the number of supported postdocs and students from each subgrantee.

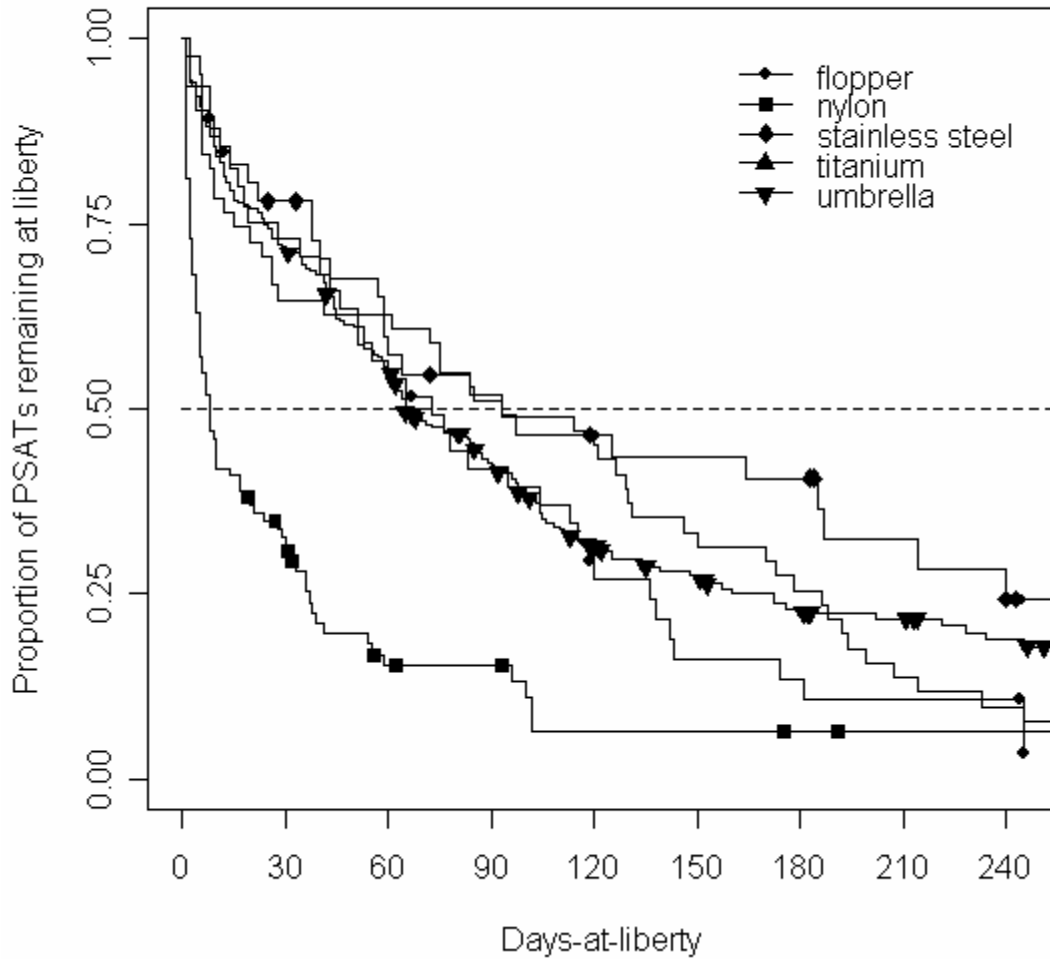
At present, no students or post-docs are paid by the project.

IMAGES AND CAPTIONS (We will also be including images for the annual report.

Please send two of your best high-resolution, color images (photo, graphic, schematic) as a **JPEG or TIFF (300 dpi)** with a caption for each image. If you do not have an electronic version of the image, a hardcopy version may be dropped off at the JIMAR office located in the Marine Sciences Building, Room 312):

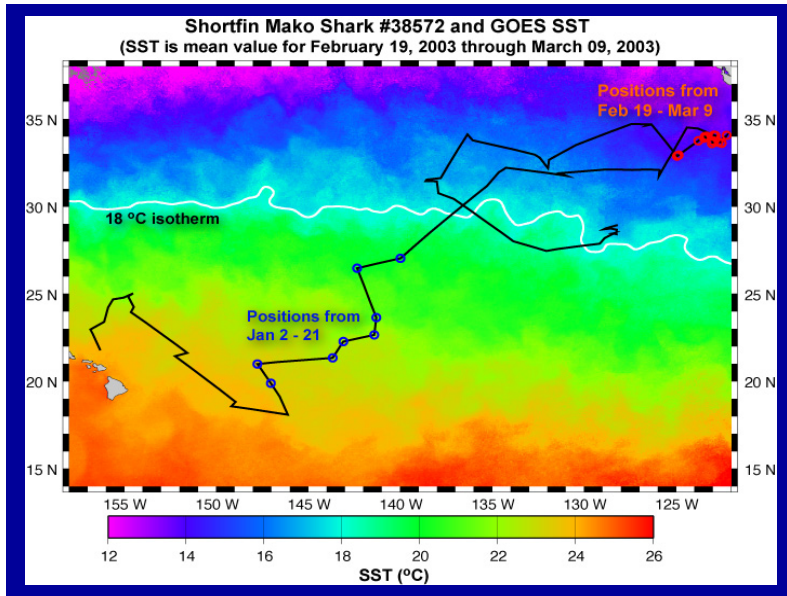
Caption 1: Kaplan-Meier survival curves of the proportion of pop-up satellite archival tags (PSATs) remaining attached to fishes and sharks by taghead type. A step downward on the survival curve represents a PSAT which detached early, while a symbol (legend) is a PSAT which hit its programmed pop-up date. The medians are found at the intersections of the lightly dashed 50<sup>th</sup> percentile line and the survival curves. Medians and sample sizes are: nylon m=8 d (n=100), umbrella m=65 d (n=253), flopper m=73 d (n=46), titanium m=93 d (n=51), stainless steel m=93 d (n=41). The differences in the survival curves were significant (likelihood ratio test,  $\chi^2=96.6$ , df=4, p<0.0001). As determined by the project using Cox Proportional Hazards models, PSAT retention appears to be more a function of latitude (temperature) and depth (pressure/temperature) experienced by the tagged animal.

Caption 2: Horizontal (A) and vertical (B) movement patterns of a pop-up satellite tagged short-fin mako. Notice how the animal dramatically altered its vertical diving patterns (B) in relation to the position of mixed layer and thermocline (orange line estimated by SODA analyses) as it moved into cooler water (A).



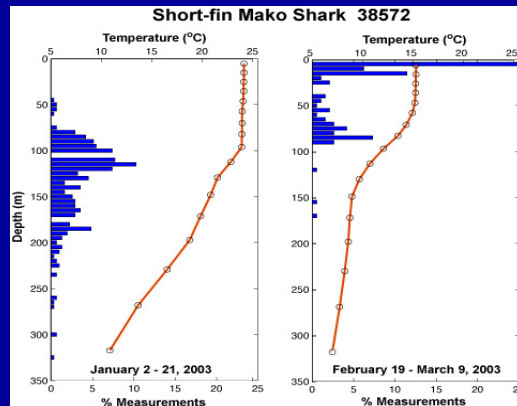
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A



B

### Vertical Distributions of SFM Shark and Temperature (SODA derived) in Tropical (left) and California Current Waters (right)



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