JIMAR – PFRP ANNUAL REPORT FOR FY 2006

P.I./Sponsor Name: Dr John R. Sibert (for Drs. Musyl, Larsen, Malte & Brill)

Project Proposal Title: Modeling the Eco-physiology of Pelagic Fishes and Sharks with Archival and Pop-up Satellite Archival Tags (PSATs) JIMAR Project #655600

Funding Agency: NOAA

NOAA Goal (Check those that apply):

x☐ To protect, restore, and manage the use of coastal and ocean resources through ecosystem-base management

☐ To understand climate variability and change to enhance society's ability to plan and respond

x☐ 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

1. Purpose of the Project (one paragraph)

We propose to use available data from archival and PSAT tags 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, VIMS/ 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 pop-up satellite archival tags (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/commonalties 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.

2. Progress during FY 2006 (One-two paragraphs, including a comparison of the actual accomplishments to the objectives established for the period, and the reasons for slippage if established objectives were not met):

At present, the database contains information from >660 tags across 18 pelagic taxa (including 3 marine turtle species). Preliminary results suggest tags have an overall reporting rate of ca. 78% but PSATs attached to certain species (e.g. swordfish, bigeye thresher shark) have lower reporting rates. Non-reporting tags is not synonymous with mortality. It is anticipated that eventually this study will examine information from over 1000 PSATs. In the future, these data will be publicly posted on the PFRP website.

Development of database (and associated tools) to examine/correlate movements patterns of PSAT tagged animals with various oceanographic parameters - on temporal and spatial scales (i.e. both horizontal and vertical) - is near completion. An abstract presented recently describes this work (Integrated Ocean Observation Systems (IOOS) for Managing Global and Regional Ecosystems.US/EU-Baltic International Symposium, May 23-25, Klaipeda, Lithuania; entitled, "IDENTIFICATION OF LARGE PELAGIC MARINE FISH HABITATS AND HABITAT UTILIZATION USING 'POP-UP' SATELLITE ARCHIVAL TAG AND OCEANIC SATELLITE REMOTE SENSING TECHNOLOGIES AND 'SODA' SIMPLE OCEAN DATA SIMULATION MODEL ANALYSES" was presented by R. Michael Laurs, David Foley, and Michael Musyl)

> "Large pelagic fishes (tuna, billfish, and sharks) are being tagged with 'pop-up' satellite archive electronic sensors (PSAT), which measure and log detailed data on the swimming environment of the fish, as well as light data, which are used to estimate the geographic locations of the fish. At predetermined periods the sensors are programmed to 'pop-off' the fish, float to the sea surface, and transmit the data collected to Argos satellites, which relay the data to ground stations on earth. Processing of these data provides detailed time-history information on the environment and estimated locations of individual free-swimming fish. The resulting information is then examined in conjunction with ocean measurements and data products derived from various satellite ocean sensors including sea surface temperature, ocean color, and ocean winds, as well as SODA ocean data assimilation model analyses. The fish habitats are thus defined in the context of surrounding ocean conditions, measured contemporaneously by oceanic satellite remote sensing and derived from outputs from the SODA ocean simulation model. An important aspect of this approach is that it provides the opportunity to identify, and subsequently monitor with satellite remote sensing, ocean features, processes, and properties that may play important roles in determining spatial and temporal variations in marine fish habitats. Data are presented that demonstrate this approach for blue shark, *Prionace glauca*."

3. Plans for the next fiscal year (one paragraph):

Complete baseline research papers (below) on horizontal and vertical movements of sharks, tunas, and billfish and performance of PSATs. This information will be used to develop the IBMs. Tentative PSAT papers currently coordinated by Musyl and slated to be drafted in 2006:

1). Post-release survivability and movements of blue shark (*Prionace glauca*) from longline fishing gear in the Central Pacific Ocean as Identified by Pop-up Satellite Archival Tags (PSATs) by Musyl, Brill, Laurs, Foley, Bigelow, & M^{c}Naughton

2). Long Term Survivability of Pacifc Blue Marlin (*Makaira mazara*) released from sportsfishing boats in Hawaii Determined from Pop-up Satellite Archival Tags (PSATs) by Musyl, Moyes, Brill, West, Bright, M^{c}Naughton

3). Movements and migration corridors of Pacific Blue Marlin (*Makaira mazara*) in relation to oceanographic conditions Determined from Pop-up Satellite Archival Tags (PSATs) by Bigelow, Musyl, Brill, Laurs, Foley & M^{c}Naughton

4). Temporal and Spatial Movement Patterns in Relation to Oceanographic Conditions for Epipelagic Sharks As Revealed by Pop-up Satellite Archival Tags (PSATs) in the Central Pacific Ocean: I. Oceanic White-tip shark (*Carcharhinus longimanus*) by Laurs, Foley, Nielsen, Bigelow, Musyl, Brill, M^{c}Naughton

5). Temporal and Spatial Movement Patterns in Relation to Oceanographic Conditions for Epipelagic Sharks As Revealed by Pop-up Satellite Archival Tags (PSATs) in the Central Pacific Ocean: II. Silky shark (*Carcharhinus falciformes*) by Laurs, Foley, Nielsen, Bigelow, Musyl, Brill, M^{c}Naughton

6). Behaviors and habitats of swordfish satellite tagged in the Atlantic and Pacific Oceans by Heidi Dewar, Eric Prince, Mike Musyl, Richard Brill, Jiangang, Joe Seraphy, Derk Snodgrass, Michael Laurs, Lianne McNaughton – draft complete

7). PSAT Performance and Meta Data Analysis Project by Musyl, Richard Brill, Michael Domeier, Molly Lutcavage, Lianne M^{c}Naughton, Yonat Swimmer, and Steve Wilson

4. List of papers published in refereed journals during FY 2006.

Brill, R.W. K.A. Bigelow, **M.K. Musyl**, K.A. Fritsches, and E.J. Warrant. 2005. Bigeye tuna behavior and physiology and their relevance to stock assessments and fishery biology. ***Col. Vol. Sci. Pap*. ICCAT 57(2):2005**

Hyde, J.R., E. Lynn, R. Humphreys Jr.,**M. Musyl**, A.P. West and R. Vetter. 2005. Shipboard identification of fish eggs and larvae by multiplex PCR, and description of fertilised eggs of blue marlin, shortbill spearfish and wahoo. ***Marine Ecology Progress Series, 286:269-277***

Nielsen, A., K.A. Bigelow, **M.K. Musyl** and J.R. Sibert. 2006. Improving light based geo-location by including sea surface temperature. ***Fisheries Oceanography 15:314-325.***

Bigelow, K.A., **M. K. Musyl**, F. Poisson and P. Kleiber. 2005**.** Pelagic Longline Gear Depth and Shoaling. ***Fisheries Research 77:173-183.***

Burgess, G.H., L. R. Beerkircher, G. M. Cailliet, J. K. Carlson, E. Cortés, K. J. Goldman, R. D. Grubbs, J. A. Musick, **M. K. Musyl** and C. A. Simpfendorfer. 2005. Is the collapse of shark populations n the Northwest Atlantic Ocean and Gulf of Mexico real? ***Fisheries (American Fisheries Society)30:19-26.***

Burgess, G.H., L. R. Beerkircher, G. M. Cailliet, J. K. Carlson, E. Cortés, K. J. Goldman, R. D. Grubbs, J. A. Musick, **M. K. Musyl** and C. A. Simpfendorfer. 2005. Reply to "Robust estimates of decline for pelagic shark populations in the Northwest Atlantic and Gulf of Mexico"***Fisheries (American Fisheries Society)30:30-31.***

Moyes, C.D., N. Fragoso, **M.K. Musyl**, R.W. Brill. 2006. Predicting post-release survival in large pelagic fish. ***Transactions American Fisheries Society (in press).***

5. Other papers, technical reports, meeting presentations, etc.

Advanced Techology Working Group (NOAA), Seattle, October 2005

1) Acoustic, archival, and pop-up satellite tags on large pelagic fishes -- a 30 year perspective. Richard Brill and Mike Musyl

2) PSAT PERFORMANCE EVALUATION AND META DATA ANALYSIS PROJECT. Michael Musyl, Geoff Arnold, Richard Brill, Michael Domeier, Nicole Lasby Lucas, Molly Lutcavage, Lianne McNaughton, Yonat Swimmer, and Steve Wilson

4th International Billfish Symposium, 31 October to 3 November 2005, Avalon, Santa Catalina Island, CA.

1) MOVEMENTS OF PACIFIC BLUE MARLIN RECORDED USING PSATs. Mike Musyl, Chris Moyes, John Sibert, Anders Nielsen, Andrew West, Lianne McNaughton, Keith Bigelow, Michael Laurs, and Richard Brill

2) BEHAVIORS AND HABITATS OF SWORDFISH SATELLITE TAGGED IN THE ATLANTIC AND PACIFIC OCEANS. Heidi Dewar, Eric Prince, Mike Musyl, Richard Brill, Jiangang, Joe Seraphy, Derk Snodgrass, Michael Laurs, Lianne McNaughton.

3) PSAT PERFORMANCE EVALUATION AND META DATA ANALYSIS PROJECT. Michael Musyl, Geoff Arnold, Richard Brill, Michael Domeier, Nicole Lasby Lucas, Molly Lutcavage, Lianne McNaughton, Yonat Swimmer, and Steve Wilson

Integrated Ocean Observation Systems (IOOS) for Managing Global and Regional Ecosystems. US/EU-Baltic International Symposium, May 23-25, Klaipeda, Lithuania

IDENTIFICATION OF LARGE PELAGIC MARINE FISH HABITATS AND HABITAT UTILIZATION USING 'POP-UP' SATELLITE ARCHIVAL TAG AND OCEANIC SATELLITE REMOTE SENSING TECHNOLOGIES AND 'SODA' SIMPLE OCEAN DATA SIMULATION MODEL ANALYSES. R. Michael Laurs, David Foley, and Michael Musyl

2005 Lake Arrowhead Tuna Conference

MOVEMENTS OF PACIFIC BLUE MARLIN RECORDED USING PSATs. Mike Musyl, Chris Moyes, John Sibert, Anders Nielsen, Andrew West, Lianne McNaughton, and Richard Brill

2006 American Fisheries Society Meeting, Anchorage, Alaska

Results from pop-up satellite archival tag (PSAT) attachments to Pacific billfish, tunas, and sharks – a cautionary tale. Richard Brill and Micheal Musyl

6. Graduates (Names of students graduating with MS or PhD degrees during FY 2006. Provide titles of their thesis or dissertation):

None

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

8. Publication Count (Total count of publications for the reporting period and previous periods 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		
	FY04	FY05	FY06	FY04	FY05	FY06	FY04	FY05	FY06
Peer-reviewed	0					2			5
Non-peer reviewed									

9. Students and Post-docs (Number of students and post-docs that were associated with NOAA funded research. Please indicate if they received any NOAA funding. For institutes that award subcontracts, please include information from your subgrantees):

At present, no students or post-docs are paid by the project. A $13,000 services contract was written to Dr. R. Michael Laurs to enable him to continue work on developing the oceanographic database with Dave Foley of PMEL. Laurs recently retired from NOAA, thus the impetus to contract him to provide continuous services/data specifically crafted for the project.

10. Personnel:
    (i) Number of employees by job title and terminal degree that received more than 50% support from NOAA, including visiting scientists (this information is not required from subgrantees):

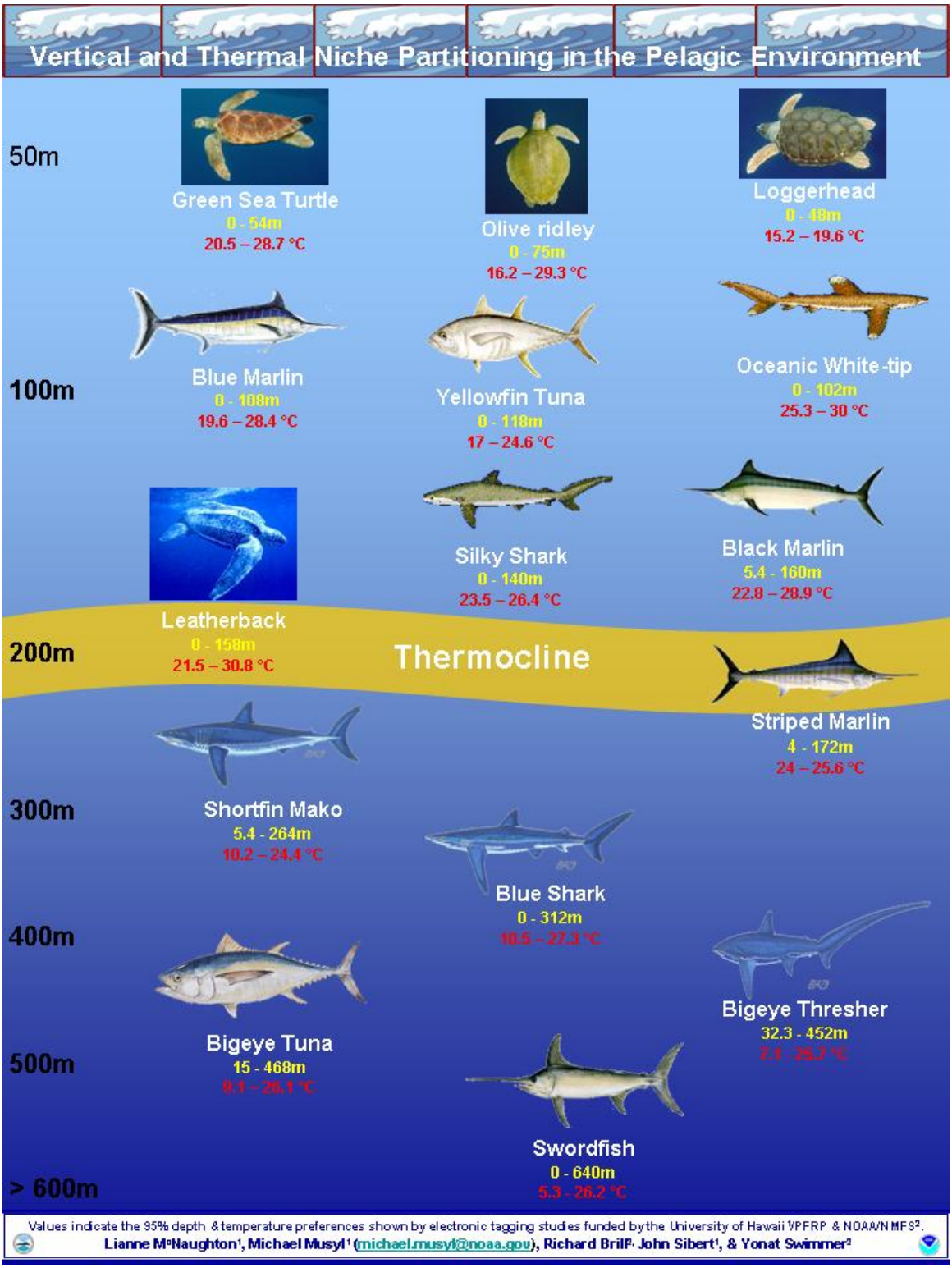
    Dr Michael K. Musyl, Senior Research Scientist
    Research Associate, to start in Sept. 2006

    (ii) Number of employees/students that received 100% of their funding from an OAR laboratory and/or are located within that laboratory.
    None

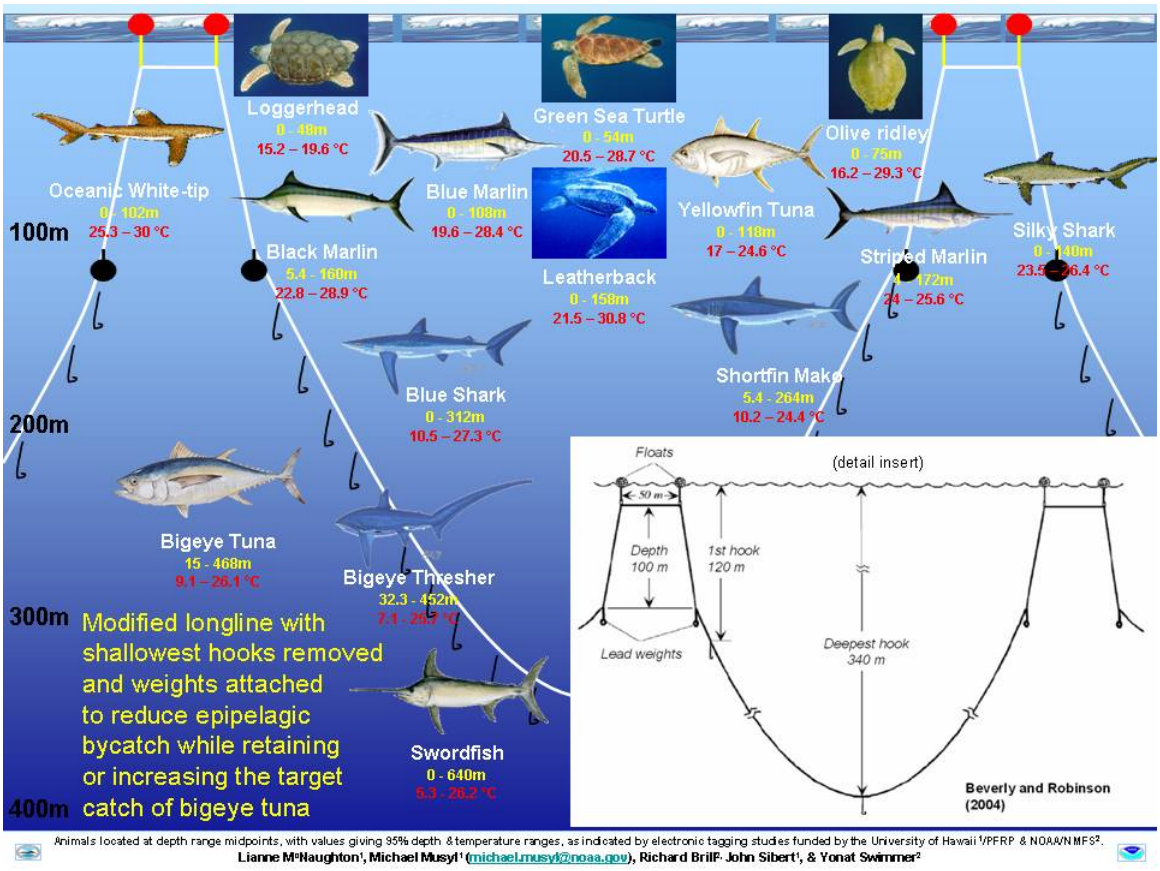
    (iii) Number of employees/students that were hired by NOAA during the past year:

    None

11. Images and Captions. (JIMAR will be including images in the annual report. Please send two of your best high-resolution, color images (photo, graphic, schematic) as a JPEG of TIFF with a caption for each image. Hardcopies of images can be dropped off at the JIMAR office if no electronic versions are available.
    (see next pages for images)



● Caption 1: Vertical Niche Partitioning in the Pelagic Environment



● Caption 2: Using Animal Behaviour to Reduce Bycatch