

JIMAR, PFRP ANNUAL PROGRESS REPORT FY 2001

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Project Proposal Title: Pop-off satellite archival tags to chronicle the survival and movements of blue sharks following release from longline gear

Funding Agency: NOAA/NMFS

1. Purpose of the project and indicative results.

Our proposal to use "fishery independent" pop-up satellite archival tags (PSATs) to study the horizontal and vertical movements, and distribution of blue shark is intended provide critical knowledge in three areas.

- i. Daily horizontal and vertical movement patterns, depth distribution, and effects of oceanographic conditions on the vulnerability of blue sharks to longline fishing gear.** The time blue shark spend at certain depth or temperature strata, can be used to better refine CPUE indices in the Pacific. For example, Hinton & Nakano (1996) used acoustic tagging data on blue marlin to adjust their CPUE estimates. The much larger amount of environmental data collected through time (and space) by PSATs used in our proposed research will have immediate application to CPUE estimates.
- ii. The survival rates of blue sharks captured and released from commercial longline fishing gear.** The morbidity of released fish will also be determined by examination of diel horizontal and vertical movement patterns (Carey and Scharold 1990) and correlated to biochemical assays performed on the tagged fishes (Linked to the Moyes et al. PFRP project to examine stressor proteins and other biochemical correlates of delayed post-hooking mortality). These results will have immediate impact in terms of management strategies for this species.
- iii. Stock identification, dispersal, and possible fishery interactions.** These, as well as critical pupping areas and possible genetic structuring in blue shark, will be elucidated by the examination of dispersal patterns (Hays, 1992; Avise, 1994; Lutcavage et al., 1999). In addition, knowledge of the movement patterns of cohorts tagged near the Hawaiian Islands will help elucidate the overall stock composition in the Pacific, and the relationship of fish caught here to those caught elsewhere. That is, are blue shark caught near Hawaii part of a larger ocean-wide population or could they be considered a separate group for management and conservation purposes?

2. Progress during FY 2001. Provide a thorough discussion of accomplishments and problems.

In FY 2001, funding for the project was awarded in September 2000 and project personnel immediately purchased PSAT tags, ancillary equipment, software and prepared the necessary applications to establish ARGOS accounts in order to receive downloaded data from the ARGOS system of satellites. Matching funds from NMFS were used to purchase a total of 14 PSAT tags for this study in year one. PSAT tether and redundant "fail-safe" pressure-release systems were evaluated, designed and assembled. Before deployment, test data transmitted by each of the PSATs were retrieved from ARGOS to ensure data integrity and quality.

During a March/April 2001 cruise of the NOAA RV *Townsend Cromwell*, project personnel PSAT tagged a total of 14 blue sharks (3 males, ca.120-204 cm FL, 11 females, ca. 120-180 cm FL) captured from longlines. The operational areas centered around 29E N, 161EW (7 sharks, 1 male) and near Kona, Hawaii (18EN, 158EW, 7 sharks, 2 males) where good catch rates have occurred in the past. In addition, since most of the six female sharks tagged up North showed evidence of "nuptial bites" (indicating mating), it was decided to swing operations South in the hope of intercepting additional male sharks (to even sex ratios) during their post-mating southernly migration. As identified with attached temperature-depth recorders (TDRs), five hook Hawaiian-style longline baskets (i.e. green chemical light sticks, circle hooks baited with squid) fished at depths < 80 m. Longlines were usually deployed after dusk and were retrieved at first light (i.e. about 8-12 hrs. soak time).

As of 10 June, 2001, PSATs deployed on blue shark are already providing dividends. Although much of the downloaded data needs to be transcribed and collated by the PSAT manufacturer, we have evidence that six PSATs attached to blue sharks (2 males) have transmitted data before their pre-programmed pop-off date. Another female shark tagged on 14 April at 19EN, 156EW was captured by a Japanese longliner on 25 May at 13EN, 159EW. At the time of tagging, possibly to try and void the hook, this shark had "thrown its stomach". In this case, communications with Japanese colleagues indicated that this shark was captured in good condition; possibly indicating that our tagging procedure was not a contributing factor to delayed mortality. Unfortunately, it was ascertained that the PSAT was housed inside the wheelhouse and therefore could not transmit its data. As such, we have expressly indicated that personnel aboard the longliner should place the PSAT outside where it is possible for transmission of data (PSATs conserve battery power by transmitting only when satellites are "in view" and we have strong evidence that tags can transmit for periods of over one month).

In brief, our PSAT system works just as we envisioned for showing mortality of tagged individuals. We have had at least one shark die, sink, and the tag automatically jettison, float to the surface and download its data. The tagged shark showed some apparently normal vertical behaviors for the first five days, then expired and sank. We have complete confidence in the conclusion that what we're seeing is a mortality. Because of the capture by longliners of a PSAT tagged shark, we are confident in our attachment procedure to rule out tag shedding over this time period. Most importantly, we also now have confidence that the

pressure-sensitive depth release mechanisms (which prevent crushing of the tag's float), downloading procedures, and analysis of ARGOS data all work. Our PSAT system incorporates redundant pressure-sensitive depth release mechanisms in case one of the release systems fail, but we can't tell which one worked in this instance.

Results like these, of course, were expected for some the deployments, but we don't view this mortality as a failure. One of the objectives of the study was to gain insights into the survivability of blue sharks released from longlines. To this end, we faced a Hobbesian choice. On the one hand we didn't want to tag moribund sharks that were obviously going to die, as that would provide no useful information. Nor did we want to tag only extremely vigorous animals as this would skew our conclusions as to rates of post-release mortality. This particular individual was one of the ones in the middle. Further, analysis of blood samples taken to look for biochemical correlates of post-released survivability will be conducted by Chris Moyes at Queens University (see Moyes et al. PFRP project). Lastly, although perhaps premature at this stage because data still needs to be transcribed and collated (by the manufacturer) for five (and possibly another) of the PSATs that have reported data before their pop-off date, preliminary data may ultimately indicate that five of these individuals perished due to stress brought on by hooking trauma. If this is the case, findings from this study will have serious implications for the management and conservation of this species.

3. Plans for the next fiscal year.

In the second year of the project (FY 2002), project personnel will continue to analyze transcribed and collated data provided by the PSAT manufacturer. It is anticipated that downloaded data from an additional seven PSAT tagged blue sharks in year one will be available in March/April 2002 (their scheduled pop-off dates) if these individuals survive long term. Given our preliminary results, however, it is possible that these PSATs could start data transmissions before their pop-off dates. In year two of the project, NMFS has committed funding and ship time for project personnel to PSAT tag another 14 blue sharks in April 2002 to evaluate, contrast and supplement the results obtained in year one. Other activities will consist of preparing draft manuscripts and disseminating preliminary findings to various venues such as those provided by scientific conferences and through the popular press.

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

None

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

Dec. 5, 2000 PRFP PI Meeting at the University of Hawaii, Honolulu:

A Pop-off satellite archival tags to chronicle the survival and movements of blue sharks following release from longline gear@ (seminar presentation given by Musyl available in PowerPoint at the PFRP website: <<http://www.soest.hawaii.edu/PFRP/>>).

Michael Musyl (with Chris Anderson). 2001. Blue Shark Study Nets Early Results. PFRP Newsletter. July-September, Vol. 6, No. 3.

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.