

JIMAR ANNUAL REPORT FOR FY 2000

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PROJECT PROPOSAL TITLE:

Investigation of Pacific Broadbill Swordfish Migration Patterns and Habitat Characteristics Using Electronic Archival Tag Technology

1. Purpose of this Project:

The overall objective of this project is to develop knowledge and understanding required to provide scientific advice to the WPRFMC for the eventual management of North Pacific broadbill swordfish and bigeye tuna. Specific objectives include: determine seasonal large-scale, regional, and local horizontal movement patterns needed for understanding fishery interactions; determine vertical distribution and diel vertical movement patterns needed for understanding catchability; obtain information on ocean thermal

characteristics of habitat for understanding environmental influences on swordfish and bigeye tuna distribution and availability; and incorporate findings in models for understanding migration, movements, and habitat. In other words, to understand harvest impacts and interactions among fisheries across the Pacific, information is needed on swordfish and bigeye tuna migration patterns and on how environmental factors influence distribution and catchability. Recent advances in electronic data storage technology have, however, made it possible to construct devices that allow the long term (months to years) recording of detailed records of vertical and horizontal movements of fishes. The so-called "archival tags" are carried by the fish and record ambient light levels, swimming depth and temperature (external and internal) and estimates of geographical position based on day length (latitude) and local noon (longitude). When the fish is recaptured, a detailed record of both the migrations and vertical movements can then be constructed. For species such as the marlins and swordfish, in which recapture rates are likely to be very low, the high cost of archival tags is a major deterrent to their use. Recognizing this, a new pop-up, satellite-transmitting archival tag (PSTAT) is under development that will come off the fish, float, and upload the data to satellites. Although significant progress in developing the pop-up tags have been made by the project, no fully functional PSTATs have yet been manufactured and in the interim the project has proceeded with conventional archival tag deployments in bigeye tuna.

2. Progress in FY 2000:

The project personnel continues to conduct joint research cruises with NMFS and JIMAR scientists aboard the NOAA vessel *Townsend Cromwell* specifically to deploy archival tags on bigeye tuna near the Hawaiian Islands. The operational area was centered on the western (leeward) coast of the Island of Hawaii. As of June 2000, 77 archival tags have been implanted into bigeye tuna and there have been 12 recaptures for a 15.6% return rate. Of larger tunas taken from longline sets, 34 fish were implanted with Northwest Marine Technologies (NMT) archival tags (mean FL=111.5 ±15.6 SD) into the dorsal musculature immediately adjacent to the first dorsal fin. Forty-three of the smaller fish captured near sea mounts and buoys (mean FL=65.2±8.3 SD) had Wildlife Computers (WLC) tags placed in the body cavity (i.e. intra-peritoneal). Different placement sites of the tags were chosen for different sized tunas because studies conducted at the NMFS Kewalo Research Facility (Brill et al. 1997) on yellowfin tuna and experiments on moribund bigeye tuna showed that the intramuscular technique was highly suitable. Moreover, experience on the cruise showed that intramuscular implantation could be accomplished more quickly, and with less risk of serious injury to bigger fish than with intra-peritoneal placement. Archived data were successfully downloaded from ten of the returned tags and much of this information culminated in several presentations (see publications). At present a summary report of this work is being prepared for submission into a referred journal. Further, researchers have used our archival data to better refine indices of abundance for bigeye tuna in the Pacific (Bigelow, K.A., J. Hampton, & N. Miyabe, "Application of a habitat-based model to estimate effective longline fishing effort and relative abundance of Pacific bigeye tuna (*Thunnus obesus*)", manuscript in prep.) and have developed movement models based on our estimates of geolocations (Sibert, J.R., unpublished results). Another aspect of the project examined the ability of submerged archival tags, fixed to a stationary mooring in the Pacific, to provide estimates of geolocation based on light-intensity (project personnel previously developed a novel approach to geolocate

bigeye tuna by examining “crepuscular” diving activity (Boggs et al. 1998, 1999)). In the mooring line study, different light-based geolocation algorithms were also evaluated. With the current generation of archival tags and light-based geolocation algorithms, “best-guess” location estimates can be within 1E of latitude and 0.25E of longitude. This work resulted in a multi-authored manuscript submission that is currently under review (Musyl et al. 2000).

3. Plans for FY 2000:

PSTATs purchased in FY 2000 will be deployed on mooring lines to further refine and improve light-based geolocation software and algorithms. Tentative mooring line locations include two sites in the southern hemisphere near Tasmania and one in the Central Pacific near Hawaii. In addition, we expect to deploy the first PSTATs on swordfish by the end of calendar year 2000. To discriminate among different movement and gene flow hypotheses erected for Pacific swordfish populations, we intend to tag fish in the Eastern and Central Pacific. We are confident that tagging can be accomplished using harpoon boats in California (as has been shown to work with Atlantic bluefin tuna), *Townsend Cromwell* cruises, or by “ride alongs” with commercial fishermen. Lastly, we intend to deploy our remaining 15 conventional archival tags into larger bigeye tuna on dedicated longline cruises of the *Townsend Cromwell* or by “ride alongs” with local commercial hand-line fishermen. Of the previous archival tags returned, most have been from smaller bigeye with short times-at-liberty (i.e. about one month) and we estimate that these fishes stayed near the location of tagging (e.g. Cross Seamount, Sea Buoy 3). To further resolve and refine problems with data interpretation - particularly dive patterns - additional archival returns of larger bigeye tuna are needed in order to gain insights into tuna behavior through different ontogenetical stages.

4. List of Papers Published in Referred Journals during FY 2000:

Musyl, M..K., R. W. Brill, D. S. Curran, J. S. Gunn, J. R. Hartog, R. D. Hill, D. W. Welch, J. P. Eveson, C. H. Boggs, and R. E. Brainard. 2000. Ability of archival tags to provide estimates of geographical position based on light intensity. *Reviews in Fish Biology (In Review)*

5. Other Papers, Technical Reports, etc.

Brill, R, K. Cousins, and P. Kleiber. 1997. Test of the feasibility and effects of long-term intramuscular implantation of archival tags in pelagic fishes using scale model tags and captive juvenile yellowfin tuna (*Thunnus albacares*). Honolulu Laboratory, SWFSC, NMFS/NOAA, Administrative Report H-97-11, 12pp.

Weihs, D. and D. Levin. 1997. A pop-up archival tag for long term monitoring of large pelagic fish.

Page 75 in: Forum on Wildlife Telemetry, Innovations, evaluations and research needs, 21-23 September 1997, Snowmass Village, Colorado

Boggs, C., M. Musyl and R. Brill. 1998. Results from archival tagged bigeye tuna. *Hawaii Fishing News*, 8, 5.

Boggs, C., M. Musyl, D. Curran and R. Brill. 1999. Geolocation by crepuscular diving behavior and lunar influences on depth distribution in a bigeye tuna carrying and archival tag. *Proceedings of the 50th Annual Tuna Conference*, Lake Arrowhead, Calif., May 24-27.

Brill, R., C. Boggs, and M. Musyl. 2000. Horizontal and vertical movements of bigeye tuna (*Thunnus obesus*) carrying archival tags. *Proceedings of the Symposium of Tagging and Tracking Marine Fish with Electronic Devices*, Univ. Hawaii, East-West Center, Honolulu, HI, February 7-11, 2000.

Musyl, M.K., R.W. Brill, C.H. Boggs, and R.E. Brainard. 2000. Ability of archival tags, submerged at varying depths on a stationary mooring line in the Pacific Ocean, to provide estimates of geographical position based on light intensity: How good are they? *Proceedings of the Symposium of Tagging and Tracking Marine Fish with Electronic Devices*, Univ. Hawaii, East-West Center, Honolulu, HI, February 7-11, 2000.

Brill, R., C. Boggs, T. Kazama, M. Musyl, and D. Curran. 2000. Horizontal and vertical movements of bigeye tuna (*Thunnus obesus*) carrying archival tags. *Proceedings of the 51st Annual Tuna Conference*. Lake Arrowhead, Calif., May 22-26.

6. Students graduating: None