

JIMAR ANNUAL REPORT FOR FY 1999

P. I. NAME: Richard W. Brill

PROJECT PROPOSAL TITLE: Laboratory and field research to enhance understanding of tuna movements and distribution, and to improve stock assessment models.

FUNDING AGENCY: NOAA , through the Pelagic Fisheries Research Program

1. Purpose of Project:

Population assessments based on catch-per-unit-effort (CPUE) data often assume "catchability" of a target species is constant; a tenuous assumption for tunas and billfishes which are both highly mobile and highly aggregated. Accurate population assessments, therefore, depend on the ability to differentiate changes in abundance due to over-fishing, from changes in specific gear vulnerability due to changes in oceanographic conditions. Before comprehensive models describing the movements and stock dynamics of tuna can be developed, and CPUE data translated into accurate population assessments, it is first necessary to understand how the vertical movements and depth distributions of tunas (i.e., their specific gear vulnerability) are effected by oceanographic conditions. It is the overall objective of this project to use laboratory and field studies (using ultrasonic telemetry and new archival data recording tags) to establish direct links between environmental conditions, fish movements, distribution, and gear vulnerability and thus provide a means of improving current tuna stock assessment models.

2. Progress during FY 1998:

The 4-year Pelagic Fisheries Research Program funded project has resulted in significant advancements in our understanding of factors limiting the vertical distribution of skipjack, yellowfin, and bigeye tunas; including the previously unsuspected influence of temperature on heart function and the resulting limiting effect on depth distribution. These studies are already adding significantly to models capable of correcting population assessments for differences in gear vulnerability (e.g., current IATTC and SPC population assessment models for blue marlin, and bigeye and yellowfin tuna). Moreover, this work will directly compliment proposed ultrasonic tracking, archival tag, and JIMAR funded fisheries oceanography studies of bigeye tuna (Polovina, Seki and Brainard).

Moreover, the project has also developed significant linkages to several separate, but related, NOAA-funded projects. The project begun 2 years ago to determine the short term movements of giant Atlantic bluefin tuna (*Thunnus thynnus*) using acoustic telemetry was expanded in FY 1998 to include a similar study of juvenile bluefin tuna off Virginia. The data from both projects are intended to provide a means of correcting aerial survey data (i.e., fishery independent resource assessments) for the fish's depth distribution and residence times under specific oceanographic conditions. A related project (a joint effort with Dr. Molly Lutcavage, Edgerton

Research Laboratory, New England Aquarium) using pop-off satellite tags to determine residence time of giant Atlantic bluefin tuna in New England waters, their long term migratory patterns, possible spawning areas, and potential mixing of eastern and western Atlantic "stocks" has continued successfully. Tags deployed in 1997 successfully jettisoned from the fish and reported their positions. An additional 23 tags were deployed in 1998 and have begun releasing and reporting their data as scheduled. A publication has been prepared (listed below) suggesting the existence of a previously unsuspected spawning area in the mid-Atlantic.

Locally, in a joint project of the NMFS Honolulu Laboratory and JIMAR's Pelagic Fisheries Research Program, an additional 26 archival tags have been deployed on bigeye tuna (*Thunnus obesus*) near the main Hawaiian Islands. More important, one of the fish equipped with a tag was recaptured after approximately 3 months at liberty yielding new insights into residence times around the main Hawaiian Islands and the remarkable depth distribution (down to ≈ 500 m) of this species. The data are currently being prepared for publication.

3. Plans for next Fiscal Year:

Efforts during the next fiscal year will concentrate on completing and submitting for publication the manuscript s listed below.

Jones, D.R., R.W. Brill, K.L. Cousins, P.B. Bushnell, J.F. Steffensen, and J.K. Keen. Capillary permeability and Starling forces in three teleosts: yellowfin tuna (*Thunnus albacares*), rainbow trout (*Onchorynchus mykiss*) and cod (*Gadus morhua*). Manuscript in preparation for Am. J. Physiol.

Swimmer, Y.B. and R.W. Brill. Intestinal $\text{Na}^+\text{-K}^+$ ATPase and $\text{Na}^+\text{-H}^+$ ATPase activity, and osmoregulatory costs in a high-energy-demand teleost, the yellowfin tuna (*Thunnus albacares*). Manuscript in preparation for Marine Biology.

Brill, R., K. Cousins, C. Taxboel, and T. Lowe. $\text{Na}^+\text{-K}^+$ ATPase activity and chloride cell density in the gills of three high energy demand marine teleosts, yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*) and dolphin (*Coryphaena hippurus*) Manuscript in preparation for Marine Biology.

Brill, R., M. Lutcavage, G. Metzger, P. Bushnell, M. Arndt, J. Lucy, and C. Watson. Horizontal and vertical movements of juvenile Atlantic bluefin tuna (*Thunnus thynnus*) determined using ultrasonic telemetry, with reference to population assessment using aerial surveys. Manuscript in preparation for Fish. Bull., U.S.

Lutcavage, M.E., R.W. Brill, J.L. Goldstein, G.B. Skomal, B.C. Chase, and J. Tutein, Movements and behavior of adult northern bluefin tuna (*Thunnus thynnus*) in the northwest Atlantic determined using ultrasonic telemetry. Manuscript in preparation for Mar. Biol..

Brill, R. W. and P. G. Bushnell. Cardiovascular System of Tunas. Manuscript in preparation for a chapter in Fish Physiology, Vol. 14; B. A. Block and E. D. Stevens (editors), Academic Press.

4. List of Papers published in Refereed Journals during FY 1997

Lowe, T., R. Brill, and K. Cousins. Responses to catecholamines of red blood cells from two high-energy-demand teleosts, yellowfin tuna (*Thunnus albacares*) and skipjack tuna (*Katsuwonus pelamis*). J. Comp. Physiol B 168: 405-418.

Brill, R., B. Block, C. Boggs, K. Bigelow, E. Freund, and D. Marcinek. Horizontal and vertical movements of adult yellowfin tuna (*Thunnus albacares*) near the Hawaiian Islands observed by acoustic telemetry. Marine Biology 133: 395-408.

Lutcavage, M.E., R.W. Brill, G.B. Skomal, B.C. Chase, and P.W. Howey. Results of pop up satellite tagging of spawning size class fish in the Gulf of Maine: Do North Atlantic bluefin tuna spawn in the mid-Atlantic? Can. J. Fish. Aquat. Sci. 56: 173-177.

Lowe, T., R. Brill, and K. Cousins. Unusually high blood oxygen affinity from a high-energy-demand teleost, bigeye tuna, *Thunnus obesus*. Mar. Biol.. (Submitted)

5. Other Papers, Technical reports, etc.

Brill, R. W. Fast fish physiology, Lessons learned when tunas tell their tales. Invited plenary lecture, International Congress on the Biology of Fish, Baltimore, Maryland, July 1998.

Braun, M.H., R.W. Brill, J.M. Gosline, and D.R. Jones. 1998. Functional morphology of the bulbous arteriosus. Fish Cardiovascular Function: Control mechanisms and environmental influences. International Congress on the Biology of Fish. pp. 13-16.

Brill, R. W., and Lutcavage, M. L. 1999. Horizontal and vertical movements of juvenile atlantic bluefin tuna (*thunnus thynnus*) determined using ultrasonic telemetry, with reference to population assessment by aerial surveys. Proceedings of the 50th Annual Tuna Conference.

Boggs, C. H., M. K. Musyl, D. S. Curran, and R.W. Brill. 1999. Geolocation by crepuscular diving behavior and lunar influences on depth distribution in a bigeye tuna (*Thunnus albacares*) carrying an archival tag. Proceedings of the 50th Annual Tuna Conference.

Lutcavage, M., R. Brill, G. Skomal, B. Chase, Paul Howey, and J. Porter. 1999. Tracking giant bluefin tuna: Integration of meso and macroscale tagging technologies. Proceedings of the 50th Annual Tuna Conference.

Lutcavage, M., R. Brill, G. Skomal, B. Chase, Paul Howey, and J. Porter. 1999. Tracking giant bluefin tuna: Integration of meso and macroscale tagging technologies. Proceedings of the Third Conference on Fish Telemetry in Europe.

6. Names of Students Graduating wit MS or Ph.D. Degrees During FY 1996; Titles of their Thesis or Dissertation.

None .