

JIMAR ANNUAL REPORT FOR FY 2012

P.I. NAME: Simon Nicol, Dan Margulies, Vern Scholey

NOAA OFFICE (*Of the primary technical contact*):

NOAA SPONSOR (NOAA TECHNICAL LEAD) NAME :

PROJECT PROPOSAL TITLE: Ocean Acidification Impacts on Tropical Tuna Populations

FUNDING AGENCY:

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.
- ☐ Mission Support

PURPOSE OF THE PROJECT (*One paragraph*): *Include at least one objective.*

The unaccounted impacts of ocean acidification (and warming) upon tuna stocks in the Pacific (and globally) represent a serious risk to the achievement of sustainability based management objectives for both Regional Fisheries Management Organisations and for the policies of sovereign states responsible for tuna fisheries management in the Pacific region. Research has demonstrated that the early life history stages of some fish species (and numerous other marine organisms) are sensitive to ocean acidification levels that are projected to occur by the end of this century. Those findings have significant implications for future recruitment success and population levels for those species. This project aims to elucidate the impacts of projected ocean acidification levels upon processes and life history stages of yellowfin tuna (*Thunnus albacores*) that are considered critical to recruitment success: sperm motility, embryonic development, hatching rates, condition, development, growth and survival in pre- and post-feeding larvae. The outputs from this project will reduce uncertainty regarding future stock trends as provided to tuna Regional Fisheries Management Organisations in the Pacific, increasing the likelihood that these organisations can make decisions that ultimately achieve sustainability based management objectives

PROGRESS DURING FY 2012 (*One-two paragraphs*):

Include a comparison of the actual accomplishments to the objectives established for the period, along with reasons for the slippage if established objectives were not met.

Trials were grouped into sperm and fertilization trials and egg and larval trials. The project originally proposed 2 years of experimental trials with the first year undertaking pilot studies in preparation for experimentation in the second year. The second year of the project was cancelled due to cessation of PFRP funding.

Experimental trials in year 1 were conducted at the IATTC's Achotines Laboratory, Panama, in October and November of 2011. Results are as follows:

Sperm activity and fertilization trials

The genetic component of this research assessed two areas: 1) which parents within the Achotines Laboratory broodstock population contributed to offspring in the next generation for each ocean acidification experiment and 2) whether offspring survival is associated with their genetic composition or level of genetic variation when exposed to different pCO₂ levels. Parentage analyses have been undertaken using molecular marker-based pedigrees. Standard methods were used for DNA extraction and amplification of highly polymorphic microsatellite loci from yellowfin tuna. Fifteen replicate individuals per pCO₂ scenario per experiment were extracted. Parentage were analyzed using the genetics software package COLONY and F-statistics, allelic diversity, and the numbers of effective and private alleles are currently being used to estimate the overall genetic diversity and inbreeding coefficients of the sample population using the software FSTAT. There appears to be substantial variation in allelic richness and frequency amongst individuals regardless of pH treatment. The relative contribution of some individuals decreased with increasing acidity whereas others had no clear pattern or increased in contribution. The 15 replicates were insufficient to detect all fluctuations in allelic richness / allele frequency. A power analysis has been completed and the number of individuals is currently being increased from 15 to 50 to guarantee with 95% confidence that contribution from all parents is included.

The Sperm Motility component of this work was undertaken to examine fertilization success under different pCO₂ levels. Despite many attempts, obtaining fresh sperm from male yellowfin tuna proved impossible and sperm from black skipjack tuna was used as a surrogate. Preliminary results showed that black skipjack sperm were relatively robust to ocean acidification: pH decreases from 8.1 (control) to 7.3 or 6.8 units had no significant effect on sperm swimming speeds. However the percentage of motile sperm at pH 6.8 was only 20.7% of that in control (pH 8.1) treatments. There was no significant effect of pH 7.3 on sperm motility. These results suggest that near-future ocean acidification (to \approx 7.7 pH units) is unlikely to influence the fertilization success of black skipjack tuna. Whether these results are representative of yellowfin tuna remains to be determined, however the extreme pH changes needed here to effect a response lead us to be cautiously optimistic that ocean acidification is unlikely to affect yellowfin tuna fertilization success in the coming century

Egg and larval trials

Analyses are ongoing to describe the condition of selected target tissues of larvae based on histological analysis. Based on prior research results with cod and herring larvae

exposed to lowered pH, it is anticipated that the most important larval tissues for histological examination of possible reduced-pH effects will include the liver, kidney, and pancreas.

The morphological development component of this work has examined deformity in relation to each pCO₂ scenario. Techniques were developed to extract small otoliths from first-feeding larvae that were sampled during both experiments. Morphometric analyses (size, shape) of the otoliths by high magnification light microscopy will be conducted in early 2013 to assess the potential impact of pCO₂ on otolith formation. Analyzes are ongoing to summarize morphometric parameters of eggs, yolk-sac larvae and feeding larvae exposed to variable pH in our experiments. Key morphometric measurements that are being summarized and compared among pCO₂ treatments include egg diameter, oil globule volume, hatching length, yolk-sac volume, body depth of yolk-sac larvae, length at first-feeding, length at final sampling, and selected body depth parameters of feeding larvae. This work is expected to be completed in early 2013.

Estimates of larval growth (length, dry weight, body dimensions) and survival were derived from the experiments conducted. The data have been formatted and preliminary GLM based statistical analyses of survival data completed and reviewed by the project group. A revision of those analyses is currently in progress to take into account issues identified during the group review. Growth and survival analyzes are expected to have been finalized by mid November 2012.

PLANS FOR THE NEXT FISCAL YEAR (*One paragraph*):

All preliminary analyses are expected to be available in November 2012 for presentation at the Annual PFRP Principal Investigators meeting. The completion of analyses and submission of journal publications expected to be completed by December 2013.

**LIST OF PAPERS PUBLISHED IN REFERRED JOURNALS DURING FY 2012
OTHER PAPERS, TECHNICAL REPORTS, ETC.
PUBLICATION COUNT**

**complete excel attachment (JIMAR publications request)*

**V. Scholey, D. Bromhead, D. Margulies, S. Nicol, J. Wexler, M. Santiago, J.E. Williamson, S. Hoyle, P. Schlegel, J. Havenhand, T. Ilyina, and P. Lehodey
(2012) Novel Research Into the Impacts of Ocean Acidification Upon Tropical Tuna. PFRP Newsletter 16(1)**

GRADUATES:

Names of students graduating with MS or PhD degrees during FY 2012; Titles of their Thesis or Dissertation

AWARDS:

Name of JIMAR employees or project receiving award during the period, and Name of award

PERSONNEL *(on Subcontracts):*

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

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: Multiple experimental tanks with nested egg incubators. Photo Donald Bromhead



Caption 2: Vertebral deformation observed at pH 7.3 and 7.7. Photo Jeanne Wexler

ACRONYMS:

Please provide the complete descriptions for any acronyms used in any areas of the report. For example: UH (University of Hawaii)