JIMAR ANNUAL REPORT FOR FY 2010

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NOAA OFFICE (Of the primary technical contact): NMFS/PIFSC

PROJECT PROPOSAL TITLE: Climate and Fishing Impacts on the Spatial Population Dynamics of Tunas

FUNDING AGENCY: NOAA

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

PURPOSE OF THE PROJECT:

A high priority for effective management of large pelagic fishes is the capability to discriminate between the effects of exploitation and climate dynamics on the sustainability of tuna populations. Climate related changes are believed to strongly influence the pelagic habitats of tuna, and thus movement and migration patterns. But not all tuna respond the same way to climate cycles, thus there should be demonstrable differences in survivorship during recruitment and responses to exploitation patterns. Empirical and analytical evidence are needed to explain the relative importance of environmental and fishing variability in structuring pelagic ecosystems. There is a need to determine the mechanisms involved in observed variability across species and oceanic regions. In this proposal, two spatial bio-physical models are proposed to be run for several tuna species concurrently with different long-term (up to 50 years) climate regime datasets. It is anticipated that the models will enable researchers to evaluate potential alternative system states due to physical and anthropogenic forcing and to help determine if the impacts of natural climate variability could be anticipated in such a way as to help establish a management regime that accommodates exploitation pressures and natural variability to build sustainable tuna fisheries.

PROGRESS DURING FY 2010:

The project has been extended until mid-2010. For the financial year 2010 (Jul-2009-Jul 2010), planned activities are listed below. A final report of the project is provided separately.

The planned activities for year 3 of the project were:

1. *Prepare the new CCSM physical-biogeochemical reanalysis to drive SEAPODYM and APECOSM.*

2. *Complete the fishing database SARDARA (public domain) and release the application on a production server available through the web after a testing phase in collaboration with RFMOs.*
3. *Complete optimization experiments with SEAPODYM for skipjack, yellowfin and bigeye with the 3 reanalyses NCEP, ERA40 and CCSM in the Pacific.*
4. *Use the optimal parameterizations obtained in the Pacific for global simulations and evaluate the results in Atlantic and Indian Oceans with catch data from the SARDARA database.*
5. *Complete optimization experiments with APECOSM for skipjack and start it for yellowfin using the ERA40 reanalysis in the Indian Ocean.*
6. *Use the optimal parameterizations obtained in the Indian Ocean for skipjack for global simulations and evaluate the results in Atlantic and Pacific Oceans with catch data from the SARDARA database.*
7. *Final report and publication(s)*
8. *Participation to PFRP PI meeting and presentation of results to various conferences and meetings.*

1. The CCSM physical-biogeochemical reanalysis has a variable horizontal and vertical resolution requiring interpolation on a regular grid. Then we had to compute euphotic depth that was not included in the dataset. To get this variable it is first needed to obtain the PAR(0) (Photosynthetically Active Radiation at surface). We tried to reconstruct this variable from the equation provided in Moore et al. (2002) using the PAR at mixed layer depth that was provided with the reanalysis. However the result was not good, due to the discretization by vertical levels in the model. After discussion with NCAR, it appeared that PAR(0) can be deduced from a variable (qsw) that was missing in the records. This variable was finally provided by NCAR and we have reprocessed the dataset. The range of variability of the euphotic depth from this reanalysis appears very small compared to other datasets. Unfortunately this reanalysis was not ready in time for the optimization experiments. However, it will be used in further optimization experiments to finalize coming publications.

2. One of the goals of the project was the setting up of a global database including fishery data (catches, fishing efforts and size-frequencies) for the tropical tunas in the three oceans over their whole historical period with an appropriate resolution and fleet stratification. Thanks to the important involvement of IRD staff and to the availability of complementary funds, the work has gone far beyond the initial objectives since the database has been completed and extended to include a total of 14 exploited species including tropical tunas in the three oceans. It has furthermore been linked to the CLIOTOP MDST (Model and Data Sharing Tool) which provides a user friendly web base interface to access, visualize and extract the data. The website has been temporarily deployed on a server at http://vmmdst-dev.mpl.ird.fr:8080/MDST/ for debugging and beta testing. However, while detailed fishing datasets of catch effort and size frequencies of catch are publicly available in IOTC and ICCAT, we did not get an official agreement to release similar public domain data sets for Pacific Ocean despite a formal request sent to the directors of both tuna commissions for the Pacific Ocean (IATTC: Guillermo Campéon and WCPFC: Andrew Wright). Those data will remain, until further notice, in restricted access, submitted to the agreement of IATTC and WCPFC.

3. Optimization experiments have been conducted with SEAPODYM for skipjack, yellowfin and bigeye with 3 reanalyses: ESSIC, NCEP, ERA40 in the Pacific. As explained above we were not able to use the CCSM reanalysis. But additional simulations were conducted using a climate model simulation (IPSL) to investigate the impact of climate change under the IPCC A2 scenario (see final report and publications).

4. The optimal parameterization obtained in the Pacific for skipjack has been used to run a simulation in the Indian Ocean (Figure). Results are very encouraging since without any change in the parameterization except for the fishing parameters (selectivity and catchability) the simulation provided very good fit to the fishing data (catch and effort and size frequency) and was able to predict the changes associated to the ENSO event of 1997-98 (see final report).

5. Optimization experiments were run using APECOSM-E, a simplified version of APECOSM devoted to parameter estimation, for skipjack in the Indian Ocean using the ERA40 reanalysis. These optimization experiments have been undertaken over various time periods ranging from 2 to 18 years (1984-2001) for testing the sensitivity of the optimization procedure (see final report).

6. The optimization work with APECOSM has been delayed due to the unexpected departure (still not replaced) of Blaise Faugeras (the engineer in charge of running APECOSM-E) from IRD in Auhust 2007 and the difficulty of recruiting a qualified postdoc (cf. previous reports). Finally Dr Sybille Dueri was recruited in IRD on February 1st, 2009, for 12 month, to conduct the optimization experiments. While first encouraging results were obtained for skipjack in the Indian Ocean, it was not possible to test the approach in the Pacific Ocean as initially proposed. Applying APECOSM in the Pacific Ocean would furthermore require that the same fishing data available for running SEAPODYM in the Pacific Ocean be made available for running APECOSM. The complete longline fishing dataset cannot be obtained from WCPCF outside of agreed tasks listed by WCPCF. This was the case for SEAPODYM due to historical links with SPC and WCPFC, but not for APECOSM.

7. A final report is provided separately. Several publications have been published during the project with acknowledgments to the JIMAR-PFRP (cf. below).

8. P. Lehodey attended the PFRP-PI meeting in Nov. 2009 and the Scientific Committee meeting of the Western Central Pacific Fisheries Commission. PL was also invited to provide a presentation at the Ecosystem meeting of the International Whaling Commission (Morocco, June 2010).

PLANS FOR THE NEXT FISCAL YEAR:
The project was closed on June 30, 2010.

LIST OF PAPERS PUBLISHED IN REFERRED JOURNALS DURING FY 2010

Lehodey, P., Murtugudde, R., Senina, I. (2010). Bridging the gap from ocean models to population dynamics of large marine predators: a model of mid-trophic functional groups. *Progress in Oceanography*, 84: 69–84.

Lehodey, P., Senina, I., Sibert, J., Bopp, L, Calmettes, B., Hampton, J., Murtugudde, R. (2010). Preliminary forecasts of population trends for Pacific bigeye tuna under the A2 IPCC scenario. *Progress in Oceanography*, 86: 302–315.

Maury, O. (2010). An overview of APECOSM, a spatialized mass balanced "Apex Predators ECOSystem Model" to study physiologically structured tuna population dynamics in their ecosystem. *Progress in Oceanography*, 84: 113-117.

OTHER PAPERS, TECHNICAL REPORTS, ETC.:

Lehodey, P., Senina, I., (2009). A user manual for SEAPODYM version 2.0: application with data assimilation. Fifth regular session of the Scientific Committee of the Western and Central Pacific

Fisheries Commission, 10–21 August 2009, Port Vila, Vanuatu, WCPFC-SC5-2009/ EB-IP-13, 82 pp.

GRADUATES (Names of students graduating with MS or PhD degrees during FY 2010; Titles of their Thesis or Dissertation):

AWARDS (List awards given to JIMAR employees or to the project itself during the period):

PUBLICATION COUNT (Total count of publications for the reporting period and categorized by NOAA lead author and Institute (or subgrantee) lead author and whether it was peer-reviewed or non peer-reviewed (not including presentations):

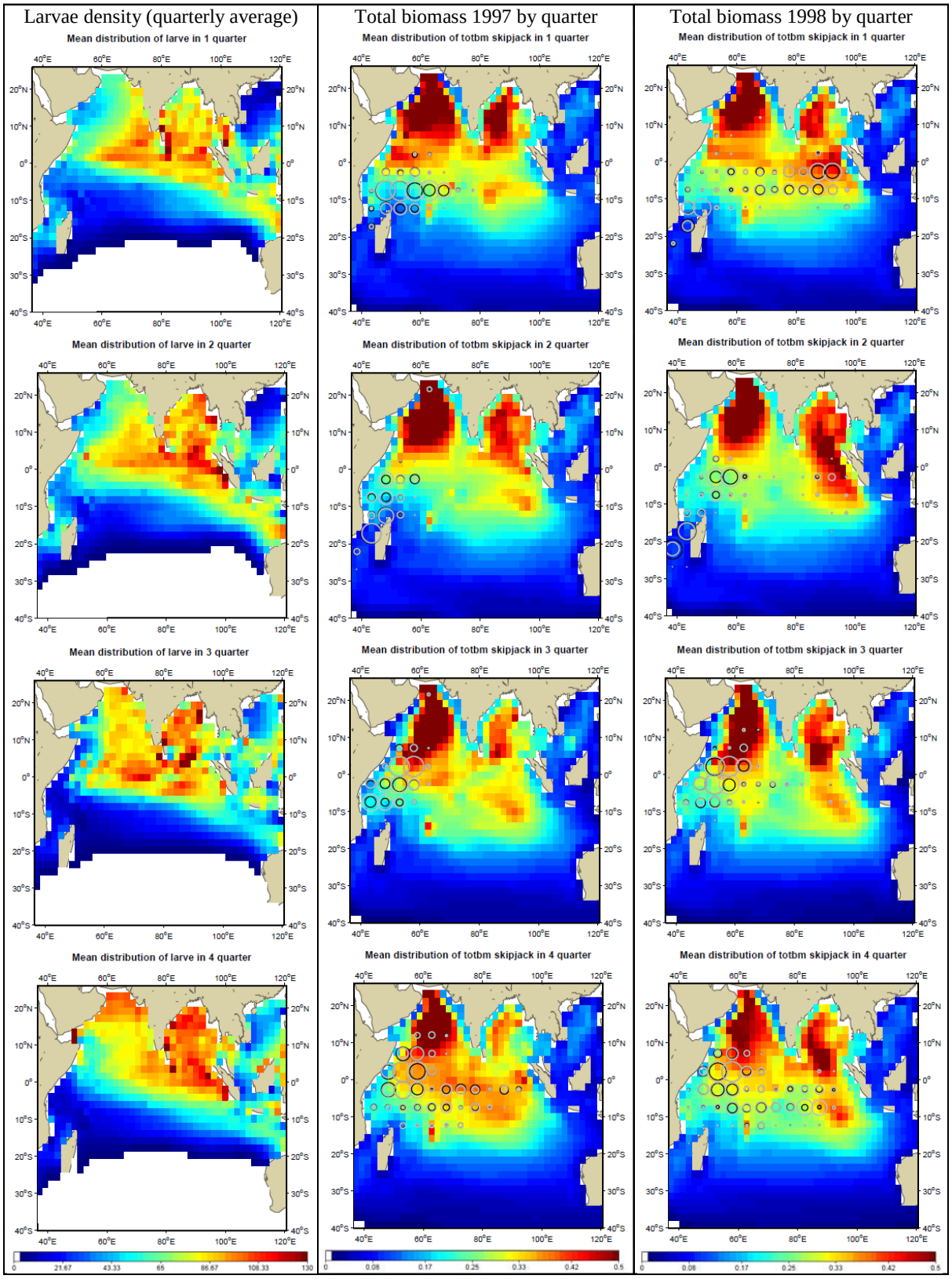
	JI Lead Author	NOAA Lead Author	Other Lead Author
Peer Reviewed			3
Non-Peer Reviewed			3

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

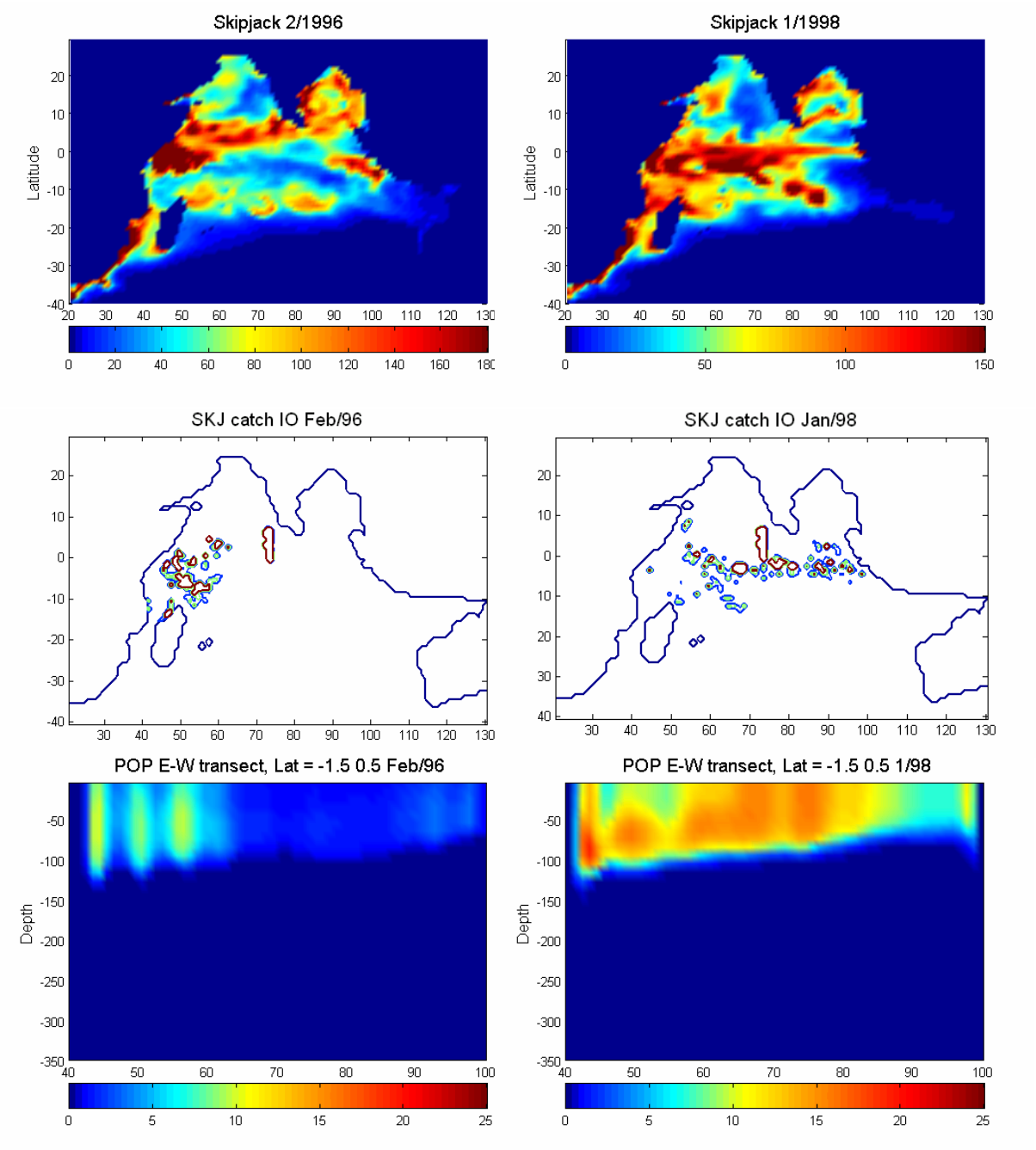
During the period covered by this report (July 1st, 2009 to June 30, 2010) the personnel hired for the project was:

- Julien Trolet, database engineer, with IRD (24 months contract funded under this PFRP grant, recruited Sep. 2007)
- Dr Sybille Dueri, research engineer working on APECOSM parameter calibration with IRD (12 months contract funded by this PFRP grant, recruited Feb. 2009)

IMAGES AND CAPTIONS



SEAPODYM application to skipjack in the Indian Ocean (with Pacific O. parameterization). Circles are proportional to catch (black circles are predicted catch, grey circles are observed catch).



APECOSM-E application to skipjack in the Indian Ocean. Distribution of vertically-integrated simulated biomass (1st line) , observed catches (2nd line) and simulated vertical distribution of biomass on an equatorial East-West transect at 0°N (3rd line): non-ENSO year (February 1996, left) vs ENSO year (January 1998, right). The simulation presented has been optimized over the 1984-1989 period. It however matches quite well the distribution of catches in other years such as 1996 or the anomalous 1998. This provides a validation of the model over data which have not been used for its optimization.