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Climate Impacts on Oceanic Top Predators (CLIOTOP) Working Groups Focus on Climate, Ecosystem Dynamics Study

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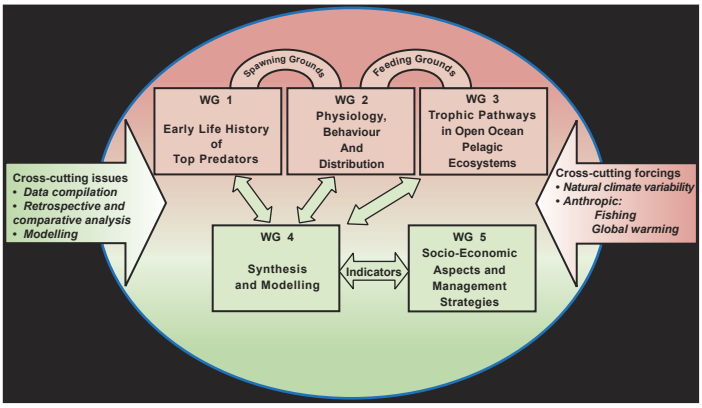
Open ocean ecosystems support catches of approximately 6 to 7 million tons per year of large pelagics, mostly tunas, billfishes and sharks. There is an increasing concern about potential top-down cascading effects that removal of large pelagic predators may have on the overall ecosystem.

Pelagic fisheries also interact with other oceanic top predators like marine mammals, turtles and seabirds. At the same time, environmental variability determines phytoplankton abundance and distribution and then leads to important bottom-up effects on forage species and then on top predator abundance and distribution. Climate variability appears to impact tuna stocks and pelagic ecosystems at seasonal, inter-annual, or decadal time scales.

In consequence, it is expected that long-term global changes modulate this variability and have unexpected effects on ecosystem dynamics. Studying the bottom-up and top-down effects in the context of climate variability is the challenging objective of the recently implemented GLOBEC (Global Ocean Ecosystem Dynamics) CLIOTOP (Climate Impacts on Oceanic Top Predators) program.

Addressing open ocean ecosystem dynamics and the influence of climate on the dynamics of top predator populations, the work of CLIOTOP is conducted by five different working groups. The Pelagic Fisheries Research Program (PFRP) of the University of Hawai'i hosted the first meetings of the working groups 2 (Physiology, behavior and distribution), 4 (Synthesis and modeling) and 5 (Socio-economic aspects and management strategies) of CLIOTOP, back to back with its annual Principal Investigators workshop. Working groups 1 (Top predators larval ecology and biology) and 3 (Trophic pathways in the open ocean pelagic ecosystem) met earlier in the year.

The PI workshop provided an ideal introduction to the CLIOTOP meeting as it covered many of the issues that have to be discussed during the CLIOTOP working groups. Forty-two participants attended the CLIOTOP workshops, which started with a general plenary session to present the current developments of the project and to define the first tasks list to be considered by each working group. Then, the three working groups met separately to refine their work plans, time lines and milestones and to list the relevant existing projects and future studies that should be organized and promoted. These studies should mainly be based on an application of the comparative approach, which is the cornerstone of CLIOTOP.



The CLIOTOP working groups

Comparing various species, regions and ecosystems by searching for regularities and differences is of fundamental importance for CLIOTOP. Universal patterns will reveal common principles underlying the organization of ecosystems and their response to climate forcing. Therefore, impacts of both fishing and climate variations on marine ecosystems inhabited by open ocean top predators will be evaluated by analyzing and comparing long-term data series, ocean/atmosphere and biogeochemical reanalyses, field observations, in situ and laboratory experiments and measurements.

In this perspective, the working group identified potential pilot activities to be undertaken, including the development of common databases (environment / fisheries / acoustic / physiological experiments / archival tagging) devoted to comparative analysis.

Links with working group 4 were also discussed and common activities such as common databases and specific model development were planned.

CLIOTOP also gives significant emphasis to modeling and simulation in a comparative framework to identify the key

(continued on page 2)

CONTENTS

CLIOTOP Working Groups: Key Scientific Questions

WG1 - Early life history of top predators

Q1: What environmental characteristics define the spawning areas and timing of top predators?
Q2: What environmental and biological characteristics most influence larval survival of top predators?

WG2 - Physiology, behaviour and distribution of top predators

Q1. To what extent do spatial dynamics result from proximate cues and to what extent is spatial dynamics independent of environmental cues?
Q2. How does school size and fidelity vary in relation to environmental variability and change?
Q3. What determines the time and place of reproductive and feeding-related behaviour?
Q4. How do anthropogenic forces such as fishing interact with environmental impacts on distribution and population structure?

WG3 - Trophic pathways in open ocean pelagic ecosystems

Q1: What are the main trophic pathways of pelagic top predators and how do they differ between and within oceans?
Q2: Is there evidence of change in trophic pathways over time and space consistent with climate variability? Can seasonal and spatial variability be used to explore climate variability?
Q3: What is the relative importance of mesopelagic versus epipelagic prey resources to oceanic top predators, and how does this vary within and among oceans. How does climate variability affect the distribution and availability of mesopelagic and epipelagic prey?
Q4: Is it possible to identify indicators, such as prey species or size spectra, that would highlight significant changes in trophic pathways?

WG4 - Synthesis and modeling

Q1: What is the relative importance of exploitation and the environment in structuring pelagic ecosystems?
Q2: Does one mechanism (e.g., match/mismatch) explain observed variation across species, trophic pathways, regions, etc.? Do alternative mechanisms have equally good explanatory power? Which mechanism(s) provide the greatest predictive power?
Q3: What alternative states might occur in pelagic ecosystems, how might they be characterized (e.g., can they be described by indicators), how might they be caused, what are their consequences, and are they reversible?
Q4: Does knowledge about environmental forcing and the nature of fisheries (e.g., the species composition of the catch) suggest an optimum allocation?

WG5 - Socio-economic aspects of managing and responding to climate impacts on oceanic top predator species

Q1: What are the socio-economic pressures on, and context of, tuna fisheries?
Q2: How have fisheries organizations (whether local, national, regional, or international) addressed climate change issues?
Q3: What are the flows in capital and knowledge among the world's large fisheries and how do they respond to variability?
Q4: How useful are the tools developed by WG 4 and 5 to support fisheries management decisions?

processes, and to deduce and understand the dynamics of the ecosystem and its constituent populations. Therefore, the working group 4 on modeling and synthesis decided to organize its mid-term work around the comparison of different ecosystem models (from spatially aggregated and taxonomically disaggregated models such as ECOPATH/ECOSIM applications to spatially explicit and taxonomically aggregated models such as SEAPODYM and APECOSM) in the three oceans. A workshop is already planned this year in La Jolla (likely in October) to actually undertake the first analysis. It should be organized in connection with a meeting of the working group.[1]

Of particular interest for CLIOTOP, socio-economic perspectives and management institutions are the focus of working group 5 which met for the first time in Hawai'i. Seventeen participants were present with an impressive diversity of interests: social and economic aspects of fisheries, bio-economic modeling, policy and law, international management were represented. Despite its obvious and necessary heterogeneity, the group succeeded in drawing a general framework combining a large range of point of view on the human dimension of pelagic ecosystems exploitation.

[1] Trophic pathways in open ocean ecosystems.

(continued on page 6)

PFRP PI Workshop Tackles Ecosystem Approaches to Management

The Pelagic Fisheries Research Program hosted its annual Principal Investigators Workshop November 29-December 1, returning to the theme of ecosystem approaches to management. The primary thematic focus of the meeting was on processes occurring at mid-trophic levels: dynamics of prey species, spatial (both horizontal and vertical) variability in prey abundance, novel tools for analysis of trophic dependencies, downward propagation changes in trophic structure due to changes in predator abundance.

Hosting more than 40 presentations on research across three oceans, the 2004 PFRP P.I. Workshop included researchers from around the world, including New Caledonia, Australia, Japan, France, the Caribbean and Hawaii. The workshop featured topics that included modeling, biology, economics, sociology, bycatch, tagging, trophic ecology and fishery management.

Michael Seki, Pacific Islands Fisheries Science Center in Honolulu, presented a "Review of current knowledge of micronekton in the North Pacific." While the micronekton community makes up a substantial portion of freely swimming living matter in the world's oceans, it remains a critical but poorly understood intermediate trophic link between the mesozooplankton & higher trophic levels (i.e., fish, marine mammals, etc.). Ranging in size from two to 10 cm and found mostly at depths of 200-1000 m, these organisms are considered significant contributors to the "biological pump" returning forage resources to the surface layer of the ocean, as well as to the sea floor.

In an experiment conducted by The North Pacific Marine Science Organization (PICES), the Micronekton Inter-calibration Experiment (MIE), the NOAA ship *Oscar Elton Sette* launched an October 2004 cruise to conduct sampling for a gear comparison and to gain a subtropical perspective of the micronekton community, as well as to use the benign weather and sea conditions to evaluate and refine the protocols, logistics, and design of the experiment.

Hazel A. Oxenford, University of the West Indies, Barbados, addressed "Flyingfish predators, prey and research methods: Lessons learned in the eastern Caribbean." With annual landings of 73,000 mt globally, most of the 67 species of flyingfish support small-scale fisheries.

In Barbados, known as the "Land of the Flyingfish," the fishery maintains a cultural significance as well as contributing to regional economics as it represents 60 percent of annual fish landings, supports six fish-processing companies, and has an ex-vessel value of $2.65 million.

Jock Young, CSIRO Marine Research Laboratories, Hobart, Tasmania, Australia, presented "Spatial variations in micronekton distributions off eastern Australia from nets and acoustics." The objective of this research is to characterize the physical and biological environment of the main fishing areas of the eastern tuna and billfish fishery, including population distribution, top predator distribution, trophic links, and development of qualitative and quantitative models.

Bruce Robison, Monterey Bay Aquarium Research Institute, Moss Landing, California, covered "ROV-based investigations of mesopelagic micronekton and zooplankton." Examining the deep basins of the Gulf of California, investigators using remotely operated vehicles have found that migratory midwater fish return to mesopelagic depths during the day, despite severely reduced oxygen levels; at depth they are sparse, lethargic and tire easily; and evidence suggests that they do not feed during the day.

While this pattern reinforces the argument that the diel vertical migrations of midwater fishes are the result of predation pressure from visually cued predators, research indicates that the reduced oxygen also influences their predators. Variations in oxygen concentration can affect vertical distribution, activity levels, and the presence of both predators and prey. Light also has a profound effect on predator/prey interactions throughout the upper kilometer of the water column. According to Robison, direct access with ROVs allows researchers to investigate behavior, physiology and activity levels, to collect live specimens and to make high resolution measurements of abundance and distribution.

Hikaru Watanabe, Oceanic Squid Section, National Research institute of Far Seas Fisheries, Shimizu, Japan, presented "The importance of squid prey for large pelagic animals in the western North Pacific." The objective is to review the importance of squid as prey for large pelagic animals in the transition region of the western North Pacific based on the data of diet of these animals and distribution of major squid prey.

Francis Marsac, Institut de Recherche pour le Developpment, Sète, France, asked "Who eats who?" as a relative approach to understanding the characteristics of an ecosystem and how the different functional groups interact in a presentation titled "Trophic ecology of four apex predators (yellowfin, bigeye, lancetfish, swordfish) of the pelagic ecosystem in the Indian Ocean."

Research indicates that surface tunas exploit a very limited number of prey species and that two functional groups, adult yellowfin tuna and lancetfish on one side and adult bigeye tuna and swordfish on the other, utilize different prey communities. The optimal feeding strategy, the high predator-prey size ratios could reveal short and simple food chains leading to apex predators in the Indian Ocean equatorial ecosystem. Continuing research will implement long-term monitoring of key descriptors of the trophic pathways, tracking the shifts in maximizing the benefit/cost ratio; determine the baseline isotope signature of the ecosystem; and integrate observations in a spatially explicit and size structured ecosystem model.

PFRP's P.I. Workshop is designed to create avenues of collaboration among scientists from different disciplines. For more information on the P.I. Workshop, visit online at http://www.soest.hawaii.edu/PFRP/.

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Publications of Note

National Technical Information Service

U.S. government publications, including NOAA Technical Memoranda, NOAA Technical Reports, and issues of Fishery Bulletin and Marine Fisheries Review, are available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, (800) 553-NTIS. (http://www.ntis.gov)

Southwest Fisheries Science Center

The Billfish Newsletter is an annual publication produced by the Southwest Fisheries Science Center (SWFSC) as a service to the international angling community. Emphasis is on billfish angling in the Pacific, Indo-Pacific and Indian Oceans. The results of the International Billfish Angler Survey and the Cooperative Marine Game Fish Tagging Program are described in each issue. The data presented are the result of cooperation by billfish anglers, sport fishing clubs and affiliated agencies with the SWFSC. (http://swfsc.nmfs.noaa.gov/billfish.html)

Proceedings of the 55th Annual Tuna Conference, Lake Arrowhead, California, May 24-27, 2004

The International Tuna Conference, sponsored annually by the U.S. National Marine Fisheries Service and the Inter-American Tropical Tuna Commission, is an international meeting of persons with scientific or commercial interest in tunas and tuna fisheries. It is a forum for discussing progress in research on all aspects of tunas and other large pelagic marine species. The informal setting at the Lake Arrowhead Conference Center provides a unique opportunity to present ongoing results and developing theories, allowing for stimulating interchange of views and opinions. (http://swfsc.nmfs.noaa.gov/tunaconf.html)

NOAA Fisheries: Office of Science & Technology

The Fisheries Statistics Division collects data and coordinates information and research programs to support the science-based stewardship of the nation's living marine resources. Integrates and disseminates state and federal statistics about marine fisheries and administers surveys used to estimate recreational landings. Site describes programs, provides access to key databases (commercial fisheries landings, foreign trade, marine recreational fisheries catch and effort), and contains relevant links and references. (http://www.st.nmfs.gov/st1/publications.html)

Online Publications

Fisheries of the United States
- Leading Commercial Fishing Ports, 2003 (Revised)
- Statistical Highlights, 2003
- Statistical Highlights, 2002
- Fisheries of the United States (PDF files) for viewing and download (1995-2003)

Annual Summary Reports (PDF files)
- Imports & Exports of Fishery Products 1996-2003
- Frozen Fishery Products 1990-2002
- Fresh Prices at Fulton Fish Market 1987-2001
- New York Frozen Wholesale Prices 1990-1997

Publications and Reports
- Marine Recreational Fisheries Statistics Survey
- Fisheries Economics

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PFRP New Projects—FY 2004

Biology Projects

Investigation of Aggregation Behavior of FAD-associated Small Yellowfin Tuna and Size Dependant Vertical Stratification
PI: Kim Holland, Laurent Dagorn, David Itano and Dean Grubbs

Fishery Dynamics in the Samoan Archipelago
PI: Keith Bigelow, Adam Langley and John Hampton

Statistics and Modeling Projects

An Analysis of Archaeological and Historical Data on Fisheries for Pelagic Species in Guam and Northern Mariana Islands
PI: Judith Amesbury and Rosalind Hunter-Anderson (Micronesian Archaeological Research Services)

Evaluation of Data Quality for Catches of Several Pelagic Management Unit Species by Hawaii-Based Longline Vessels and Exploratory Analyses of Historical Catch Records from Japanese Longline Vessels
PI: William A. Walsh

Addition of Multi-species Capability, Sex Structure and other Enhancements to the Length-Based, Age-Structured Modeling

(continued on next page)

Software MULTIFAN-CL
PI: John Hampton, Pierre Kleiber and John Sibert

Socio-Cultural Project

Sociological Baseline of Hawaii-Based Longline Fishery: Extension and Expansion of Scope
PI: Stewart Allen

Economics Projects

Spatial Modeling of the Tradeoff between Sea Turtle Take Reduction and Economic Returns to the Hawaii Longline Fishery
PI: Keiichi Nemoto and Michael Parke

Human Dimensions Analysis of Hawaii's Ika-Shibi Fishery
PI: Ed Glazier and John Petterson (Impact Assessment, Inc.)

Protected Species Project

Diet Dynamics and Trophic Relations of Laysan and Black-footed Albatrosses
PI: David Duffy and Jeremy Bisson

Comparing Sea Turtle Distributions and Fisheries Interactions in the Atlantic and Pacific
PI: Molly Lutcavage and Selina Heppell

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UPCOMING EVENTS

Marine Fisheries Advisory Committee

January 10-13, 2005, Hawaii
Contact: Laurel Bryant at Laurel.Bryant@noaa.gov

Online information: http://www.nmfs.noaa.gov/mafac.htm

56th International Tuna Conference on Tunas and Billfish

May 23-26, 2005, Lake Arrowhead, California
Contact: Simon Hoyle and Michael Hinton at TunaConf@iattc.org

Online information: http://swfsc.ucsd.edu/tuna-conf.html

International Fishers Conference on Responsible Fisheries and the 3rd International Fishers Forum

September 2005, Tokyo, Japan

Online information: http://www.fishersforum.org

American Fisheries Society 135th Annual Meeting

September 11-15, 2005, Anchorage, Alaska
Contact: Bill Wilson at bill.wilson@noaa.gov

Online information: http://www.wdafs.org/Anchorage2005

Fourth International Billfish Symposium (FIBS)

October 31-November 3, 2005, Avalon, Santa Catalina Island, California
Contact: Michael Domeier at domeier@cs.com or Kim Holland at kholland@hawaii.edu

Online information: http://www.pier.org/billfish_symposium/index.htm

Climate Impacts (continued from page 2)

This framework will be used to develop pilot studies based on existing projects and approaches. It should also serve as a guide for conducting a "gap analysis" to define new projects to be promoted. Links with working group 4 have been discussed and especially the idea of developing bio-economic models based on the already existing WG 4 approaches, as well as the will to conduct long-term time series analysis in collaboration with WG 4.

A complete report of this meeting as well as the revised science plan of CLIOTOP will be soon available on the GLOBEC web site (http://www.pml.ac.uk/globec). For more information, contact Olivier Maury, IRD, Sete (maury@ird.fr) or Patrick Lehodey, SPC, Noumea, New Caledonia (PatrickL@spc.int).

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The participants in the CLIOTOP WG 2-4-5 meetings in Hawai'i.

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