

Future of Marine Animal Populations (FMAP)

Heike Lotze
Dept. of Biology, Dalhousie University
1355 Oxford Street, Halifax, Nova Scotia B3H 4J1 CANADA
Phone: (902) 494-3406 FAX: (902) 494-3736 E-mail: hlotze@dal.ca

Hiroyuki Matsuda
Yokohama National University
Tokiwadai, Hodogaya-ku, Yokohama City, Kanagawa Prefecture,
240-8501 JAPAN
Phone: +81-45-339-4362 FAX: +81- 045-339-4373 Email: matsuda@ynu.ac.jp

Ransom A. Myers
Dept. of Biology, Dalhousie University
1355 Oxford Street, Halifax, Nova Scotia B3H 4J1 CANADA
Phone: (902) 494-1755 FAX: (902) 494-3736 E-mail: Ransom.Myers@dal.ca

Gunnar Stefansson
University of Iceland
Háskóli Islands, Sudurgötu, 101 Reykjavík, ICELAND
Phone: +354-525-5915 FAX: : +354-562-3790 E-mail: gunnar@hafro.is

Boris Worm
Dept. of Biology, Dalhousie University
1355 Oxford Street, Halifax, Nova Scotia B3H 4J1 CANADA
Phone: (902) 494-2478 FAX: (902) 494-3736 E-mail: bworm@dal.ca

Project Manager and E&O Liaison: Gretchen Fitzgerald and Andrea Ottensmeyer
Dept. of Biology, Dalhousie University
1355 Oxford Street, Halifax, Nova Scotia B3H 4J1 CANADA
Phone: (902) 494-2146 FAX: (902) 494-3736 E-mail: fitz@mathstat.dal.ca

<http://www.fmap.ca>

1. 2006 ACCOMPLISHMENTS & SCIENTIFIC HIGHLIGHTS

Major scientific activities completed this year include three major papers in *Science*, two meetings on global assessment of biodiversity, and international media coverage associated with high impact publications. FMAP has produced eleven peer-reviewed papers as of September 2006 and collaborated with TOPP, CMarZ, HMAP, CenSEAM, CReefs, OBIS, GoMA, and NaGISA Projects by participating in meetings, co-authoring publications, and / or providing advice on sampling and modeling techniques.

In their paper, 'Global patterns of predator diversity in the open oceans' (*Science*, Worm et al. 2005), FMAP researchers revealed a striking downward trend in the diversity of fish in the open ocean – the largest and least known part of our planet (Figure 1). Teasing apart the effects of climate change and

fishing over the past 50 years, the authors show a clear link to overfishing and highlight a surprising global pattern of open ocean hotspots - areas with predictable congregations of tuna, marlin, swordfish, and other ocean predators.

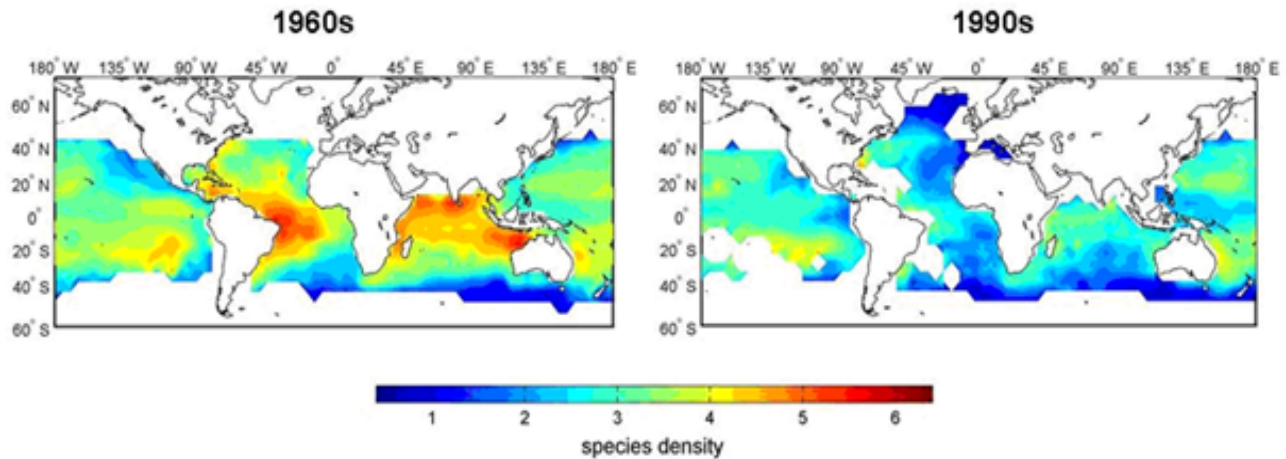
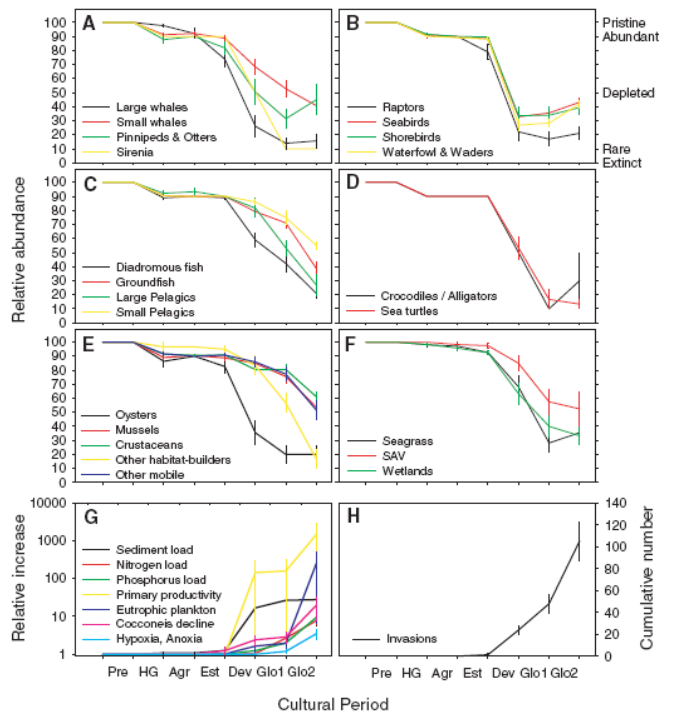


Figure 1: Change in species found on standard pelagic longline in 1960s (top) and 1990s (bottom; Worm et al. 2005).

Lotze et al. (Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science*. 2006), in collaboration with HMAP, determined that human activity over the centuries has depleted 90% of marine species, eliminated 65% of seagrass and wetland habitat, degraded water quality 10-1,000 fold, and accelerated species invasions in 12 major estuaries and coastal seas around the world. However, in areas where conservation efforts have been implemented in the 20th century, signs of recovery are apparent.

Figure 2: Common patterns of decline in 22 species guilds averaged over 12 study systems for (A) marine mammals, (B) coastal birds, (C) fish, (D) reptiles, (E) invertebrates, and (F) vegetation. (G) Degradation of water quality as indicated by the relative increase in eutrophication parameters [eight systems (10)]. (H) Cumulative increase in recorded species invasions [five systems (10)]. Data are means and standard errors. Cultural Periods are defined as follows:
 Pre - pre-human
 HG - hunter-gatherer
 Agr - agricultural
 Est - market-colonial establishment
 Dev - market-colonial development
 Glo1 - global market 1900-1950
 Glo2 - global market 1950-2000



Using satellite imagery and conducting interviews with over 1000 coral reef managers, Mora et al. (Conservation of coral reefs by a global network of marine protected areas, *Science*, 2006) performed the first global assessment of coral reef protection within Marine Protected Areas (MPAs; Figure 3). According to this assessment, of the 18.7% of tropical coral reefs that lie within "Marine Protected Areas," less than 2% are extended protection complete with regulations on extraction, poaching and other major threats. The research represents the first global assessment of the extent, effectiveness and gaps in coverage of coral reefs by MPAs. The team, made up of researchers in the OBIS and FMAP projects, built a database of MPAs for 102 countries, including satellite imagery of reefs worldwide, and surveyed more than 1,000 managers and scientists to determine the conservation performance of MPAs.

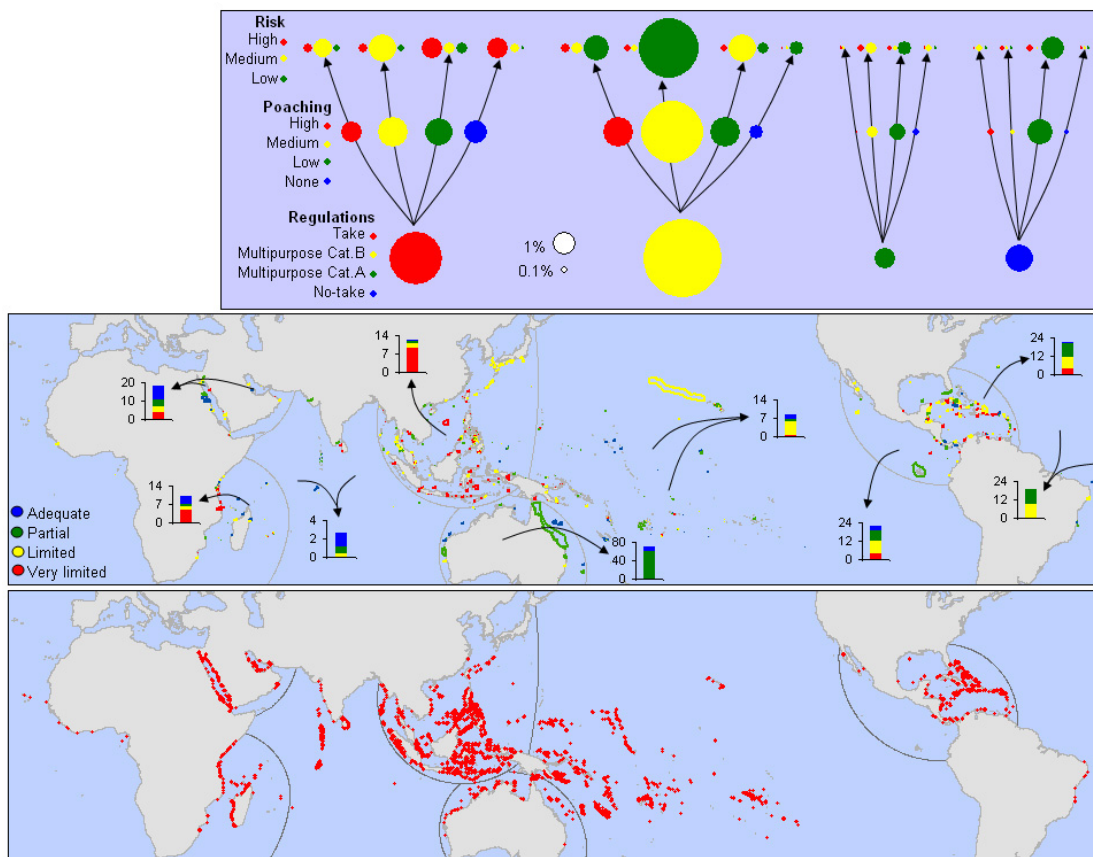


Figure 3: *Top:* World's coral reefs included within MPAs and how such areas breakdown according to the different attributes. Multipurpose MPAs were defined as zoned areas including take and no-take areas. In take areas, those MPAs that allow artisanal and recreational fishing but prohibit commercial fishing were classified as Multipurpose Cat. A and those that do not allow any fishing as Multipurpose Cat. B. *Middle:* All coral reef MPAs classified according to the average of their scores in the attributes analyzed (i.e. regulations on extraction, levels of poaching and risk, size and isolation). For simplicity, the resulting averages were categorized into four groups representing a hierarchical order, from adequate to very limited, in the quality of the analyzed attributes. *Bottom:* Gaps in the current global network quantified as the number of MPAs, of 10km² and spaced at 15km from each other, that would fill the area of coral reefs that is not covered by the existing MPAs. (adapted from Mora et al. 2006).

2. SOCIETAL BENEFITS, IMPACT & APPLICATIONS

Impacts of Over-fishing on Fish Diversity

Our findings on the impacts of over-fishing on fish diversity fall under three categories: 1) impacts of over-fishing on target and bycatch species, 2) identification of diversity hotspots for pelagic fish species, and 3) food web implication of the loss of top predators. FMAP Principle Investigators have been asked to address US Senate Commerce Committee Hearing on Overfishing, US Congress' Ocean Caucus, UN consultative process on the **Law of the Sea**, and to testify before the Canadian Standing Committee on Fisheries and Oceans. Ransom Myers and members of his lab also participate in IUCN Shark Specialist Group, which evaluates elasmobranch populations that are candidates for conservation status. In 2005, Ransom Myers was named by *Fortune* magazine as one of the world's "Top Ten to Watch" because of his work on fish population dynamics and the depletion of sharks, tuna and other fish species will foster "new and better ways to husband the wealth beneath the sea." By advising decision-making bodies such as the UN and by the prominence of their publications, FMAP researchers are helping reduce fishing pressure on over-harvested populations, either through listing as IUCN protected species or improved fisheries assessments. It is hoped that by identifying hotspots for finfish diversity, critical habitat will be protected through time-area closures. FMAP data on large predator diversity have been incorporated into recent plans for high-seas MPAs and are informing management of high seas fish stocks in general. Finally, by examining how over-fishing affects food webs, FMAP is producing some of the first evidence of the consequences of the loss of top predators in the ocean. It is hoped that such assessments will foster ecosystem-based approach to ocean management in the future.

Degradation of Estuaries

The work on degradation of coastal ecosystems helps create baseline assessments of ecosystem status through time. Such assessments provide quantitative targets for ecosystem-based management and restoration and a general appreciation of the impact of human activities on coastal ecosystems (impacts which are often under-estimated because of centuries of shifting baselines). Further, the ranking of anthropogenic drivers of change provides priority targets for management and conservation action and highlights the need to manage for the cumulative effects of multiple human activities in coastal ecosystems.

Coral Reef Diversity and Protection

We hope that FMAP/OBIS work on coral reef protection will encourage better stewardship of existing Marine Protected Areas and the adoption of a coherent network of marine protected areas that will truly protect coral reefs in the future.

3. WORK PLANNED FOR 2007

Publications

Global assessment of gelatinous plankton - We hope to produce an assessment that will increase understanding of the role of gelatinous plankton in marine food webs, predictions about changes in gelatinous plankton abundance and diversity under various climate change and eutrophication scenarios. High impact articles on the trophic role of gelatinous zooplankton in Antarctic Oceans and global maps of gelatinous zooplankton diversity are anticipated.

Global assessment of seamount diversity – We hope to produce an assessment that will identify areas for protection, and promote the adoption of the proposed ban on high seas trawling currently under

consideration by the United Nations. We anticipate a high impact publication on diversity of seamount communities.

New modeling techniques - Three new publications are also in preparation which describe new methods for dealing with sparse data coverage and rare species.

Ecosystem-based management and extinction risk – Hiroyuki Matsuda and colleagues will study ecosystem effects of the performance of adaptive management and related issues in ecosystem management and biodiversity (including a databook of rare aquatic species in Japan, by the Japan Fisheries Agency). Dr. Matsuda will also create a management plan for Shiretoko World Heritage Site.

New FMAP Students

The following students are joining FMAP on 2006-2007:

Allison Schmidt (*PhD student*, supervised by Heike Lotze) – Predicting impacts of near shore habitat loss on coastal biodiversity (funding from scholarship and Lenfest Ocean Program). Link to HMAP and NAGISA

Marta Coll (*Post-doctoral fellow*, with Heike Lotze) – Modeling past, present and future of coastal biodiversity (funding from scholarship). Link with HMAP

Kristin Kaschner (*Post-doctoral Fellow*, with Boris Worm) - Predicting Global Distributions of Marine Mammals (funding supposed to come from FMAP), Link with OBIS-SEAMAP

New FMAP Staff

OBIS Liaison (*Staff*, hired for three years) – Data manager will be hired by FMAP to increase data input into OBIS (funding obtained from Lenfest Ocean Program)

The creation of a data manager position in FMAP (who will be Liaison with OBIS) will greatly enhance our capacity to have FMAP data available on OBIS and also (we hope) increase the data available on OBIS from other CoML projects. The compilation of data in OBIS is essential to FMAP's role as the modeling component of the Census and the completion of the CoML Synthesis Analysis.

The role of the FMAP-OBIS liaison will be to target key data-generating components of the Census and to incorporate their data into OBIS or link these databases to the OBIS site.

Data from FMAP previous research will be made available on OBIS or linked to OBIS. This would mean that data on pelagic top predators, coral reef distributions, deep-sea coral habitat and movement data would be made available through OBIS.

Liaisons with other Census Projects

We hope to establish the following liaisons with Census Projects:

HMAP and NaGISA - Allison Schmidt

CRReefs – Derek Tittensor, Camilo Mora

CoMarGe and NaGISA – Jana McPherson (as part of the Lenfest Marine Extinction Project)

OBIS-SEAMAP - Kristin Kaschner

OBIS Liaison – Daniel Ricard

Hiring new data manager will increase our data input into OBIS and data obtained from Census projects. New data manager will attempt to populate OBIS with data from CoML projects in “analyzable” format.

Datasets we anticipate placing on OBIS

1. Seamount diversity data
2. Gelatinous plankton data will be linked to OBIS or made available on OBIS
3. Data on distribution of large pelagic fish and sea turtles (in anticipation of the completion of the Global Shark Assessment)
4. Groundfish Catch Data from the Northwest Atlantic

4. EDUCATION & OUTREACH

In addition, the FMAP website (www.fmap.ca) is a source of continually updated information on our work and offers examples of modeling techniques for other scientists in the Census. The FMAP team will be producing a meta-analysis textbook that will be of great value to others in the Census who are dealing large datasets from multiple sources. Our success in reaching a wider audience was evident when *Fortune* magazine named Ransom Myers as one of the “Top Ten to Watch,” selected from a global pool of candidates whose work will have lasting influence.

Over **300** media interviews have been given by members of the FMAP team over the last year. For example, the recently released FMAP paper on protection of coral reefs (Mora et al. 2006, *Science*) received extensive media attention (including *The Times of London* and worldwide coverage via Reuters Newswire) and Heike Lotze’s paper in *Science* was reported by Science News; BBC, ABC, and CBC News, New York Times, Berliner and Sueddeutsche Zeitung, Union Tribune San Diego, among others. Hiroyuki Matsuda has been invited panellist to the United Nations’ Informal Consultative Process on Oceans and the Law of the Sea and performed numerous television, radio and newspaper interviews (e.g.: NHK BS1 Today’s World, Tokyo Newspaper, and Hokkaido Newspaper).

Members of the FMAP team have also delivered public talks on the results of their work, including a public lecture delivered as part of the *Fish Forever* event organized by the David Suzuki Foundation and an invited talk at Ohio State University, a presentation to managers, politicians, scientists, and media at a Marine Ecosystem-Based Management Meeting organized by COMPASS in Monterey, California.

Eminent talks by FMAP researchers:

Matsuda H: 2006. Risk assessment and management, Special Lecture, 22 May 2006, United Nations University.

Matsuda, H. 2006. Why do I criticize the maximum sustainable yield theory? 7th UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea, 12 June 2006-12 June 2006, United Nations, invited panelist.

Matsuda H & Abrams PA: Effects of predator-prey interactions and adaptive change on sustainable yield, S8 Sustainable harvesting of natural resources: New insights from evolutionary ecology and community dynamics, 18 September 2006, Japan Society for Mathematical Biology.

- Matsuda H & Abrams PA: Maximal yields from multispecies fisheries systems: rules for systems with multiple trophic levels, Advances in Food-Web Theory and its Application to Ecological Risk Assessment, 13 September 2006, Yokohama National University.
- Matsuda H & Abrams PA: Maximal yields from multispecies fisheries systems: rules for systems with multiple trophic levels, 28 August 2006, International Symposium for Ecological Modeling.
- Matsuda H, Abrams PA: Maximal yields from multispecies fisheries systems: Rules for systems with multiple trophic levels, The 2nd Scientific Congress of East Asia Federation of Ecological Societies (EAFES2), 27 March 2006.
- Matsuda H: How to avoid extinction under the adaptive ecosystem management and the maximum sustainable yield theory, The Okazaki Biology Conference, 14 March 2006, National Institute for Basic Biology, Okazaki, Japan.
- Myers, R.A. Consequences of Over-fishing on Fish and Fish Habitat. Fish Forever - Seafood choices for a sustainable planet. Headliner at David Suzuki Foundation Event. Toronto, Ontario. May 2006.
- Myers, R.A. The Global Loss of Top Predators in the Ocean: Consequences of a World Without Sharks, Tuna, and Great Fish. The Mathematical Biosciences Institute Public Lecture Series, Ohio State University, Columbus Ohio, U.S.A. Feb. 2006.
- Myers, R.A. The Underestimated Impacts of Commercial Fisheries on Target Species. Annual Meeting of the American Association for the Advancement of Science, Washington, D.C. Feb. 2005.
- Myers, R.A. Testified at the House of Commons (CANADA) Standing Committee on Fisheries and Oceans on Northern Cod. Sept. 2005.

5. GEOGRAPHIC EXPANSION

This year, FMAP has increased its global coverage to include coral reefs and coastal ecosystem assessments. In the upcoming year, we will increase our coverage to include assessments of polar diversity (CAML and ArcOD), as well as strengthen our participation in the following areas:

- HMAP and NaGISA - Allison Schmidt
- CReefs – Derek Tittensor, Camilo Mora
- CoMarGe and NaGISA – Jana McPherson (as part of the Lenfest Marine Extinction Project)
- OBIS-SEAMAP - Kristin Kaschner
- OBIS Liaison – Daniel Ricard

6. PARTNERSHIPS & COLLABORATION

a. Partnerships

Organization Name	Point-of-Contact (Name)	Nature of Relationship
Department of Fisheries and Oceans (Canada)	Bob O'Boyle	Co-sponsorship of PhD student and OBIS liaison, Dan Ricard
Department of Fisheries and Oceans (Canada)	Richard Heisner	Equipment Support for Hosting OBIS Database – Canada Node
University of Toronto	Peter Abrams	Co-author (ecosystem approach)
National Research Institute of Fisheries Sciences	Mitsutaku Makino	Co-author (co-management)

Hokkaido University	M. Kishi, M. Kaeriyama, Y. Sakurai	Collaboration of research grants (Shiretoko and ecosystem modeling)
National Institute for Environmental Sciences (Japan)	Junko Shimura	Collaboration of research grant proposal (related to OBIS)

b. Links to CoML Ocean Realm Projects

Project Name	Liaison or Cross-Over personnel	Nature of Relationship
NaGISA	Heike Lotze, Allison Schmidt, Jana McPherson, Yoshihisa Shirayama at Kyoto University	Assessment of coastal degradation, global assessment of marine extinctions
CReefs	Camilo Mora, Derek Tittensor, Jana McPherson, Ransom Myers	Assessment of coral reef protection, global assessment of coral reef diversity and extinctions on coral reefs
GoMA	Jeremy Collie, Ransom Myers	Improved assessment of winter flounder in Long Island Sound
POST	Ian Jonsen, Joanna Mills-Flemming, Ransom Myers	Developing state-space methods to analyze animal movement data, assistance in developing field methods and data analysis
COMARGE	Jana McPherson	Global assessment of marine extinctions
CeDAMar		
CMarZ	Andrea Ottensmeyer, Beth Sampson, Larry Madin	Assessment of gelatinous plankton diversity and role in food webs
TOPP	Ian Jonsen, Joanna Mills-Flemming, Ransom Myers, Mike Stokesbury	Developing state-space methods to analyze animal movement data, assistance in developing field methods and data analysis
MAR-ECO		
CenSeam	Derek Tittensor, Boris Worm	Assistance in developing field methods and data analysis, global assessment of seamount diversity
ChEss		
ArcOD	Andrew Edwards	Assistance in collaboration with other polar project (CAML) and developing methods to assess polar diversity
CAML	Andrew Edwards	Assistance in collaboration with other polar project (ArcOD) and developing methods to assess polar diversity
ICoMM		

c. Links to CoML National and Regional Implementation Committees (NRICs)

NRIC	Liaison or Cross-over personnel	Nature of Relationship
Australia	Ransom Myers	Planned analysis of data from the GBR with AIMS.
Canada	Mike Sinclair	We will be collaborating with Dr. Sinclair on the Census Synthesis planned for 2010.

Caribbean	Camilo Mora	Camilo is carrying out an analysis of shark populations in the Caribbean, he is also planning a project with CReefs in the region, which will link to the regional committee
China		
Europe		
Indian Ocean		
Japan	Hiro Matsuda	
South America		
Sub-Saharan Africa		
USA		

d. Liaisons to CoML Cross-Cutting Groups

Project Name	Liaison Name & Institution	Nature of the Relationship
OBIS	Daniel Ricard Kristin Kaschner	PhD student; Participant in Canadian Regional Node Liaison with OBIS-SEAMAP
HMAP	Heike Lotze, Boris Worm and Allison Schmidt	Research collaborators
SCOR Tech Panel		
E&O	Gretchen Fitzgerald, Andrea Ottensmeyer	Website Manager, Coordinating Press Material, Scientific Writing and Publicity
Barcoding		

e. Effectiveness of the Partnerships and collaborations

FMAP has been extremely productive in the last year and we anticipate that the upcoming year will be equally productive, if not more so. We have established liaisons with most of the CoML projects and increased the profile of the Census through high-impact publications and media attention. As outlined in our Milestones report last year, we have two ongoing problems with enhancing our collaboration with other Census Projects:

1. We have attempted to utilize the OBIS format for our data but in many cases OBIS cannot accommodate our needs. OBIS must be re-vamped so that data can be incorporated in an “analyzable” format e.g. errors can be estimated etc. Also, other projects within the Census must work harder to make their data available so that we can assist with their modeling efforts.

2. Unfortunately, the idea of creating research nodes around the globe has not been highly successful because: a) researchers in different geographical areas already have extensive commitments to other projects; and b) the level of communication amongst principle investigators has not been adequate.

The global assessments that FMAP performs can be carried out from a single geographic location. We hope that a new database manager will help resolve some of these problems with the OBIS format.