The Future of Marine Animal Populations

(FMAP)

Data Synthesis and prediction of future marine populations and communities for the Census of Marine Life

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LONG-TERM GOALS

The Future of Marine Animal Populations (FMAP) is the modeling component of the Census of Marine Life. It is a network of statisticians and mathematical modelers that will ultimately address the third question of CoML, "What will live in the oceans?" The network will contribute to CoML in several key ways besides prediction, including exploration of the limits of knowledge in the past, present, and future.

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Besides intellectual interest, FMAP, the modeling component of the CoML, will be key to improved conservation of the natural resources of the ocean. The results from mapping the present diversity, distribution, and abundance in the ocean will improve conservation and sustainable use of ocean life. The meta-analysis of communities will improve our understanding of species interactions and help to predict how the diversity of marine life will change with natural and anthropogenic impacts. The extinction models will enable protection of endangered life. FMAP will surprise us with how much we can know and it will shock us with how much we might never know. In short, FMAP brings to the CoML the statistical and analytical tools needed for its success, for maximum impact for the conservation and understanding of life in the ocean.

APPROACH AND WORK PLAN

The FMAP apporach centers around the 5 themes of Design, Data Exchange and Model Interface, Model Development, Data Synthesis, and Prediction.

1) Statistical Design for the CoML. Efficiency and cost of scientific surveys can often be greatly enhanced by careful statistical design. FMAP will serve to improve future survey and experimental design through at least three means: (1) a statistical advisory team (working groups have been set up with (2), data quality control models for CoML and (3) standard programs for extrapolation of sample data. This part of the project is to provide support for other CoML projects. Strong links have been established with about half the other CoML projects by hosting workshops that coincide with previously scheduled project meetings. Over the past year, this has been found to be a successful and cost-effective strategy because we have been able to have short meetings with other components of CoML at times and locations where they are already planning to meet. We have had such meetings with the CenSEAM proposal group, CmarZ, and POST, and will do so with NaGISA in November. These meetings bring

together expertise to address particular issues and build trust amongst team players that is essential to co-ordinating data gathering and management strategies. FMAP plans to organize about four of these micro-meeting in the coming year that will be held in conjunction with other meetings if at all possible.

2) **Data Exchange and Model Interface.** Application of models benefits greatly from data format and access standardizations. Initial FMAP projects will focus on (1) development of standard data exchange formats easing likely model use (work with seamap) , (2) getting the large volumes of fisheries data quickly into OBIS in forms suitable for types of modeling key for CoML, and (3) improving archiving of non-fisheries data likely to be used early in CoML modeling. Database Construction FMAP will expand my publicly accessible database on an ongoing basis. With Ph.D. student Dan Ricard, working jointly with OBIS FMAP will develop a XML standard that will allow fisheries data to be exchanged among systems and programs. With Boris Worm, I will expand the range of species compiled. Emphasis will be given to reliable marine invertebrate time-series data.

Providing a Conduit for Fisheries and Time-series Data into OBIS. This task requires an extremely high level of technical skill, and cannot be accomplished via a network of researchers. Instead, we have engaged a very good quantitative Ph.D. student, Dan Ricard, to work on this jointly with OBIS. Although progress has been slower that I would have hoped, this has a potentially high payoff when the scheme works. There is also a very good opportunity to store data sets in OBIS on an ongoing basis. For example, ECOSYM workshops are being held around the globe. The input to these models and time-series of abundances of different ecosystem components will all be input into OBIS as these results are produced. This outcome is of great importance since there is currently no systematic way of storing these data. In the next two years, we will attempt to provide a mechanism to capture these data

3) Model Development and Sharing. It is crucial that a diversity of modeling approaches be considered within CoML. FMAP will serve as a central clearing house for important advances in analysis of present and future CoML projects. Early projects primarily concerned with analysis will (1) develop standard interpolation and overlap models to be used with CoML data (Andy Cooper and ?? at Univ. of New Hampshire), (2) develop standard mapping models to optimally use environmental and location data (Jana McPherson will coordinate mapping models this coming year) (3) model pelagic fish biodiversity (Boris Worm, Marcel Sandow, Andreas Oschlies, Heike K Lotze Univ. of Kiel and Dalhousie plan to publish 2 papers in the coming year on this topic), (4) develop movement models that will use newly developed state space methods to infer the distributions of marine animals from state-of-the-art tracking devices (Ian Jonsen, Joanna Flemming, Chris Field, Greg Breed and Ransom Myers at Dalhousie will continue this work, this will be integrated with TOPP more closely in the coming year), and (5) develop spatial multispecies models (Gunnar Stefansson, Univ of Iceland, is carrying out a large EU project using state of the art data storage tags). In each case, we will explicitly consider the limits of knowledge and why the limits now are where they are.

FMAP is initiating the following projects to improve the estimation of trends from data poor regions: Student Leah Gerber will assess changes in abundance using only presence-absence data using hierarchical Bayesian analysis.We have already used a preliminary version of this technique to demonstrate that 10 species of sharks and rays in the Mediterranean meet the IUCN criteria for being designated as critically endangered. Joanna Flemming and Eva Cantoni (Univ. of Geneva) we will extend robust estimation of negative binomial and other over-dispersed discrete distributions. Ph.D. student Dan Kehler, we will extend our very successful methods for making inferences on trends when zeros recorded in the data are not reliable (Baum et al. 2003).

4) **Data Synthesis.** Recent meta-analytic methods have revolutionized interpretation of medical and scientific research, showing that in some cases much more be "known" than is apparent. FMAP will adapt and bring to CoML the latest of such techniques. These efforts will be focused on the

meta-analysis of interactions. Meta-analytic state space models of the interactions of marine species will be developed by FMAP will continue to examine systematic changes in exploited marine ecosystems, using meta-analysis to evaluate the strength of multi-species interactions and extend the approach used in Worm and Myers (2003). Coilin Minto, using a EU funds, \ will test the hypothesis that cod have not recovered from over-fishing because of predation on juvenile cod by herring-like species and other species interactions. Post-doctoral fellow Andy Edwards will extend previous analysis of cod-shrimp interactions (Worm and Myers 2003} to a wide variety of ecosystems to search for patterns in community structure in exploited marine communities. Dan Ricard will combine meta-analytical approaches with reaction-diffusion equations to estimate the parameters of fishing effect and migration for animals on the boundaries of marine protected areas. Such models utilize functions developed by chemists to describe chemical reactions to describe animal motions in the wild. Working with the Seamout CoML group, Ph.D. student Derek Tittensor will develop hierarchical models of endemism to aid conservation and management of seamount communities. Our theoretical models will be constructed using the concept that local species richness is the summation of species richness categorized in a nested hierarchy from local (the seamount), to regional (seamount chain and oceanic basin), to global (all oceans) scales. This formulation is a new direction in modeling species richness and will be developed and tested in a number of systems, e.g. freshwater fish, and used to guide future sampling protocols.

FMAP will work closely with several HMAP workers to develop methods to assess historical abundance.

5) **Prediction.** We will attempt to predict the future of marine life. Heretofore, such attempts have consisted of imposing large changes on a poorly understood baseline. CoML should provide a much better baseline FMAP will continue its work on extinction prediction and modeling of bony fish and elasmobranches, and is in the process of seeking funds for a global project on assessing extinction risk in the ocean from a variety of funders.

FMAP will initiate three meta-analytic studies on the conservation of wild salmonids in the ocean to determine: the effect of caged aquaculture salmonids on the survival of wild salmonids (student Jen Ford) and the decline of fitness in hatchery fish released in the wild as a function of years under domesticated conditions

DROP THE NEXT SECTION: We will focus on two major aspects: the effects of trends in fishing and of possible climate change. Both will profoundly change the nature of marine ecosystems, and what will live in the ocean in the future. Initial prediction projects address: (1) global fishing effort and its consequences, (2) effects of climate change on marine biodiversity, and (3) possible marine extinctions. Future fishing effort, depending on social choice, is fundamentally unknowable. Climate change may also be unknowable at the level of detail important for many species. However, we believe the use of plausible scenarios allows useful research.

2. *Providing Support for Highly Qualified Researchers.* We have provided funding (or partially funding) for quantitative graduate students or postdoctoral fellows that will be co-supervised by well-respected modelers or statisticians and a member of a CoML field project. This strategy seems to work well, and provides access to high quality advisor with little cost. So far, the following research nodes have been created:

Oceanic Region	Investigators	Links to CoML Project
Northwest Atlantic, Gulf of Mexico	Drs. Andrew Cooper and Ernst Linder, University of New Hampshire	GOM Project
Northwest Atlantic	Drs. Gunnar Stefansson and Violeta Cailin, University of Iceland	MarECO Project
S.E. Asia/Australia	Drs. Mark Costello and Marti Anderson, University of Auckland, New Zealand, linked with the	
North Atlantic and Pacific	Drs. Boris Worm and Marcel Sandow, Institute for Marine Science, Kiel Germany	
Japn	Dr. Matsuda Hyroyuki	NaGISA

In addition to the 5 items above, FMAP will emphasize two additional projects. The Global Shark Assessment will serve as a model of how a global census could be undertaken for one taxa.

Providing a Model a Global Census. The Global Shark Assessment (Ransom Myers), will serve as a model for other taxonomic groups that will be studies as a part of the Census. Already, my research group has performed assessemtns of the status of pelagic shark populations in the Mediteranean, Atlantic, and Pacific Oceans. In the upcoming years, we will expand these assesemtns to include coast shark species through surveys of SCUBA divers and by

Analyzing Global Patterns of Marine Biodiversity (Boris Worm)- The open ocean comprises 80% of the biosphere, yet global-scale patterns of species abundance and diversity are enigmatic. We will attempt to provide a theoretical framework from which we worldwide marine biodiversity patterns can be analyzed, and interpreted. These patterns are crucial for testing ecological hypotheses and defining what we know about the ocean. Such a global map only exists for one taxa (Foraminifera, or 'forams'). FMAP has produced diodiversity maps for pelagic fish from fisheries data, and they reveal peak diversity at intermediate latitudes and distinct diversity ‘hotspots’ in all oceans. These results correlate well with regional diversity patterns for a wide range of predators and zooplankton. Oceanographic analyses reveal that temperature, dissolved oxygen, and depth gradients jointly explain the distribution of diversity. We propose to extend this analysis to other taxa in the coming year working closely with many other researchers in the CoML. This work can be used to guide ongoing global conservation efforts.

WORK COMPLETED

FMAP has established research nodes at various locations around the globe. Researchers at each of these nodes are beginning to assembler the data required for a global assessment of biodiversity. Over the past year, we have produced 20 publications as part of the FMAP project.

Four workshops have been or will be held this year to provide advise and assistance to other CoML projects:

Census of Seamounts (CenSeam)	Sept. 16 2003 Woods Hole, MA, USA
CMarZ	Sept. 17 2003 Woods Hole, MA, USA
POST	Oct. 2003 Vancouver Aquarium, Canada
NaGISA	Nov. 15-17, Japan

Futhermore, FMAP researchers have worked closely with several HMAP researchers to improve quantitiave analysis. FMAP researchers have worked with Andy Rosenberg at UNH on the historic abundances of cod, with Brian R. MacKenzie (Danish Institute for Fisheries Research) to reconstruct historic bluefin tuna abundances in the North Sea, the Mediterrainan, and the south Atlantic, and with Heike Lotze (Univ. of Kiel) on the history of marine animal populations in the Bay of Fundy and the North Sea.

RESULTS

Put section in from Boris's hotspot paper.

State space models of movement. With post-doctoral fellows Joanna Flemming and Ian Jonsen, I will simplify the utilization of meta-analytic state-space models.
We will search for general scaling laws for movement using our state-space approach to modeling and estimating movement parameters (Jonsen:Myers:Flemming:2003. We will extend our work to take into account estimation of errors, and produce a statistical toolbox for use by ecologists. We will also attempt to determine if there are scaling laws governing the ability of animals to estimate location, and test models of home range behaviour in a way that is currently not possible.

Add state space models. {\it Meta-analysis of community dynamics. I have extended the analysis of population dynamics to community dynamics and species interactions with former postdoctoral fellows Boris Worm and Heike Lotze (Worm:Myers:2003,Myers:Worm:2004. This work has produced some of the first assessments of changes in food web structure that coincided with declines in groundfish and whales in the northern Atlantic and Pacific Oceans (Worm:Lotze:Myers:2004.

FMAP researchers have introduced the meta-analytic state-space approach to understanding the dynamics of movement from the large amount of data that is becoming available from satellite, acoustic, and other remote-sensing tags (Jonsen Myers Flemming and 2003). Using these methods, we have been able to make inferences about behaviour, e.g. differences in abilities to estimate location, that are not apparent in the raw data.

{\it Development of meta-analytic methods. With three of my Ph.D.\ students, I have developed new meta-analytic methods that allow the visualization of complex meta-analyses (Barrowman:Myers:2003.
Our advances in meta-analysis enable fisheries ecologists to estimate maximum reproductive rates, depensation (the Allee effect), and carrying capacity, and will lead to recommendations for preventing further declines and even allow the recovery of fish populations.

1. Industrial exploitation of sharks in the open ocean regions of the Gulf of Mexico has placed certain species in serious risk of extirpation. **Our analysis demonstrated that that oceanic whitetip sharks in the Gulf of Mexico have decline 150-fold in numbers (300-fold by biomass) since the 1950's (Baum and Myers, 2004).** Other commonly caught shark species, silky and dusky sharks, are estimated to have declined by 91 and 79%, respectively. Sharks presently caught by longliners in the Gulf of Mexico are at or below the size at which they reproduce. In the most extreme case, silky sharks caught on longlines now average 97 cm in length, almost half the size at which they mature.

2. The total biomass of pelagic fish caught on longlines has been reduced by 90% between the 1950's and 1990's in the tropical Pacific Ocean (Ward and Myers, 2004, *In press*). Population declines were shown for blue, mako, oceanic whitetip, silky, and thresher sharks in this region. Ward and Myers found preliminary evidence that these drastic declines in top predators are having impacts for the pelagic ecosystem. They observed an increase in catches of small species such as the pelagic stingray and pomfrets which corresponded to declines in large predators.

3. Myers and Worm (In press) discovered that the risk of extinction depends on the age at which fish enter the fishery. In this way, the extinction risk declines as fishing becomes more selective for older fish. Based on estimates of extinction risk in shark species in the Northwest Atlantic, Worm and Myers predict the collapse and extinction of several species if current levels of fishing mortality remain the same.

6. Correlations were found between baleen whales (fin and minke), forage fish species (herring, sandlance, and) and groundfish (walleye pollock, cod, haddock) in the North Atlantic and Pacific Oceans. Whaling had little effect on the Grand Banks ecosystem, whereas the reduction in cod populations on the Grand Bank was shown to have a positive impact on prey species. In the Bering Sea, whaling resulted in a shift from whales to groundfish as the dominant predator in this system.

8. Methods of estimating spawner-recuit points for fish populations are In contrast, the decision theoretic method of maximizing the expected yield exhibited less Variability, produced higher yields and substantially reduced the risk of over-exploiting the population. We show how these methods can be extended to include information from other populations. Bayesian priors for the SR parameters, obtained through meta-analyses of population dynamics at some higher organizational level (e.g., the species), may be used to assess the plausibility of parameter estimates obtained for a single population, or combined with the data for the population of interest. Reference fishing mortality rates are then estimated from the resulting joint posterior distribution.

9. Large predatory fishes have long played an important role in marine ecosystems and fisheries alike. Overexploitation, however, is gradually diminishing this role. Recent estimates indicate that exploitation has depleted large predatory fish communities worldwide by at least 90% over the last 50-100 years. Here, we demonstrate that these declines are general, independent of methodology, and even higher for sensitive species such as sharks. Then we attempt to predict the future prospects of large

predatory fishes. (1) An analysis of maximum reproductive rates predicts the collapse and extinction of sensitive species under current levels of fishing mortality. Sensitive species occur in marine habitats worldwide and have to be considered in most management situations. (2) We show that to ensure the survival of sensitive species in the Northwest Atlantic fishing mortality has to be reduced by 40-80%. (3) We show that rapid recovery of community biomass and diversity usually occurs when fishing mortality is reduced. However, recovery is more variable for single species, often due to the influence of species interactions. We conclude that management of multispecies fisheries needs to be tailored to the most sensitive, rather than the more robust species. This requires reductions in fishing effort, reduction in bycatch mortality, and protection of key areas to initiate recovery of severely depleted communities.

10. In addition to these high impact publications, the FMAP project has hosted to successful workshops with the Census of Seamounts and the Census of Marine Zooplankton Projects of the census of Marine Life. Technical achievements resulting from these workshops include

IMPACT AND APPLICATIONS

1. Fishing pressure must be drastically reduced in the Gulf of Mexico to ensure shark populations will recover from their depleted state. (Baum & Myers, 2004, *Ecology Letters* 7(2):135-145). Declines in large top predators can result in changes in the abundance and distribution of pelagic fish by releasing smaller fish from predation (Ward and Myers, 2004, In press).

2. In order to protect sharks in the Northwest Atlantic from imminent extinction, Myers and Worm (In press) recommend fishing mortality be reduced by 40-80%.

3. Systematic biases in catch data from pelagic longline fisheries**.** Based on these findings, Ward and Myers recommend modification to data collection to improve mortality estimates, and changes management strategies to address the bias introduced to fisheries assessments by fish and seabirds “lost at sea.”

4. Analysis of changing catchability with depth enables us to infer the depth distribution of pelagic fishes in the Pacific Ocean. This standardization will also improve estimates of changes in catchability when longline fishing gear is lengthened to access deeper water. Estimates of catchability can be also be used to correct abundance indices for pelagic fish. These methods also mean that data from early surveys in the time series of commercial catch rates can be used in assessment. Since there was a rapid shift to deep longlining in the 1970’s this analysis will allow inclusion of pre-1970’s data in assessments; key information if we are to truly asses changes in the pelagic fishes. Our analysis also demonstrates that catchability distribution does not always match depth preferences derived from tracking studies, so these studies should not be used to correct abundance indices without additional information on feeding behavior.

5. Estimates of catchability can be also be used to correct abundance indices for pelagic fish. These methods also mean that data from early surveys in the time series of commercial catch rates can be used in assessment. Since there was a rapid shift to deep longlining in the 1970’s this analysis will allow inclusion of pre-1970’s data in assessments; key information if we are to truly asses changes in

the pelagic fishes. Our analysis also demonstrates that catchability distribution does not always match depth preferences derived from tracking studies, so these studies should not be used to correct abundance indices without additional information on feeding behavior.

6. Correlations in abundances of fish and marine mammals of different trophic levels have shown that t large changes in North Pacific and Atlantic ecosystems have occurred as a result of exploitation, and that humans are strongly implicated as a driving force.

7. Statistical models rather that models based on depth preference would improve assessments of pelagic fish based on catch data.

Ocean Observing Systems

FMAP will synthesize data to provide a baseline for future observations, particularly those for large species. For example, the FMAP analysis of decline of large pelagic predators, provide a baseline for changes of these species.

Marine Ecosystem-based Resource Management

The principal impediments for effective marine ecosystem-based management are being addressed by FMAP. These are (1) the identification of historic ecological baselines, (2) identification of species and populations that will go extinct under present management regimes. (3) understanding of species interactions. FMP has developed meta-analytic approaches to understanding (4) understanding the role of movement in management. Gunnar Stefansson (Univ. of Iceland) has established an ambitious program to combine data from tagging data on multiple species with the statistical estimation of a geographically structured, age specific multispcies model of marine fisheries. The FMAP state-space movement model approach allows the better estimation and protection of endangered species.

is A major goal of FMAP is to provide the scientific basis for ecosystem management. The following FMAP projects will have direct implications for improving marine ecosystem-based management:

1. Identification of hotspots in the global pelagic ecosystem (Worm, Lotze, and Myers, 2004, *Proceedings of the National Academy of Science*, Worm, Lotze, Myers, submitted to *Science*).
2. Meta-analysis of species interactions (Worm and Myers, 2004, much ongoing work).
3. Identification of species likely to go extinct due to over-exploitation (Myers and Ottensmeyer, In press).
4. Atlantic modeling and meta-analysis of diffusion rates of species from MPA's.
5. Improved statistical methods to improve assessment of fish and seabirds (

The significance of my research is demonstrated by the w
ide coverage it has received in the international media, e.g. six N.Y.\ Times stories, two of which were on the front page.
In 2003, the body of work produced by my lab was ranked by {\it Discover} magazine as one of the top 100 most significant adv
ances in science. I was also asked to testify for a committee meeting of the US Senate Commerce Committee.

In February 2004 Boris Worm presented his recommendation to the US Commission on Ocean Policy and the Pew Ocean Commission at the American Association for the Advancement of Science (*BioScience*, June 2004, 54, page 495-500*).*

Science Education and Communication

FMAP project has achieved outreach and education goals through media attention generated by high-impact publications, the new FMAP website (www.fmap.ca), and by delivering public talks. Over 300 media interviews have been given. For example, the FMAP paper biodiversity hotspots in the blue ocean (Worm et al. 2003) also received wide media attention, including Boris Worms paper PNAS paper received coverage in the BBC New Service, the United Press International, and Scientific American ("Protection needed for 'marine Serengetis' August 5, 2003, BBC News, August 4, 2003; Scientists spot 'Serengetis' of the sea, *United Press International*, August 5, 2004; and "Researchers Find Marine Predator Hotspots," *Scentific American*, August 6, 2003).
The FMAP discovery of the drastic declines of oceanic whitetip sharks in the Gulf of Mexico (Baum and Myers, 2004) also attracted media attention (**"**Analysis: Researcher argues there's evidence of a dramatic decline in the numbers of the white-tipped shark.**"**, *All Things Considered*, NPR, July 8, 2004; "Sharks in the soup," Feb 16, 2004.Vol.136: 57; "Where once shark bit men, man bites shark," *New Scientist*, February 12-20, 2004).

Members of the FMAP team have also delivered public talks on the results of their work, including a public lecture delivered at the Vancouver Institute, the Society of Environmental Jounalists and the US congresses Ocean Caucus.

There are 22 graduate students and 7 postdoctoral fellows that are receivening training in quantitative marine biology that will be avaailbe to carry through the goals of CoML. Each students and postdoctoral fellows participates in field work, and well as modeling.

The interest created by the Global Shark Assessment, the analysis of large pelagic predators, and the mapping of marine global biodiversity will provide oppurtunites to engage students around the world in the CoML.

RELATED PROJECTS

"Spin-Off" Projects

Please list projects replicating your CoML project's protocols in different geographic locations. Include the PI(s) name.

Project Name	Principal Investigator	Geographic Locale

Links Within CoML

Please identify other projects within CoML with which your project shares common themes, cruises of taxonomic expertise. Describe how you are working with the project(s) to build links and minimize redundant effort.

Project Name	Principal Investigator	Nature of Relationship
HMAP		Heike Lotze and Boris Worm collaborators on publications (e.g. "Ecosystem effects of fishing and whaling in the North Pacific and Atlantic Ocean."). Participation at the HMAP meeting in San Diego
OBIS	Fred Grassle	Joint supervision of Ph.D. student, Dan Ricard and Collaborating on data standards and database construction.
Census of Seamounts (CenSeam)		Joint supervision of Ph.D. student Derek Tittensor. Collaborating on data standards and database construction. Met in Wood's Hole, September, 2004.
CMarZ		Collaborating on data standards and database construction. Met in Wood's Hole, September, 2004.
POST		Collaborating on data standards and database construction. Met in British Columbia, October, 2004.
TOPP		Collaborating on data standards and database construction.
Canadian Participation of Census of Marine Life	Paul Snelgrove	Participating in meeting, "Three Oceans of Biodiversity."
MarECO		Collaboration with Gunnar Steffanson
Global Shark Assessment	Ransom Myers	The data gathered and some of the analysis of diversity of large pelagic fishes are integrally linked to the goals of FMAP.

External Projects

Please identify non-CoML projects that you consider closely related to your CoML project and briefly describe the nature of each relationship.

Project Name	Principal Investigator	Nature of Relationship

PUBLICATIONS

Ward, P. and R.A. Myers. 2004. Do habitat models accurately predict the depth distribution of pelagic fishes? Fisheries Oceanography *Submitted*.

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Derek Tittensor and Ransom A Myers. In press. Exploitation and Macroecology in the Ocean. In Marine Macroecology, Editors Kaustuv Roy and Jon Witman, University of Chicago Press.

Please list references for Submitted, In Press, or Published; books, chapters, or significant papers. Please also include papers in preparation or development with an estimated date of submission or publication.

EDUCATION & OUTREACH

Media: see other section.

Creation of FMAP Website. The target audience of this website is the general public. This website has been successful in making the work of FMAP available to the general public.

website

We have created an experimental website where scientifically and recreational divers can enter data on shark sightings, and have their results compared with information from other sources. We now testing it to determine if it can provide useful data.

Please list substantial Education & Outreach activities associated with this effort and indicate the target audience for each. Please indicate the success of each effort, if known.

Like all parts of the Census, FMAP has huge potential for education and outreach. We will work closely with the group led by Sara Hickox at the U. of Rhode Island now charged to encourage education and outreach throughout the Census. FMAP will designate a network member (or perhaps the Network Manager) to participate in CoML E&O network.

PROJECT PARTICIPANTS

Please list current project participants (student, technician, liaisons, etc.), including contact information and their role within the project, if this has not been provided in earlier reports (e.g., note changes in personnel).

Surname	First Name	Organization	Address	Email	Role in project
Anderson	Marti	University of Auckland	Warkworth, New Zealand		Research scientist
Baum	Julia	Dalhousie University	Halifax, Nova Scotia	baum@mathstat.dal.ca	Ph. D. Student
Blanchard	Wade			wade@mathstat.dal.ca	Statistical consultant
Breen	Justin			breen@cs.dal.ca	Computer systems manager
Calian	Violeta	University of Iceland	Reykjavik	calian@raunvis.hi.is	Post-doctoral fellow
Collie	Jeremy			jcollie@gsosun1.uri.edu	FMAP liason to the Gulf of Maine Project (GoM)
Cooper	Andy	University		andrew.cooper@unh.edu	Research

		of New Hampshire			scientist
Costello	Mark	University of Auckland		m.costello@aukland.ac.nz	Research scientist
Edwards	Andrew			Edwards@mathstat.dal.ca	Post-doctoral fellow
Ferretti	Francesco			ferretti@mathstat.dal.ca	Ph.D. student
Fitzgerald	Gretchen			fitz@mathstat.dal.ca	Projects manager
Flemming	Joanna			Joanna.Flemming@ metri.unige.ch	Post-doctoral fellow
Gerber	Leah			lgerber@mathstat.dal.ca	M.Sc. student
Hiroyuki	Matsuda	University of Tokyo	Tokyo, Japan	matsuda@ori.u-tokyo.ac.jp	Project leader for FMAP in Japan
Jonsen	Ian			Jonsen@mathstat.dal.ca	Post-doctoral fellow
Linder	Ernst	University of New Hampshire			Research scientist
Lucifora	Luis			Lucifora@mathstat.dal.ca	Post-doctoral fellow
MacKenzie	Brian			brm@dfu.min.dk	
McPherson	Jana			jana.mcpherson@zoology.oxford.ac.uk	
Minto	Coilin			minotc@mathstat.dal.ca	M.Sc. student
Myers	Ransom			myers@mathstat.dal.ca	Principle Investigator
Porter	Aswea		Courtenay, British Columbia	porter@mathstat.dal.ca	Past Prpojects Manager and Website Designer
Rosenburg	Andrew	University of New Hampshire	Durham, New Hampshire	Andy.Rosenberg@ unh.edu	FMAP liason to the History of Marine Animals

					Project (HMAP)
Sandow	Marcel	Institute of Marine Science	Kiel, Germany		Post-doctoral fellow
Shepherd	Travis			shepherd@mathstat.dal.ca	Post-doctoral fellow
Sherrill-Mix	Scott			sherrill@mathstat.dal.ca	M.Sc. student
Stefansson	Gunnar	University of Iceland	Reykjavík Iceland	gunnar@rhi.hi.is	Project leader for FMAP in Iceland
Stokesbury	Micheal			mstokesb@dal.ca	Ph.D. student
Tittensor	Derek			derekt@mathstat.dal.ca	Post-doctoral fellow
Ward	Peter			ward@mathstat.dal.ca	Ph.D. student
Worm	Boris			bworm@dal.ca	Boris was the FMAP liason in Kiel, Germany.

ISSUES FOR THE SSC

Please identify any issues you would like to raise with the international Scientific Steering Committee (SSC).

I would like to address here how FMAP plans to overcome major challenges in the next year.

One of the chief challenges faced by FMAP is to carry out the diverse projects, and interact in a construtive way with the other census field projects.

We have tried several approaches:

1. Analyze biodiversity questions on a globsl scale. For example, we do not have published biodiversity maps on a global scale expcept for foraminierea. Worm and Myers has produced such maps for large pelagic fish (in review in Science). A new postdoctoral fellow has been hired from expernal (non Sloan sources) who is a specialist in this area (Jana MacPherson will complete her Ph.D. in Dec. from Oxford). She has already been to two FMAP meetings, and will coordinate efforts to maps global patterns of biodiversity in the ocean and offere assisstance to other CoML project.s

2. Micro workshops. Over the past year, this has been found to be a successful and cost-effective strategy because we have been able to have short meetings with other components of CoML at times and locations where they are already planning to meet. We have had such meetings with the CenSEAM proposal group, CmarZ, and POST, and will do so with NaGISA in November. These meetings bring together expertise to address particular issues and build trust amongst team players that is essential to co-ordinating data gathering and management strategies.

3. Partial funding for postdoctoral fellows and graduate students jointly with quantiative experts. This has been done with POST, the seamount project, OBIS (two one working joinly with Branton in Halifax and one in New Zealand).
4. A large scale demonstration project
5. Development of tools.

MEETINGS

CENSUS OF MARINE LIFE FMAP – CMARZ COORDINATION WORKSHOP

Date: 16 September 2004

Workshop location: Smith Laboratory, Conference Room
Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA