

Gulf of Maine NEWS

Regional Association for Research on the Gulf of Maine

Spring 1994

Marine Resource Management needs Integration of Resource Economics and Natural Sciences

Yoshiaki Kaoru and Bruce Tripp,
Woods Hole Oceanographic Institution

Economists and natural scientists need to work together toward a more integrated approach to marine resource management. Effective resource management requires quantitative understanding of economic benefits to the public of various marine resources (e.g., clean water, shellfish beds, swimming beaches, fish stocks, etc.), both in their current state and under improved conditions. We also need a better understanding of how scientific and environmental parameters influence such benefits and how costly it is to improve these parameters. If an objective of managing the Gulf of Maine is to attain the highest benefit to the public, then economic research is needed to measure and identify what the public values and to provide this information to decision makers. Natural and physical science research efforts to measure biological or oceanographic characteristics alone cannot reveal this information; management applications within the context of quantitative benefit-cost analysis should be an important objective of scientific assessment, monitoring and modeling efforts.

A number of coastal marine areas have received special designations because of their environmental uniqueness or

importance to human well-being. Through a variety of federal or state programs such as the National Estuary Program, the National Marine Sanctuary Program and the Gulf of Maine Regional Marine Research Board, many research projects have been undertaken in specific geographic areas. In Massachusetts Bay, for example, more than 15 research projects have been conducted in the past 3-5 years to understand the physical processes responsible for mixing and circulation in the bay, the cycling of contaminants and nutrients, and biological responses to these chemicals. Most of these federal or state programs require the drafting of a management plan as an important objective. This requirement recognizes the increasing public interest in marine resource protection and the importance of satisfying public needs by managing these valuable public resources.

Every marine environment is important, but marine protection or clean-up is not without cost. Because decision-making will require the allocation of scarce public funds, we need to ensure that the benefits associated with each management decision are greater than its costs, and that the most critical areas receive the highest priority. Thus, an essential element of the management process is the ability to quantify the benefits and costs accruing to each proposed protection or clean-up task. Knowledge about ecosystem functioning is important in order to manage marine resources. Scientific research provides valuable information about, for example, biological, chemical and physical characteristics of marine ecosystems such as the Gulf of Maine. However, information needs for the best management of marine resources go beyond the physical science information. We also need to consider how such scientific information can be utilized to measure or improve the value of the Gulf of Maine to the public. Information needs for implementing benefit-cost analysis and selecting the best management plan should be addressed at the

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(Resource Economics continued)

outset of federal or state marine environmental management programs and should be considered as a component of any research plan.

According to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Departments of Interior and Commerce), in 1991, 6.9 million adults traveled a mile or more from their homes to the coast for the primary purpose of enjoying such non consumptive recreational activities as observing, feeding, or photographing wildlife. It has been estimated that 1.1 million people took part in 9,000 whale-watching trips around Stellwagen Bank in 1985, and that Acadia National Park in Maine and Cape Cod National Seashore together attracted 9.7 million visitors in 1988. The table below summarizes some additional information about the public's utilization of marine resources in the three New England states that border the Gulf of Maine.

These figures don't reflect the full value of benefits from marine resources of the Gulf of Maine. They reflect only use values that people attach to the in situ consumption of the services from these resources. It is important that we comprehensively estimate the many other use values of Gulf of Maine resources. Furthermore, so-called non use values (i.e., the component of the value that is not derived from in situ consumption) such as the benefits from mere preservation of the marine ecosystem, should be given important consideration in this comprehensive estimate.

Management plans, to be useful, should take into account both their costs and benefits which will be measured in part based on this type of information as well as information derived from the physical and biological sciences. A number of difficult questions need to be answered. For example, how much do recreational users of the Gulf of Maine value cleaner beaches or improved fish catch rates? Is the value of their benefits greater than the management costs? How important is the protection or improvement of the Gulf of Maine ecosystem to coastal residents? To what extent does the marine water need to be cleaned for specific uses, and at what cost? Policy makers involved in management programs need more quantitative information about the extent to which use and non use values of the Gulf of Maine resources are affected by their decisions.

Inevitably, there are uncertain factors about the benefits and costs as well as the ecosystem itself. Economic and scientific research can help resolve some of the uncertainty. However, uncertainty will never be completely resolved and management decisions must be made within the context of stated (or implied) limits to knowledge. This implies that policy makers also need to know the public's preference with respect to benefit-cost tradeoff involving uncertainty. For example, some may be willing to incur very high management costs now to avoid possible but highly unlikely future damage to the ecosystem. Others may prefer to keep using marine resources at current rates without any improvement or maintenance plan until they see further evidence of environmental stress. It is incumbent upon the scientific and economic researchers to place this inevitable uncertainty within a framework useful for decision making.

Monetary resources for the formidable task of managing the Gulf of Maine are limited. To best serve the public, benefit-cost analyses should be used to help establish regulatory and management priorities. Such analysis needs to be based on a realistic assessment of the full value of these public resources. The most effective and successful management plan can be established only through the synthesis of economic and scientific information.

The WHOI Marine Policy Center and Coastal Research Center are currently laying the groundwork for a RARGOM planning workshop. The emphasis of this workshop is to bring together a small group of economists and natural scientists to identify research needs and priorities for integrated economic and scientific research, and discuss a research plan for the management of marine resources. This workshop will begin to bridge the gap in resource management perspectives between economists and natural scientists, who typically have different perspectives on what information is required for managing marine resources, the economic value derived from marine resources and how to measure it, how environmental risk and uncertainty should be managed, and the proper regulatory/administrative approaches for managing marine resources. We believe this effort to synthesize economic and scientific information is an essential first-step toward devising a long-term research plan for the efficient management of the regional marine environment.



Cruise and Field Reports

Monitoring Significant Inflows to the Gulf of Maine: A Field Experiment as part of US GLOBEC

Peter C. Smith, Bedford Institute of Oceanography (BIO)

The inaugural cruise, aboard CSS Parizeau, of the BIO field component of the US GLOBEC project entitled Importance of Physical and Biological Processes to Population Regulation of Cod and Haddock on Georges Bank; A Model-Based Study was conducted during 11-16 October, 1993. The primary goal of this project is to model the 3-D circulation of the Gulf of Maine, with particular reference to the Georges Bank ecosystem. To this end, BIO scientists will attempt to monitor, simultaneously, the important inflows to the Gulf, specifically the flow of fresh surface water from the Scotian Shelf past Cape Sable, N.S., and the deep inflow of warm, saline slope water to the Gulf through Northeast Channel. Annual and interannual variability of these inputs produce significant changes in the 3-D circulation of the Gulf, which are to be 1) modeled by the finite element model developed by Daniel Lynch and colleagues at Dartmouth College, and 2) monitored by long term moorings placed on Georges Bank as part of other GLOBEC projects.

Activities during the cruise included the strategic placement of three moorings along the eastern boundary of the Gulf; two on opposite sides of Northeast Channel and one off Cape Sable, N.S. In addition to the moorings, a CTD survey and repeated acoustic Doppler current profiler (ADCP) transects across Northeast Channel were conducted. Preliminary analysis of the ADCP data has now been completed, including the removal of a time- and space-dependent semi-diurnal tidal component. The removal of the dominant tidal signal from the axial flow component in Northeast Channel reveals the structure of the residual mean inflow current field and allows the net transport to be estimated for later comparison to the moored data. Section plots of the axial flow field are in qualitative agreement with previous moored measurements, featuring surface outflow on the Georges Bank side and deep inflow on the eastern side of the Channel. Furthermore, the net transport into the Gulf below 75m ($472 \times 10^3 \text{ m}^3 \text{ s}^{-1}$) is close to the October estimate from earlier moored measurements ($300 \times 10^3 \text{ m}^3 \text{ s}^{-1}$). Detailed ADCP surveys of the current field in Northeast Channel over the duration of the GLOBEC field program will assist in relating the moored measurements to the net inward transport to the Gulf.

The CTD data indicate that Gulf Stream-like water was present in the Channel inflow as a result of the presence of a warm-core ring at the mouth. Satellite infrared imagery reveals that this ring moved into the region in September, 1993, and remained "parked" in the Channel entrance until the end of October. This forcing may have been responsible for elevated transport in the Channel, suggested by the ADCP results. Detailed analysis of inflow events such as these is expected to provide important insights into the climatological variability of the Gulf and their biological consequences.

Hydrographic and Ichthyoplankton Survey Cruises - Gulf of Maine and Georges Bank

David Townsend, University of Maine

Two second-year survey cruises in the Georges Bank - Gulf of Maine area have recently been completed aboard the R/V *Columbus Iselin*, from April 7 through 15th and from May 12 through 20th. Two cruises were also conducted last year in April and May. The primary purpose of the cruises was to survey the mesoscale distributions of cod larvae in relation to the hydrography on the Bank. A secondary priority was the survey of hydrographic properties in the Gulf of Maine. The 1994 station locations are given in the two figures.

Standard CTD/*in situ* fluorometer/transmissometer casts were made at each station; water samples were collected using the ship's rosette system, and analyzed for phytoplankton chlorophyll and nitrate+nitrite. In addition, 150 and 600 Khz ADCP current measurements were made throughout each survey cruise. Ichthyoplankton samples were collected at the Georges Bank stations, using 60-cm Bongo nets and 505 μm mesh nets. Data are still being reduced and organized as of this writing, and we expect that a data report for all four cruises during 1993 and 1994 will be available by early fall. Our GLOBEC colleagues can expect to be sent copies automatically.

Three Estuary Experiment

Larry Mayer, University of Maine

The definition of an estuary - a mixing zone twixt river and ocean - implies a critical role of river input to its functioning. Examination of this importance usually relies on temporal "experiments" (ecosystem variations measured under different river flow in a single estuary) or spatial "experiments" (comparing different estuaries with different levels of river input). The Kennebec, Sheepscot, and Damariscotta estuaries of central coastal Maine offer a perhaps unique, spatial "experiment" in that they are very similar in terms of climate, tidal feedwater, many watershed characteristics, morphometry and other factors. However, their average river input varies in roughly order of magnitude steps, respectively. We are examining the role of this riverine input variable on the circulation, stratification, light field, nutrient dynamics, biological production, and particle dynamics in these three systems. This examination involves a series of cruises from summer of 1993 through the summer of 1994, with sampling from the UNH R/V Gulf Challenger. The PIs on this Sea Grant funded project are Larry Mayer, Neal Pettigrew, and Dave Townsend from the University of Maine, and Ted Loder from the University of New Hampshire.

Gulf of Maine Coastal Current Study

Rocky Geyer, Woods Hole Oceanographic Institution

As part of the physical/biological study of harmful algal blooms in the western Gulf of Maine, a hydrographic and biological survey was conducted during the period of May 31 to June 6, 1994. This survey was the sixth cruise conducted in 1994 as part of the research program. The R/V ARGO Maine left Woods Hole at 1900 GMT and started the Leg 1 survey track (shown in figure 1). The ship finished Leg 1 on June 3rd and went to Boothbay Harbor. Leg 2 started from Boothbay Harbor on June 3rd and finished in Portsmouth on June 6th (figure 2).

Scientific crew included Greg Boyer from SUNY Syracuse, Dot Medeiros-Bergen, Ginger Cota, Scott Drummy, Dave Fredriksson, and Jim Moffatt from the University of New Hampshire, and Rocky Geyer, chief scientist, Song Hui, and Bruce Keafer from the Woods Hole Oceanographic Institution. Brian Gomez was the CTD technician.

CTD casts were performed with a Neil Brown MK 3 CTD at all locations. The CTD included a 25-cm pathlength transmissometer. A 1.2 MHz acoustic Doppler current profiler (ADCP) obtained velocity data over the top 30 m of the water column. Water samples were obtained at near-bottom, 20-m, 10-m, 5-m and 1-m depths at most stations. Subsamples were obtained for nutrient analysis by Loder at UNH and dinoflagellate cell counts by Anderson at WHOI. During Leg 1, Madeiris collected larval sea cucumbers, and Boyer collected samples for iron chelating studies. During leg 2, Moffatt and Boyer collected samples for trace metals. A near-surface drifter with temperature and conductivity sensors was deployed prior to the cruise by the Coast Guard off the mouth of the Kennebec, and another drifter was deployed off Cape Elizabeth from the R/V ARGO Maine on Leg 1.

The hydrographic data revealed strong upwelling conditions (figure 3), due to strong southwesterly winds that occurred before and during leg 1. The drifters indicated that the coastal current was not flowing southwestward during the cruise, but rather was spreading across shore. The upwelling conditions appear to decrease the abundance of dinoflagellates in the coastal current, perhaps due to offshore advection. Preliminary cell counts performed during the survey indicated higher abundance of dinoflagellates in the vicinity of Cape Elizabeth and Saco Bay than in other parts of the region that were sampled.

Western Gulf of Maine Circulation: The Observation Program

Wendell S. Brown, University of New Hampshire

This report describes the recent activities associated with the UNH moored measurement and hydrographic measurement component of the 1993-1995 Regional Marine Research Program (RMRP). On 16 March 1994, a bottom pressure/temperature (BP/T) instrument was diver-mounted on one of the pilings on the Cape Porpoise town pier, followed by the deployment of the Cape Porpoise (CP) temperature/conductivity (T/C) array in about 100 m (see table for instrument configuration). The new UNH research vessel, the R/V Gulf Challenger, was used for deployment operations, which included deploying a separate bottom-mounted BP/T instrument near the surface mooring. Also, hydrographic measurements were made across the inner shelf between the coast and the Cape Porpoise mooring.

On 21 March, after waiting for suitable weather, we deployed a T/C array and a BP/T instrument in 270 m of water in northern Wilkinson Basin. We also conducted a hydrographic survey between Cape Porpoise and Wilkinson Basin.

Our late March sequence of hydrographic measurements near the coast showed rapidly increasing amounts of less saline water in the coastal zone. Between late March and late May, the water with salinities less than 32 psu deepened to nearly 50 m inshore of the 80m isobath and at shallower depths extended offshore to about Jeffrey's Ledge. The coastal freshening appears to be continuous along the coast, as evidenced by the similar picture along the Portsmouth section. Our March hydrographic measurements in Wilkinson Basin clearly show that we "captured" the beginning of the water mass season. The late March CTD profiles in Wilkinson Basin reveal a well-mixed water column of winter water between 150 m and the surface. By late May, warming had begun to stratify the upper water column, isolating 1994 Maine Intermediate Water (MIW) at about 4°C, 33 psu. We also documented the arrival of the more saline Maine Bottom Water (MBW) between March and May.

Reports Received

The following reports have been received at the Association office and are available for distribution by contacting the author.

Auster, P. J., and A. N. Shepard, "An Annotated Bibliography of Visual and Optical Survey Methods for Aquatic Megafauna", NOAA's National Undersea Research Center, University of Connecticut at Avery Point, Groton, CT 06340, Connecticut Sea Grant Publication Number CT-SG-93-02

Mooring Configurations. A data acquisition unit on the surface buoy stores the temperature/conductivity (T/C) measurements and also transmits them ashore via the GOES satellite. In-line rubber tethers (RT) help reduce wave-induced mooring wear. An acoustic release enables easy retrieval.

Mooring ID	Water Depth	Instrument Depth	Instrumentation
CH	5 m	4 m	BP/T
CP	107 m	4 m 30 m, 70 m 106 m	VACM/T T/C BP/T
WB	271 m	4 m 30 m, 70 m, 120 m, 220 m 270 m	VACM/T T/C BP/T

The UNH RMRP station location map. Moored pressure/water property measurement stations in Cape Porpoise Harbor (CH), offshore of Cape Porpoise (CP) and in northern Wilkinson Basin (WB) are located along with the hydrographic stations relative to the 100m and 200m isobaths.

"Biological Populations as Indicators of Environmental Change", vol.1, EPA/230/R-001, December 1992, Public Information Center, U. S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460

"Gulf of Maine Circulation Modeling: Workshop Proceedings", RARGOM Report number 94-1, Braasch, E., editor

"U.S. GLOBEC: Global Ocean Ecosystems Dynamics". *Topical Studies in Oceanography, Deep Sea Research Part II* (a companion journal to *Continental Shelf Research*) James. E. Eckman, guest editor, Pergamon Press, New York, Vol.41, No.1.

Resources

Xbrowse Satellite Data Archive now Available

Jim Bisagni, NOAA Remote Sensing Laboratory, NOAA/NMFS

Near real-time, daily, satellite-derived sea surface temperature (SST) data, which cover Georges Bank and the Gulf of Maine are available for browsing over the Internet. This browse capability is being made available via the Xbrowse (X-window based) client/server system developed by Jim Gallagher (jimg@dcz.gso.uri.edu) in Peter Cornillon's group located at the University of Rhode Island's Graduate School of Oceanography. In addition to visual "browsing" of the data, the Xbrowse system also allows the names of user-selected images to be listed in a file on your local host for later use in retrieving those images from the Xbrowse server via ftp.

The latest Xbrowse client (ver. 3.3.7) and accessory files are available for SunOS 4.1.3 (Sun SPARC), OSF 1.3 (DEC Alpha) and Ultrix 4.3 (DECstation) via anonymous ftp from zeno.gso.uri.edu (/pub/xbrowse) and must be uncompressed, restored (via "tar") and properly installed on your local host for the system to work.

At the present time all daily NOAA-11 Advanced Very High Resolution Radiometer satellite passes from 1 October 1993 up to the present day (generally 2 passes per day) have been remapped (earth-located) to our Georges Bank/Gulf of Maine "standard" region (given below) in a Mercator projection and are available for browsing from the image server located on dcz.gso.uri.edu. Our standard region is bounded by: 39.013 - 45.429 deg N latitude, and 63.487 - 72.164 deg W longitude.

Precision navigation of each image on the server to within 1 or 2 pixels has begun with the image file names receiving a ".nav" file extension when navigation is completed. Be aware that "un-navigated" images ("rmp" file extension) may possess navigation errors of up to 6 or 7 pixels in the meridional and/or zonal directions.

Daily remapping and weekly backups of these data will continue until after completion of the GLOBEC and Gulf of Maine field programs are completed. Each of these images are in University of Miami XDR04 format, consisting of an 8-bit, 512 X 512 pixel binary image, preceded by three 512-byte header records. The size of each image file (in uncompressed form) is ~250K bytes.

Assuming that the client is properly installed on your local host, you can start the remote server by typing: xbrowse -server dcz.gso.uri.edu

Those of you who have an earlier version of Xbrowse and would like access to the server should get an update because the latest version handles the Mercator projection properly.

If you would like to download any of the images over the Internet to your local host for your own use, please contact me Omnet: J.BISAGNI, Internet: bisagni@fish1.gso.uri.edu, (401) 782-3313, or Carl Wolfeich(carlw@chips1.gso.uri.edu).

Regional Marine Research Program

David Townsend, University of Maine

Data & Information Management RFP Announced September 1st deadline

A total of up to \$300 K will be awarded to fund a winning proposal to develop and operate for an initial three year period, with potential for continued funding beyond those three years, a regional scientific Data and Information Management System to support the needs of the RMRP and the broader Gulf of Maine research community. Interested researchers should refer to the guidelines established in the Recommendations from the Data and Information Management Systems workshop held last November at the University of New Hampshire, and also to the complete RFP, available from Kathy Carson at the RMRP office (207) 581-1435. The RFP is posted on the OMNET Oceans Bulletin Board. In addition to developing a system that directly supports the RMRP, the system design and operation should be such that other non-RMRP marine scientists will contribute to and make use of it. This initial effort is expected to serve as the basis for a broader and more comprehensive regional system to be developed in support of the long range goals identified at the workshop.

Projects Recommended for Year 3

The following projects have been recommended by the RMR Board and were approved by NOAA on June 20th. Including these third-year awards, total RMR program participation includes 17 projects, 39 investigators at 14 different institutions (11 university or private, 3 government).

- Particulate Export Dynamics in the Gulf of Maine: Time Series Biogeochemical Fluxes and Transformations
C. H. Pilskaln, University of Maine
- A Program to Investigate Long-Term Seasonal and Interannual Variability in the Optical Properties and Optically-Active Constituents in the Gulf of Maine Waters: Phase 2, Field Investigations in the Gulf of Maine
C. S. Yentsch, Bigelow Laboratory for Ocean Sciences
- A Seafloor Atlas of the Inner Continental Shelf of the Western Gulf of Maine
J. Kelley, S. Dickson, Maine Geological Survey; D. Belknap, W. Barnhardt, University of Maine; L. Ward, University of New Hampshire
- Spring Bloom Dynamics in the Gulf of Maine, with Emphasis on the Noxious, Indicator Phytoplankton Species, *Phaeocystis pouchetii*
M. Keller, M. Sieracki, Bigelow Laboratory for Ocean Sciences
- Geochemical Transport of Trace Metals and Organic Contaminants via Particle Settling in the Gulf of Maine
S. Morgan, University of Rhode Island

Calendar

This list includes workshops, meetings, working groups and deadlines for proposals. If you know of upcoming events that might be of interest to the Gulf of Maine research community, please contact us.

June			
22-25	The Crustacean Society Second Summer meeting Darling Marine Center, Walpole, ME contact: Lauren Armstrong, Univ. ME, (207) 563-3146 ext.200	12	Proposal deadline, North American Wetlands Conservation Act Grants Program U.S. Fish & Wildlife Service contact: Dr. Robert Streeter, (703) 358-1784
July			
1	MWRA Abstract deadline, 1995 ASCE National Conference on Water Resources Planning & Management, Cambridge, MA, May 7-10 conference theme: "Integrated Water Resources Planning for the 21st Century" contact: Mike Domenica, 100 First Ave., Charlestown Navy Yard, Boston, MA 02129	15-18	ICES Symposium on Zooplankton Production Plymouth, UK contact: R.P. Harris, Plymouth Marine Lab (+44 752 222772)
15	NERRS Pre proposal deadline FY 1995 "Habitat Restoration" contact : Michele Dionne (207) 646-1555	19	GLOBEC International & ICES Cod & Climate Change mini-symposium Plymouth, UK contact: B. Rothschild, CBL, Univ. Maryland, (410) 326-7289
22	NURC Pre Proposal Deadline FY 1995 contact: Peter Auster, UCAP (203) 445-3452	September	
August		2	NURC Final Proposal Deadline '95 contact: Peter Auster, UCAP (203) 445-3452
2-4	GoM Council on the Marine Environment Conference Acadia University contact: Patricia Hinch, NS Dept. of the Environment, (902) 424-6345	20-23	Coastal Zone Canada '94 Halifax, NS contact: Brian Nicholls, (902) 426-3246
		22-30	ICES Annual Meeting St. John's, Newfoundland, CANADA contact: ICES secretariat, Palaegade 2-4, DK-1261, Copenhagen, DK, tel: 33 15 70 92
		October	
		14	RARGOM meeting St. Andrews Biological Station St. Andrews, New Brunswick contact: Genie Braasch, Dartmouth College, (603) 646-3480

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We welcome Cornell University, which joins RARGOM as a full member. Chuck Greene will serve as the representative.

Research Vessels Schedule 1994
