

# U.S. GLOBEC NEWS

Number 10

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## Georges Bank Investigators Summarize 1994 and 1995 Results at Workshop

The U.S. GLOBEC Georges Bank Program Scientific Investigators met at the Woods Hole Oceanographic Institution for two days in October 1995 to discuss the results of the 1994 and 1995 field investigations. U.S. GLOBEC supported 8 cruises (81 days) to Georges Bank in 1994, and 24 cruises (278 days) in 1995. The Coastal Ocean Program of NOAA also supported 4 cruises (47 days) and 5 cruises (61 days) in 1994 and 1995, respectively. The workshop objectives were to enable the scientific investigators to describe their research activities to one another, to exchange data and information, and to work together toward developing the scientific products that will fulfill the program's goals and objectives.

### Goals

**Proximate:** to understand the population dynamics of target species on the Bank, in terms of their coupling to the physical environment and their predators and prey.

**Ultimate:** to predict changes in the distribution and abundance of these species as a result of changes in their biotic and physical environment and to anticipate how their populations will respond to climate change.

The workshop was organized around four major themes:

- Bank-wide physical and biological structures
- water column stratification and its effects on biological distributions and processes
- the population dynamics of the target species (cod, haddock, *Calanus finmarchicus*, *Pseudocalanus*)
- hot topics: unexpected findings/discussions or interesting tidbits

Each of the sessions was a blend of physics, biology and modeling work. Presentations and discussions were designed to improve our understanding of the coupling of

physics and biology of the region. For each session there was a chairman and two rapporteurs. After each session, an open discussion was held. A total of 66 presentations were made over the 2.5 days of the workshop. Abstracts of most of the presentations are available via the U.S. GLOBEC Georges Bank World Wide Web site at:

<http://globec.whoi.edu/globec-dir/reports/siworkshop.1995/report.html>

### Unexpected Findings

Several of the scientific results from the studies conducted on Georges Bank in 1994 and 1995 were unexpected. Prior to this program it was believed that nutrition of larval cod during the first few weeks after hatching was almost exclusively derived from the yolk carried in the yolk sac. This assumption is apparently incorrect; investigators in the program have discovered through a set of experiments that

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*Georges Bank—(Cont. from page 1)*

within a couple of hours after hatching, cod larvae are capable of feeding on microzooplankton, and that this energy intake is essential to their survival. A second surprise was *Calanus finmarchicus* actively feeding and reproducing throughout the summer and autumn. Previously, it was thought that *C. finmarchicus* entered a deep-dwelling (off the Bank—in the Gulf of Maine or slope water) quiescent (or diapause) state in summer (after the spring bloom) as C<sub>3</sub> copepodites, to later complete development and reproduction in late winter or early spring during the period of the phytoplankton bloom. Cruises in late fall and early winter of 1994 and 1995 found some *C. finmarchicus* awake, feeding and maturing. Moreover, analysis of data collected during the 1977-1987 MARMAP program show that a small fraction of the population continued to reproduce and develop throughout the year. Finally, sessile hydroids, *Clytia gracilis*, apparently transported from the bottom on Georges Bank by strong tidal currents, were very abundant, up to 25000 per m<sup>3</sup>, in the water column. Laboratory experiments and gut content analysis suggest that the hydroids could consume 50-100% of the daily production of copepods and may also prey directly upon cod larvae.

### **Session I. Bank-wide structures** **David Mountain (Chair), Ann Bucklin and Dan Lynch (Rapporteurs)**

The session had 29 presentations that addressed Bank-wide structure of the physics and biology as observed in recent field studies, in historic data sets and in modeling efforts. From the presentations two issues were identified for discussion. Winter time observations in the program found *Calanus finmarchicus* actively involved in growth and reproduction in the near surface layer. This finding diverged from the conventional *Calanus* life cycle paradigm, which would have the organisms in diapause at depth in the western Gulf

of Maine in winter. Charlie Miller summarized the knowledge of the *Calanus* life cycle and led a discussion on the implications of the recent findings. The second issue identified was how to evaluate the relative importance of predation by different predator groups and the combined importance of predation compared to other factors in the life history of the target species. Michael Fogarty led a discussion of this issue.

Hydrographic conditions and physical transports on the Bank and adjacent regions were the subject of a number of presentations (John Loder; Peter Smith; David Mountain; James Bisagni; Christopher Naimie; Glen Gawarkiewicz; Robert Beardsley; Charles Flagg and Robert Houghton). Three presentations addressed biological variability using historical data sets: Steve Bollens used data from *Atlantis* cruises in 1939-41 to examine the distribution and abundance of zooplankton; Carol Meise and Barbara Sullivan reported on the seasonal, interannual and spatial patterns of copepods and invertebrate predators, respectively, using the MARMAP data set collected from 1977-1987.

Nine presentations were made on broad-scale biological observations obtained during 1994 and 1995. Ted Durbin reported on the abundance, age structure, and distribution of plankton on the bank. Adult *C. finmarchicus* appeared to be advected onto the bank, encounter higher food levels leading to high egg production, and were advected along the southern flank. Nauplii and young stage copepodites developed rapidly, in some cases near estimated maximum rates, at all sites. Conversely, development of older copepodite stages of *Calanus* and *Pseudocalanus* progressed slowly. Jack Green reported that 90% of the larval fish sampled during April and May 1995 had prey in their guts, mostly the naupliar stages of calanoids and *Oithona* in April, but calanoid copepodites also in May. Ann Bucklin used mtDNA to document regional differences in *Meganycitophanes norvegica* populations. Genetically, *C.*

*finmarchicus* constitutes a single population from the Gulf of St. Lawrence to the Gulf of Maine. mtDNA measures of genetic similarity may be useful for documenting dispersal pathways in the NW Atlantic. April and May conditions on the bank were described by Dave Townsend from (non-GLOBEC) cruises made during 1993 and 1994. Hydrographic, nutrient, chlorophyll and zooplankton data suggest that both primary and secondary production on the Bank are nitrogen-limited; zooplankton production is highest on the Northern Flank and Northeast Peak, where new nitrogen is supplied to the bank. Planktonic hydroids were very abundant on the bank in 1994; in 1995, experiments were done to estimate growth rates, life histories and feeding rates of the hydroids (Barbara Sullivan). Spatial changes in the distribution of larval cod and haddock and their fish predators, and how these distributions shift in response to temperature changes on the southern flank were reported on by William Michaels. Charlie Miller reported on his investigations of the storage lipids of *C. finmarchicus*, especially the dynamics of transfer between the wax ester and triacylglyceride lipid pools. Liz Clarke's data suggest that the variability in enzyme activities of larval fish and copepods is probably related to small-scale heterogeneity in the local oceanography. Condition varied with season and by year (using 1993 and 1994 samples), and the patterns differed for the *Calanus* and larval fish. Peter Wiebe found quantitatively comparable estimates of the abundance and size of the most abundant zooplankton taxa (copepods and pteropods) using MOCNESS and VPR sampling. The relative proportions of individual taxa observed in net and VPR samples were used to apportion high frequency acoustic estimates of zooplankton biomass into individual taxa over the gridded sampling region.

The final seven presentations of this session addressed physical, biological and coupled bio-physical modeling of the Georges Bank system. Using

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*Georges Bank—(Cont. from page 2)*

climatological hydrography, Frank Bub (and Wendell Brown) developed a box-model of late-summer and autumn transports (advection) and mixing (diffusion) for the Gulf of Maine and Georges Bank region. Cisco Werner presented the results of including turbulence in a coupled trophodynamic-transport model of cod and haddock larvae, which indicate that more detailed information on larval feeding behavior is needed to evaluate the impact that turbulence has on growth; although turbulence may enhance encounter rates with prey (a positive impact), its impact on search behavior, pursuit and capture may negatively impact larval growth.

Dan Lynch summarized efforts to develop realistic dynamic prey fields to support larval fish growth experiments in highly detailed 3-D circulation fields; the specific example presented was a stage-structured population dynamics model of *Pseudocalanus* in a realistic circulation field. The advection of cod and haddock larvae from the NE peak site of spawning was accurately simulated (compared to the distribution of larvae determined from high resolution sampling during the spring) by a 3-D prognostic model hindcast using observed nearby winds and climatological density fields (James Manning). Using the Lynch model of circulation on the bank, Fred Page showed particle tracking results that indicate that the cod and haddock are spawning in the areas and at times that result in their longest residence times on the bank (see also the article by Sinclair and Page in U.S. GLOBEC NEWS No. 8, March 1995). Greg Lough showed how the distribution and retention of larvae on Georges Bank differed among years (using MARMAP data), and that this may contribute to variable recruitment. They are using a particle tracking 3-D model with observed past physical forcing to examine how large an impact these interannual differences in forcing can have on the distribution and survival of the larvae. Changsheng Chen described an NPZ model coupled with a mixed-layer physics model that produced spatial patterns of biomasses and fluxes

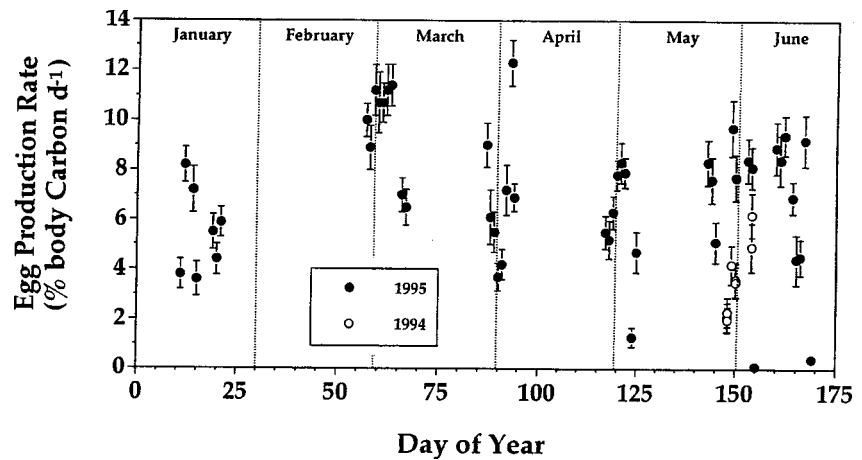


Figure 1. Weight-specific egg production of *Calanus finmarchicus* measured during process cruises on Georges Bank (filled circles: 1995; open circles: May-June, 1994). Female body carbon measured directly; egg carbon mass assumed to be 0.23  $\mu\text{g}$ . Rates are not adjusted for seasonal changes in ambient temperature.

of biological variables that agreed reasonably well with field measurements on and off the Bank.

## Session II: Stratification and Its Effects

**Bob Beardsley (Chair), Dian Gifford and Ted Durbin (Rapporteurs)**

The session on stratification was subdivided into four parts: (1) physical oceanographic setting; (2) biological oceanographic setting; (3) measurement of vital physiological rates; and (4) a panel discussion of the effects of stratification and microturbulence on the biology of Georges Bank.

**Physical Oceanographic Setting.** The suite of presentations covered scientific ground as extensive as Georges Bank itself. Jeff Van Keuren used measured light fields on the Bank during the development of stratification to estimate the times and depths where larval fish, which are visual predators, are able to feed. Jim Bisagni presented a retrospective analysis of SST and stratification on the Bank, and related interannual variability in stratification to differences in heat flux.

Five presentations dealt with various aspects of the program's long- and short-term mooring programs. Jim Irish gave an overview of the long-term mooring program, including Page Valentine's

bottom surveys of the mooring sites and preliminary data from the crest and southern flank moorings. Bob Beardsley described the evolution of vertical stratification at mooring site ST1, including resolution of an ca. 20 day "salt event" of warm salty water intruded from offshore in May 1995 (presumably associated with a warm-core ring). Jim Manning presented preliminary data from mooring site ST2, including measurements of wind stress associated with vertical velocity shear during wind events. Jim Churchill and Sandy Werner described various aspects of the bottom tripod (BASS) system deployed at mooring site ST1, including resolution of stratification events in the bottom five meters of the water column.

Drifter studies were described in two presentations. Jim Churchill reviewed the small-scale drifter program, which assisted the larval fish component in tracking plankton patches and studied small scale fluid dynamics. Peter Garrahan described the short-term drifter deployments performed on the 1994 and 1995 vital rates process cruises.

Two presentations concerned turbulence fields on the Bank. Russ Burgett presented maps of microturbulence measurements done in the spring of 1995 using Neil Oakey's Epsode probe system. Chris Naimie reviewed model-generated turbulence patterns on the Bank.

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# Small Pelagic Fishes and Climate Change (SPACC) Programme of GLOBEC Progress Toward an Implementation Plan

by Juergen Alheit and John Hunter

## Background and Objectives

This article summarizes the first Implementation Meeting of the SPACC Programme held in Swakopmund, Namibia, 4-8 December 1995. SPACC is an element of GLOBEC which is one of the Global Change Core Projects of the IGBP. The objective of SPACC is to use ecosystem comparisons to determine the impact of climate variation and change on those ecosystems where small pelagic fish such as sardine, anchovy, sprat and similar species play an important role. The Science Plan of SPACC was published in 1995 as GLOBEC Report No. 8. The strategy for implementing GLOBEC-SPACC is to develop an Implementation Plan over the course of two international community meetings, one in Africa in 1995 (Swakopmund, Namibia) and a final meeting in Mexico City in August of 1996 thereby facilitating world-wide participation.

The meeting was supported by the Namibian Fisheries Ministry and was held in the National Marine Information and Research Center (NATMIRC) of Namibia in Swakopmund. It was sponsored by NATMIRC, the Scientific Committee of Oceanic Research (SCOR), the Intergovernmental Oceanographic Commission (IOC) of Unesco, the German Agency for Technical Cooperation (GTZ) and the U.S. GLOBEC Office.

The meeting was attended by 36 scientists from 16 countries (Namibia, South Africa, Angola, Ghana, Morocco, Turkey, Romania, Italy, Spain, France, Germany, Denmark, Sweden, Norway, Russia and USA; see Table 1).

The objectives of the meeting were to:

- initiate the SPACC Implementation Plan and draft a working document for distribution to the whole SPACC community
- create rapid-start subgroups which would accelerate the development of the SPACC Programme
- enhance SPACC cooperation among African scientists, countries and regions.

## Meeting Plan

The objective of the Swakopmund meeting was to plan efficient implementation of two key goals of the GLOBEC-SPACC Science Plan (International GLOBEC Report No. 8): (1) to understand the impact of climate variations on marine ecosystems inhabited by small pelagic fishes by analyzing long-term data series; and, (2) to develop a comparative core

programme on small pelagic fishes and climate variability which could involve all SPACC countries in process-oriented sea projects, on mechanisms linking physical forcing, zooplankton production, and pelagic fish dynamics. Modeling and remote sensing receive special attention in the report because participants believed a successful SPACC Programme shall be strongly dependant upon strength in these disciplines. Paleocological and genetic investigations are also important parts of the SPACC Science Plan and discussion of the implementation of these components is scheduled for the second Implementation Meeting in Mexico.

The working group assignments and terms of reference evolved over the meeting. The focus of Working Group I, *Decadal Ecosystem Changes*, was on the use of retrospective data to answer fundamental questions regarding DECADAL variability of small pelagic fish populations and atmospheric teleconnections between systems. Working Groups II and III focused on using comparative process studies to understand the links between climatic, zooplankton and fish population dynamics, but their approach differed. Group II used a "bottom up" while group III used a "top down" approach to design a minimum core programme. Working Group II, *Fish Growth and Zooplankton Distribution*, examined existing surveys and research programmes in six West African or Mediterranean countries to define a common minimum core programme that could lead to significant insight without a major outlay of new resources. Working Group III, *Process-oriented Studies on Zooplankton and Fish Dynamics in Relation to Hydrography*, considering the full range of measurements needed for a comprehensive comparative programme addressed a wide range of questions concerning fish productivity and then defined the minimum core programme. Working Group IV, *Implementation of Modeling*, focused on strategies for implementing modeling in SPACC.

## Summary of Working Group Reports

### Working Group I: Decadal Ecosystem Changes

In most of the world's ecosystems supporting populations of small pelagic fishes, major changes in their productivity may persist for decades producing regimes of high or low productivity. These regimes appear to be linked on a world-wide scale (see SPACC Science Plan, GLOBEC Report No. 8). The Working Group formulated eleven key

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Addenda to U.S. GLOBEC Report No. 15.----

- 1) The correct date of the report, May 1996, is on the cover. The date on the title page should be corrected from 1995 to 1996.
- 2) The acknowledgements (page preceding the Table of Contents) should state:

This is a report of the U.S. GLOBEC Workshop on the Climate Change and Carrying Capacity of the North Pacific Ecosystem held at the Batelle Conference Center in Seattle, WA, USA, from 19-20 April 1995. Anne Hollowed and Art Kendall co-chaired the workshop. The workshop report was edited by Anne Hollowed. The following people made a significant contribution by making a presentation at the meeting, or in preparing text for the workshop report.

Hal Batchelder, Richard Brodeur, Nick Bond, E. D. Cokelet, Dan Costa, Robert DeLong, Robert Francis, Scott Hatch, Al Hermann, Anne Hollowed, Art Kendall, Thomas Loughlin, Bernard Megrey, Jeff Napp, Jim Overland, William Pearcy, Tom Powell, Ron Reed, Tom Royer, James Schumacher, Alan Springer, Phyllis Stabeno, Ted Strub, and Warren Wooster.

- 3) Two tables (No. 8 and 9) were mistakenly left out. They are found on this and the next page of this newsletter.

Table 9. Potential monitoring platforms in the Gulf of Alaska

Source	Physical	Chemical	Biological
Coastal observations - Marine Laboratories	T, S, sea level, P, wind	Nutrients	Plankton
Volunteer Observation Ships - VOS	T, S, P, wind		Plankton
Commercial fishing vessels	T, S, CTD, P, wind		Plankton, spp. composition, growth
Alaska Ferries	T, S, P, wind		Plankton
Moored buoys	T, S, CTD, P, wind, current	Nutrients	Fluorescence
Drifters - reusable	T, current		
ALACE floats	T, S, current		chlorophyll, fluorescence
Autonomous Underwater Vehicles	T, current		chlorophyll
Remote Sensing	T, S, current, sea level		
SAR aircraft (NOAA)	current, sea level		
Ocean Station P and Line P	T, S, CTD, P, wind	Nutrients	Plankton
GAK 1	T, S, CTD, P, wind	Nutrients	Plankton, spp. composition, growth
Meteorological observations	Precipitation, temperature, P, wind		
Automated buoys, sea chests	T, S	Nutrients	physiology, behavior growth, abundance, distribution, food habits
Intelligent tags			distribution
Monitor seabird populations			distribution, catch historical growth rates
Marine mammal logbook program	T		Plankton abundance, distribution
Commercial fisheries logbook program	T		growth, abundance, distribution, food habits
Aging structures (otoliths, teeth, fin rays)			growth, abundance, distribution, food habits
Continuous plankton recorders	T, S		growth, abundance, distribution, food habits
Marine mammal surveys at rookeries			growth, abundance, distribution, food habits
Surveys of groundfish and pelagic fish	T, S, CTD		growth, abundance, distribution

Pacific Seabird Monitoring Database

ALACE = Autonomous Lagrangian Circulation Experiment; T = Temperature (air and SST); S = Salinity; P = Atmospheric Pressure; CTD = Conductivity-Temperature-Depth

Table 8. Summary of data types and sources for retrospective studies of the Gulf of Alaska.

Physical	Air		Data Type												
	Temp.	SST	Salinity	Wind	Wave Height	Pressure	Humidity	Precip.	Cloudiness	Glacial Extent	Current	Freshwater Discharge	Solar Radiation	Sea Level	Tides
Source															
GAKI/UAF	x	x	x												
Line P	x	x	x	x			x								
FOCI Line 8	x	x	x	x											
CMS	x	x	x	x			x								
NWS	x	x	x	x											
COADS	x	x	x	x											
NODC	(x)	x	x												
FNOC															
Remote Sensing	x	x	x												
NCBC	x	x	x												
FBHU	x	x	x												
UAF/T.Royer				x											
Tidal Stations															

FOCI = Fisheries Oceanography Coordinated Investigations; CMS = Coastal Meteorological Stations; NWS = National Weather Service; COADS = Comprehensive Ocean Atmosphere Data Set; NODC = National Oceanic Data Center; FNOC = Fleet Numerical Oceanographic Center; NCBC = National Climatic Buoy Center; UAF = University of Alaska Fairbanks; FBHU = Faculty of Fisheries, Hokkaido University, Japan; (X) = Buoy data only.

Biological	Data Type										
	Historical Records	Phyto. abund. & distrib.	Zoop. abund. & distrib.	Ichthy. abund. & distrib.	Ichthy. Growth	Ichthy. Food Habits	Fish & Shellfish catch	Fish & Shellfish Growth	Fish & Shellfish Reprod.	F & S abund. & distrib.	F & S Food Habits
Source											
Sediment Cores	x										
Tree Rings	x										
Middens	x										
Oolith Analysis	x										
Remote Sensing											
Station P											
Hatcheries											
FOCI											
AFSC											
ADP&G											
ADP&G											
IPHC											
INPFC/NPAFC											
OCSEAP											
UAF											
UAF											
FBHA											
UW											
EVOS											

FOCI = Fisheries Oceanography Coordinated Investigations; AFSC = Alaska Fisheries Science Center; ADP&G = Alaska Department of Fish and Game; UW = University of Washington; UAF = University of Alaska Fairbanks; IPHC = International North Pacific Halibut Commission; EVOS = Exxon Valdez Oil Spill Trustees; INPFC = International North Pacific Fisheries Commission; NPAFC = North Pacific Anadromous Fisheries Commission; FBHU = Faculty of Fisheries, Hokkaido University, Japan; F & S = Fish and Shellfish

Biological	Data Type									
	Seabird Growth	Seabird Reprod.	Seabird abund. & distrib.	Seabird food habits	Marine mammal growth	Marine mammal reproduction	M. mammal abund. & distribution	M. mammal food habits		
Source										
Middens										
EVOS										
U.S. FWS	x	x	x	x	x	x	x	x	x	x
UC Irvine	x	x	x	x	x	x	x	x	x	x
UAF	x	x	x	x	x	x	x	x	x	x
NPUMARC										
ADP&G										
NMML										

U.S. FWS = United States Fish and Wildlife Service; NMML = National Marine Mammal Laboratory; ADP&G = Alaska Department of Fish and Game; UAF = University of Alaska Fairbanks; NPUMARC = North Pacific Universities Marine Mammal Research Consortium; UC Irvine = University of California Irvine; EVOS = Exxon Valdez Oil Spill Trustees

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## "Six months, two years, five years"

by Zack Powell (U.S. GLOBEC SSC Chairman)

Good advisors learn quickly to discover what an advisee wants to do. They often counsel the advisee to do just what he or she wants — unless it's a felony, or some other socially undesirable act. So, with my students, I find myself asking, "where would you like to be in...six months,...two years,...five years?"

The editor of U.S. GLOBEC News has turned the tables on me. He asked, "where would you like this program to be in '...six months,...two years,...five years.'" I cannot offer the reader a completely unbiased wish list. Any entry for the shorter, six-month time scale will reflect my involvement in program planning. Pretty safe. Conversely, even though our Long Range Science Plan (GLOBEC Report No. 12) covers a decade, the longer, five-year time horizon must contain a healthy dose of speculation. Finally, in this short space, I could only include a small number of the many desirable directions.

In the next six months NSF and NOAA sponsors will release an Announcement of Opportunity (AO) that will kick off U.S. GLOBEC activities on the west coast of North America. The AO will focus on modeling and retrospective studies, as is our convention. Successful projects will be the first steps up the ramp to a fully integrated program of modeling, retrospective investigations, field surveys, and process studies. Within six months the second phase of Georges Bank process studies, focusing on sources, sinks, and retention on the Bank, will begin. Funding decisions have been completed. Investigators in the Northwest Atlantic will be trying to find the time to complete the analyses of data collected in 1995, and prepare for an enormous number of days at sea in 1997. And Peter Wiebe, chair of the Georges Bank Executive Committee, his image looming over computer screens and cruise reports, will ceaselessly encourage and cajole his colleagues into 25 hour days, and more.

I have confidence in these "six-

month" projections — especially Wiebe's presence.

In two years, after a review of the existing Science Plan, the GLOBEC Core Project of the International Geosphere-Biosphere Program (IGBP) will have produced an exciting Implementation Plan. That Plan will contain an ambitious schedule for coordinated, multi-national GLOBEC activities in the Southern Ocean. A review of the U.S. GLOBEC program in the Northwest Atlantic will be complimentary to the energy and scientific productivity of the investigators. Well over one hundred articles will have originated from the Georges Bank investigations. The Northwest Atlantic program will be in the final stages of preparation for their third and final intensive field season. Collaborative cruises with Canada GLOBEC studies on the Scotian Shelf will be a feature of this last field effort. West coast modelers will be preparing for an AGU/ASLO Ocean Sciences session on coupled physical/biological models for the west coast of North America. An unprecedented number of proposals for process studies on the west coast will have just been submitted. Researchers will be anxiously awaiting decisions from NSF and NOAA funding sources.

Over one hundred articles by mid-1998 is an underestimate. The present number of contributions stands at 71. Check our homepage for U.S. GLOBEC contributions. I am confident about the quality of the U.S. GLOBEC research on Georges Bank. I trust any review team will agree. And a target date of the year 2000 for the first process studies on the west coast seems within our grasp, funding willing.

In five years funded research for the Northwest Atlantic program on Georges Bank will have ended. A skeletal broad-scale survey will continue, however. The survey data, as well as results from coupled physical-biological models developed during the GLOBEC endeavors, will be routinely incorporated into

NMFS stock assessments for Georges Bank and nearby regions. Under sponsorship from IGBP, the GLOBEC SPACC (Small Pelagic and Climate Change) program will be underway in the Benguela Current, off Peru/Chile, and in the Southern California Bight. Studies with coupled physical-biological models for the entire Pacific and Atlantic Oceans will have begun in the previous year. Embedded in these basin-scale models will be mesoscale coupled models that contain detailed, realistic formulations for various biological phenomena, including vertical migration and food capture by copepods. The models in the Pacific will assimilate biological data routinely from two of the three SPACC sites, Canadian and Japanese GLOBEC activities in the North Pacific, as well as U.S. activities in the Calif. Current and the Gulf of Alaska.

Perhaps my "five-year" time horizon for basin-scale modeling is optimistic — but not by much. Moreover, the routine incorporation of model data into fisheries stock assessments is already here. In the Gulf of Alaska stock assessments for walleye pollock now utilize model results from the NOAA/NMFS Shelikof Strait FOCI (Fisheries Oceanography Cooperative Investigations), a program that closely resembles U.S. GLOBEC studies.

When I encounter acquaintances from the broader U.S. oceanographic community, the greetings, kidding, and good-natured ribbing are inevitably followed by "Well, how's GLOBEC doin'?" Often I sense my questioner would prefer an answer like, "just fine". Or "not so well, but I don't have time to explain". So "just fine" is how I usually answer. Nothing elaborate. But the U.S. GLOBEC community is entitled to a more detailed answer. My optimistic "six months,...two years,...five years" prognoses are more than a wish list, of course. I offer them to the reader as my short answer to how well U.S. GLOBEC is doing. △△△

# U.S. GLOBEC Calendar

1996

**12-17 August:** Modelling the Role of Zooplankton in the Marine Food Chain, An Isaac Newton Institute Euroconference, Cambridge, UK. Contact: Mike Fasham, Southampton Oceanography Centre (Phone: 44-1703-596343; Internet: Michael.J.R.Fasham@soc.soton.ac.uk)

**13-16 August:** Pacific Ocean Remote Sensing Conference "Ocean Science and Probing", Victoria, BC, Canada. Contact: Jim Gower, PORSEC'96, Inst. of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada V8L 4B2 (Phone 604-363-6558; FAX 604-363-6479; Internet: gower@ios.bc.ca)

**16-19 September:** Gulf of Maine Ecosystem Dynamics: A Scientific Symposium and Workshop, St. Andrews, New Brunswick, Canada. Contact: RARGOM, Thayer School of Engineering, Dartmouth College, Hanover, NH 03755 USA (Phone: 603-646-3480; Fax: 603-646-3856; Internet: braasch@dartmouth.edu)

**27 September-1 October:** 1996 ICES Annual Science Conference, Reykjavik, Iceland Contact: ICES, Palaegade 2-4, DK-1261 Copenhagen K, Denmark (Phone: +45 33 15 42 25; FAX: +45 33 93 42 15; Internet: postmaster@server.ices.inst.dk; Website: <http://www.ices.dk/>)

**10-11 October:** U.S. GLOBEC Scientific Steering Committee meeting, San Francisco, CA, USA. Contact: H. Batchelder, Department of Integrative Biology, University of California, Berkeley, CA 94720-3140 (Phone: 510-642-7452; FAX 510-643-1142; Internet: halbbatch@violet.berkeley.edu)

**11-20 October:** PICES 5th Annual Meeting, Nanaimo BC, Canada. Contact: PICES Secretariat, c/o Institute of Ocean Sciences, P.O. Box 6000 Sidney BC, Canada V8L 4B2 (Phone: 604-363-6366; FAX: 604-363-6827; Internet: pices@ios.bc.ca; Website: <http://pices.ios.bc.ca/>)

**28-29 October:** International Symposium on Assessment and Status of Pacific Rim Salmonid Stocks, Sapporo, Hokkaido, Japan. Contact: Hisashi Endo, NPAFC Secretariat, 6640 Northwest Marine Drive, Vancouver, BC, Canada V6T 1X2 (Phone: 604-228-1128; FAX: 604-228-1135; Internet: endo@unixg.ubc.ca)

**29 October-1 November:** CalCOFI Conference (Special Symposium on the biology of Hake), Asilomar Conference Center, Pacific Grove, CA, USA. Contact: George Hemingway or Mary Olivarria, MLRG, Scripps Inst. of Oceanogr., La Jolla CA, USA 92093-0227 (Phone: 619-534-4236/2868; FAX: 619-534-6500; Internet: ghemingway@ucsd.edu; Internet: molivarria@ucsd.edu)

**5-12 November:** U.S. GLOBEC Georges Bank Scientific Investigators' Workshop, University of New Hampshire, Durham, New Hampshire, USA. Contact: Bob Groman, WHOI, Swift House, MS #38, Woods Hole, MA 02543-1127 (Phone: 508-289-2409; FAX: 508-457-2169; Internet: rgroman@whoi.edu; Website: [http://globec.whoi.edu/globec-dir/siworkshop1996\\_invitation.html](http://globec.whoi.edu/globec-dir/siworkshop1996_invitation.html))

**13-15 November:** International Symposium on the Role of Forage Fishes in Marine Ecosystems, Anchorage AK, USA. Contact: Brenda Baxter, Alaska Sea Grant College Program, Univ. of Alaska, PO Box 755040, Fairbanks AK, USA 99775-5040 (Phone: 907-474-6701; FAX: 907-474-6285; Internet: fnbrm1@aurora.alaska.edu)

**22-24 November:** Symposium on Seabird Ecology and Distribution in Relation to the Marine Environment, Glasgow, Scotland. Contact: ICES, Palaegade 2-4, DK-1261 Copenhagen K, Denmark (Phone: +45 33 15 42 25; FAX: +45 33 93 42 15; Internet: postmaster@server.ices.inst.dk; Website: <http://www.ices.dk/symposia/sb.html>)

**25-27 November:** International Symposium on Benguela Dynamics: Impacts of Variability on Shelf-Sea Environments and their Living Resources, Cape Town, South Africa. Contact: The BEP Symposium Secretariat, Dept. of Zoology, Univ. of Cape Town, Rondebosch 7700, South Africa (FAX: 27-21-685-3937; Internet: bep@ucthpx.uct.ac.za; Website: <http://www.sea.uct.ac.za/samss/index.html>)

1997

**7-10 January:** All-TASC-II (Trans-Atlantic Studies of *Calanus*) Meeting, Copenhagen, Denmark. Focus will be on ongoing European and North American *Calanus* research, modeling and integration of TransAtlantic *Calanus* studies beyond 1997, "The year of the *Calanus*". Contacts: Charles Miller, College of Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR (Phone: 503-737-4524; FAX: 503-737-2064; Internet: cmiller@oce.orst.edu) or Roger Harris, Plymouth Marine Lab, Plymouth, UK (Internet: rph@wpo.nerc.ac.uk) or Kurt Tande, Norwegian College of Fishery Science, University of Tromso, 9037 Tromso, Norway (Internet: kurt@nfh.uit.no)

**10-14 February:** ASLO 97 Aquatic Sciences Meeting, Santa Fe, New Mexico, USA. Contact: C. Susan Weiler, Dept. Biology, Whitman College, Walla Walla, WA 99362 (Phone: 509-527-5948; FAX: 509-527-5961; Internet: weiler@whitman.edu; Website: <http://www.ngdc.noaa.gov/paleo/aslo/aslo.html>)

**10-11 April:** U.S. GLOBEC Scientific Steering Committee meeting, Washington, DC, USA. Contact: H. Batchelder, Department of Integrative Biology, University of California, Berkeley, CA 94720-3140 (Phone: 510-642-7452; FAX: 510-643-1142; Internet: halbbatch@violet.berkeley.edu)

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**U.S. GLOBEC welcomes six new members to the SSC. They are (L to R) Jose Torres (Univ. South Florida), Louis Botsford (Univ. Calif., Davis), Valerie Loeb (Calif. State U., Moss Landing Marine Lab), Jim Shumacher (NMFS Pacific Marine Environmental Laboratory), Dale Haidvogel (Rutgers), and Stephen Reilly (NMFS Southwest Fisheries Science Center). Valerie proves that there is no truth to the rumor that you must have a beard to become a SSC member.**

*SPACC IP—(Cont. from page 4)*

questions as research foci and stipulated some prerequisites for such a retrospective programme.

**Biological Data Bases:** Appropriate time series of information for populations of small pelagic fish need to be collated. The time series data should be prepared in a spreadsheet format as described by SCOR WG 98 on World-wide Large-scale Fluctuations of Sardine and Anchovy Populations. It was recommended to convene soon a workshop at which the data sets be presented, clarified and collated in a standard format. A wealth of proxy series exists for both environmental and biological phenomena of interest including deposits of fish scales in sediments, records of harvests of seabird guano, width of annual tree rings from related areas and qualitative anecdotal records of fish catches. All these data are essential for comparison with the biological, physical and meteorological time series mentioned above and for the extension of these time series into the past for which time series data are not available.

**Hydrographic and climatic time series:** Data series on physical hydrographic and climatic factors that may drive small pelagic fish populations need to be available for comparison with the biological time series. A catalogue of the available time series and where they may be obtained needs to be prepared. This should be done by a small group of experts.

**A formal assessment of satellite imagery as a retrospective tool:** The Working Group recommended a formal assessment of the usefulness of satellite imagery for decadal-scale studies. Data giving spatial resolution are available for the last 15 years.

**Investigations of teleconnections:** Teleconnection patterns can be investigated through comparison of climatic indices such as SOI, NAO, air pressure anomalies between St. Helena High and South African Low, variations in the position of the ITCZ, and precipitation patterns or other meteorological parameters.

**Modeling:** Modeling can provide insight into many of the key questions concerning decadal changes in ecosystem productivity. They will help to identify the studies that have the greatest chance of improving our understanding of decadal-scale changes and provide forecasts.

#### **Working Group II: Minimum Core Programme on Fish Growth and Zooplankton**

The terms of reference of this Working Group was to identify a minimum core programme that could be carried out by most countries wishing to participate in SPACC using the West African coast and the Mediterranean as an example (participants in WG II included scientists from South Africa,

*(Cont. on page 10)*

SPACC IP—(Cont. from page 9)

Namibia, Angola, Ghana, Morocco and Spain). The programme should lead to significant new insights into decadal scale variability in productivity of small pelagic fishes, introduce new skills without a major outlay in manpower, equipment or ship time, and take advantage of on-going national or regional fisheries programmes.

The group concluded that somatic

Table 1. Participants at the SPACC Implementation Plan Meeting held in Swakopmund, Namibia. **Bolded Names** also participated in La Paz Meeting, 20-24 June 1994

Country	Participants
Angola	Lourenco Constanca Kumbi Kilongo Nsiguii
Denmark	Ole Henrik Haslund
France	<b>Claude Roy</b>
Germany	<b>Jürgen Alheit</b> Wolfgang Fennel <b>Eberhard Hagen</b> Astrid Jarre-Teichmann
Ghana	Kwame Koranteng
Italy	<b>Andy Bakun</b> <b>Peter Schlittenhardt</b>
Morocco	Aziza Lakhnigie
Namibia	Jan Botha David Boyer Rudi Cloete Bauleth D'Almeida Ekkehard Klingelhöffer Mick O'Toole Gernot Otte
Norway	Stein Kaartvedt Svein Sundby
Romania	Roxana Bojariu
Russia	Sergey Lobov
South Africa	Robert Crawford Ian Hampton Larry Hutchings Coleen Moloney <b>Su Painting</b> Frank Shillington
Spain	Juan Pablo Pertierra
Sweden	Sture Hansson
Turkey	Ilkay Salihoglu
United States	Hal Batchelder <b>John Hunter</b> <b>John Moisan</b> <b>Ted Strub</b>

growth was the most informative and practical ecological response to study in this context. Changes in fish growth during the critical first months of life, or shifts in birthdate distribution from the norm, are early indicators of ecosystem shifts affecting the productivity of small pelagic fish populations. Comparisons of growth and birthdate shifts in present ecosystems in different productivity states (indicated by declining, increasing, or stable population trends of target fish stocks and differences in size structure and distribution of zooplankton populations) will help to identify the critical links between somatic growth, zooplankton production and physical forces affecting stock productivity.

The group proposed to use daily somatic growth in the first 6 to 12 months of life, and the mapping of acoustic backscatter from zooplankton in relation to fish distribution and physical structure as a field measurement programme. Modeling, particularly fish growth energy models, and ones needed to facilitate comparisons between ecosystems would be essential as well as training in the use of such models. It was considered that the acoustic measurements of zooplankton would reflect prey abundance often enough to be used in comparing food distribution in certain areas with that of the fish, which would be mapped synchronously. The acoustic measurements would have to be supplemented by quantitative net hauls to identify targets and confirm a relationship between back-scattering strength and prey abundance in the various zooplankton regimes encountered during the survey.

Enhancements to this most basic field programme are highly desirable and would be expected in many SPACC countries or regions.

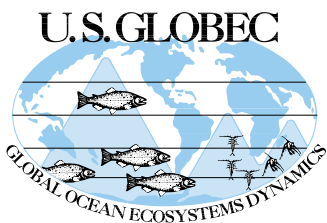
### Working Group III: Process-oriented Studies on Zooplankton and Fish Dynamics in Relation to Hydrography

The terms of reference were: to

consider observations, process studies, data analysis and modeling that could be done within a generalized SPACC program to evaluate zooplankton and fish population dynamics and how the physical processes of enrichment, concentration, retention and transport affect those dynamics. The group was to develop a comprehensive framework for core programmes thereby providing a firm footing for comparing ecosystems and the dynamics of small pelagic fishes they support. The minimum core programme can be derived as a subset of a larger and more comprehensive programme.

The fundamental question of a SPACC program is to understand the causal mechanisms responsible for the fluctuations in abundance of small pelagic fish populations. To understand these causal mechanisms, the SPACC programme will, with respect to process-oriented studies, incorporate and integrate a number of elements,

(Cont. on page 11)



**U.S. GLOBEC NEWS**

U.S. GLOBEC NEWS is published by the U.S. GLOBEC Scientific Coordinating Office, Department of Integrative Biology, University of California, Berkeley, California 94720-3140, telephone (510) 642-7452, FAX (510) 643-1142. Correspondence may be directed to Hal Batchelder at the above address. Articles, contributions to the meeting calendar, and suggestions are welcomed. Contributions to the meeting calendar should contain dates, location, contact person and telephone number. To subscribe to U.S. GLOBEC NEWS, or to change your mailing address, please call Hal Batchelder at (510) 642-7452, or send a message to Internet address halbatch@violet.berkeley.edu, or write to the address above.

U.S. GLOBEC NEWS Staff  
Hal Batchelder  
Tom Powell  
Kay Goldberg

including: field surveys of standardized core measurements at critical periods in the life history of the fish; more frequent monitoring of a subset of the core measurements at a few points (coastal or offshore) or transects; and development of biophysical models. Where resources allow, additional parameters will be measured on the core surveys and monitoring stations and intensive studies will focus on specific processes for shorter periods.

Measurements and sampling strategy were identified for a core SPACC Sampling Programme. The major processes to be determined are:

- egg production (spawner biomass and length frequency, fish condition, temperature, available food);
- early life history mortality (predation, cannibalism, starvation);
- growth (temperature, food concentration, light, turbulence, otolith analysis, models);
- transport (winds, density structure, currents; vertical distribution, egg buoyancy, larval behaviour; modeling).

Particular emphasis in the discussion was given to zooplankton sampling, mortality estimates and application of remote sensing. The core programme was designed on three levels depending on the resources available to individual institutions or countries.

#### **Working Group IV: SPACC Modeling Implementation**

SPACC requires a strong modeling component. This means model development and training should begin as soon as possible. Several different types of models are needed (see SPACC Science Plan). Some models, for example high resolution circulation models linked to biological models, are needed but cannot be quickly produced, while others can be developed in timely fashion to meet the needs of the developing core programme. A small set of generic models will be immedi-

ately needed in the core programme. They include: 1) Energy budget models, 2) Simple food web models and, 3) Space dependent ecosystem models. Some of the models should be designed specifically to integrate core programme measurements and any or all of these models could be designed to make use of existing data, and to cover the broad range of time and space scales important to SPACC. No technical barrier exists in developing such models nor finding appropriate data to test them in a SPACC context.

From the standpoint of implementation, the modeling needs of the SPACC Programme can be broadly categorized into two classes: (1) advanced models for general application and (2) models for regional application and training. Each is discussed below.

#### **Advanced models for general**

**application:** Advanced models are needed as tools to integrate and compare the results from different SPACC regions. General circulation models (GCMs) should be coupled with biological models of different complexity to create generic ecosystem models. This requires the participation of modelers with existing state-of-the-art expertise. To initiate this aspect of the modeling studies, biologists and modelers should meet at a workshop to identify a minimum group of specific models that need to be developed. A hierarchy of generic models will be developed which can be made available for application to different SPACC regions. In this way, results from field programmes would be synthesized and the models would facilitate intersystem comparisons.

#### **Models for regional application and**

**training:** Given the general paucity of regional modeling expertise and the large number of SPACC-related regions, training and education should proceed immediately and in conjunction with the development and implementation of simple models such as individual-based energy budgets or

trophic flow models of ecosystems. Initial training could start with a workshop addressing a specific ecological problem, such as the development of an energy-budget (e.g. individual-based) model for small pelagic fish or an energy flow budget model, summarizing the existing knowledge on the various components in the ecosystem of interest in a clear manner. A workshop such as this could help identify potential key individuals for further training in modeling.

#### **Rapid Start Projects and Training**

In order to have a fast start implementing SPACC, several pilot projects will be identified which could begin immediately after the preparation of the Implementation Plan. Candidates for such pilot projects include: modeling, remote sensing, analysis of long-term time series for climate impact. Meetings to implement these Rapid-Start projects are recommended by Working Groups I and IV.

Training, Education and Mutual Assistance (TEMA) is an important part of SPACC and most research elements of SPACC will have training components. Given the paucity of modeling expertise in many participating countries and the dependence of SPACC process studies on the application of models, training in the use of simple models receives a high priority in SPACC. A training and education component in the use of simple models appropriate to SPACC is a certainty and shall be a key part of SPACC implementation. Priorities for training and education in other fields cannot be set until the characteristics of the core programmes are finalized.

#### **Managing SPACC**

The number of activities and scientists, institutions and countries participating in GLOBEC-SPACC is increasing rapidly. Twenty seven

*(Cont. on page 13)*

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# North Pacific Marine Science Organization to hold PICES V in Nanaimo, BC, Canada, October 11-20, 1996

## Time and Location

The North Pacific Marine Science Organization (PICES) will hold its Fifth Annual Meeting October 11 - 20, 1996 at the Coast Bastion Inn in Nanaimo, British Columbia, Canada. The meeting is hosted by the Department of Fisheries and Oceans, Government of Canada, in coordination with the PICES Secretariat. Local arrangements are made by the Pacific Biological Station and the Malaspina University-College.

## Program Sessions

**1. Methods and findings of retrospective analyses. (Science Board)** *Co-convenors: Robert C. Francis (U.S.A.) and Kimio Hanawa (Japan).*

To consider the effects of climate variations on marine ecosystems requires long time series of data extending back through and beyond the historical record. Retrospective analyses of such data have been identified as a major approach in the "Climate Change and Carrying Capacity" (CCCC) Program which has organized this symposium. Papers are invited that deal with methods of data analysis, their application to studies of physical and biological time series, including those using paleo-data, and their findings. Selected papers from this first CCCC Symposium will be published in the PICES Scientific Report Series.

**2. Exchanges of water, organisms, and sediment between continental shelf waters and the nearby ocean. (POC)** *Co-convenors: Kenneth L. Denman (Canada) and Kuh Kim (Korea).*

The PICES member countries, like most coastal nations, have many large

centers of population within 50 km of the ocean, and depend on the continental shelves and coastal seas for food, minerals, transportation, waste disposal, and recreation. The continental shelves exchange water, organisms, sediments and other materials with the North Pacific Ocean. This Symposium will focus on current scientific research in the PICES countries on these exchanges between the continental shelf waters and the open ocean and their consequences.

**3. Regional and interannual variants in life histories of key species. (BIO)** *Co-convenors: David L. Mackas (Canada) and Tsutomu Ikeda (Japan).*

The productivity and structure of marine communities can be strongly affected by the timing match between key environmental and life cycle events (e.g., migration, spawning, developmental timing). There is increasing evidence that life history strategies of key plankton and fish species vary from place to place and over time, and that shifts in seasonal transitions and other environmental events accompany climate trends and fluctuations. We invite papers for this session that examine the variability of life history strategy in response to environmental conditions, mechanisms of adaptation, and robustness in the face of climate variability.

**4. Ecological effects of truncated age and size distributions and fishing on fish populations. (FIS)** *Co-convenors: Richard J. Beamish (Canada), Anne B. Hollowed (U.S.A.) and Suam Kim (Korea).*

The structure of the population has evolved to adapt to the particular habitat. In many species this has resulted in fish obtaining older ages and larger sizes. Fishing has become a force of selection and may be altering the

structure in a manner that reduces the population's ability to adapt to extremes in the environment. In particular, many populations have greatly truncated age structure and reductions in average size at age. Presentations should focus on: (1) providing examples of truncated age and size distributions resulting from fishing; (2) discussing the ecological importance of longevity; and (3) modelling the consequences of extreme reductions in the number of age groups in populations. There is interest in publishing the papers in a refereed journal. Please indicate whether you are prepared to do this when submitting an abstract.

**5. Processes of contaminant cycling. (MEQ)** *Co-convenors: Lee Harding (Canada), Tracy Collier (U.S.A.) and D.B. Yang (Korea).*

This session will discuss the roles of advection, sedimentation and re-suspension, atmospheric transport and biological processes in controlling the distribution of contaminants in the marine environment. Papers dealing with long range transport (e.g., on a trans-Pacific scale) are especially encouraged.

Scientific sessions will include invited and contributed papers on these topics as well as contributed papers on other subjects of interest to the Committees. Contributed papers will be selected for oral or poster presentation.

In addition to the scientific sessions, there will be meetings of the Science Board, Governing Council and meetings of the Scientific and Technical Committees. The Scientific and Technical Committee sessions, which are open to public, will be on October 16 and 17.

*(Cont. on page 13)*

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*SPACC IP—(Cont. from page 11)*

countries have been represented at SPACC meetings and broader participation is anticipated. SPACC is currently managed by the two co-chairmen, John Hunter (La Jolla, USA) and Juergen Alheit (Warnemünde, Germany) and the Steering Committee which consists of the two co-chairmen, Kevern Cochrane (FAO, Italy) and Claude Roy (ORSTOM, France). For GLOBEC-SPACC to succeed in its mission in the future, it will require guidance by an energetic and broadly based steering committee, chairpersons of special committees and, importantly, a SPACC administrative office to facilitate smooth running of an international organization. Discussion about changes in organizational structure will be held during the second Implementation Meeting in August 1996.

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*PICES V—(Cont. from page 12)*

### **Registration, Accommodations, and More**

Pre-registration is encouraged. The registration deadline is September 12, 1996. There is a registration fee of CDN\$45.00 (includes reception and banquet). Please pay by cheque or money order in Canadian funds payable to the North Pacific Marine Science Organization.

Participants are expected to make their own reservations before September 12, 1996. A large block of rooms has been reserved at the Coast Bastion Inn (venue for the meeting) [Fax: (604) 753-4155] and two smaller blocks of rooms at the Dorchester Hotel (50m from meeting venue) [Fax: (604) 754-2638] and the Tally-Ho Motel (four city blocks from meeting venue) [Fax: (604) 753-6522]. PICES participants have priority for reserving these rooms until September 12.

For more information, contact the PICES Secretariat, c/o Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C. Canada V8L 4B2 [Phone: (604) 363-6366; Fax: (604) 363-6827; Internet: pices@ios.bc.ca]       $\Delta\Delta\Delta$

It is important to resolve the issue of a SPACC office as soon as possible as the need is urgent (current efforts of Hunter, Alheit and their secretaries cannot be sustained much longer). Precedents exist for such an office; three of the four International GLOBEC sponsors (SCOR, ICES, PICES) are currently hosting offices for GLOBEC Programmes. It was suggested in Swakopmund that SPACC could approach IOC regarding support of the future SPACC office. This seemed appropriate because SPACC is the GLOBEC activity with the by far largest number of developing countries participating and because the goals of SPACC are at the heart of the OSLR (Ocean Science in Relation to Living Resources) Programme of IOC.

A SPACC-GLOBEC Newsletter will be established which serves to rapidly disseminate information to the SPACC community. The information will be given in "bullet" form indicating a source for further information. The issues will be published as soon as sufficient information has been accumulated. Ramiro Sanchez, Argentina, is the editor of the Newsletter. The first issue was distributed in late December 1995.

### **SPACC Meeting Chronology**

#### **Held**

- Science Plan Meeting, La Paz, Mexico, June 20-24, 1994
- First Implementation Meeting, Swakopmund, Namibia, December 4-8, 1995

#### **Planned**

- Second Implementation Meeting in Mexico City, August 1996 (see note below)
- SPACC Modelling Workshop in Ispra, Italy, October 1996
- SPACC Workshop(s) to present, clarify and collate climatic, oceanographic and biological time series in a standard format

*(John Hunter and Juergen Alheit are co-chairs of the SPACC program of International GLOBEC. Dr. Hunter is a fisheries biologist with the National Marine Fisheries Service in La Jolla, CA. Dr. Alheit is a scientist at the Baltic Sea Research Institute in Warnemuende, Germany)*

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### **Second SPACC Implementation Meeting**

An implementation meeting for International GLOBEC/SPACC will be held to address three objectives:

- finish the global implementation plan for SPACC that was begun in Swakopmund, Namibia in December 1996;
- establish working groups to carry out joint comparative research; and
- form an IAI consortium for training, education and mutual assistance in the Americas and Pacific related to small pelagic fish, and climate change. This implementation meeting shall emphasize the Americas and Pacific (the first implementation meeting [in Namibia] focused on Africa and Europe).

Participants from anywhere in the world are welcome to attend the meeting.

The SPACC/IAI implementation meeting for the Americas and Pacific will be held in Conference rooms of the Hotel El Camino Real [fax 5/250-6897; phone 5/203-2121] in Mexico City, D.F. Mexico, from 830 AM Monday, August 19 to after lunch on Friday August 23. Dr. John Hunter is co-chair of the meeting and should be contacted for further details (John Hunter, phone 619-546-7127; fax 619-546-7003; email john\_hunter@ccgate.ssp.nmfs.gov)

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### Biological Oceanographic Setting.

Topics covered ranged from phytoplankton to predators. Mike Sieracki, Scott Gallagher, Mark Berman and Ted Durbin described aspects of the biological setting of Georges Bank during the 1994-1995 process cruises, proceeding from the base of the food chain to distributions of crustacean zooplankton. Mike Sieracki described an abundant microbial loop consisting of a diversity of phytoplankton and protozoan taxa which function as prey for larger zooplankton and larval fish. Zooplankton distributions were determined by a variety of techniques including the Video Plankton Recorder (VPR) and the Tracor Acoustic profiling System (TAPS). Scott Gallagher described micro- to mesoscale vertical and horizontal distributions of plankton relative to Bank hydrography. The VPR was able to resolve the distributions of a number of fragile forms

that are inadequately sampled by more traditional means, including the colonial diatom *Chaetoceros socialis*, the colonial stage of *Phaeocystis pouchetti*, and delicate gelatinous zooplankters. Mark Berman reviewed acoustic studies using the TAPS system, emphasizing the abundance of sand grains in the water column on the Bank crest, and the potential problems they cause by interfering with acoustic determination of crustacean zooplankton abundance. Ted Durbin described the age structure of target copepod populations over time, noting that the Bank crest was relatively devoid of copepod naupliar stages. In contrast, nauplii were abundant on the northeast peak and downstream on the southern flank. Irving Kornfeld, a guest from the University of Maine, described genetic effects of fishing on haddock.

**Vital Physiological Rates.** Presentations concerning vital physiological rates focused on target zooplankton taxa. Ted

Durbin, Dian Gifford, Jeff Runge, Bob Campbell, Melissa Wagner, Elaine Calderone, Scott Gallagher, Greg Lough, Lew Incze, Michael Moore, Larry Madin and Grace Klein-MacPhee presented data on various aspects of zooplankton vital physiological rates. A number of presentations dealt with rate measurements of target copepod species. Ted Durbin's mesocosm experiments suggested that copepod growth was food-limited in May-June 1994. Dian Gifford's feeding studies showed that *Calanus* was primarily a carnivore in May-June 1994, obtaining most of its nutrition from planktonic protozoa. Jeff Runge's data showed that egg production rates were high at all stations in 1995 (Figure 1) and that female *Calanus* produced eggs everywhere on the Bank, but that egg hatching success varied, probably as a function of diet. Bob Campbell's growth rate experiments indicated that younger stages of *Calanus* grow faster than older stages, but that growth was not related to chlorophyll concentration. Larry Madin described patterns of distribution and abundance of invertebrate predators, with emphasis on the hydroid *Clytia* sp. and the impact of its feeding activities on crustacean zooplankton populations on the Bank. Grace Klein-MacPhee's data demonstrated the impact of predation by the ctenophore *Pleurobrachia* on crustacean zooplankton, fish eggs, and fish larvae.

Four presentations covered various aspects of the physiology and ecology of larval cod and haddock. Elaine Calderone used RNA/DNA ratios to determine the condition of cod and haddock larvae on the Bank in 1993 (a year of a pilot project) and 1994 (Figure 2). In 1993 larvae of both species were in good condition overall. In contrast, larvae of both species were in relatively poorer condition in 1994, but condition could not be related to hydrographic conditions. Scott Gallagher described the exclusively microzooplankton diet of larval cod before yolk sac absorption. Greg Lough presented a model relating turbulence and larval fish feeding

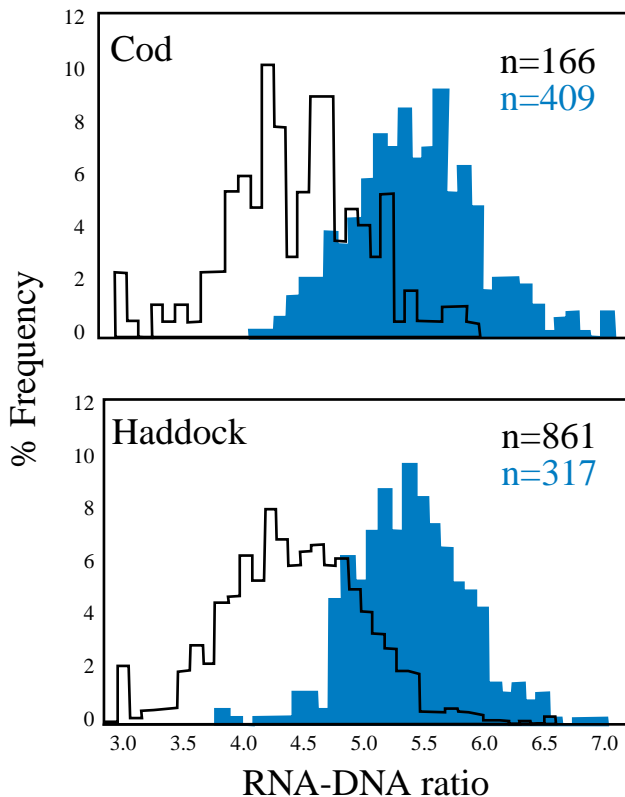


Figure 2. Frequency distributions of RNA-DNA ratios from cod (top panel) and haddock (bottom panel) collected from Georges Bank in May 1993 (blue data) and May 1994 (black line).

(Cont. on page 15)

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*Georges Bank—(Cont. from page 14)*

success, and Lew Incze described his May 1992 study of the influence of turbulence on larval cod and their naupliar prey.

Two presentations concerned methods development. Melissa Wagner presented data indicating that RNA/DNA ratios of individual *Calanus* is related to aspects of nutrition (food availability, perhaps growth rate). Michael Moore reviewed development of his cell proliferation method for measuring copepod growth rates.

### **Session III: Population Dynamics of Target Species**

**Charlie Miller (Chair), Cabell Davis and Dan Lynch (Rapporteurs)**

This session included four presentations on models of individual populations or communities interacting with their physical environment, and one presentation on using genetic probes to examine distributions and timing of reproduction. Mike Fogarty described several stage-structured models of fish community dynamics on Georges Bank, which will hopefully lead to models of exploited multispecies systems for fishery management that can accommodate various nonlinear processes and spatial dynamics. Ann Bucklin reviewed work being done to use oligonucleotide probes to discriminate *Pseudocalanus* spp. with eventual application to examine seasonal timing and location of reproduction in the various *Pseudocalanus* species. Cisco Werner described an individual based model of cod and haddock growth and mortality coupled to physical circulation (this model was previewed in U.S. GLOBEC NEWS No. 7, September 1994). Andrew Leising described an individual based model of cod larval growth, incorporating variability in prey density, turbulence and temperature, that suggested that the timing and location of cod spawning were crucial to eventual larval survival. Glenn Flierl used empirical orthogonal functions (EOFs) to reduce the complexity of a stage-

structured model of the life-cycle dynamics of the copepod, *Pseudocalanus* spp. With the model, the full (200 variable) system can be adequately reproduced using between 5 and 15 EOF modes.

### **Session IV: Hot Topics Discussion**

**Steve Bollens (Chair), Greg Lough (Rapporteur)**

This session served as a forum for investigators to briefly (5 minutes) present novel and intriguing research results that either did not fit readily under the theme areas established for the other three sessions or for which investigators did not have adequate time to present during the other sessions. As such, some of these presentations addressed topics only indirectly related to the GLOBEC target species (sand storms on Georges Bank by Peter Wiebe; the *Chaetoceros* patch by Dian Gifford et al.; planktonic hydroid growth by Steve Bollens et al.), whereas others addressed more specific aspects of the population biology of the target species (*Calanus* mating behavior by Charlie Miller; interdecadal zooplankton abundances by Landsteiner et al.; *Calanus* egg viability by Jeff Runge). But throughout all of this session's diverse presentations was a common theme of trying to elucidate the intricate web of biological-physical interactions that comprise the Georges Bank ecosystem.

*(This report summarizes results of the Scientific Investigator's Workshop, which was organized by the U.S. GLOBEC Georges Bank Executive Committee, whose members are Robert Beardsley, Steve Bollens, Ann Bucklin, Cabell Davis, Ted Durbin, Mike Fogarty, Dian Gifford, Greg Lough, Dan Lynch, David Mountain, and Peter Wiebe. Much of the text is directly from or a summary of information contained in an unpublished report of the workshop).*

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### **Judy Gray Aboard as New U.S. GLOBEC Program Manager**

Judy Gray has been hired by NOAA's Coastal Ocean Program as the new GLOBEC Program Manager. She will be working closely with NSF as well as NOAA's Office of Global Programs and the National Marine Fisheries Service in coordinating the program.

Judy is a meteorologist trained at Penn State and the University of Washington. She spent 10 years at the Pacific Marine Environmental Laboratory in Seattle where she was the Coordinator of the Fisheries Oceanography Coordinated Investigations (FOCI) in the Gulf of Alaska and Bering Sea. Her research areas were coastal winds and mesoscale atmospheric variability over the ocean, both of which involved extensive field work at sea and aboard research aircraft. More recently, Judy has gained both line and program management experience in a variety of NOAA capacities: as an advocate of NOAA research for the Office of Oceanic and Atmospheric Research, as the Acting Executive Director and Acting Deputy Director of NOAA's 11 Environmental Research Laboratories, and as the Program Manager for NOAA's Coastal Forecast System. Judy joined the Coastal Ocean Program staff in March 1996, where she will continue her coordination of ocean forecasting efforts in addition to her U.S. GLOBEC responsibilities.

Judy is enthusiastic about her position with GLOBEC, describing it "... like going home." She can be reached by phone: 301-713-3338; fax: 301-713-4044; or Internet: [jgray@cop.noaa.gov](mailto:jgray@cop.noaa.gov).

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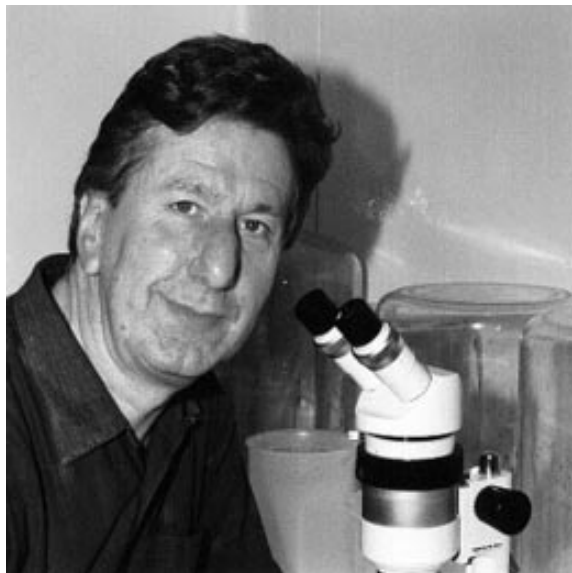
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## Roger Harris to Head GLOBEC International

With the adoption of GLOBEC by IGBP, Roger Harris has accepted the Chairmanship of the International GLOBEC SSC for a three year term. He is currently Research Project Coordinator at the Plymouth Marine Laboratory leading a group working on productivity and physical structure in pelagic ecosystems.

Dr Harris has a Ph.D. in marine biology from the University of London, his doctoral work being on the ecology of marine meiobenthos. Postdoctoral work with Don Heinle at the Chesapeake Biological Laboratory, and with Gus Paffenhöfer at the Biological Anstalt Helgoland Litoralstation, List/Sylt ensured that his research interests “moved rapidly up into the water column” where they have remained ever since, concentrating particularly on calanoid copepods. Roger Harris has held previous research positions in Germany, the United States, British Columbia and with the Marine Biological Association in Plymouth. He has carried out biological oceanographic field work in a variety of environments ranging from the Bellingshausen Sea, Antarctica to the Patuxent River in Chesapeake Bay. His research interests focus on the control of biological production by physical processes, the role of water-column biology in global oceanic carbon flux, and the laboratory culture and ecology of marine zooplankton.

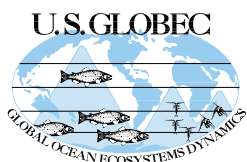
He has been particularly interested in the development of GLOBEC, having been a member of the UK GLOBEC committee, and local organizer of the 1994 Plymouth ICES



Marine Science Symposium on Zooplankton Production. He looks forward to working with US, and international colleagues, to realize the full potential of GLOBEC over the coming years.

Information about the adoption of GLOBEC as a core project of IGBP, it's relation to other IGBP core projects, and the organizational structure of GLOBEC within IGBP will be provided in the next issue of the newsletter.      ΔΔΔ

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