Report of the
U.S. GLOBEC Northeast Pacific
Coastal Gulf of Alaska
Scientific Investigator's Meeting
Hotel Captain Cook, Anchorage, Alaska
January, 13 - 17, 2003

Edited by Harold P. Batchelder

Held as part of, and in conjunction with, the Symposium:

Marine Science in the Northeast Pacific: Science for Resource Dependent Communities

Acknowledgements

This meeting was organized by the U.S. GLOBEC Northeast Pacific Coordination Office. We gratefully acknowledge the contributions from the scientific investigators who attended the meeting and provided the summaries and figures for this report. A special thanks go to Molly McCammon of the EVOS Trustee Council for arranging logistical support prior to and throughout the meeting.

The U.S. GLOBEC Northeast Pacific Scientific Investigator's Meeting and this report were sponsored by the National Science Foundation and the National Oceanic and Atmospheric Administration.

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Marine Science in the Northeast Pacific: Science for Resource Dependent Communities

Hotel Captain Cook, Anchorage, Alaska
January 13 - 17, 2003

The joint scientific symposium *Marine Science in the Northeast Pacific: Science for Resource Dependent Communities*, was co-sponsored by the following programs:

Exxon Valdez Oil Spill (EVOS) Trustee Council
GLOBEC Northeast Pacific Program
Steller Sea Lion Investigations (SSLI)
North Pacific Research Board (NPRB)
North Pacific Marine Research Institute (NPMRI)
Pollock Conservation Cooperative Studies (PCCS)

The third annual U.S. GLOBEC Coastal Gulf of Alaska (CGOA) Scientific Investigator (SI) meeting was held as part of the *Marine Science in the Northeast Pacific* symposium in order to provide opportunities to convey the results of GLOBEC funded research in the CGOA to the local public of Alaska, and to permit the exchange of results and scientific ideas with scientists involved in research funded by the other sponsoring organizations. The U.S. GLOBEC portion of the public symposium and workshops was organized by the U.S. GLOBEC Northeast Pacific Coordination Office. The scientific investigators who attended the workshop provided the abstracts, posters, and figures for this report. Hal Batchelder and Linda Hunn put this report together.

The U.S. GLOBEC CGOA workshop and this report were sponsored by the National Science Foundation and the National Oceanic and Atmospheric Administration. We thank Lowell Fritz, coordinator of the Steller Sea Lion Investigations (SSLI) for coordinating the production of the volume of abstracts distributed at the meeting, Dede Bohn of the USGS for coordinating the poster sessions at the meeting, Rob Bochenek of EVOS for providing presentation technical support, and Paula Banks and all of the other staffers at EVOS for staffing the registration desk and providing facilities support. We also would like to thank Dr. Thomas Weingartner of the University of Alaska, Fairbanks, for suggesting in November 2001 that GLOBEC-NEP and EVOS-GEM have a joint science meeting—a suggestion that ultimately led to this symposium. Most of all, we thank Molly McCammon, Executive Director of the EVOS Trustee Council, for all of her up-front and behind-the-scenes work that resulted in a terrific symposium, venue and workshop.

Introduction

The U.S. GLOBEC Northeast Pacific (NEP) Program is a large multidisciplinary, multi-year oceanographic effort focusing on the biology and ecology of juvenile salmon, euphausiids, large copepods, and forage fish in coastal regions of the North Pacific, and how these populations are controlled by physical and biological processes at large- to meso-scales. Two specific regions have been targeted for intensive field studies and long-term observations: (1) the wind driven, coastal upwelling California Current System (CCS), especially the region extending from central Oregon south to Northern California, and, (2) a coastal Gulf of Alaska (CGOA) shelf region southwest of Prince William Sound. The January 2003 workshop was for the Scientific Investigators (SIs) that are involved in the CGOA region. U.S. GLOBEC studies in the CGOA began in 1997 with integrated, multi-investigator, interdisciplinary programs of modeling, retrospective analysis, and long term observation programs (LTOPs). Focused process-oriented and field surveys of the CGOA occurred in the spring and summer of 2001, and are planned for spring and summer in 2003. The U.S. GLOBEC research effort in the NEP has an ultimate goal of improving the predictability and management of living marine resources in the region by developing better insights and understanding of ecosystem interactions and the coupling between the physical environment and the living resources at multiple temporal and spatial scales. The U.S. GLOBEC research program is supported primarily by the U.S. National Science Foundation Division of Ocean Sciences, and by the U.S. National Oceanic and Atmospheric Administration's Coastal Ocean Program and

National Marine Fisheries Service. Ancillary funding for some projects within the program is provided by the National Aeronautics and Space Administration. U.S. GLOBEC is a component of the U.S. Global Change Research Program.

Workshop Structure

The January 2003 U.S. GLOBEC Northeast Pacific Coastal Gulf of Alaska Scientific Investigator's (SI) workshop was held at the Hotel Captain Cook in Anchorage, AK, as a part of a joint scientific symposium: "*Marine Science in the Northeast Pacific: Science for Resource Dependent Communities*". This was the first NEP-CGOA SI meeting at which the SIs met jointly with scientists from other research programs in the Gulf of Alaska. Overall, the symposium format was well received and well attended by the local community, although scientific investigators from the various sponsors comprised the majority of participants. The symposium was reported upon by the local newspaper (Anchorage Daily News). A list of GLOBEC SIs that attended is provided in Appendix II. The meeting was structured (Appendix I) around plenary presentation/ discussion sessions and breakout sessions.

Narrative

Monday, 13 January 2003

Four GLOBEC SIs spoke for 45 minutes each during the public symposium on Monday, 13 January (Appendix X). Tom Weingartner spoke on the physical structure of the Gulf of Alaska coastal region, Suzanne Strom spoke on the connections between physical conditions, plankton productivity and salmon production, Jack Helle spoke about salmon migrations and habitat utilization in the coastal migration corridor of Alaska, and Frank Schwing spoke about climate forcing of the Gulf and its connection to other regions in the North Pacific. The symposium presentations were nearly all excellent and were reported in the press the following day (Appendix III). Monday evening there was a poster session and reception.

Tuesday, 14 January 2003

In the Plenary Presentation Sessions within the GLOBEC workshop beginning Tuesday, 14 January, most of the GLOBEC-funded CGOA projects had 15 minutes to present their recent research results. These were summaries only, since most of the projects had one or more posters displayed to convey the detailed scientific results to their colleagues. Abstracts of most poster and/or oral presentations from the GLOBEC workshop are in Appendix IV.

The NEPEXCO members in attendance met Tuesday evening from 1730-1915 to discuss several issues: 1) GLOBEC National Office Leadership and activities of other US GLOBEC regional programs; 2) future NEP synthesis timelines, costs, and coordination of CCS and CGOA groups in an eventual NEP-wide synthesis; 3) future venues for special GLOBEC sessions at national and international meetings; and 4) possible future special publications on the NEP program. Items 2-4 of this list are summarized later in this document, when they were presented to the SIs on Wednesday, 15 January.

Wednesday, 15 January 2003

Two breakout group sessions occurred Wednesday morning, 15 January. The first involved the investigators who will participate in GLOBEC cruises in the CGOA during spring-summer 2003. They discussed logistical considerations, ranging from cruise schedules, to sampling gears, to cruise tracks and coordinated sampling of multiple vessels. The cruise logistic discussions were continued in depth over the next several days. A summary of the current cruise schedules, chief scientists and tentative cruise tracklines is presented in Appendix V. A second breakout group discussed modeling issues in the CGOA. The model group also met again later in the morning. A summary of their discussion is included in Appendix VI. Following the format from the November 2002 California Current System SI meeting, a second breakout session was held, with the intent of soliciting input for future announcements of opportunity for CGOA and NEP-wide synthesis. Three breakout groups formed to discuss: 1) Ecosystem responses to large scale climate shifts; 2) Mesoscale forcing patterns and responses; and 3) Modeling the CGOA (continued from the earlier breakout group). A fourth topic, "GLOBEC Guidance for Resource Management" did not engender wide interest (only 2-3 attendees selected this group in the initial show of hands), so rather than hold a breakout group with only a few members, all of the other three breakout groups were asked to consider how GLOBEC research results could provide guidance or improve resource management in the CGOA.

A poster session and reception occurred on Monday evening, and this was followed up by a dedicated poster viewing session on Wednesday afternoon. Posters provide an excellent way to convey the details of GLOBEC research projects without consuming excessive time.

A plenary session was held late Wednesday afternoon, 15 January, in which Batchelder summarized the discussions that were held by the NEPEXCO on the previous evening. The major item presented during this time was the plans for future synthesis phases of the CGOA, CCS, and NEP (see Appendix VII for a summary). We also discussed upcoming scientific meetings at which GLOBEC, and specifically, GLOBEC NEP, would have dedicated sessions. Following the suggestion of the GLOBEC national SSC, we agreed to have GLOBEC NEP sessions at the 26-30 January 2004 American Geophysical Union (AGU) Ocean Sciences meeting in Portland, OR. There was a preference on the part of some of the PIs for the major meeting to be the ASLO meeting in Honolulu, HI during February 2004, but we followed the lead of the National Office. Some NEP SIs may present their findings at both of these national meetings. We also remain interested in participating in a "Pan-US GLOBEC symposium" proposed for summer 2004 by Peter Wiebe, but we had insufficient details about the meeting and its likely prospects for actually taking place at that time. It was also noted that the September 2004 Eastern Pacific Ocean Conference (EPOC) will occur in British Columbia, and could provide a venue for the CCS and CGOA scientists to interact further. Finally, Batchelder noted that the PICES XIII meeting in October 2004 will be held in Honolulu, and that this might provide a venue for presenting U.S. GLOBEC NEP results to a broader international audience.

We discussed a future GLOBEC NEP special publication. There was a general consensus that a special issue of a prestigious journal would be good for the program. Batchelder agreed to take the lead as senior guest editor of a special issue. Subsequent to the meeting, Batchelder contacted the editors of both *Progress in Oceanography* and *Deep-Sea Research II, Topical Studies in Oceanography*. The latter has been selected as the target journal for this special issue, and the editor of DSRII has added a GLOBEC NEP issue to their list of future issues. Ted Strub, Tom Weingartner and Evelyn Lessard have agreed to serve with Batchelder as guest editors for this publication. Appendix VIII has the text of an email that was sent to the NEP SIs soliciting manuscripts. Target date for manuscript submission is 1 July 2003.

Also during plenary on Wednesday, we heard several short summaries of the breakout group discussions. Al Hermann provided a report of the two modeling group reports (Appendix VI). Group A2 discussed detailed logistics and needs for improving the codes for physical models of the Gulf, linking them to the larger NEP wide model and the NoPac Basin model, and what was needed to link the physical models to the biological models. Group B4 (also on modeling) discussed the bigger picture of how modeling efforts can contribute to better understanding the linkages between climate, ocean productivity and fish populations and fluctuations. One need is to better interface model output with data by conducting specific MODEL-DATA comparisons. Other needs are to implement better atmospheric-ocean coupling, and to develop better linkages between lower trophic levels and upper trophic levels. The model group suggested that future synthesis activities focus on several specific questions: 1) How does the CGOA shelf stratify? And is it a 1D or 3D process?, 2) What are the key mechanisms and pathways that provide nutrients into the surface shelf waters, where they can be used by plankton and provide suitable feeding conditions for young salmon and other upper trophic level organisms?

Tom Royer provided a brief summary of the discussions held by breakout group B1 (Appendix IX).

Dave Musgrave summarized the progress that was being made on planning the 2003 cruises. It was clear that much more discussion needed to occur, including the development of detailed cruise tracks with estimates of how long they would require for the mapping activities. There was discussion also of what might be added to the GLOBEC mapping effort if a proposal submitted by Hopcroft and Coyle to the NPRB is funded. That project would add acoustic, MOCNESS, and Optical Plankton Counter sampling of zooplankton to the mapping program. [Addendum 3/30/2003: NPRB declined to fund this project]. Dave, Scott Pegau and Hank Statscewich agreed to develop a strawman sampling plan and present it first thing on Thursday morning.

Thursday, 16 January 2003

Dave Musgrave presented an overview of the recently funded CGOA Mesoscale survey effort including detailed hypotheses that would be investigated (these are listed in Appendix V). He then showed a strawman sampling plan for the Mesoscale and Finescale surveys for the May and August 2003 SeaSoar cruises (Appendix V). During May when the process cruise (*RV Alpha Helix*; Strom, Chief Sci.) departs Seward prior to the mapping cruise (*RV Wecoma*; Musgrave, Chief Sci.) there is less than optimal overlap between the process and mapping cruises. Weather permitting, the process cruise will attempt to complete the outer-shelf Seward station first (before the mapping vessel is surveying), since there appears to be (in May) less mesoscale structure there than at the inner- and mid-shelf stations. The mapping vessel will first conduct a finescale survey in conjunction with the process sampling—assumed to be either the inner- or mid-shelf station (again weather permitting). Finescale survey activities will cover a region of ca. 21 x 21 nm twice, sample to document tidal effects on velocities and include station work (see Appendix V for details). Because of the mismatch in time of the two cruises in May, the finescale surveys will be done while both ships are available to work collaboratively. This means the ca. 7 day mesoscale survey (Appendix V) will be done at the end of the May cruise. NOAA/PMEL will be deploying moorings using the *RV Kilo Moana* in late April and will conduct station sampling from that vessel during the first half of May. This station sampling may be coordinated also with the process and survey work being conducted by other vessels in early May.

In August, when the vessels have better overlap in time, the mesoscale survey may be done first, followed by the finescale surveys, tightly coordinated with the process vessel. Also in August, there will be coordinated sampling by the *RV Alpha Helix* (process stations) and a chartered fishing vessel sampling salmon (Haldorson, Chief Sci.) to specifically examine salmon distributions and prey contents in relation to prey availability. The chartered trawler *FV Great Pacific* doing the coastwide GLOBEC/OCC sampling will sample the Seward Line at this time and will devote an extra day to sampling in conjunction with the other vessels working there.

Batchelder led a discussion of inter-vessel communication issues and potential data sets that could be provided in real or near-real time to the research vessels during the May and August intensive periods of field work. He demonstrated what was done to facilitate communications between shore-side data providers (satellite, buoy, HF radar) and ship data providers (mapping vessel) and ship receivers (process vessel) during the CCS work done in 2002. An FTP drop-off site and web-based URL on the GLOBEC NEP web server were used to provide a single site for transfer of data and/or plots of data. In 2002 in the CCS a variety of communications modes were used including Iridium satellite transmissions, other satellite systems and cellular phone technology. He proposed that the vessels plan for Iridium satellite communications in the CGOA in 2003. Batchelder has one Iridium Phone-Laptop system that will be installed on the *RV Wecoma* for use during the GLOBEC cruises. The University of Alaska Ship Facilities group has purchased and installed an Iridium Phone system on the *RV Alpha Helix*. An issue with both systems will be transmission costs. Although both are much less expensive than other reliable alternatives, they are still rather expensive. Data transfer rates on Iridium are ca. 2400 baud, and costs are about $1.35/minute. The best solution is to ensure that all transmitted files are reasonably small—preferably 60 Kb or less. Iridium systems can drop the connection, and by keeping file sizes small, you minimize the probability of losing files and having to retrieve or send the file a second time. He showed the types of plots and data files that were exchanged in the CCS program. Several specific data sets (specific buoys from NDBC, sea level pressure maps from the NWS) were suggested as additional products to exchange. Satellite data (Quikscat winds, AVHRR SSTs, SeaWiFs chlorophyll-a, and perhaps plots of MODIS) will be provided.

The 2003 GLOBEC NEP-CGOA workshop adjourned at 1700 on Thursday, 16 January 2003.

APPENDIX I

AGENDA

Pre-Meeting Draft Agenda

U.S. GLOBEC Northeast Pacific Coastal Gulf of Alaska Scientific Investigator's Meeting

Hotel Captain Cook, Anchorage, Alaska January 13 - 17, 2003

Tuesday, January 14, 2003, Morning

GLOBEC-1 (Adventure Room)

1000 *Workshop Introduction/Overview/ Structure* - Hal Batchelder

1015 *Ocean climate conditions during GLOBEC Northeast Pacific Program (NEP) Long Term Observing Program (LTOP)* – Tom Royer

1030 *Overview of shelf transports in the Gulf of Alaska* – Phyllis Stabeno

1100 *Seaglider surveys of the Alaska Coastal Current* - Craig Lee

1115 *Seasonal and spatial dynamics of plankton communities on the Gulf of Alaska shelf* - Evelyn Lessard

1130 Seasonal cycles of nitrate concentrations on the Gulf of Alaska shelf from the GAK4 mooring - Terry Whitledge

1145 General discussion

1200 Lunch provided: *Canada's Coasts Under Stress,* Dr. Rosemary Ommer (University of Victoria), GLOBEC FOCUS 4

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Tuesday, January 14, 2003, Afternoon

GLOBEC-2 (Adventure Room)

1330 *Seasonality in planktonic communities in the coastal Gulf of Alaska* - Suzanne Strom

1345 *Annual cycle of zooplankton abundance, biomass and production on the northern Gulf of Alaska shelf, Oct. 1997-Oct. 2000* - Ken Coyle

1400 *A comparison of copepod egg production rates in the Gulf of Alaska* - Russ Hopcroft

1415 *Secondary production and advection of shelf zooplankton in a predominantly downwelling ecosystem* - Jeff Napp

1430 *Patterns of fish food source generation and utilization in the northern Gulf of Alaska and Prince William Sound region* - Tom Kline

1445 *Seasonal and annual patterns of abundance and size of juvenile pink salmon on the shelf of the northern Gulf of Alaska* - Lew Haldorson

1500 Break

GLOBEC-3 (Adventure Room)

1530 *Factors affecting the distribution of juvenile salmon in the Gulf of Alaska* - Ned Cokelet

1545 *Diagnosis of coastal Gulf of Alaska air-sea interactions using a high resolution numerical weather prediction model* - Nick Bond

1600 *Nested biophysical modeling of the coastal Gulf of Alaska: inferences from recent circulation results* - Al Hermann

1615 *Comparison of the coastal Gulf of Alaska circulation (3-km grid) to GLOBEC data* - Dave Musgrave

1630 *Progress in 3-dimensionalization of GLOBEC coastal Gulf of Alaska NPZ model and other aspects of CGOA NPZ modeling* - Sarah Hinckley

1645 General discussion

1715 US GLOBEC NEPEXCO Meeting, Executive Tower 1

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Wednesday, January 15, 2003

GLOBEC-2 (Adventure Room/Voyager Room/Quadrant Room)

0830 Breakout Group Discussions
- Group A1. 2003 Field Season Logistics
- Group A2. Modeling the CGOA

1000 Break

1030 Group Discussions (topics are suggestions only)
- Group B1: Ecosystem Responses to Large Scale Climate Shifts
- Group B2: Mesoscale Forcing Patterns and Responses
- Group B3: GLOBEC Guidance for Resource Management
- Group B4. Modeling the CGOA (if not held earlier as A2)

1200 Lunch provided: *SFOS: Partnering with Government and Industry to Meet Alaska's Marine Research Needs*, Vera Alexander (SFOS University of Alaska Fairbanks)

GLOBEC

1330 Poster viewing time

1500 Break

GLOBEC (Adventure Room)

1530 Plenary
- Summaries of Breakout Group Discussion (A's. B's above) (10 min. each)
- Strategy for Thursday Breakout Group Discussion (20-30 min.)

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Thursday, January 16, 2003

GLOBEC (Adventure Room)

0830 (**Note**: Schedule for Thursday will be determined at the end of Wednesday's session; below is a template for what might occur)

1000 Break

GLOBEC (Adventure Room)

1030 Continued Discussion of 2003 Field Season Logistics (if needed, otherwise poster viewing time)

1200 Lunch provided: *Alaska SeaLife Center's research program,* Shannon Atkinson (Alaska SeaLife Center and University of Alaska Fairbanks)

GLOBEC (Adventure Room/Voyager Room/Quadrant Room)

1330 Breakout Group Discussions Opportunity for subsets of SIs to discuss and outline collaborative interdisciplinary publications

1500 Break

GLOBEC (Adventure Room/Voyager Room / Quadrant Room)

1530 OPEN for General Discussion (Plenary) or smaller Breakout Group discussion

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Friday, January 17, 2003

GLOBEC (Adventure Room)

0830 Discussion
1. Future NEP Activities
   a) Special Publications
   b) Future NEP meeting
   c) Highlighted NEP sessions at Scientific Meetings
   d) CGOA, NEP, and GLOBEC Wide Synthesis
2. Status Reports
   a) Breakout Group Discussion
   b) 2003 Field Logistics
3. Meeting Wrap up
   a) Recommendations
   b) Action Items

1000 Break

1030 (continued)

1200 GLOBEC adjourn

1200 Lunch on your own

APPENDIX II

LIST OF PARTICIPANTS

Attendees
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Coastal Gulf of Alaska
Scientific Investigator's Meeting
Hotel Captain Cook, Anchorage, Alaska
January 13 - 17, 2003

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APPENDIX III

LOCAL PRESS COVERAGE OF SYMPOSIUM

Anchorage Daily News
www.adn.com
14 JANUARY 2003
(FRONT PAGE)

No quick answer to salmon crash

■ **WORKSHOPS:** Biologists gather to discuss nature's delicate balance.

By DOUG O'HARRA
Anchorage Daily News

Big, fat king salmon swarmed into the Columbia River last year, producing the largest run of fish observed since 1938 and climaxing a four-year surge in returning fish. An Oregon newspaper trumpeted rising catches.

"They called it the Year of the Chinook," oceanographer Hal Batchelder told a gathering of about 500 people Monday during the first day of a marine science conference in Anchorage.

But over the same period, Alaska salmon runs have dropped and economic disasters have

See Back Page, CONFERENCE

CONFERENCE: *Steller sea lions on the agenda*

Continued from A-1

been declared. The 2002 statewide catch of about 130 million fish was the lowest since the late 1980s, the state Department of Fish and Game reported.

The two regions are connected, Batchelder said, through a complex seesaw relationship that reaches across 1,000 miles of ocean. It hinges on vast cycles in currents, temperatures, winds, storms, melting snow, river runoff and the saltiness of the sea.

The quick explanation sounds simple: The ocean may have cooled in the Northeast Pacific in the late 1990s, possibly triggering a regime shift in which animals will thrive and which won't, Batchelder said. A warming trend in the late 1970s had the opposite effect: Alaska salmon runs shot up and Pacific Northwest returns crashed. The nature of marine life throughout the region changed.

But figuring out what triggered the shift, possibly part of a 100-year cycle, is more difficult.

"In order to understand these long-term, large-scale changes, we need to decipher the nature of these ecosystem shifts," said Batchelder, a key scientist in an investigation into how climate variability affects sea life.

Over the next four days at the Hotel Captain Cook, biologists will present 360 technical talks and participate in workshops about Steller sea lions, climate change and oceanography, fisheries, plankton and biochemistry. Results from about 100 scientific studies have been posted on the walls.

On Monday, a series of speakers took a big-picture approach, explaining studies that try to understand the vast climactic engines that drive the ocean and its marine life. The details are complex, but speakers kept emphasizing how the Gulf of Alaska, with its location and huge inflow of fresh water, is especially sensitive to climate shifts.

University of Alaska Fairbanks scientist Thomas Weingartner talked about how the spinning of the Aleutian-low storm system helps create upwelling of cold, salty water. That nutrient-rich water is necessary to trigger the annual blooms of plankton and tiny sea life during spring's sunny days.

Biologist Suzanne Strom of Western Washington University described how that plankton bloom occurs only when the right conditions converge — just the right mixing of the ocean's layers, just the right amount of sunlight. Those tiny animals and plants then form the basis of a complex food web that feeds juvenile fish like pink salmon.

Ted Cooney, a University of Alaska Fairbanks researcher who studied the ecosystem of Prince William Sound, explained how researchers gradually came to a more sophisticated understanding of the relationship between pink salmon and those little critters over the past 25 years. Predators play a big role.

They once believed that salmon thrived when they found enough food. But pollock and herring, trying to eat the same food, can turn on the young salmon and eat them up. In the end, no simple mechanism controlled salmon survival in the Sound.

"We learned that Mother Nature is sophisticated and robust," Cooney said. "We also saw that asking for a silver bullet was, in the words of the Borg, futile."

The conference runs through Friday. It has been organized by the Exxon Valdez Oil Spill Trustees Council staff with sponsorship from the U.S. Global Change Research Program, the National Marine Fisheries Service, the North Pacific Research Board, North Pacific Marine Research Institute and Pollock Conservation Cooperative Studies.

ON THE Web

■ A SCHEDULE for the Marine Science in the Northeast Pacific Symposium can be viewed at **www.oilspill.state.ak.us/events/Sympos.html**

■ Doug O'Harra can be reached at do'harra@adn.com and 257-4334.

APPENDIX IV

TITLES AND ABSTRACTS OF GLOBEC POSTERS AND PRESENTATIONS

U.S. GLOBEC NEP-CGOA SI Meeting
13-17 January 2003, Anchorage, AK
List of Abstracts

1 **GLOBEC Research: Food Habits and Feeding Patterns of Gulf of Alaska Juvenile Pink Salmon** (Poster)
Janet L. Armstrong[1], Jennifer L. Boldt[2], Alison D. Cross[1], Jamal H. Moss[1], Nancy D. Davis[1], Katherine W. Myers[1], Robert V. Walker[1], David A. Beauchamp[1], and Lewis J. Haldorson[2] ([1]School of Aquatic and Fishery Sciences, University of Washington, Box 355020 Seattle, WA 98195-5020; [2]School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Hwy, Juneau, AK 99801) [janeta@u.washington.edu]

2 **Diagnosis of Coastal GOA Air-Sea Interactions Using a High Resolution NWP Model** (Talk)
Nicholas A. Bond[1], Richard Steed[2] Albert J. Hermann[1], Dylan Righi[1] and Phyllis J. Stabeno[3] ([1]Joint Institute for the Study of Atmospheres and Oceans, University of Washington; [2]Atmospheric Sciences, University of Washington; [3]NOAA Pacific Marine Environmental Laboratory)

3 **Factors Affecting Marine Growth and Survival of Auke Creek, Alaska Coho Salmon (*Oncorhynchus kisutch*)** (Poster)
Ryan J. Briscoe and Milo D. Adkison (Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Highway, Juneau, AK 99801), Alex Wertheimer (Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801) [ftrjb@uaf.edu]

4 **Abundance, Biomass, and Production rates of *Oithona similis* in the Gulf of Alaska** (Poster)
A.G. Byrd, R.R. Hopcroft (University of Alaska, Fairbanks, AK) [byrd@ims.uaf.edu]

5 **A Preliminary Look at Nitrate Sources and Sinks in the Shelf Waters of the Northern Gulf of Alaska** (Poster)
A.R. Childers, T. E. Whitledge, D.A. Stockwell, and T. J. Weingartner (University of Alaska, Fairbanks, AK) [ruehs@ims.uaf.edu]

6 **Factors Affecting the Distribution of Juvenile Salmon in the Gulf of Alaska** (Talk)
E. D. Cokelet, E. V. Farley Jr., C. M. Kondzela, P. J. Stabeno and J. H. Helle [cokelet@pmel.noaa.gov]

7 **Factors Affecting the Distribution of Juvenile Salmon in the Gulf of Alaska: Physical Oceanography** (Poster)
E. D. Cokelet, P. J. Stabeno and A. J. Jenkins [cokelet@pmel.noaa.gov]

8 **Annual Cycle of Zooplankton Abundance, Biomass and Production on the Northern Gulf of Alaska Shelf, October 1997 through October 2000** (Talk)
Kenneth O. Coyle (University of Alaska, Fairbanks, AK)

9 **Modeling Bioenergetics of Juvenile Pink Salmon in Prince William Sound and the Coastal Gulf of Alaska** (Poster)
Alison D. Cross[1], David A. Beauchamp[1], Janet L. Armstrong[1], Jennifer L. Boldt[2], Nancy D. Davis[1], Lewis J. Haldorson[2], Jamal H. Moss[1], Katherine W. Myers[1], and Robert V. Walker[1] ([1]School of Aquatic and Fishery Sciences, University of Washington, Box 355020 Seattle, WA 98195-5020; [2]School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Hwy, Juneau, AK 99801) [crossad@u.Washington.edu]

10 **Annual and Interannual Variability in Atmospheric Heat Flux over the Northern Gulf of Alaska** (Poster)
Seth L. Danielson, Thomas J. Weingartner and Dean Stockwell (University of Alaska, Fairbanks, AK) [seth@ims.uaf.edu]

11 **Comparison of Physical-Biological Models of the California Current System and the Coastal Gulf of Alaska** (Poster)
Elizabeth L Dobbins (JISAO, University of Washington, Seattle, WA) Craig V. W. Lewis (University of California, Berkeley, CA) Sarah Hinckley (Alaska Fisheries Science Center, NOAA, Seattle, WA) Albert J. Hermann (JISAO, University of Washington, Seattle, WA) [dobbins@pmel.noaa.gov]

12 **Factors Affecting the Distribution of Juvenile Prince William Sound Hatchery Pink Salmon in the Gulf of Alaska** (Poster)
E.V. Farley, Jr and J.H. Helle (NOAA, Auke Bay Laboratory) [ed.farley@noaa.gov]

13 **Seasonal and Spatial Dynamics of Phyto and Microzooplankton in the Gulf of Alaska** (Poster)
Michael S.Foy and Evelyn J. Lessard (University of Washington) [elessard@u.Washington.edu]

14 **GLOBEC Research: Seasonal and Annual Patterns of Abundance and Size of Juvenile Pink Salmon on the Shelf of the Northern Gulf of Alaska** (Poster and Talk)
Lewis Haldorson and Jennifer Boldt (School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Hwy, Juneau, AK 99801) [ffljh@uaf.edu]

15 **Modeled Lagrangian Drifters in the Gulf of Alaska** (Poster)
K. Hedstrom (University of Alaska, Fairbanks, AK), D. Musgrave (University of Alaska, Fairbanks, AK), A.J. Hermann(University of Washington, JISAO), and E.L. Dobbins (University of Washington, JISAO) [kate@arsc.edu]

16 **Juvenile Salmon Migrations along the Continental Shelf in the Gulf of Alaska** (Talk)
Jack Helle (NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory)

17 **Nested Biophysical Modeling of the Coastal Gulf of Alaska: Inferences from Circulation Results** (Poster and Talk)
J. Hermann (University of Washington, JISAO), D. B. Haidvogel (Rutgers University), E. L. Dobbins (University of Washington, JISAO), S. Hinckley (NOAA, Alaska Fisheries Sciences Center), P. J. Stabeno (NOAA, Pacific Marine Environmental Lab), D. Musgrave (University of Alaska, Fairbanks, AK), K. Hedstrom (University of Alaska, Fairbanks, AK) [Hermann@pmel.noaa.gov]

18 **Progress in GLOBEC Coastal Gulf of Alaska NPZ Modeling** (Poster and Talk)
S. Hinckley (NOAA, Alaska Fisheries Science Center), A. Hermann (University of Washington, JISAO), E. Dobbins (University of Washington, JISAO) [sarah.Hinckley@noaa.gov]

19 **A Comparison of Copepod Egg Production Rates in the Gulf of Alaska** (Talk)
R. R. Hopcroft (University. of Alaska, Fairbanks, AK) [hopcroft@ims.uaf.edu]

20 **Egg Production Rates of Pseudocalanus mimus and Pseudocalanus newmanii in the Gulf of Alaska** (Poster)
Hopcroft, R.R., Clarke, C., Pinchuk, A.I. (University of Alaska, Fairbanks, AK) [hopcroft@ims.uaf.edu]

21 **Egg Production Rates of *Metridia pacifica* in the Gulf of Alaska** (Poster)
Hopcroft, R.R., Clarke, C., Pinchuk, A.I., Byrd, A.G. (University of Alaska, Fairbanks, AK) [hopcroft@ims.uaf.edu]

22 **Nutrient Supply to the GOA Shelf in Summer: The Role of Troughs and Shallow Banks** (Poster)
N. B. Kachel, C. Ladd, C. W. Mordy, J. A. Napp, , S. A. Salo, P. J. Stabeno, [stabeno@pmel.noaa.gov]

23 **Patterns of Fish Food Source Generation and Utilization in the Northern Gulf of Alaska and Prince William Sound Region from Natural Stable Isotope Abundance: Results from SEA and GLOBEC (1994 to 2002)** (Poster and Talk)
Thomas C. Kline, Jr. (Prince William Sound Science Center) [tkline@pwssc.gen.ak.us]

24 **Origin of Juvenile Chum Salmon from Gulf of Alaska** (Poster)
Christine Kondzela and Richard Wilmot [chris.kondzela@noaa.gov]

25 **Physical Oceanography of the Eastern Aleutian Passes** (Poster)
Carol Ladd, G. Hunt, C. W. Mordy, R. Reed, S. Salo, P. J. Stabeno [carol.ladd@noaa.gov]

26 **Satellite Tracked Drifter Studies in the Eastern Aleutian Passes** (Poster)
Carol Ladd, G. Hunt, D. Kachel, S. Salo, P. J. Stabeno [carol.ladd@noaa.gov]

27 **Seaglider Surveys of the Alaska Coastal Current** (Talk)
Craig M. Lee[1] and Charles C. Eriksen[2] ([1]Applied Physics Laboratory, University of Washington; [2]School of Oceanography, University of Washington

28 **Direct and Indirect Modifications of Pelagic Food Webs in the Gulf of Alaska by the Particle Grazing Copepods *Neocalanus spp.*** (Poster)
Hongbin Liu, Michael Dagg (LUMCON), S. Strom [mdagg@lumcon.edu]

29 **Phytoplankton Community Structure and Taxon-Specific Growth and Grazing Rates in the Coastal Gulf of Alaska** (Poster)
Erin Macri (Western Washington University), Suzanne Strom (Western Washington University), Jeffrey Napp (NOAA, Alaska Fisheries Science Center), Michael Dagg (LUMCON) [macrie@cc.wwu.edu]

30 **Climate Trends in the Gulf of Alaska and the Bering Sea, 1950-97: Ecosystem Implications** (Poster)
Roy Mendelssohn, Steven J. Bograd, Franklin B. Schwing Nathan Foley-Mendelssohn [fschwing@pfeg.noaa.gov]

31 **Timing and Mesoscale Variability of Phytoplankton Blooms in the Northern GOA** (Poster)
C. W. Mordy, S. A. Salo, J. A. Napp, D. P. Wisegarver, P. J. Stabeno [stabeno@pmel.noaa.gov]

32 **Quantifying Trophic Interaction and Energetics of Juvenile Pink Salmon in the Gulf of Alaska and Prince William Sound** (Poster)
Jamal H. Moss[1], Dave A. Beauchamp[1], Alison D. Cross[1], Katherine W. Myers[1], Nancy D. Davis[1], Janet L. Armstrong[1], Robert V. Walker[1], Lewis J. Haldorson[2], Jennifer L. Boldt[2], Mikhail Blikshteyn[2], Edward V. Farley[3], Steve E. Ignell[3], and John H. Helle[3] ([1]School of Aquatic and Fishery Sciences, University of Washington, Box 355020 Seattle, WA 98195-5020; [2]School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Hwy, Juneau, AK 99801; [3]Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, 11305 Glacier Hwy, Juneau, AK 99801-8626) [jmoss@u.Washington.edu]

33 **Comparison of the Coastal Gulf of Alaska Circulation (3-km grid) to GLOBEC Data** (Talk)
D.L. Musgrave[1], K. Hedstrom[1], A. J. Hermann[2] and D. B. Haidvogel[3] ([1]University of Alaska Fairbanks; [2]Joint Institute for the Study of Atmospheres and Oceans, University of Washington; [3]Rutgers University)

34 **Secondary Production in a Downwelling Ecosystem: Egg Production Rates of *Calanus marshallae* and *Pseudocalanus* spp. in the Coastal Gulf of Alaska, 2001** (Poster and Talk)
J.M. Napp and C.T. Baier (NOAA, Alaska Fisheries Science Center) [jeff.napp@noaa.gov]

35 **Advection of Shelf Zooplankton in a Predominantly Downwelling Ecosystem: Bioacoustic Detection of the Dominant Modes of Variability** (Poster and Talk)
J.M. Napp (NOAA, Alaska Fisheries Science Center), C.F. Greenlaw, D.V. Holliday, P.J. Stabeno (NOAA, Pacific Marine Environmental Lab) [jeff.napp@noaa.gov]

36 **Distribution and Growth of Euphausiids in the Northern Gulf of Alaska** (Poster)
A.I. Pinchuk, R.R. Hopcroft, K.O. Coyle (University of Alaska, Fairbanks, AK) [hopcroft@ims.uaf.edu]

37 **Mesoscale Variability along the Kenai Peninsula** (Poster)
R. Reed, N. Kachel, C. Mordy, N. Bond, J. Napp, S. Salo, P. Stabeno [stabeno@pmel.noaa.gov]

38 **Ocean Climate Conditions during GLOBEC Northeast Pacific Program (NEP) Long Term Observation Program (LTOP)** (Talk)
Thomas C. Royer, Chester E. Grosch and Nandita Sarkar (Old Dominion University)

39 **Complex Empirical Orthogonal Function (CEOF) Analysis of the Hydrography Along the Seward Line from 1997 to 2001: Preliminary Results** (Poster)
Nandita Sarkar, Chester E. Grosch and Thomas C. Royer (Old Dominion University, Norfolk, VA) [sarkar@ccpo.odu.edu]

40 **Annual Spatial Variability of the Hydrographic Structure Along the Seward Line: Preliminary Results** (Poster)
Isaac D. Schroeder, Chester E. Grosch, Thomas C. Royer (Old Dominion University, Norfolk, VA) [Isaac@ccpo.ocu.edu]

41 **From Physics to Fish: the Global Climate Connection to the Gulf of Alaska Ecosystem** (Talk)
Franklin B. Schwing (NOAA Pacific Fisheries Environmental Laboratory)

42 **Along-shelf and Cross-Shelf Flow on the GOA Shelf** (Poster)
P.J. Stabeno, N. Bond, D. G. Kachel, N. Kachel, C.W. Mordy [stabeno@pmel.noaa.gov]

43 **Overview of Shelf Transports in the GOA** (Talk)
P.J. Stabeno, (NOAA Pacific Marine Environmental Laboratory) [stabeno@pmel.noaa.gov]

44 **Surface Current Mapping Via CODAR in Cook Inlet, Alaska** (Poster)
Hank Statscewich, D. Musgrave, Tony D'Aout [musgrave@ims.uaf.edu]

45 **Preliminary Observations on Chlorophyll a and Primary Productivity Distributions Obtained During the Gulf of Alaska GLOBEC Monitoring Program** (Poster)
Dean Stockwell, T.E. Whitledge, A.R. Childers (University of Alaska, Fairbanks, AK) [terry@ims.uaf.edu]

46 **Planktonic Processes in the Coastal Gulf of Alaska: Interconnections with Weather, Ocean Conditions, and Salmon Production** (Talk)
S. Strom[1], J. Napp[2], M. Dagg[3], L. Haldorsen[4] and R. Hopcroft[5] ([1]Western Washington University; [2]NMFS Alaska Fisheries Science Center; [3]LUMCON; [4]School of Fisheries and Ocean Sciences, University of Alaska Fairbanks; [5]University of Alaska Fairbanks)

47 **Seasonality in Planktonic Community Structure, Phytoplankton Growth and Microzooplankton Grazing in the Coastal Gulf of Alaska** (Poster and Talk)
Suzanne Strom and Brady Olson (Western Washington University), E. Macri, C. W. Mordy [stroms@cc.wwu.edu]

48 **Diel Feeding and Gastric Evacuation of Juvenile Salmon** (Poster)
Molly Sturdevant, Emily Fergusson, Joseph Orsi, Alex Wertheimer (NOAA, Auke Bay Laboratory) [molly.sturdevant@noaa.gov]

49 **Order and Chaos: The Physical Structure of the Gulf of Alaska Shelf/Slope Ecosystem** (Talk)
Thomas J. Weingartner (Institute of Marine Science, University of Alaska, Fairbanks) [weingart@ims.uaf.edu]

50 **Seasonal, Interannual, and Decadal Scale Freshwater Variability in the Alaska Coastal Current** (Poster)
Thomas J. Weingartner (University of Alaska, Fairbanks, AK), Seth L. Danielson (University of Alaska, Fairbanks, AK) and Thomas C. Royer (Old Dominion University, Norfolk, VA) [weingart@ims.uaf.edu]

51 **Alaska Region Research Vessel** (Poster)
T.E. Whitledge, V. Alexander, R. Elsner, T. Weingartner, T. Smith, R. Pittenger, R. Dinsmore, J. Coburn (University of Alaska, Fairbanks, AK) [terry@ims.uaf.edu]

52 **Seasonal Cycles of Nitrate Concentrations on the Gulf of Alaska Shelf from the GAK4 Mooring** (Poster and Talk)
T.E. Whitledge, S.J. Thornton, A.R. Childers, D. Musgrave, and H. Statscewich (University of Alaska, Fairbanks, AK) [terry@ims.uaf.edu]

53 **Idealized Modeling of Seasonal Variation in the Alaska Coastal Current** (Poster)
W. J. Williams, T. J. Weingartner (University of Alaska, Fairbanks, AK) [wjw@ims.uaf.edu]

GLOBEC Research:
Food Habits and Feeding Patterns of Gulf of Alaska Juvenile Pink Salmon

Janet L. Armstrong[1], Jennifer L. Boldt[2], Alison D. Cross[1], Jamal H. Moss[1], Nancy D. Davis[1], Katherine W. Myers[1], Robert V. Walker[1], David A. Beauchamp[1] and Lewis J. Haldorson[2]

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The Global Ocean Ecosystem Dynamics program (GLOBEC) was developed to advance our understanding of marine ecosystems and their response to climatic changes. An integral part of assessing the ecosystem of the northern Gulf of Alaska (GOA) is the analysis of the food habits and feeding patterns of abundant zooplantivorous fish. Juvenile pink salmon have been selected for study because they are zooplanktivorous, highly abundant in the study area, and as adults support valuable commercial fisheries. In addition, pink salmon have a short two-year lifespan, which might provide a clear link between short-term climatic changes and associated biological response. We present major trends in food habits by summarizing interannual (August 1999, 2000, and 2001), seasonal (July to October 2001,) and diel (August 2000, and July and August 2001) feeding patterns based on analysis of stomach contents of juvenile pink salmon collected along the Seward Line (GAK stations 1-6) and in Prince William Sound (PWS), Alaska. Results of interannual changes in juvenile pink salmon diets indicated that prey were more diverse in 2001 compared to either 1999 or 2000. Pteropods (*Limacina helicina*) comprised the majority of prey consumed in 1999 and 2000; whereas high proportions of copepods, pteropods, euphausiids, amphipods, crabs, gastropods, and fish were consumed in 2001. Seasonal changes indicated that juvenile pink salmon consumed increasingly larger prey items from July to October 2001, in the GOA. The diet of juvenile pink salmon in the GOA was different and more diverse than diets of fish caught in PWS. In PWS during July to October, the main prey of juvenile pink salmon was amphipods. The primary prey in the GOA in July, were larvaceans and euphausiids. In August, while copepods comprised the majority of the prey, pteropods (*L. helicina*), amphipods, euphausiids, crabs, and shrimp were also important. September and October samples collected from both areas contained a high proportion of larger prey items including fish, euphausiids, and large pteropods (*Clio* sp.). Diel comparisons of stomach contents showed pink salmon fed during daylight hours with stomach fullness increasing from dawn to a maximum fullness 12 hours after sunrise, and declining thereafter. The predominant prey during all diel time periods was pteropods, (*Limacina* sp.) in the August 2000 samples from the Seward line (GAK stations 3 and 4 combined). Euphausiids were also present in the stomachs of pink salmon early in the day. Diel studies in PWS indicated that the dominant prey items in the July were larvaceans and pteropods (*Limacina* sp.), however, in August stomach samples contained predominately hyperiid amphipods. In PWS, pink salmon stomach content volume was substantially larger in August than in July 2001. Future work will integrate food habits data with fish condition and growth data, zooplankton abundance, and water temperature to develop foraging and bioenergetics models. These models will enable us to assess the habitat quality and growth conditions for juvenile pink salmon. This will contribute directly to the GLOBEC goal of understanding how pink salmon, and, therefore, tertiary production are affected by changes in ocean conditions.

Diagnosis of Coastal GOA Air-Sea Interactions Using a High Resolution Numerical Weather Prediction (NWP) Model

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This work represents one element of a series of studies assessing air-sea interactions important to the Alaska Coastal Current (ACC) under the auspices of GLOBEC's Coastal Gulf of Alaska Program. The objective of this particular study is to construct high-resolution atmospheric fields in the coastal zone of the GOA, and determine the degree to which the ACC is sensitive to details in the local atmospheric forcing in the coastal zone. The atmospheric fields are derived from MM5 numerical weather prediction (NWP) model simulations on a 15-km horizontal grid using the NCEP/NCAR Reanalysis data set, which is on a 2.5 degree horizontal grid, as initial and boundary conditions. The MM5 simulations are a suitable method for incorporating the effects of the prominent coastal terrain of the GOA in a dynamically consistent manner. The MM5 output is used to drive ROMS numerical ocean model simulations of the ACC. The results here illustrate the nature and magnitude of the upper ocean's response to mesoscale atmospheric structures in the coastal zone, such as barrier jets. The eventual goal is to use the downscaling technique outlined here to investigate how climate changes impact the coastal GOA, and in particular the relative importance of remote, gyre-scale effects versus local, mesoscale atmospheric forcing on the ACC.

Factors Affecting Marine Growth and Survival of Auke Creek, Alaska Coho Salmon (*Oncorhynchus kisutch*)

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Ocean-basin and regional-scale fluctuations in climate have been observed in conjunction with fluctuations in salmon growth and abundance. The need exists to examine effects of local climatic trends on the growth and survival of specific stocks. Scales from Auke Creek, Alaska adult coho salmon collected at the Auke Creek Weir and archived since 1977 are being digitized and measured. Scales from juvenile coho salmon collected in Northern Southeast Alaskan waters since 1997 as part of the Auke Bay Lab's Southeast Coastal Monitoring Project (SECM) are also being digitized and measured. Using the juvenile scales as a reference, marks will be placed on the adult scales indicating when the coho transit as juveniles from Northern Southeast Alaska coastal/strait habitat into Gulf of Alaska waters. For analysis, we will attempt to further divide growth zones into four phases: early marine nearshore, early marine coastal/strait, pre-winter Gulf of Alaska, and post-winter Gulf of Alaska. Growth from the adult Auke Creek scales will be analyzed for correlation with geographically relevant biophysical parameters that are thought to have a mechanistic effect on salmon growth. Growth will also be analyzed for statistical relationships it has with size at return, marine survival, and abundance of Southeast Alaska salmon.

Abundance, Biomass & Production rates of *Oithona similis* in the Gulf of Alaska

A.G. Byrd and R.R. Hopcroft

University of Alaska Fairbanks

Oithona similis is one of the most numerous and least studied copepod species in the Gulf of Alaska. Abundance, biomass and (egg) production rates for *O. similis* were estimated in coastal and offshore water in the Gulf of Alaska during 2001 using 0.053-mm mesh plankton nets. Abundance varied between 650-2900 m^{-3}, while their biomass ranged between 1.2 and 11 mg AFDW m^{-3}, with biomass remaining high from late spring to early fall. Clutch size was relatively stable varying between 14 and 23 eggs per female. The percentage of females with eggs varied between 43.2% and 9.8%, with the specific egg production rates of 0.7% to 5.8% per day. Applying this rate to all stages, production rates of *O. similis* varied between 0.02 and 0.24 mg AFDW m^{-3} day^{-1}.

POSTER Session GLOBEC

A Preliminary Look at Nitrate Sources and Sinks in the Shelf Waters of the Northern Gulf of Alaska

A.R. Childers, T. E. Whitledge, D.A. Stockwell and T. J. Weingartner

University of Alaska Fairbanks

Nutrient data collected in 1998, 1999, and 2000 from the northern Gulf of Alaska shelf as part of the Global Ocean Ecosystem Dynamics (GLOBEC) Gulf of Alaska Long Time Series Observation Program (LTOP) have provided preliminary data on the sources and sinks of nitrate to the shelf waters. Surface nitrate exhibited an annual cycle of spring and summer drawdown followed by replenishment throughout the winter months. First order new production estimates revealed that springtime nitrate utilization was similar among years within the shelf regimes (except over the shelf-break) with the highest rates over the inner shelf. Deep-water measurements provided evidence of a summer onshore flux of dense, nitrate-rich bottom water onto the shelf when the predominant downwelling regime relaxed. This seasonal flux created a reservoir over the inner shelf that was ultimately mixed into the upper water column through winter wind mixing. In an effort to determine the source of nitrate to the euphotic zone after summer depletion, first order calculations of vertical diffusion and surface Ekman transport were made. These estimates indicated that vertical diffusion could potentially play a much larger role in transporting nitrate to the euphotic zone over the inner shelf. There were distinct interannual differences in the chemical and physical properties across the Gulf of Alaska shelf in 1998 (El Niño) and 1999-2000 (La Niña). The water column in spring 1998 was more stratified and fresher due to high freshwater discharge and anomalously strong downwelling, consequently nitrate concentrations were notably lower in spring 1998 than those measured in spring 1999 and spring 2000. Overall, it is apparent from this data that new production is an important element for supporting the phytoplankton community, however the underlying mechanisms in transporting nitrate to the euphotic zone remain unclear.

Factors Affecting the Distribution of Juvenile Salmon in the Gulf of Alaska

E. D. Cokelet, E. V. Farley Jr., C. M. Kondzela, P. J. Stabeno and J. H. Helle

Our goal is to relate the distribution of juvenile salmon to oceanographic parameters in the Gulf of Alaska. Observations were made aboard the charter fishing vessel, *F/V Great Pacific*, during mid-July to early August - the expected peak migration period. The study region is larger than that covered by most GLOBEC Gulf of Alaska field experiments. We occupy 11 transects across the continental shelf from near shore to >2000-m depth between Icy Point or Yakutat in SE Alaska and the southwestern tip of Kodiak Island including Shelikof Strait. Oceanographic measurements include sea-surface temperature, salinity and fluorescence from an underway, flow-through water system and vertical profiles of temperature and salinity. Ocean current is measured with an acoustic Doppler current profiler (ADCP) and via the trajectories of satellite-tracked drifting buoys launched at sea. Zooplankton are captured in bongo hauls or Tucker trawls. Juvenile salmon are caught in a 198 x 45 x 10 m (LxWxH) midwater rope trawl towed at the surface. These are identified, counted, weighed and sampled for hatchery-induced otolith thermal marks and genetic analysis to determine their natal streams. Oceanographically, the surface salinity decreases near shore in the Alaska Coastal Current. Buoys deployed there tend to remain in a narrow band near shore and to exit through Shelikof Strait. The surface salinity increases toward each transect's seaward end, and buoys launched there remain offshore and enter the Alaskan Stream. Juvenile pink salmon from Prince William Sound (PWS) hatcheries in 2000 and 2001 were not significantly related to sea surface temperature or zooplankton volumes. They were smallest at nearshore and offshore locations along the Seward and Gore Point transects. Those located offshore tended to have significantly higher condition factor than those caught nearshore or within the middle of the transect. Their condition factor was negatively related to zooplankton volume during 2000 (Bongo nets) and not significantly related to zooplankton volume during 2001 (Tucker trawl). Juvenile chum salmon migration patterns have been updated with the use of distribution data from thermally marked hatchery stocks and the first genetic stock identification analysis of juvenile salmon migrating through Gulf of Alaska coastal corridors. Results from the genetic analyses indicate that juvenile chum salmon caught east of Prince William Sound were from the Southeast Alaska/ Northern British Columbia region with smaller proportions from the Queen Charlotte Island and Washington State/Southern British Columbia regions. Those caught west of Prince William Sound were mostly from Prince William Sound and Southeast Alaska/Northern British Columbia with a small proportion from Washington State/ Southern British Columbia. Juvenile chum salmon caught within Shelikof Strait were mostly from the Alaska Peninsula/Kodiak Island and Susitna River regions with a small proportion from the Southeast Alaska/Northern British Columbia region. These results from genetic analyses compare favorably with the otolith thermal mark results from Southeast Alaska and Prince William Sound hatcheries. Future analyses will include more effort to link oceanographic measurements (temperature, salinity and current) collected during Ocean Carrying Capacity/GLOBEC surveys in the Gulf of Alaska to zooplankton distributions and juvenile salmon biological characteristics (distribution, size, condition and origin).

Factors Affecting the Distribution of Juvenile Salmon in the Gulf of Alaska: Physical Oceanography

E. D. Cokelet, P. J. Stabeno and A. J. Jenkins

Our goal is to relate the distribution of juvenile salmon to oceanographic parameters in the Gulf of Alaska. Sea-surface temperature, salinity and fluorescence were measured in conjunction with zooplankton and juvenile salmon from net tows during mid-July to early-August of 2001 and 2002 - the expected peak migration period. The charter fishing vessel, F/V Great Pacific, carried a conductivity-temperature-depth probe (CTD) to measure water column stratification. An acoustic Doppler current profiler (ADCP) and satellite-tracked drifting buoy trajectories measured the ocean current. The study region is larger than that covered by most GLOBEC GoA investigations. It occupies 11 transects across the continental shelf from near shore to >2000-m depth between Icy Point in SE Alaska and the southwestern tip of Kodiak Island. Resulting maps show that the surface salinity decreases near shore in the Alaska Coastal Current. Buoys deployed there tended to remain in a narrow band near shore and to exit through Shelikof Strait. The surface salinity increases toward the transects' seaward ends, and buoys launched there remained offshore and entered the Alaskan Stream. Work is underway to remove tidal currents from the ADCP velocities via modeling in order to reveal the mean flow field and how salmon juveniles position themselves within it.

Annual Cycle of Zooplankton Abundance, Biomass and Production on the Northern Gulf of Alaska Shelf, October 1997 Through October 2000

Kenneth O. Coyle

University of Alaska Fairbanks

Zooplankton abundance from March through October on the northern Gulf of Alaska shelf in 1998, 1999 and 2000 was dominated by calanoid copepods; the biomass was dominated by calanoids and cnidarians. Although we sampled during the 1997-1998 El Niño, marked interannual differences in the major copepod taxa were not observed. Zooplankton abundance and species composition was influenced primarily by salinity, secondarily by the mean temperature above the thermocline. An annual biomass peak, averaging about 0.5 g wet weight m^{-3}, occurred in May and consisted primarily of the oceanic copepod species *Neocalanus cristatus*, *Neocalanus plumchrus* and *Neocalanus flemingeri*. A second biomass peak, 0.5 g wet weight m^{-3}, was observed in August and consisted mainly of the cnidarian *Aequorea* spp. Regression equations from the literature relating biomass and temperature to production indicate that copepod production peaked in July at about 65 mg C m^{-2} d^{-1}. Although the small neritic copepods made up about 30% of the biomass, they accounted for about 60% of the total annual copepod production between March and October. Initial calculations suggest an annual copepod production on the order of 10 g C m^{-2} y^{-1}, probably less than 10% of the annual primary production. The apparent resilience of the zooplankton assemblage on the northern Gulf of Alaska shelf to the 1997-1998 ENSO may have been due to its large geographic separation from the faunal boundary between zooplankton communities in the California Current and North Pacific Subartic gyre.

Modeling Bioenergetics of Juvenile Pink Salmon in Prince William Sound and the Coastal Gulf of Alaska

Alison D. Cross[1], David A. Beauchamp[1], Janet L. Armstrong[1], Jennifer L. Boldt[2], Nancy D. Davis[1], Lewis J. Haldorson[2], Jamal H. Moss[1], Katherine W. Myers[1] and Robert V. Walker[1]

[1]School of Aquatic and Fishery Sciences, University of Washington
[2]School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

We currently lack a mechanistic understanding of the carrying capacity for juvenile salmon in the Gulf of Alaska. Juvenile pink salmon (*Oncorhynchus gorbuscha*) are a major component of this region, and their abundance is heavily subsidized by hatchery production. The primary objective of this Global Ocean Ecosystem Dynamics (GLOBEC) study is to use bioenergetics model simulations to compare spatial and temporal patterns of temperature and food supply with juvenile pink salmon growth and consumption in Prince William Sound and the coastal Gulf of Alaska. We are focusing on the July–October period of their first year at sea, a critical time for feeding, growth, and survival. The energy-balance approach of bioenergetics models enables estimates of consumption over time based on predator weight change, diet, and thermal experience, and energy densities of both predator and prey. We applied monthly GLOBEC 2001 data on local ocean conditions and juvenile pink salmon diet, growth, and distribution patterns to the Wisconsin Bioenergetics Model to determine the level of consumption necessary to achieve observed growth from July to October of the pink salmon's first year at sea. Consumption estimates indicate the ecosystem's influence on juvenile pink salmon growth and condition and allow us to account for spatial, temporal, and size-specific interactions between juvenile pink salmon, their prey, and the ocean environment in future management schemes.

Annual and Interannual Variability in Atmospheric Heat Flux over the Northern Gulf of Alaska

Seth L. Danielson, Thomas J. Weingartner, and Dean Stockwell

University of Alaska Fairbanks

Stratification dynamics on the Gulf of Alaska shelf are influenced by freshwater runoff, atmospheric heating and cooling, wind mixing and ocean dynamics. The influence of these processes varies seasonally and spatially. For example, the transport and dispersal of freshwater (a three-dimensional process) on the inner shelf and within the Alaska Coastal Current appears important to the onset of springtime stratification. However, over the outer shelf, the vertical exchange of heat between the ocean and atmosphere might in fact be dominant in controlling the onset of springtime stratification and therefore the spring phytoplankton bloom. Moreover, heating and cooling affects the seasonal shelf heat budget and these fluxes can structure the shelf ecosystem through the temperature dependence of metabolic rates. We computed the air-sea heat fluxes over the northern Gulf of Alaska shelf using hourly data collected from Middleton Island (PAMD) for the period of 1945-1963 and 1973-present. The PAMD data set is ideal for these calculations because it is a low-lying island situated ~80 km south of Prince William Sound and near the shelfbreak. The island's low relief and distance from shore suggest that it provides an unbiased measurement platform for the meteorological measurements used herein. We use this long-term data record to compute the mean annual cycle and interannual variations in the radiant, latent, and sensible heat fluxes and the vertical freshwater flux (precipitation minus evaporation). Our results allow us to estimate the time window in spring when stratification is likely to occur on the outer shelf assuming that freshwater contributions are unimportant to stratification. We also use these data, in conjunction with oceanographic measurements, to quantify differences in atmospheric cooling and heating and the alongshore advection of heat that occurred during the 1997-99 El Niño-La Niña transitions.

Comparison of Physical-Biological Models of the California Current System and the Coastal Gulf of Alaska

Elizabeth L Dobbins[1], Craig V. W. Lewis[2], Sarah Hinckley[3] and Albert J. Hermann[1]

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The California Current System (CCS) and the Coastal Gulf of Alaska (CGOA) are both regions of high biological productivity. While the dynamics governing the CCS's upwelling system are fairly well understood, the reasons for high productivity on the CGOA's downwelling shelf are more mysterious. Two biological models, each embedded within the Regional Ocean Modeling System (ROMS), are being used to investigate the differences between these systems; a simple NPZD model is used for the CCS, but for the CGOA, a specialized, 10-compartment model, called GLNPZ, has been developed and tuned to conditions in the Gulf. In order to compare the biological models, independent from the different physical conditions of the regions, a pseudo 1-D test case of ROMS was developed to run with both. We compare the biological results produced by implementations of this test case, and consider implications for interregional comparisons.

Factors Affecting Distribution of Juvenile Prince William Sound Hatchery Pink Salmon in the Gulf of Alaska

E.V. Farley, Jr and J.H. Helle

NMFS Auke Bay Laboratory

Variations in distribution, size and condition factor for juvenile Prince William Sound hatchery pink salmon caught in oceanic waters during August 2000 and 2001 along transects across the continental shelf of the Gulf of Alaska west of Prince William Sound were examined with respect to distance off shore, surface temperature, and zooplankton volume. Distribution, represented by catch per unit effort, was not significantly related to sea surface temperature or zooplankton volumes. Juvenile PWS hatchery pink salmon were smallest at nearshore and offshore locations along the Seward Line and Gore Point transects. Juvenile PWS hatchery pink salmon located offshore tended to have significantly higher condition factor than those caught nearshore or within the middle of the transect. Condition factor was negatively related to zooplankton volume during 2000 (bongo nets were used) and not significantly related to zooplankton volume during 2001 (Tucker trawl was used). Future analyses will link oceanographic measurements collected during Ocean Carrying Capacity surveys in the Gulf of Alaska (ADCP or current and salinity) to juvenile salmon biological characteristics (distribution, size and conditions) and zooplankton distributions.

Seasonal and Spatial Dynamics of Plankton Communities on the Gulf of Alaska Shelf

Michael S. Foy and Evelyn J. Lessard

University of Washington

The size-structure, taxonomic composition and seasonal dynamics of the lower trophic food web can be highly responsive to physical forcing and, in turn, exert strong influences on zooplankton growth, fecundity, and nutritional state. Examining the temporal changes and spatial variability of the lower food web structure over seasonal and interannual cycles is critical to understanding bottom-up controls on salmon production and ecosystem responses to climate change. The goal of this project is to determine seasonal and spatial variability in abundance, biomass and composition of the autotrophic and heterotrophic plankton (<0.200-mm in size) and to interpret these distributions in the context of physical and biological data collected on the GLOBEC LTOP and Process cruises. Highlights of results from sampling on the 2001 LTOP cruises will be presented. Throughout the year, there were generally three distinct plankton communities at inner shelf, middle shelf and outer shelf/slope regions. However there was very high degree of heterogeneity in both autotrophic and heterotrophic biomass, species and community structure across the shelf over short (<10-km) distances. Diatom blooms were generally restricted to inshore stations in mid-April to late June, but they also sporadically occurred on the outer shelf, perhaps fueled by upwelling at the shelf edge. In terms of biomass, small phytoplankton (<5 µm) generally dominated mid shelf and outer shelf stations, even in early spring. Cyanobacteria biomass was significant in late spring through summer, particularly in the middle and offshore regions. Heterotrophic protist biomass increased in response to phytoplankton development and reached high levels by late summer. The heterotrophic biomass was dominated by dinoflagellates and ciliates, particularly very large ones; these were observed to ingest a wide range of prey (cyanobacteria to large diatoms). As microzooplankton are the major herbivores in this coastal system and important prey for zooplankton, these two microplankton groups may play a central role in food web dynamics throughout the year.

GLOBEC Research: Seasonal and Annual Patterns of Abundance and Size of Juvenile Pink Salmon on the Shelf of the Northern Gulf of Alaska

Lewis Haldorson and Jennifer Boldt

School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Juvenile pink salmon occupy water over the continental shelf of the northern Gulf of Alaska (NGOA) for much of the summer and fall after entering nearshore marine waters in late spring. While in shelf waters they grow rapidly from less than 100-mm fork length in July to over 200 mm in October. They return to spawn in the following summer. A major objective of the GLOBEC program is to determine how variation in oceanographic conditions and plankton production affects juvenile pink salmon growth and survival while they reside in waters over NGOA continental shelf. Many juvenile pink salmon in the NGOA originate in PWS hatcheries; consequently, an estimate of marine survival is available a year after they pass through the study area. Our field program included annual samples over the continental shelf on the Seward Line in August beginning in 1999; and monthly samples on the Seward line and in Prince William Sound (PWS) from July through October in 2001. In July 2001 catches in PWS were very high, relative to the Seward Line; however, in subsequent months the distribution shifted onto the shelf, and by October very few juvenile pink salmon remained in PWS and they were in low numbers on the shelf. Highest abundance on the Seward Line occurred in August and September. In 1999-2002, pink salmon were the most abundant juvenile salmonids on the Seward Line in August. They were broadly distributed across the shelf, but were uncommon over deeper water off the shelf. Over the shelf, patterns of abundance varied annually, and August of 2002 was most anomalous with a concentration of pink salmon near the shelf edge. Juvenile chum and sockeye salmon were also common across the shelf. Mean lengths of juvenile pink salmon in August varied annually, there was also significant variation in mean length among Seward Line stations in each year. In August 2000 the largest fish occurred in the middle shelf, whereas in 2001 the smallest fish were found there. Hatcheries in PWS release around 600 million juvenile pink salmon each year, and those fish were an important component of our samples. In 2001, the proportion of hatchery fish decreased in each month, from a high of 66% in July to less than 15% by October. Marine survival of hatchery fish varied during our study, with highest survival (0.056) by those fish entering marine waters in 1999, and lower survival (<0.04) by those in 2000 and 2001. In GLOBEC pink salmon studies we will use bioenergetic modeling to determine if variation in growth and survival is related to habitat quality while juveniles occupy shelf waters of the NGOA.

POSTER Session GLOBEC

Modeled Lagrangian Drifters in the Gulf of Alaska

K. Hedstrom[1], D. Musgrave[1], A.J. Hermann[2] and E.L. Dobbins[2]

[1]University of Alaska Fairbanks
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We have carried out a model simulation of the Gulf of Alaska at 3 km resolution. Within this model, Lagrangian drifters were released in groups of twenty, at depths of 5 and 50 meters. The drifters were reinitialized every season so that seasonal and interannual variability can be assessed. Many of the drifters were started in Prince William Sound. Of these, some left through Montague Strait and others left through Hinchinbrook Entrance, both groups getting caught up in the Alaska Coastal Current. The drifter tracks will be analyzed in terms of vertical motions, vertical shear, and seasonal cycles.

PLENARY Session: Monday, 13 Jan 1:30-2:15 PM

Juvenile Salmon Migrations along the Continental Shelf in the Gulf of Alaska

Jack Helle
NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory

Research on the migration and growth of juvenile salmon in the coastal areas in the Gulf of Alaska was initiated in 1964 by the Fisheries Research Institute of the University of Washington under contract to the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). These studies continued through 1968. Salmon production in Alaska increased to record levels in many areas after the mid-1970's. This large increase in numbers of salmon coincided with changes in coastal ocean conditions and resulted in adult salmon becoming smaller and older. These changes in size and age at maturity of salmon suggested that there may be limits to the carrying capacity of the North Pacific Ocean for salmon production. The NMFS Alaska Fisheries Science Center, Auke Bay Laboratory in Juneau, Alaska, initiated an Ocean Carrying Capacity (OCC) research program in 1995 to address the causes of these changes in salmon populations.

One portion of the OCC program was directed at research on juvenile salmon in the coastal areas and was coordinated with biologists at the Pacific Biological Station in Nanaimo, British Columbia. OCC juvenile salmon surveys in 1996-98 covered the coastal areas of the Gulf of Alaska from southern southeast Alaska to Attu Island in the western Aleutian Islands. In 2000 OCC juvenile salmon surveys concentrated on the northern Gulf of Alaska. In 2001 the OCC program collaborated with NOAA oceanographers from the Alaska Fisheries Science Center and the Pacific Marine Environmental Laboratory in Seattle to work with U.S. GLOBEC (Global Ocean Ecosystem Dynamics) to focus on the relation between physical and biological oceanographic factors and juvenile salmon distribution in the Gulf of Alaska. These OCC/GLOBEC studies are concentrated in the northern Gulf of Alaska between Yakutat and western Shelikof Straits.

The shelf environment outside of Prince William Sound (PWS) and extending westwards to Kodiak Island is a section of a coastal corridor through which juvenile salmon from many locations further south (SE Alaska, BC, WA and OR) migrate, as well as the first "ocean" experienced by pink salmon exiting from PWS. Physical and ecological conditions (temperature, stratification, productivity, prey concentration and energy density, predator abundance and activity, etc.) in this region have significant impacts on the growth and survival of juvenile salmon. The influence of certain oceanographic processes, e.g. eddies, on the migration of juvenile salmon leaving Prince William Sound also will be discussed.

OCC expanded their research effort in 1999 to include research on juvenile sockeye salmon in Bristol Bay. In 2002, OCC undertook a major expansion in juvenile salmon research to include the coastal waters of the eastern Bering Sea from Bristol Bay to Norton Sound. In addition, OCC collaborated with Japan and Russia through the North Pacific Anadromous Fish Commission (NPAFC) in 2002 to initiate BASIS (Bering-Aleutian Salmon International Survey), a coordinated international research program aimed at understanding the relation between ocean conditions in the Bering Sea and salmon biomass.

POSTER Session and Session GLOBEC-3

Nested Biophysical Modeling of the Coastal Gulf of Alaska: Inferences from Circulation Results

A. J. Hermann[1], D. B. Haidvogel[2], E. L. Dobbins[1], S. Hinckley[3], P. J. Stabeno[4], D. Musgrave[5] and K. Hedstrom[5]

[1]Joint Institute for the Study of Atmospheres and Oceans, University of Washington
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[4]NOAA Pacific Marine Environmental Laboratory
[5]University of Alaska Fairbanks

As part of the Northeast Pacific GLOBEC program, we have developed a set of nested physical and biological models at basin (North Pacific: NPAC at 40 km resolution), regional (Northeast Pacific and Bering Sea: NEP at 10 km resolution), and local (Coastal Gulf of Alaska: CGOA at 3 km resolution) scales. These models are nested in one direction, with each finer-scale domain receiving its boundary conditions from a larger-scale model. This allows us to investigate basin-scale influences on coastal transport, lower trophic level biological dynamics, and, ultimately, salmon life histories. Following a brief overview of our techniques for nesting, we examine several aspects of the circulation fields derived thus far. Eulerian characterstics of the upwelling and downwelling regions in the regional NEP model are examined via EOF analysis; monthly timeseries of the dominant spatial modes of SST and SSH are compared with monthly climate indices such as the PDO and ENSO. In earlier NEP results without NPAC-derived boundary conditions, a significant correlation between modeled coastal SSH and observed ENSO is evident, suggesting that this correlation can be present even with only local wind forcing. In the CGOA domain, Eulerian currents and salinity fields exhibit statistical features observed by the LTOP moorings and drogued drifters. Specifically, a 5-6 day periodicity is evident in the results from the fall, which may be due to advection of baroclinic instabilities. Also in the CGOA, the histories of the depth, temperature and salinity of simulated Lagrangian floats are examined as a function of release time, location and depth, and compared with drogued drifter tracks. The resulting tracks suggest the spatial pathways of nutrients, plankton, and juvenile fish in different seasons.

POSTER Session and Session GLOBEC-3

Progress in 3-Dimensionalization of GLOBEC CGOA NPZ Modeling

S. Hinckley[1], A. Hermann[2] and E. Dobbins[2]

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This past year we have made substantial progress in the ecosystems modeling of the GOA for GLOBEC. The structure of the model has been improved in 3 ways. First, we have revised the trophic linkages in the model (GLNPZ) to separate pathways through small and large phytoplankton and microzooplankton, as was recommended at the last CGOA PI meeting. Second, we have extended the original coastal model to include oceanic applications by implementing an iron limitation function. This will allow biology to be simulated within water masses moving on and off the CGOA shelf. Third, GLNPZ has been incorporated directly into the Regional Ocean Modeling System (ROMS) in order to take advantage of its superior advection, mixing, and boundary conditions, and its ability to run on massive parallel computers. Results from this new code in 1D compare well with those from the original C code. GLNPZ within ROMS has been run on nested grids of increasing resolution. The larger grid, 12 km resolution from California to Russia, provides boundary conditions to the 3 km grid that stretches from Queen Charlotte Island to Unimak Pass. We discuss here some issues in development of the nested 3D models, describe the accomplished simulations, and analyze the 3D model results with respect to Seward Line LTOP data. In addition, we've begun exploring how to compare these biological modeling results with other GLOBEC sponsored models in the California Current System (CCS). Powell and Lewis have also used ROMS with a simple NPZD model to estimate production in the CCS. Preliminary comparisons have been completed between 1D versions of their NPZD model and GLNPZ; though the model structures are different, results indicate that comparison of regional dynamics will be possible with certain caveats.

Session GLOBEC-2

A Comparison of Copepod Egg Production Rates in the Gulf of Alaska

R. R. Hopcroft

University of Alaska Fairbanks

Egg production rates of the common copepod species in the Gulf of Alaska will be summarized. Data will include *Oithona similis*, *Pseudocalanus mimus*, *Pseudocalanus newmanii*, *Acartia longiremis*, *Centropages abdominalis*, *Metridia pacifica*, *Metridia okhotensis*, *Calanus pacificus*, *Eucalanus bungii*, and *Neocalanus flemingeri*. The seasonal patterns of production will be contrasted and related to their life history strategies.

POSTER Session GLOBEC

Egg Production Rates of *Pseudocalanus mimus* and *Pseudocalanus newmanii* in the Gulf of Alaska

R. R. Hopcroft, C. Clarke and A. I. Pinchuk

University of Alaska Fairbanks

Copepods are the essential linkages between phytoplankton production and fish in marine ecosystems. Numerically, the abundance of *Pseudocalanus* in the Gulf of Alaska is only exceeded by *Oithona similis*, but owing to its larger size, the majority of the year-round copepod production is likely contributed by *Pseudocalanus* species. In order to better understand their importance, egg production rates of the two *Pseudocalanus* species in the Gulf of Alaska were examined over 2001 and 2002. Both average clutch size and female length varied seasonally in both species, with peaks in May during the spring phytoplankton bloom. During May clutches averaged 30-40 eggs (~60-90% of the female's weight), compared to seasonal means of 15-18 eggs (~45% of the female's weight). Yet, from May through October, daily specific egg production rates remained relatively constant at 10-16% for *P. mimus* and 10-20% for *P. newmani*. Although clutch size suggests production should be highest in May, the impact of subsequently smaller clutches were offset by a greater percentage of females producing clutches on a daily basis. It appears that higher summer/fall temperatures resulted in shorter egg carrying times and hence a higher clutch turnover rate. As water cooled, and chlorophyll dropped, daily specific egg production rates fell to only few percent over the winter and into early spring.

Egg Production Rates of *Metridia pacifica* in the Gulf of Alaska

R. R. Hopcroft, C. Clarke, A. I. Pinchuk and A. G. Byrd

University of Alaska Fairbanks

Copepods of the genus *Metridia* are among the more abundant large bodied zooplankters in the Gulf of Alaska and Prince William Sound, and are known to be important prey of fishes. Egg production rates of the two *Metridia* species in the Gulf of Alaska were examined over 2 years. Preliminary experiments in 2001, using traditional techniques, indicated unusually low egg production. On 7 cruises in 2002, we used a new incubation system that separates females from their eggs and allows observation of eggs that remain undisturbed from the time they were laid. Observations indicate *Metridia* eggs are unusually thin-shelled, such that many shells (up to 100%) break down during incubation, leading to severe underestimates of egg production for this genus in the past. *Metridia* lays distinct clutches of eggs in early morning (~dawn), with some producing clutches daily. Up to 100 eggs were laid per clutch by *Metridia pacifica*, up to 150 were laid by the larger *Metridia okhotensis*. At individual stations, egg-producing females averaged specific egg production rates up to 25 and 36% respectively, with equivalent population rates up to 18 and 20%. Egg production by *Metridia pacifica* continued throughout most of the year, while *Metridia okhotensis* was more confined to the spring. In most cases, egg production was coupled to the cycles of primary productivity.

POSTER Session GLOBEC

Nutrient Supply to the GOA Shelf in Summer: The Role of Troughs and Shallow Banks

N. B. Kachel[1], N. A. Bond[2], J. A. Napp[3], C. W. Mordy[1], S. A. Salo[1], P. J. Stabeno[1] and David P. Wisegarver[2]

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Satellite imagery of ocean chlorophyll distributions in the Gulf of Alaska indicate that from mid to late summer, productivity offshore of Kodiak Island is extremely high relative to the surrounding shelf waters. The bathymetry to the south and east of Kodiak Island is characterized by multiple banks and troughs. Hydrographic transects during four cruises in 2001 and 2002 focused on Portlock Bank, a shallow (~50-m), broad plateau to the east of Kodiak Island. These hydrographic casts revealed a well-mixed water column with significant concentrations of nutrients. Some of the satellite-tracked drifters (drogued at 40-m depth) deployed in the region were trapped over the bank during much of the summer and were advected off the bank only when strong storms began in the fall. The significant concentrations of nutrients over the bank indicate a continual replenishment of nutrients. Nutrients are transported far onto the shelf in two nearby troughs, Amatouli and Stevenson. This deep water in the troughs is likely the source of nutrients observed on the bank and is introduced to the bank through bottom processes up the sloping sides of the troughs.

POSTER Session and Session GLOBEC-2

Patterns of Fish Food Source Generation and Utilization in the Northern Gulf of Alaska and Prince William Sound Region from Natural Stable Isotope Abundance: Results from SEA and GLOBEC (1994 to 2002)

Thomas C. Kline, Jr.

Prince William Sound Science Center

A recurrent cross-shelf stable isotope gradient with low dC^{13} values diagnostic of "off-shore" pelagic production in the northern Gulf of Alaska was based upon observed temporal and spatial patterns in the isotopic composition of terminal feeding stages of *Neocalanus cristatus* from the GOA and Prince William Sound (PWS) region. PWS dC^{13} values had a relatively narrow isotopic range. There was, however, significant isotopic variation in the Gulf among years. Nevertheless, dC^{13} values <-21.5 were only found off-shore. dC^{13} values similar to those found in PWS were found consistently at station GAK1, located downstream in the Alaska Coastal Current from PWS, and occasionally at other stations. The pattern of these occasional occurrences is consistent with eddy patterns observed in satellite images. When the data from among all the years were pooled there was a good correlation between the nitrogen and carbon stable isotopic composition. The regression slope was ~0.5 instead of ~3.4, the expected slope if isotopic fraction was primarily due to trophic level effects. Isotopic variation was thus more likely due to variation in isotopic discrimination by algae. Gulf isotopic extremes varied by year with the most enriched values occurring during 1996 and the most depleted values occurring during 2001. The most isotopically enriched values were observed when uncharacteristically calm and sunny weather prevailed. Based on stable isotope analysis, juvenile fishes from within PWS consisted, in part, of offshore carbon. The proportion of offshore carbon in fishes varied considerably among years. During fall 1995, juvenile fishes consisted almost entirely of Gulf carbon. The proportion of off-shore origin *Neocalanus* diapausing (over-wintering resting phase) within the deep area of PWS in fall 1995 was ~90%. These observations suggest that changes in off-shore zooplankton production occurring at inter-decadal time scales can potentially impact coastal wasters such as PWS, since off-shore production can be an important subsidy.

POSTER Session GLOBEC

Origin of Juvenile Chum Salmon from Gulf of Alaska Coastal Waters, 2001

Christine Kondzela and Richard Wilmot

NMFS Alaska Fisheries Science Center, Auke Bay Laboratory

We provide updated information on salmon migration patterns in the Gulf of Alaska, relying upon migration and distribution data from thermally marked chum salmon hatchery stocks and the first genetic stock identification analysis of juvenile salmon migrating through this coastal corridor. Juvenile chum salmon were collected July 17 to August 6, 2001 at eleven transects between Icy Point in northern SE Alaska and southwestern Kodiak Island. Most chum salmon from Alaska were caught just beyond major coastal exit corridors; few fish were caught on the seaward side of Kodiak Island and preferentially migrated through Shelikof Strait. Over one-third of the chum salmon examined were thermally marked from one of three hatcheries: Wally Noerenberg in Prince William Sound (PWS) and Macauley and Hidden Falls in SE Alaska. East of PWS, 40% of the chum salmon were thermally marked from SE Alaska hatcheries. West of PWS, 60% of the chum salmon were thermally marked from the Wally Noerenberg hatchery and 21% from the SE Alaska hatcheries. The genetic analysis generally corroborated the thermal mark results. Chum salmon from the Washington/southern British Columbia stock group were found in low frequency in the Kenai Peninsula transects and fish from the Queen Charlotte Islands were recovered from both the transects east of PWS and the southern Shelikof Strait transect. Upper Cook Inlet stocks were abundant in the northern Shelikof Strait transect.

Seaglider Surveys of the Alaska Coastal Current

Craig M. Lee[1] and Charles C. Eriksen[2]

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Seaglider operations in the coastal Gulf of Alaska began on 24 October 2002 with the successful deployment of a single vehicle (SG009) near the entrance of Resurrection Sound. Following launch, SG009 moved southward along its designated survey track, where it quickly encountered the Alaska Coastal Current (ACC). Fresh, cold coastal discharge formed a 10-20 m thick buoyant surface layer (salinities of 24-28, temperatures of 8-9°C and elevated backscatter, perhaps reflecting the water's terrestrial origins), with freshening often extending as deep as 50 m. Frequent southward and southwestward wind events with sustained speeds of 30-40 knots accelerated both the buoyant surface layer and the underlying ACC. SG009 encountered depth average speeds within the ACC of up to 0.4 m s^{-1}, with surface layer velocities frequently attaining speeds of 1.0-1.5 m s^{-1}. Energetic flows extended to the seabed, with strong backscatter signals suggesting active resuspension of particulates. These depth-average speeds exceed Seaglider's navigational capabilities, and SG009 was carried downstream as it crossed the ACC. Preliminary analysis of the Seaglider section extending 90 km south of Resurrection Sound indicates an ACC width of at least 50 km and a transport of over 3 Sv, an order of magnitude larger than that anticipated from previous reports. Significantly, SG009 has maintained communications and navigation through several strong storms, with winds gusting to 60 knots and seas reaching 9 m. At the time of this writing (15 November 2002), the vehicle is moving slowly eastward, maintaining a course that keeps it just offshore of the ACC. An onshore section will be attempted to the southwest of Montague Strait.

Direct and Indirect Modifications of Pelagic Food Webs in the Gulf of Alaska by the Particle Grazing Copepods *Neocalanus flemingeri, N. plumchrus* and *N. cristatus*

Hongbin Liu, Michael Dagg, and Suzanne Strom

LUMCON

Three species of large calanoid copepods of the genus *Neocalanus* dominate mesozooplankton biomass throughout the subarctic Pacific and its marginal seas in the spring and early summer. All three species of *Neocalanus* are particle-grazing copepods that consume both phytoplankton and microzooplankton. As a part of the GLOBEC CGOA Process Study, we conducted grazing experiments during cruises in April, May and July 2001. On each cruise, 4 locations in the coastal water of the Gulf of Alaska were occupied to study the effects of *Neocalanus* spp. grazing on the structure of the pelagic web. In these experiments, live *Neocalanus* were placed into 2-L polycarbonate bottles filled with natural seawater and incubated on deck for 24 hours. Bottles without *Neocalanus* were also incubated as controls. Chlorophyll a concentrations in 3 size classes (<5, 5-20 and >20 µm) were measured for each incubation bottle at the beginning and end of each experiment. Additional samples were preserved for enumerating and identifying phytoplankton and microzooplankton. Based on the chlorophyll analyses, all three species of *Neocalanus* fed primarily on phytoplankton cells larger than 20 µm. In April, CIV and CV of *N. cristatus* and *N. flemingeri* were abundant in the surface waters. Mean clearance rates are 186 and 432 ml $copepod^{-1}$ d^{-1} for CIV and CV *N. cristatus* and 63 and 205 ml $copepod^{-1}$ d^{-1} for CIV and CV of *N. flemingeri*. In May, all three species were abundant and the mean clearance rates were 492, 148 and 146 ml $copepod^{-1}$ d^{-1} for CV of *N. cristatus, N. flemingeri,* and *N. plumchrus*, respectively. The abundance of all three *Neocalanus* species was low in the surface water in July and most of them were not feeding. Direct effects of *Neocalanus* spp. grazing on microzooplankton are currently being determined. Indirect effects of *Neocalanus* spp. grazing were also apparent. In many experiments, especially ones with low total concentrations of phytoplankton, there was an increase in cells of <5-µm in size. We attribute this to a reduction in their mortality from larger microzooplankton associated with *Neocalanus* predation on larger microzooplankton. In some cases, this cascade effect can be seen in the picoplankton and bacteria populations also. As additional samples are analyzed, more detailed understanding of the direct and indirect effects of *Neocalanus* spp. grazing on pelagic food webs will become more apparent.

Phytoplankton Community Structure and Taxon-specific Growth and Grazing Rates in the Coastal Gulf of Alaska

Erin Macri[1], Suzanne Strom[1], Jeffrey Napp[2] and Michael Dagg[3]

[1]Western Washington University
[2]NMFS Alaska Fisheries Science Center
[3]LUMCON

Process studies in the Coastal Gulf of Alaska (CGOA) seek to understand how climate driven variations in the physical-chemical environment of the coastal zone affect production levels and food web structure. Microplankton abundance, composition and grazing were studied in the CGOA during cruises in April, May and July of 2001. During each cruise four core sites (inner shelf, mid shelf, outer shelf, and Prince William Sound) were occupied. These sites and dates represent a diversity of seasons and physical-chemical conditions in the CGOA. Dilution experiments in conjunction with copepod grazing experiments were used to investigate food web dynamics. Using HPLC analysis and phytoplankton pigment biomarkers we are able to look at temporal and spatial variation in phytoplankton community structure. As a means of understanding the fate of phytoplankton production under various conditions, we will also present taxon-specific growth rates of phytoplankton and grazing rates of both micro- and macrozooplankton on phytoplankton in the CGOA.

POSTER Session GLOBEC

Climate Trends in the Gulf of Alaska and the Bering Sea, 1950-97: Ecosystem Implications

Roy Mendelssohn, Steven J. Bograd, Franklin B. Schwing, and Nathan Foley-Mendelssohn

NOAA Pacific Fisheries Environmental Laboratory

State-space decompositions and subspace identification methods are used to examine long-term trends and variations in the seasonal phase and amplitude of surface atmospheric and oceanographic parameters in the Gulf of Alaska. Sea surface temperature, north-south and east-west wind stress, and wind speed cubed are analyzed over a regular grid of sites for the period 1950 through 1997. The aim of the analysis is to see whether observed changes in surface ocean conditions can provide mechanistic explanations for the changes in the Steller Sea Lion populations. The entire Gulf region is examined in order to differentiate climate forcing of distinct Steller populations.

Timing and Mesoscale Variability of Phytoplankton Blooms in the Northern GOA

C. W. Mordy[1], S. A. Salo[1], J..A. Napp[2], David Wisegarver, and P. J. Stabeno[1]

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Seasonal dynamics of primary production are strikingly different offshore of Kodiak Island compared to other regions of Gulf of Alaska (GOA). In general, high nutrient concentrations in early spring are observed over the entire shelf due to winter entrainment and onshore Ekman flow of nutrient rich water from the basin. The spring bloom persists until nutrient concentrations become limiting, and, thereafter, chlorophyll concentrations remain low. A dramatic exception is offshore of Kodiak Island where chlorophyll concentrations remain high all summer, suggesting distinctive mechanisms of nutrient supply. We compare mesoscale and interannual variability in sea-surface chlorophyll over the GLOBEC domain from 1998 to 2002 using in-situ data and time-series of SeaWiFS satellite imagery. To examine interannual variability of production from spring to fall, two week composites were examined from May to September in each year. These images also reveal the relevant extent to which eddies and filaments contribute to chlorophyll production. To better examine seasonal variability, five-year averages were generated at 2 week intervals. Sustained production over the shallow banks and troughs off Kodiak Island is a clear indication of a stable localized nutrient source. These results are compared to time series from moorings and other in situ data.

Quantifying the Trophic Interaction and Energetics of Juvenile Pink Salmon in the Gulf of Alaska and Prince William Sound

Jamal H. Moss[1], Dave A. Beauchamp[1], Alison D. Cross[1], Katherine W. Myers[1], Nancy D. Davis[1], Janet L. Armstrong[1], Robert V. Walker[1], Lewis J. Haldorson[2], Jennifer L. Boldt[2], Mikhail Blikshteyn[2], Edward V. Farley[3], Steve E. Ignell[3] and John H. Helle[3]

[1]School of Aquatic and Fishery Sciences, University of Washington
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Pink salmon are one of the predominant planktivores in the Gulf of Alaska and are a culturally and economically important species in the North Pacific. The goal of our Global Ocean Ecosystem Dynamics (GLOBEC) research is to quantitatively model spatial and temporal patterns in distribution, feeding, food supply, and growth by juvenile pink salmon in Prince William Sound and the coastal Gulf of Alaska. Field data collected over multiple years during GLOBEC cruises provide broad spatial coverage around the coastal, shelf, and off-shelf regions of the Gulf of Alaska during mid-July through mid August, as well as enhanced temporal resolution in Prince William Sound and along the Seward Line during July-October. By applying this mechanistic approach within a spatial-temporal framework over multiple years, we hope to develop a functional understanding of the relative importance of climate, oceanographic conditions, and planktivore density and distribution on the growth and survival of juvenile pink salmon. Two complementary approaches are being taken to model feeding and growth of juvenile pink salmon in the Gulf of Alaska. The first method will estimate the daily consumption rates required to satisfy the measured growth rates of pink salmon, based on diet, growth, and temperature data collected during GLOBEC cruises, and other sources. Consumption demand at each sampling station will be compared to concurrent estimates of the food supply (numerical zooplankton density, biomass, and energy density for edible-sized zooplankton) collected from surface-towed Tucker trawls. The second method will develop a spatially-explicit model to estimate growth potential for juvenile pink salmon at each station during each cruise. A spatially-explicit model of growth potential uses a foraging model to link data on environmental conditions (temperature, light, turbidity) and prey density (number of edible-sized prey m^{-3}) to a bioenergetics model of fish growth to predict the per capita growth potential available in a grid cell. Growth potential will vary among cells based on geographic differences in prey density and environmental conditions. Pink salmon feed visually on planktonic or neustonic prey, and detection can vary as functions of light, turbidity, prey size and contrast. The first step in model development has been to define initial boundaries to constrain the visual foraging model to relevant times, depths, and environmental conditions associated with the observed diel feeding chronology of juvenile pink salmon. These feeding patterns help define the appropriate spatial and temporal dimensions of the prey field and limit the availability of prey to just the depths and times associated with salmon feeding. Diel stomach fullness data from multiple sampling dates were consistent with a daylight feeding pattern. Prey were predominantly large zooplankton (>1.5 mm) or insects. Turbidity levels were low in both the Gulf of Alaska (0.2-1.3 NTU) and Prince William Sound stations (0.3-1.0 NTU) during the July through October 2001 cruises. Average light extinction coefficients measured during midday (0900-1500 hours) ranged from 0.160 to 0.301 m^{-1}. Based on these preliminary results, the visual foraging model will limit feeding by pink salmon to daylight hours in 0-10 m depths with low turbidity. Field data inputs will include: sea surface temperature adjusted to 0-10 m depths from CTD data; prey fields will be limited to the numerical density of edible-sized zooplankton (> 1.0 mm) available during daylight in 0-10 m depths. Prey density will be converted to consumption rates using visual encounter rates and/or an experimentally-derived functional response curve. Initially, uniform zooplankton densities will be assumed within each spatial cell but will vary among cells. The model will estimate growth potential (grams growth per gram body weight per day) for specified sizes of juvenile pink salmon within a cell based on the temperatures and prey densities measured during the cruises. To link with other biological models, estimates of numerical density and size structure of edible-sized zooplankton during daylight in surface waters (0-10 m) will be needed as an output from NPZ models, and the temporal-spatial scales for linking these models should be resolved.

Comparison of the Coastal Gulf of Alaska Circulation (3-km grid) to GLOBEC Data

D.L. Musgrave[1], K. Hedstrom[1], A. J. Hermann[2] and D. B. Haidvogel[3]

[1]University of Alaska Fairbanks
[2]Joint Institute for the Study of Atmospheres and Oceans, University of Washington
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Results from the 3-km grid model of circulation of the Gulf of Alaska shows very good agreement with the features observed by moorings, hydrography and satellite. We will present the comparisons as well as general concepts derived from the model and what they mean for the replenishment of nutrients in the surface waters of the shelf waters in the GLOBEC LTOP areas. Noteworthy aspects include the interaction of the eddy field with the bathymetry, steering of bottom flows by canyons, and the path of the Alaska Coastal Current.

Secondary Production in a Downwelling Ecosystem: Egg Production Rates of *Calanus marshallae* and *Pseudocalanus* spp. in the Coastal Gulf of Alaska, 2001

J.M. Napp and C.T. Baier

NMFS Alaska Fisheries Science Center

The highly productive coastal Gulf of Alaska ecosystem is anomalous among the world's most productive systems in that the dominant winds produce downwelling at the coast for most of the year. To understand the interaction of climate and trophic dynamics that affect the transfer of energy to pink salmon (*Oncorhynchus gorbuscha*) juveniles migrating out of Prince William Sound, we examined egg production rates of several copepod taxa in April, May, and August of 2001 during GLOBEC Process cruises. *Calanus marshallae* was abundant only during the May cruise, and was restricted to Prince William Sound and the Alaska Coastal Current. All females were ovigerous and egg production rates were approximately 40 eggs female^{-1} day^{-1} with a clutch interval of 1-3 days. *Pseudocalanus* spp. females were approx. 10X as abundant during the May cruise as *Calanus*. In general, *P. newmani* dominated in Prince William Sound and *P. mimus* dominated in the ACC and middle shelf. Clutch size (as number and volume) increased with female prosome length, although for the same prosome length, *P. newmani* tended to have larger clutch volume than *P. mimus*, despite similar clutch size between the two species. Individual egg production rates were lower in August than April and May, but total egg production was nearly equivalent for the three time periods due to an increase in female concentration in August.

Advection of Shelf Zooplankton in a Predominantly Downwelling Ecosystem: Bioacoustic Detection of the Dominant Modes of Variability

J.M. Napp[1], C.F. Greenlaw[2], D.V. Holliday[2] and P.J. Stabeno[2]

[1]NMFS Alaska Fisheries Science Center
[2]NOAA Pacific Marine Environmental Laboratory

The highly productive Gulf of Alaska shelf ecosystem is unique in that the dominant mode of wind forcing produces downwelling at the coast for most of the year. The persistent downwelling may, in part, explain how large calanid copepods with oceanic affinities (*Neocalanus* spp.) enter the coastal domain. *Neocalanus* spp. play an important role in the trophodynamics of the shelf ecosystem, especially in the transfer of energy to hatchery-raised and wild pink salmon (*Oncorhynchus gorbuscha*) from Prince William Sound. To test the hypothesis that transport of zooplankton is highly correlated with wind events, we deployed an 8-frequency acoustic device (TAPS-8; 104-3000 kHz) from a single mooring on the Seward Line in the coastal Gulf of Alaska. The TAPS-8 is suitable for size-abundance estimation of zooplankton from ca. 0.25-mm to > 25-mm total length. We present preliminary bioacoustic data from our first deployment and recent recovery (May-September 2002) highlighting important modes of variability in total zooplankton biovolume, and the time series of winds from an adjacent mooring. In addition, we describe the biovolume distributions of individual *Neocalanus* spp. developmental stages as well as other taxa whose biovolume distributions may overlap that of *Neocalanus*

Distribution and Growth of euphausiids in the Northern Gulf of Alaska

A.I. Pinchuk, R.R. Hopcroft and K.O. Coyle

University of Alaska Fairbanks

Euphausiids (krill) are important food items of fish, seabirds and whales: consequently, it is important to understand their seasonal cycles. The interannual, seasonal and spatial abundance, distribution and population dynamics of the euphausiids *Thysanoessa inermis, Thysanoessa spinifera, Thysanoessa longipes* and *Euphausia pacifica* were studied in the Northern Gulf of Alaska during production season from 1997 to 2000. The greatest abundance of juveniles, males and females of *T. inermis* and *T. spinifera* were observed in March-April and in August on inner shelf, especially when a strong shelf break front was developed. In contrast, *Euphausia pacifica* tended to be more abundant on outer shelf in August-October. Dense aggregations of *T. longipes* were observed in Prince William Sound in March. The spawning of *T. inermis* and *T. longipes* occurred in April-May, while *E. pacifica* spawned from July through October. The spawning of *T. spinifera* was extended from April through October. The spawning of *T. inermis, T. longipes* and *T. spinifera* appeared to be closely related to the phytoplankton spring bloom on inner shelf, while the spawning of *E. pacifica* occurred later in season. The life span of *Thysanoessa* spp. appeared to be just over 2 years; the life span of *E. pacifica* was more difficult to determine. The euphausiid growth rates were maximal between April and August coinciding with the spring and summer phytoplankton blooms. *T. inermis, T. spinifera* and *T. longipes* showed a significant increase in abundance from 1998 to 2000 indicating progressing favorable conditions on the inner shelf.

Mesoscale Variability along the Kenai Peninsula

R. Reed[1], N. Kachel[1], C. Mordy[1], N. Bond[1], J. Napp[2], S. Salo, and P. Stabeno[1]

[1]NOAA Pacific Marine Environmental Laboratory
[2]NMFS Alaska Fisheries Science Center

In May 2001 and 2002, five hydrographic lines were occupied, including the Seward Line and the Gore Point Line. In addition to measuring temperature, salinity, fluorescence, chlorophyll and nutrients, net tows were made along these lines to collect zooplankton. Using these data we compare the mesoscale variability in this part of the GLOBEC domain, and also compare 2001 to 2002. Baroclinic flow during both years was weak to moderate. The freshwater core of the Alaska Coastal Current was evident near the Kenai Peninsula, with small-scale features occurring over the middle and outer shelf. Concentrations of chlorophyll varied both spatially and temporally, complicating attempts at synoptic interpretation. Nutrients were inversely correlated with chlorophyll, with weaker correlations occurring with temperature and salinity.

Ocean Climate Conditions during GLOBEC Northeast Pacific Program (NEP) Long Term Observation Program (LTOP)

Thomas C. Royer, Chester E. Grosch and Nandita Sarkar

Old Dominion University

A time series of temperature and salinity versus depth to 250 m at the mouth of Resurrection Bay, Alaska (60°N, 149°W) (GAK1) is used to establish the climatic conditions for the Northeast Pacific GLOBEC Long Term Observation Program (LTOP). The modes of hydrographic structure are determined and their responses of the first two modes to regional and remote forcing are considered. The first two vertical modes of the hydrographic structure at GAK1 contain significant changes during the GLOBEC sampling program. Mode 1 temperature and salinity had sudden changes in 1998 as possible responses to either ENSO or winds. For temperature and salinity mode 2, there is a simultaneous response to ENSO followed by a delayed response in the temperature mode. These simultaneous responses must be atmospherically forced though the exact mechanism is uncertain. However in 1998 there was a significant decrease in the upwelling (increased downwelling). The delayed thermal response is due to the propagation of coastal Kelvin wave.

Complex Emperical Orthogonal Function (CEOF) Analysis of the Hydrography Along the Seward Line from 1997 to 2001: Preliminary Results

Nandita Sarkar, Chester E. Grosch and Thomas C. Royer

Old Dominion University

Complex Emperical Orthogonal Function (CEOF) Analysis of the temperature, salinity and density structures has been carried out for the set of hydrographic stations along the Seward Line in the northern Gulf of Alaska at standard depths, to a depth of 200 m. The time series of the hydrographic data extends from 1997 to 2002. Hydrographic sampling is carried out about 7 times a year and the data are interpolated for even temporal resolution. Spectral analysis using the Maximum Entropy Method (MEM) and wavelet techniques have been used to yield information about the dominant frequencies in their energy spectra. The length of the time series (approximately 5 years) limits the resolution of these techniques to higher frequency components. These analysis techniques permit the detection and assessment of the relative magnitudes of stationary and propagating modes on the Alaskan shelf.

POSTER Session GLOBEC

Annual Spatial Variability of the Hydrographic Structure Along the Seward Line: Preliminary Results

Isaac D. Schroeder, Chester E. Grosch, and Thomas C. Royer

Old Dominion University

Temperature, salinity and density data along the Seward line in the northern Gulf of Alaska are analyzed for seasonal variability. The Seward line starts at the inner shelf (GAK1) and extends a distance of 213-km to the edge of the continental slope (GAK13). The hydrographic stations are spaced at varying distances ranging from 2 to 20-km. The temporal coverage is from 1997 to 2002 with approximately 7 cruises per year. Orthogonal reduction techniques, Normal Mode Analysis (NMA) and Empirical Orthogonal Functions (EOF) are used to find dominate seasonal modes and to relate these variations to the seasonal forcing functions of heat flux, freshwater discharge and wind.

PLENARY Session: Monday, 13 Jan 2:15-3:00 PM

From Physics to Fish: the Global Climate Connection to the Gulf of Alaska Ecosystem

Franklin B. Schwing

NOAA Pacific Fisheries Environmental Laboratory

Since 1998, a number of Alaska salmon stocks have been dramatically reduced relative to levels in the previous several decades, causing severe economic downturns in many coastal communities. In contrast, many Oregon and Washington salmon fisheries appear to be recovering from decades of poor returns. This reversal of fortune is not an isolated case. The California sardine fishery made famous by John Steinbeck's Cannery Row, which collapsed in the 1940s, has in recent years returned to a population level sufficient to support commercial fishing again. For centuries, populations as distinct as Baltic Sea herring and Japanese sardine have waxed and waned. Were these changes a product of fishing and fishery management, or were other forces at work? Scientists know the earth's climate fluctuates on long time scales, and that ecosystems are not stable by nature. The structure of marine ecosystems, which includes the population size, geographical distribution, and health of commercially important fish stocks, varies with climate. Whether natural or anthropogenic in its source, climate change is a critical force driving environmental change, including the physical processes that dictate ecosystem dynamics in the Gulf of Alaska. The sensitivity of the coupled physical-biological system to climate variability implies great sensitivity to climate change. It is a foregone conclusion that impending climate change will have a major impact on resource availability in the future. The goal of the US GLOBEC Northeast Pacific program, sponsored by the National Science Foundation and the National Oceanic and Atmospheric Administration, is to evaluate and project the consequences of climate change on the coastal marine ecosystems of the Gulf of Alaska and California Current. We can observe climate variations on interannual (for example, El Niño) and multidecadal scales; the latter are termed climate regime shifts. The effects of regime shifts appear to be amplified in the northeast Pacific, and have been associated with significant changes in fishery resources and their socioeconomic consequences. While regional environmental conditions ultimately shape the ecosystem and individual populations, conditions on a local scale are connected to a global pattern of climate oscillations. Thus, ocean temperatures in the western tropical Pacific and the snow pack in Asia may be factors in the changing state ecological state of the northeast Pacific. Moreover, evidence suggests that regional stocks fluctuate in synchrony with a number of other stocks globally, through these global climate connections. However, these large-scale climate signals are manifested in an ecosystem at much smaller spatial scales. Global climate change interacts with the unique regional character of ecosystems, resulting in a heterogeneous response by the ecosystem. Climate change feeds into specific processes, for example coastal upwelling and upper ocean stratification, which directly affect marine populations on a regional level. The key to understanding how climate change shapes marine fish populations is in understanding how the energy of large-scale change cascades down to ecosystem scales, and what ecosystem-scale physical processes and features are affected by climate variability. This presentation will highlight: the principle patterns and features of global climate variability and climate change; the mechanisms by which climate change impacts the physical state of the northeast Pacific; link regime shifts to changes in marine ecosystems; and speculate on how climate change may lead to shifts in fish populations.

Overview of Shelf Transports in the GOA

P. J. Stabeno

NOAA Pacific Marine Environmental Laboratory

Since May 2001, moorings have been deployed at 25 sites in the Gulf of Alaska, over 50 satellite-tracked drifters have been deployed. There have been two dedicated hydrographic/sampling cruises, together with four cruises during which moorings were deployed. This work has been done as part of GLOBEC, Steller Sea Lion Research and Fisheries Oceanography Coordinated Investigations. We introduce the results of this data collection effort in a series of posters and examine the results in context of mechanisms in which nutrients are resupplied to the shelf.

Along-shelf and Cross-Shelf Flow on the GOA Shelf

P. Stabeno[1], N. Bond[2], D. Kachel[1], N. Kachel[1] and Calvin Mordy[1]

[1]NOAA Pacific Marine Environmental Laboratory
[2]Joint Institute for the Study of Atmospheres and Oceans, University of Washington

Since May 2001, flow on the Gulf of Alaska shelf between Prince William Sound and the east end of Kodiak Island has been measured using moorings and satellite tracked drifters. Trajectories from approximately 50 satellite-tracked drifters have been examined, along with the data from moorings that were deployed at 25 sites. Currents, temperature and salinity were measured at each mooring site. The transport in the Alaska Coastal Current is significantly correlated with local winds, with maximum transport occurring in winter and minimum transport in the summer. Most of the flow along the Kenai Peninsula continues down Shelikof Strait, with the remainder continuing southeastward along the southern coast of Kodiak Island. Comparisons of near bottom flow are made with results from the numerical model. Cross-shelf flow is common in the vicinity of the Seward Line, while farther eastward at Gore Point the transport is along shelf. Flow in Amatouli, Chiniak and Barnabas Troughs is typically onshore on the eastern side and offshore on the western side.

Planktonic Processes in the Coastal Gulf of Alaska: Interconnections with Weather, Ocean Conditions, and Salmon Production

S. Strom[1], J. Napp[2], M. Dagg[3], L. Haldorsen[4] and R. Hopcroft[5]

[1]Western Washington University
[2]NMFS Alaska Fisheries Science Center
[3]LUMCON
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The central goals of the GLOBEC process studies in the coastal Gulf of Alaska are 1) to understand how weather and ocean processes affect production at the base of the food web, and 2) to understand how transfer of that production to larger consumer species is regulated. To that end, we have conducted a series of oceanographic research cruises in the region offshore of Seward, Alaska. Spring in the coastal Gulf is a time of intense blooms of phytoplankton (single-celled algae, the dominant plant life in marine waters). Waters over the inner continental shelf support high amounts of large phytoplankton cells (diatoms), while outer shelf waters support lesser quantities of mainly small cells (flagellates and photosynthetic bacteria). This inshore-offshore difference, important in determining which consumers can feed directly on the phytoplankton, may be established by the availability of iron and/or other plant micronutrients. This picture is complicated by the interplay among coastal topography and bathymetry, alongshore currents, tides, and winds. This interplay lead to vigorous exchange of water masses across the shelf, so that phytoplankton production in any one location is intensely variable in time. Late summer and early fall is the time of highest juvenile pink salmon abundance on the shelf. During this season, freshwater run-off combined with heating from the sun creates a shallow, low-salinity surface layer depleted in plant nutrients. Classically such ecosystems are thought to support low phytoplankton productivity. However, the combination of high light availability in this surface layer with periodic nutrient injection by winds, eddies, tides, and other processes may be key to generating unexpectedly high amounts of summer production in the coastal Gulf. Characteristics of the late summer food web important in determining the availability of prey for juvenile pink salmon will be discussed. Changes in weather and, over the longer term, climate in the coastal Gulf of Alaska will alter patterns of precipitation, runoff, and mixing. The close interconnections between these processes, phytoplankton production, and availability of prey for larger consumers gives rise to an ecosystem in which fish production depends strongly on climate conditions.

Seasonality in Planktonic Community Structure, Phytoplankton Growth and Microzooplankton Grazing in the Coastal Gulf of Alaska

Suzanne Strom, Brady Olson, Erin Macri, and Calvin Mordy

Western Washington University

We conducted GLOBEC process cruises to the coastal Gulf of Alaska (CGOA) during April, May and July 2001. Depending on station and season, we encountered conditions ranging from well-mixed to strongly stratified, cold to warm (5 to 14°C) and "blue" to "green" (chlorophyll 0.2 to 6-µg L^{-1}). The highest phytoplankton cell division rates (over 1.4 doublings per d) were observed in April, when waters were cold. Macronutrient limitation of phytoplankton growth was observed as early as May in Prince William Sound and on the inner shelf, leading to lower in situ growth rates; by July nutrient limitation was evident everywhere except the outer shelf. All phytoplankton size fractions exhibited nutrient limitation, although growth of the largest cells (>20 µm) was usually the most strongly affected. Microzooplankton grazing was, on average, equivalent to phytoplankton growth for all phytoplankton <20 µm, meaning that essentially all production by small phytoplankton was consumed by microzooplankton (mainly protists). For phytoplankton >20 µm (mostly chain diatoms), microzooplankton grazing mortality was lower and seasonally variable, averaging 42% of phytoplankton growth in April, 60% in May, and 80% in July. This increase in protist-caused diatom mortality appeared to be related to the seasonal increase in the biomass of large heterotrophic dinoflagellates. Grazing interactions involving diatoms and heterotrophic dinoflagellates were also seen in field samples analyzed by FlowCAM. Data from the three process cruises reveal a fundamental difference between inner and outer shelf planktonic processes, with the mid-shelf variably exhibiting both sets of conditions. Phytoplankton blooms on the outer shelf during 2001 process cruises consisted entirely of <5 µm phytoplankton, with the cyanobacterium *Synechococcus* an important component, while inner shelf blooms were dominated by chain diatoms. This difference was reflected in macronutrient levels: while July nitrate levels were extremely low across the shelf, outer shelf silicate levels remained relatively high into July 2001. Outer shelf blooms were never observed to develop biomass levels comparable to inner shelf diatom blooms, probably because of strong microzooplankton grazing control of small outer shelf cells. A fundamental question is, What regulates the partitioning between outer shelf small cell-dominated and inner shelf large-cell dominated blooms in the CGOA?

Diel Feeding and Gastric Evacuation of Juvenile Salmon

Molly Sturdevant, Emily Fergusson, Joseph Orsi and Alex Wertheimer

NMFS Alaska Fisheries Science Center, Auke Bay Laboratory

Studies of diel feeding periodicity and gastric evacuation rates were conducted by Auke Bay Laboratory, National Marine Fisheries Service, on juvenile pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), and coho (*O. kisutch*) salmon in Icy Strait, Southeast Alaska from May-September 2001. These process studies were part of the Southeast Coastal Monitoring (SECM) Project conducted in marine waters of the northern region of southeastern Alaska since 1997 and funded in part by GLOBEC. Objectives were to monitor diel feeding intensity and prey composition monthly for each species and to monitor evacuation of food from the gastric tracts of juvenile pink and chum salmon in May and July. We sampled monthly at the SECM Icy Strait transect, by beach seining in May and by surface trawling at one station 6.4-km offshore in later months. For the diel feeding study, we examined up to ten individuals per species every three hours between 0400 and 2200 each month. Catches of juvenile coho salmon were sufficient to conduct diel studies only in June and July but were never sufficient to conduct gastric evacuation studies. Juvenile salmon fed actively during all diel periods in all months; stomach percent fullness averaged 50-100% and prey percent body weight (%BW) averaged 1-4% for each species. Of the 220 pink, 226 chum, and 137 coho salmon stomachs examined, only two empty stomachs were observed. Diel patterns in feeding were evident for pink and chum salmon in June and July and for coho salmon in July, with mean fullness index and %BW increasing from minima in the morning to maxima late in the day. Diet composition changed monthly and prey frequencies (percent numbers) changed diurnally. Juvenile pink and chum salmon predominantly ate small and large calanoid as well as harpacticoid copepods in May, larvaceans and euphausiids in June and July, and larvaceans and hyperiid amphipods in August and September. Juvenile coho salmon diets were comprised of decapod larvae and fish in June and July. For the gastric evacuation study, we held juvenile pink and chum salmon in live tanks without food and sacrificed sub-samples of up to ten individuals at intervals between 1 and 32 hours from the time of capture. We examined 152 chum and 171 pink salmon stomachs from May and 159 chum and 104 pink salmon stomachs from July. Stomachs averaged 70% fullness at the onset of experiments conducted at 7-9°C in May and at approximately 12°C in July. We evaluated the decline in stomach contents over time to compute gastric evacuation rates for the two months. Results of both process studies will be used to derive biophysical input parameters for bioenergetic models and to continue to build our understanding of the trophic relationships and growth of juvenile salmon en route to the Gulf of Alaska.

PLENARY Session: Monday, 13 Jan 9:00-9:45 AM

Order and Chaos: The Physical Structure of the Gulf of Alaska Shelf/Slope Ecosystem

Thomas Weingartner

Institute of Marine Science, University of Alaska Fairbanks

Oceanographic conditions over the northern Gulf of Alaska shelf and slope reflect its high-latitude setting, geological history, and the large-scale atmospheric and oceanographic forcing of the northern North Pacific. In aggregate these factors contribute to moderately low water temperatures, persistent cyclonic winds, and high rates of coastal precipitation and runoff. The winds and the runoff, which are a consequence of the quasi-random storms associated with the Aleutian Low Pressure system, organize the regional circulation and thermohaline fields. Two counterclockwise circulation features dominate the region. One, the Alaska Current/Stream, flows along the continental slope, and provides the oceanic connection between the Gulf of Alaska shelf and the Pacific Ocean. This current system imports warm water from lower latitudes into the northern Gulf of Alaska and is bounded on its inshore side by a shelfbreak front. The other is the Alaska Coastal Current (ACC), which hugs the coastline as a narrow (~35 km wide), low-salinity current bounded on its offshore edge by a salinity front. Both current systems originate offshore of British Columbia and eventually feed the Bering Sea, thereby providing oceanic pathways by which organisms, contaminants and climate signals can be transmitted over broad distances. A mid-shelf region, having a weak mean, but highly variable flow, separates the inner shelf from the shelfbreak. Consequently the ACC and the slope currents are generally not in direct communication, although their water masses mix with one another over the mid-shelf domain. Imposed upon this mean structure are large seasonal variations associated with the seasonality of the Aleutian Low.

However, there are a variety of random perturbations to the marine environment that could significantly influence biological productivity in the Gulf of Alaska. These fluctuations include mesoscale, episodic phenomena having space and time scales of 20–200 km and 10-30 days, which arise due from flow instabilities and/or interactions of the mean currents with the complex shelf/slope bathymetry. Basin and larger scale variations have periods ranging from the intraseasonal to the decadal. These tend to modify the strength and trajectory of storm systems resulting in regional changes in wind and precipitation patterns. Such changes affect oceanic mixing and the transport and fluxes of heat, salt, nutrients, and organisms, which could lead to restructuring of the marine ecosystem.

Seasonal, Interannual, and Decadal Scale Freshwater Variability in the Alaska Coastal Current

Thomas J. Weingartner[1], Seth L. Danielson[1] and Thomas C. Royer[2]

[1]University of Alaska Fairbanks
[2]Old Dominion University

The Alaska Coastal Current (ACC) is forced by winds and coastal freshwater runoff and is the most prominent circulation feature on the Gulf of Alaska shelf. The ACC extends around the perimeter of the Gulf of Alaska linking the waters of southeast Alaska and British Columbia to the Bering Sea. It also appears to be an important migratory corridor and/or habitat for a variety of marine organisms including juvenile salmon migrating from nearshore nursery areas into the interior Gulf. We construct a conceptual model based on historical discharge and oceanographic data to estimate the annual cycle in freshwater volume and transport of the ACC. On an annual basis the baroclinic components of the mass and freshwater transports by the ACC varies seasonally with a maximum in fall and minimum in summer. The volume of freshwater within the ACC also varies seasonally although these variations are not in-phase with the transports. Freshwater content increases rapidly in July and August, remains nearly constant from August through December, decreases abruptly in early winter and then remains relatively constant from March through June. These relationships suggest that the coastal buoyancy flux due to freshwater is approximately balanced by the alongshore buoyancy flux of the ACC. We attempt to assess the role of wind-induced cross-shelf Ekman transport on the ACC freshwater budget, although reliable estimates of this flux are difficult to make because of the uncertain nature of the cross-shelf circulation field. We also find that monthly anomalies in the baroclinic components of the mass and freshwater transports and freshwater content of the ACC can be reasonably well-predicted based on a simple multiple linear regression incorporating measurements of nearshore salinity (station GAK1), freshwater discharge, and local winds as the independent variables. For example the model explains ~60% of the mass transport anomaly and ~75% of the freshwater transport and content anomalies in the ACC. This predictive model allows us to examine interannual variability in the ACC since 1970 when the GAK1 time series began. A model using only freshwater transport also has significant predictive skill (explaining ~50% of the freshwater transport anomaly), which allows us to examine interannual variability in the ACC from 1930 to the present. Finally we show that freshwater discharge into the Gulf of Alaska (and hence a proxy time series of ACC transport anomalies) can be hindcast back to 1900 using sea level pressure difference between Seward and Ketchikan. These results suggest that the first decade of the 20th century time was the driest on record, while the period from 1920-30 was the wettest.

Seasonal Cycles of Nitrate Concentrations on the Gulf of Alaska Shelf from the GAK4 Mooring

T.E. Whitledge, S.J. Thornton, A.R. Childers, D. Musgrave and H. Statscewich

University of Alaska Fairbanks

A biophysical shelf mooring at the GAK4 location at the 250-m isobath in the Seward Line has been maintained for two years with deployment/recovery every six months. In addition to current meters the mooring includes W.S. Oceans Systems NAS-2EN nitrate instruments at two depths (11-m and 75-m), and SBE SeaCat salinity, temperature, pressure, fluorescence, light transmission and PAR sensors at three depths (8-m, 23-m and 40-m). The nitrate instrument samples every four hours and analyzes a standard once per day to provide about 1000 data records from each full term deployment.

Nitrate data records obtained during the spring bloom periods of three years clearly showed the nitrate drawdown trend with occasional "event scale enrichments" in the surface layer. During two spring periods concurrent drawdown trends were observed in the nitrate records at 75-m depth but concentrations only decreased to values of approximately twice those in the surface layer. Some "event like" periodicity of nitrate concentration was also observed in the 75-m records. Comparisons of the nitrate data with physical/optical sensors showed the set of complex processes affecting the temporal and spatial distribution of nutrient-productivity processes in the Gulf of Alaska LTOP study area. In general, nitrate and chlorophyll fluorescence showed the expected inverse relationship throughout the records. Comparison of the chlorophyll estimated by the fluorescence sensors with SeaWiFS indicates that the early bloom events were captured accurately but the later subsurface chlorophyll event was missed by the remote sensing. Fall nitrate concentrations on the shelf were observed during one deployment at 75-m which displayed a series of "event like" changes through the month of January.

Idealized Modeling of Seasonal Variation in the Alaska Coastal Current

W. J. Williams and T. J. Weingartner

University of Alaska Fairbanks

The Alaska Coastal Current (ACC) is a wind and buoyancy forced, 30-50 km-wide current of low-salinity water that flows along the coast of the Gulf of Alaska from southeastern Alaska to Unimak Pass where it enters the Bering Sea. It is a consequence of the massive, annual coastal freshwater discharge which is distributed in numerous rivers draining from coastal mountain ranges. Seasonally, the discharge is a minimum in winter and increases through the summer to a maximum in fall. The ACC can either store this freshwater, mix it offshore, or transport it to the Bering Sea. The wind-stress along the coast of the Gulf of Alaska is generally cyclonic due to the Aleutian Low. It is strong and persistent in winter and weak and more variable in summer. The ACC is unique among coastal currents because of this downwelling wind stress, the massive, distributed coastal buoyancy forcing and the relatively-deep, nearshore bottom depths. CTD sections across the ACC show the current to be narrow, deep and bottom-attached in winter; but wider, shallow and predominantly surface-trapped in summer. A simplified numerical model of the ACC is used to examine the dynamical processes that govern this seasonal cycle. We use the Regional Ocean Modeling System (ROMS) forced by a combination of downwelling wind-stress and a 'half-line' source coastal-buoyancy-influx. The origins of the ACC are represented by the beginning of the line source. For this model, the scales of time evolution, the dynamical balance and density balance, and the relative importance of cross-shelf mixing to along-shelf transport of freshwater are presented. The numerical simulations of the 'half-line' source show a narrow deep 'ACC' during winter forcing and a wider, shallow 'ACC' during summer forcing.

APPENDIX V

CRUISE LOGISTICS

Summary of CGOA Cruises in 2003

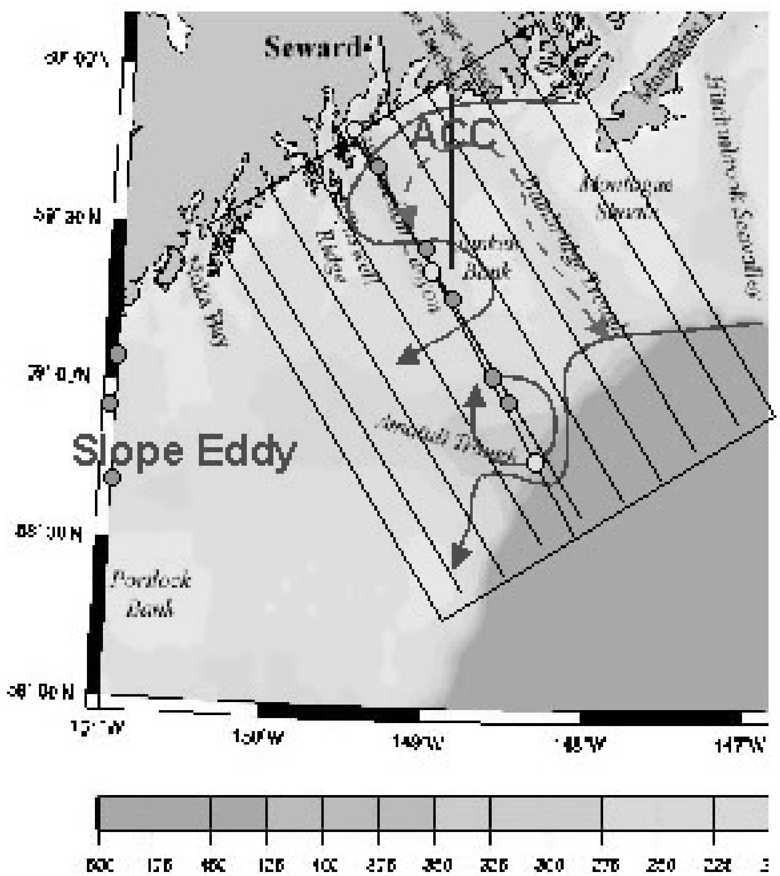
(Last Revised: 21 January 2003)

Dates	Vessel	Cruise Activity	Chief Scientist	Chief Sci. Email	Departure-Arrival Port
4-12 March	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
2-10 April	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
17-29 April	*Kilo Moana*	Mooring Service	?	?	Kodiak-Seward
24 April-15 May	*Alpha Helix*	Process	Strom	stroms@cc.wwu.edu	Seward-Seward
1-21 May	*Kilo Moana*	Station Sampling	Kachel	nancy.kachel@noaa.gov	Seward-Kodiak
1-21 May	*Wecoma*	Survey/Mapping	Musgrave	musgrave@ims.uaf.edu	Seward-Seward
23-31 May	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
5-13 July	*Wecoma*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
14-23 July	*Pandalus*	Salmon Sampling	Haldorson	ffljh@uaf.edu	Seward-Seward
17 July-8 August	*Great Pacific*	Fish Survey-Leg I/II	Farley	ed.farley@noaa.gov	Leg I:Yakutat-Seward Leg II: Seward-Dutch Harbor
20 July-11 August	*Alpha Helix*	Process	Napp	jeff.napp@noaa.gov	Seward-Seward
21 July-11 August	*Wecoma*	Survey/Mapping	Musgrave	musgrave@ims.uaf.edu	Seward-Seward
early August	unid. Chartered Trawler	Salmon Sampling	Haldorson	ffljh@uaf.edu	Seward-Seward
14-22 August	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
20-29 August	*Pandalus*	Salmon Sampling	Haldorson	ffljh@uaf.edu	Seward-Seward
21-30 September	*Pandalus*	Salmon Sampling	Haldorson	ffljh@uaf.edu	Seward-Seward
9-29 September	*Kilo Moana*	Mooring Service & Station Sampling	Kachel	nancy.kachel@noaa.gov	Dutch Harbor-Kodiak
8-16 October	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward
2-10 December	*Alpha Helix*	LTOP	Weingartner	weingart@ims.alaska.edu	Seward-Seward

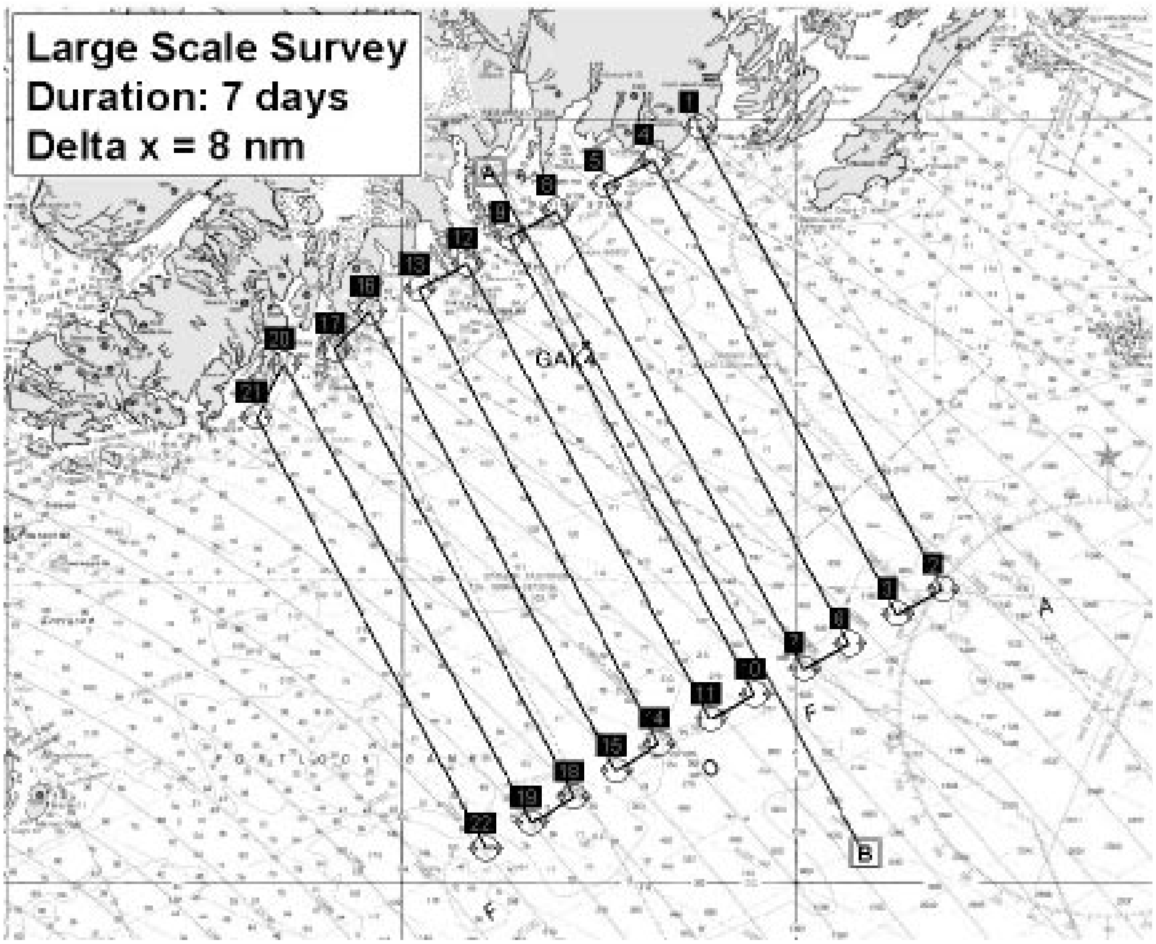
Summary of Mesoscale Survey Discussions held at the Anchorage Symposium on 15-16 January 2003.

(Summary prepared by Hal Batchelder, 21 Jan 2003)

Figures shown by Dave Musgrave in his presentation of the CGOA mesoscale survey on 16 January 2003, Anchorage, Alaska. The figure on this first page is taken directly from the Musgrave et al., proposal to conduct Mesoscale surveys in the vicinity of the Seward Line in the Gulf of Alaska. The figure shows bathymetry (shaded), ACC circulation, including the "Seward Eddy" nearshore, shelf-break jet and eddy, and deep water flow onshore via Bainbridge Trough, and then westward north of Junken Bank. Also shown are a tentative series of transects to conduct the mesoscale survey—ignore these and see the next several figures.



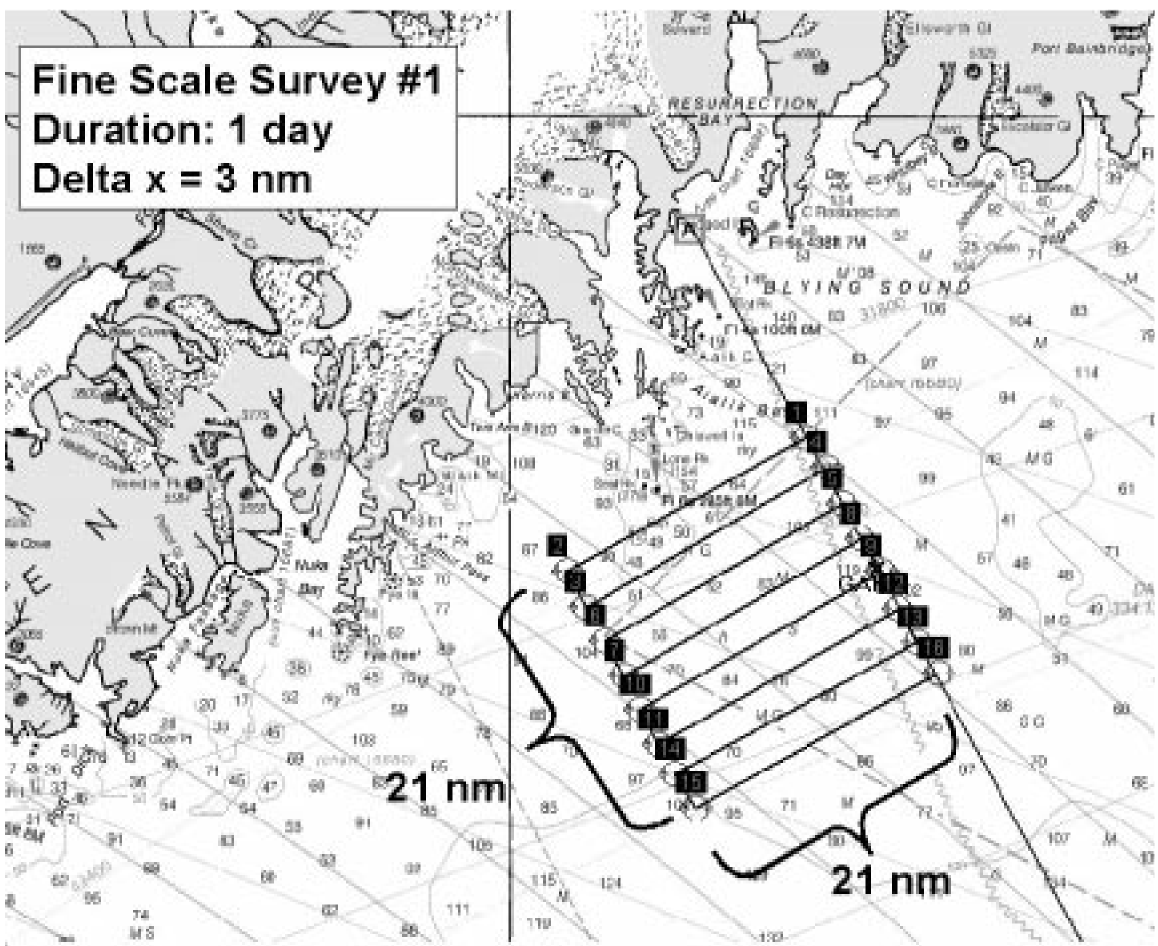
The figure on this page shows an example of the spatial coverage that can be covered from a 7 day long "**mesoscale survey**" in the CGOA region. Subsequent discussion during the meeting indicated that this grid might be shifted slightly to the NE, with shorter lines coming to shore near the SW end of Montague Island (perhaps an additional two transect lines on the NE, with 2-4 lines from the west edge of the grid deleted). Also, it was felt by many of the SIs that the lines did not extend sufficiently far offshore. So, rather than being a survey of 100 nm alongshore and 80 nm cross-shore, the lines might each be extended to 100 nm cross-shore, and not cover as much alongshore. This will be discussed more fully in the next few months. Principal contacts for this discussion are Dave Musgrave (musgrave@ims.uaf.edu) and Suzanne Strom (stroms@cc.wwu.edu).



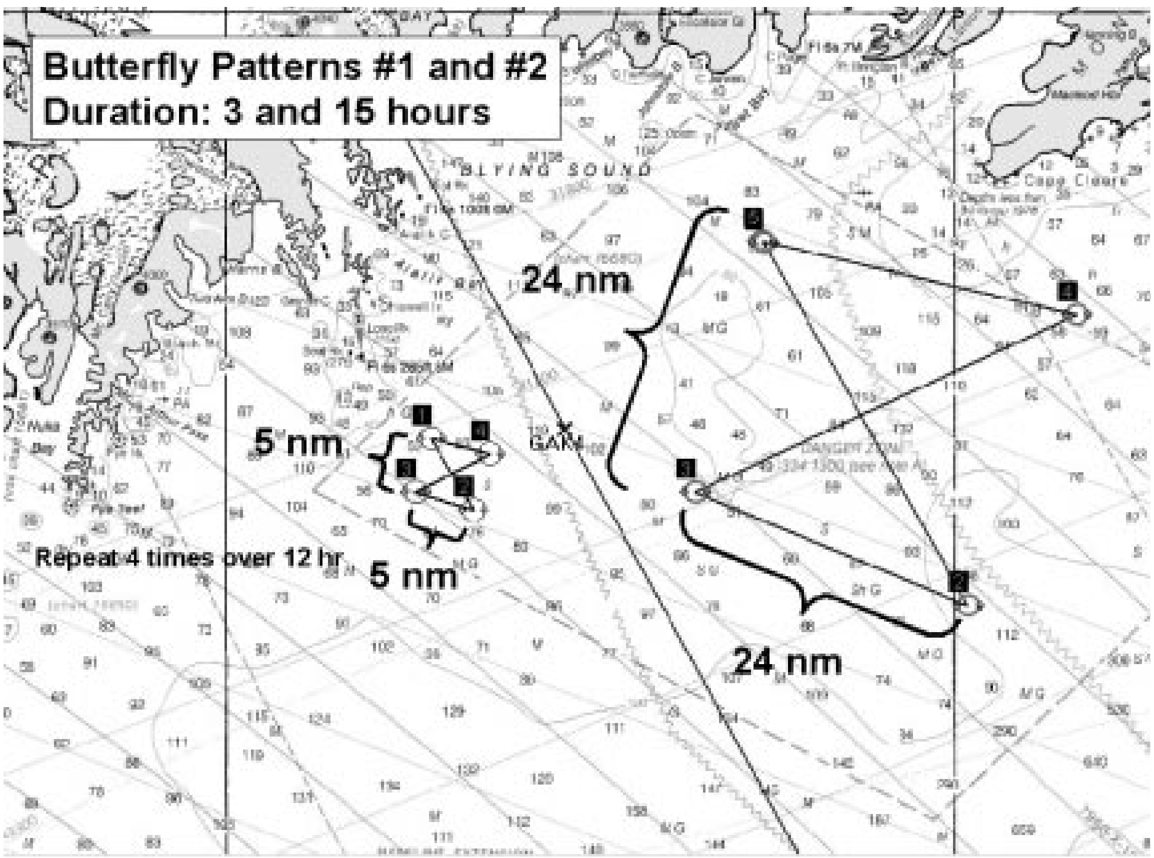
This figure shows one of several grid patterns that were discussed for "fine-scale" SeaSoar surveys on the May and August cruises. This one, having a separation of 3 nm between parallel transects, was viewed most favorably, and could be completed in 1 day. This pattern assumed a tow speed of ca. 8 kts. The total tow distance from the pattern shown below is 189 nm, which can be accomplished in 24 hours (barely). The sequence of mapping vessel activities proposed as collaborative with the 4-day Process stations being conducted on the Alpha Helix is as follows:

Day 1:	21nm x 21nm fine-scale survey, centered on Process Station
Day 2:	5nm x 5nm butterfly pattern (repeated 7-8 times in one day—see next page)
Day 3:	repeat Day 1 activities
Day 4:	Conduct station work from Mapping Vessel

This sequence of activities will occur 2-3 times on the cruise in May, subject to equipment reliability and weather. Process cruise scientists prioritized the need for close collaboration with the mapping vessel as: MIDSHELF > INNERSHELF >> OUTERSHELF. Thus, if weather cooperates, Process cruise in April-May 2003 will begin with OUTERSHELF Station (the Mapping cruise departs about 7 days later than process cruise), and hopefully the two ships will work the MIDSHELF and INNERSHELF stations together.



At the meeting, Craig Lee pointed out the difficulty of removing high frequency tidal circulations from the "mean circulation". He suggested a repeated "butterfly" pattern, done many times per tidal cycle would be the most useful way to estimate mean advection near the Process stations. Subsequently, Musgrave proposed a 5nm x 5nm butterfly pattern that has 28 nm of trackline (two 7 nm legs and two 5 nm legs), which requires about 3.5 hours (at 8 kts) to complete. This pattern would be repeated ca. 7 times in 24 hours.



APPENDIX VI

MODELING ISSUES IN THE CGOA

BREAKOUT GROUP DISCUSSION

GLOBEC Northeast Pacific Coastal Gulf of Alaska PI meeting
Anchorage, AK January 2003

Modeler Breakout session notes (Al Hermann, rapporteur)

Morning session notes (technical issues):

Dave Beauchamp – salmon feed in upper 10m in daylight on gelatinous (non-crustacean) prey. His group has a running bioenergetic model to predict consumption
Fish appear to feed at 80% maximum efficiency

Georgina Blamey – will add pteropods and *limacina* to model and split out cyanobacteria (which pteropods and *limacina* eat). Energetics of gelatinous organisms will be addressed.

TOMS (currently the same as ROMS 3.0) does not yet have parallelized float tracking.
Does TOMS have general data assimilation capability for all scalars?

Merits of one- versus two-way physical coupling were discussed

Planned and ongoing tasks (under GLOBEC and other related programs) include:

Kate Hedstrom – will develop ROMS shell to advect tracers and floats
Georgina Blamey – will continue work on NPZ issues
Emmanuel DiLorenzo - will lead on ROMS post-processing toolkit, starting with Bill Williams' momentum balance analysis package.
Nick Bond – NCEP reanalysis underestimates sea fog; he will look into ways of compensating for this bias
Al Hermann and Liz Dobbins – will investigate nudging towards Reynolds SST climatology, instead of COADS SST climatology.
Al Hermann – will investigate use of ECMWF reanalysis products, as a possible improvement over NCEP reanalysis product for driving the models

Afternoon session notes (management and science issues):
(notes presented here in chronological order):

Dave Musgrave – Small scale physical variations feed into larger spatial scales and longer time scales (example: storms -> runoff -> ACC). May ultimately need unstructured grid, to capture this cascade.

Jia Wang – telescoping grid is one way to approach the spatial nesting problem

Mike Dagg – interactions of lower trophic levels with salmon are not being accounted for with present one-way coupling of models. Need more modelers working on pieces of ecosystems.

Hal Batchelder – strongly recommends a NE Pacific-wide NPZ model.

Al Hermann – seconds Hal's recommendation; NEP-wide NPZ model should be a key goal of the program

Ken Coyle – need to include fish within that model

Dave Beauchamp and Jamal Moss – Salmon managers can use IBM results

Hal Batchelder – the big question is what processes are injecting nutrients onto the shelf – strong need to quantify this

Jia Wang – need to apply statistical tests to differences in model output

Hal Batchelder – event scale is crucial (e.g. storms)

Mike Dagg – timing of nutrient fluxes is crucial

APPENDIX VII

SUMMARY OF NEPEXCO DISCUSSION ON

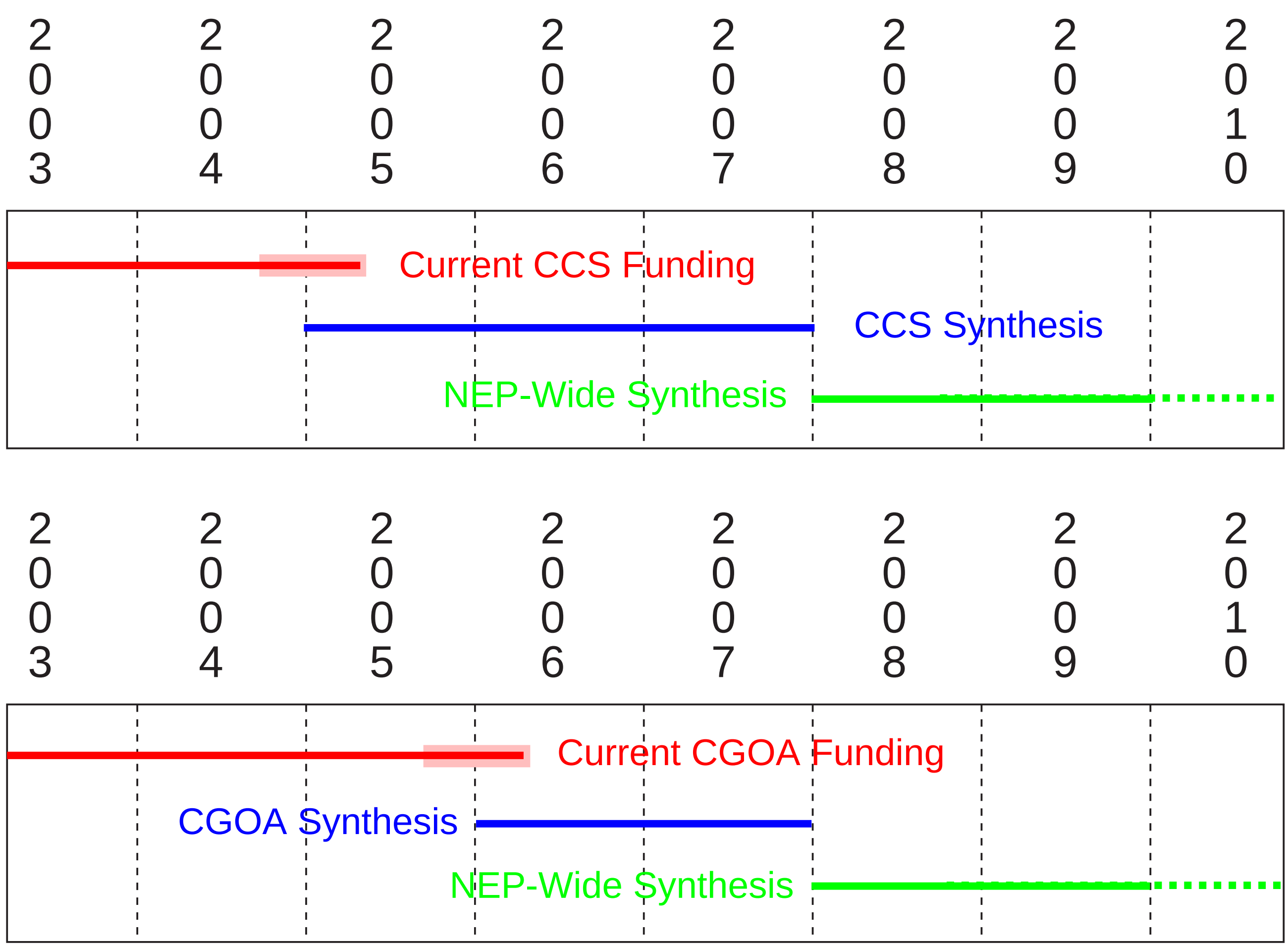
FUTURE SYNTHESIS PHASES

OF THE CGOA, CCS, AND NEP

U.S. GLOBEC Northeast Pacific Synthesis

The U.S. GLOBEC Northeast Pacific Executive Committee (NEPEXCO) met Tuesday evening, 14 January 2003. The members of the NEPEXCO are Jack Barth, Mike Dagg, Russ Hopcroft, Bill Peterson, Zack Powell, Tom Royer, Frank Schwing, Phyllis Stabeno, Suzanne Strom, and Ted Strub. Ted Strub is the chair. All but Barth, Peterson and Powell were present for this meeting. Also attending were Beth Turner (NOAA COP Program Manager) and Hal Batchelder (NEP Coordinating Office).

Much of the discussion was about future synthesis phases of the NEP program. Everyone recognized that the slightly different phasing of the CGOA and CCS programs would eventually need to be brought together for a NEP-wide synthesis phase. This phasing different results from the later field program of the CGOA, and the different ending dates of ongoing projects in the two regions. It was agreed to bring the two regions (CGOA and CCS) into phase by having the regional synthesis phase for the CCS be three years and the regional synthesis phase for the CGOA be two years. In consideration of these different durations is was suggested that the CCS synthesis phase be funded at $1.5M/yr for each of three years (total of $4.5M), while the CGOA synthesis phase be funded at $2.2M/yr for each of two years (total of $4.4M). Although the specifics (duration, costs) of a subsequent NEP-wide synthesis were not discussed at length, it was expected that such a phase would occur and would likely have a duration of 2-3 years. The figure below is a summary of the timeline for NEP synthesis. The red line shows the timeline of currently funded activities in the CCS and CGOA. Light red shading indicates the approximate range of ending dates, since the five year projects had various starting dates. Blue line shows the projected timeline for regional synthesis in the CGOA and CCS. Green line shows the projected NEP-wide synthesis phase, which may be two or three years in duration.



APPENDIX VIII

SOLICITATION FOR MANUSCRIPTS

DATE: 31 January 2003
TO: NEP Scientific Investigators
FROM: Hal Batchelder, NEP Coordinating Office
SUBJ: Special GLOBEC NEP Issue

Hello all,

At the two recent SI meetings (CCS: November 2002; CGOA: January 2003) the GLOBEC NEP SIs expressed interest in having a GLOBEC NEP special issue. I approached the editors of both Progress in Oceanography and Deep Sea Research II, Topical Studies in Oceanography (DSR2) concerning our desire to solicit papers for a special GLOBEC NEP issue. According to a "rather loose agreement" between the two journals regarding papers coordinated by research groups, it appears that DSR2 is the more appropriate publication outlet for this next collection of NEP papers. John Milliman received our proposal favorably and has added our special NEP issue to the list of future DSR2 special issues. He also thought that a special issue of 17-20 papers would be an appropriate size. If the number of papers submitted and accepted to this issue is 30 or more it will probably require multiple special issues.

The guest editors of this special issue are:

Hal Batchelder
Evelyn Lessard
Ted Strub
Tom Weingartner

The editors discussed the proposal review process at the recent CGOA meeting in Anchorage. A problem in the past for Guest Editors of special issues has been that some of the papers submitted were closer to "first drafts" than to "polished final drafts". This is a problem for coordinated special issues, because papers that require substantial changes/rethinking delay the publication of the papers that were polished to begin with and require few, if any, changes. To deal with this issue, the guest editors will evaluate the overall quality of all submitted papers before requesting mail reviews. If, in the opinion of the editors, a paper is not ready for mail review, it will be returned to the author unreviewed.

The deadline for submission of papers to this special GLOBEC NEP issue is 1 July 2003.

Please submit your papers to:

Hal Batchelder
College of Oceanic & Atmospheric Sciences
Oregon State University
104 Ocean Admin Bldg
Corvallis, OR 97331-5503
Phone: 541-737-4500
Email: hbatchelder@coas.oregonstate.edu

Please include 4 paper copies and all electronic files (for figures, text, tables). See the attached quidelines for authors and instructions for artwork.

As a first step, I'd like to receive from you expressions of intent to submit to this special issue. A tentative title and list of authors for planned submissions would assist us greatly. I will send information that I have received from the publisher regarding the preparation of manuscripts and figures to all who indicate they will be submitting manuscripts. Thank you.

REMEMBER, THE DEADLINE FOR SUBMISSION OF MANUSCRIPTS IS 1 JULY 2003.

Sincerely,

Hal
(on behalf also of Ted, Evelyn and Tom)

PS. Since I am sending this to the NEPPI mailing list, I'd appreciate your circulating this email and attachments to all members of your GLOBEC research group. Thanks.

APPENDIX IX

REPORT OF BREAKOUT GROUP BI

ECOSYSTEM RESPONSES TO

LARGE SCALE CLIMATE SHIFTS

Report of Breakout Group B1 – Ecosystem Responses to Large Scale Climate Shifts
Participants – Royer, Schwing, Grosch and Bond

Recommendations:

I. Develop and improve estimates of the potential forcing functions; wind (upwelling index), coastal freshwater discharge, precipitation, and sea level. Obtain estimates of the Gulf of Alaska basin circulation during the GLOBEC LTOP sampling period.

II. Develop regional heat and salt budgets.

III. Establish a consolidated data server for the GOA, including key timer series, indices, and data products.

IV. Relate the variability in the Seward Line hydrography to regional/local scale forcing.

V. Place the local conditions into a basin or global context including:

a) Biology (Ocean color)
b) CPR (Continuous Plankton Recorder)
c) SST
d) Other remote sensing
e) Other basin indices (NPI, SOI, PDO, NOI_x, etc.)

APPENDIX X

PLENARY SESSIONS

SUMMARY OF CONFERENCE EVENTS

Monday January 13	Tuesday January 14	Wednesday January 15	Thursday January 16	Friday January 17
7:30a.m.–8:30 am Registration **8:30a.m.** Opening/Plenary Session **10:30a.m. – 11:00a.m.** Break **11:00a.m.** Plenary Session **12:30p.m. – 1:30p.m.** Lunch provided – Keynote Address **1:30p.m.** Plenary Session **3:00p.m. – 3:30p.m.** Break **3:30p.m.** Plenary Session **5:00p.m.** Reception and poster session	**7:30a.m. – 8:00a.m.** Registration continues **8:00a.m.** Plenary Session **9:30a.m. – 9:45a.m.** Break **9:45a.m.** Concurrent Sessions – Fore Deck, Adventure **10:00a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure **12:00p.m. – 1:30p.m.** Lunch provided – Keynote Address **1:30p.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure **3:00p.m. – 3:30p.m.** Break **3:30p.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure **5:00p.m. – 6:00p.m.** EVOS Public Advisory Committee	**8:00a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure, Resolution **10:00a.m. – 10:30a.m.** Break **10:30a.m.** Concurrent Sessions – Endeavor, Voyager, Quadrant, Fore Deck, Adventure, Resolution **12:00p.m. – 1:30p.m.** Lunch provided – Keynote Address **1:30p.m.** Concurrent Sessions – Fore Deck, Adventure, Quadrant, Voyager, Resolution **3:00p.m. – 3:30p.m.** Break **3:30p.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure, Quadrant, Voyager, Resolution	**8:00a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure, Resolution **10:00a.m. – 10:30a.m.** Break **10:30a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure, Resolution **12:00p.m. – 1:00p.m.** Lunch provided – Keynote Address **1:00p.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure, Resolution **3:00p.m. – 3:30p.m.** Break **3:30p.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure	**8:00a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure **9:00a.m. – 5:00p.m.** PCCRC Advisory Board Annual Meeting, off site **10:00a.m. – 10:30a.m.** Break **10:30a.m.** Concurrent Sessions – Endeavor, Fore Deck, Adventure **12:00p.m.** GLOBEC and GEM/NPRB adjourn **12:00p.m. – 1:00p.m.** Lunch on your own **1:00p.m. – 5:00p.m.** SSL1 work sessions - Quadrant, Resolution

Monday, January 13, 2003

Plenary Session

7:30 – 8:30	Registration
8:30 – 9:00	Welcome and Introductory Remarks Molly McCammon (EVOS Trustee Council), Jack Phelps (Office of the Governor), Clarence Pautzke (NPRB), Hal Batchelder (GLOBEC), Lowell Fritz (SSLI), and Heather McCarty (PCCRC)
9:00 – 9:45	*Order and chaos: the physical structure of the Gulf of Alaska shelf/slope ecosystem* Thomas Weingartner (University of Alaska Fairbanks) GLOBEC
9:45 – 10:30	*Planktonic processes in the coastal Gulf of Alaska: interconnections with weather, ocean conditions, and salmon production* Suzanne Strom (Western Washington University) GLOBEC
10:30 – 11:00	Break
11:00 – 11:45	*Dancing with Mother Nature: the search for mechanisms in the juvenile pink salmon ecosystem - a Prince William Sound case history* Ted Cooney (University of Alaska Fairbanks) EVOS
11:45 – 12:30	*Bottom-up and top-down processes in ecosystem management* Douglas Demaster (Alaska Fisheries Science Center) SSLI
12:30 – 1:30	Lunch provided: Keynote address by Dr. William Hogarth, Assistant Administrator NOAA Fisheries
1:30 – 2:15	*Juvenile salmon migrations along the continental shelf in the Gulf of Alaska* Jack Helle (National Marine Fisheries Service) GLOBEC
2:15 – 3:00	*From physics to fish: the global climate connection to the Gulf of Alaska ecosystem* Franklin Schwing (Pacific Fisheries Environmental Laboratory) GLOBEC
3:00 – 3:30	Break
3:30 – 4:15	*Scientific review of the harvest strategy currently used in the Bering Sea/Aleutian Islands and Gulf of Alaska groundfish fishery management plans* Daniel Goodman (Montana State University) SSLI
4:15 – 5:00	*Past and present fluctuations in fish stocks: what do they mean for management today* Bruce Finney (University of Alaska Fairbanks) EVOS/GEM
5:00 – 7:30	Reception and Poster Session

Tuesday, January 14, 2003

Plenary Session

7:30 – 8:00	Registration continues
8:00– 8:45	*Monitoring changes in fisheries production: using vessels of opportunity* David Welch (Canadian Dept of Fisheries & Oceanography) GEM/NPRB
8:45 – 9:30	*Conducting marine research in a resource-dependent community: the role of outreach* Kate Wynne (Fisheries Industrial Technology Center) SSLI
9:30 – 9:45	Break