REPORT OF BASS TASK TEAM

The Basin Scale Studies (BASS) Task Team met on the morning of October 7, 2001, to review the past year's activities and to plan activities for 2002. The Co-Chairmen, Drs. Andrey S. Krovnin and Gordon A. McFarlane, welcomed participants (*BASS Endnote 1*) and outlined the objectives of the meeting. The agenda was approved as presented (*BASS Endnote 2*).

Activities and accomplishments in 2001

A 2-day BASS/MODEL Workshop on *Quantification of a food web model for the subarctic gyre systems* was convened March 5-6, 2001, in Honolulu, Hawaii, U.S.A. The workshop was productive and results are published in the PICES Scientific Report No. 17.

A 1-day BASS/MODEL Workshop on *Ecosystem models for the subarctic Pacific gyres* (developed at the March 2001 workshop) was convened in conjunction with the Tenth Annual Meeting in Victoria. Twenty-one participants reviewed work to date and developed and tested trophic change scenarios using ECOSIM.

The Iron Fertilization Experiment Panel (IFEP) met October 6, 2001, and the report of their meeting is appended as *BASS Endnote 4*. The Panel focused their discussion on the results of the successful Japanese iron enrichment experiment in western subarctic Pacific, in July 2001, and on planning for the Canadian SOLAS iron enrichment experiment to take place at Station P, in July 2002.

Proposed inter-sessional activities

Participants recommended convening a joint BASS/MODEL Workshop on *Using models to test hypothesis on effects of climate change on the North Pacific subarctic gyre system* in conjunction with the Symposium on *North Pacific transitional areas* in April 2002, in La Paz, Mexico (*BASS Endnote 3*). The final data synthesis of marine mammal and bird information should be completed prior to the workshop. Following the inter-sessional workshop, BASS should prepare the two baseline models, including the results and interpretation of hypothesis testing and data inventory, for publication in the PICES Scientific Report Series.

Proposed activities at PICES XI

Fisheries managers have been moving toward ecosystem considerations in their management. Understanding the interrelationships among species in an ecosystem is an integral part of developing this approach. BASS proposed a 1-day (or half-day) Topic Session on *Role of predation in the regulation of populations*[1], co-sponsored by FIS, be held at PICES XI.

With the successful linking of the NEMURO model to the eastern and western gyre ECOPATH/ECOSIM models, participants discussed linking basin-scale events to coastal ecosystems. It was noted that this is also a focus of the International GLOBEC Program. BASS proposed that the BASS/MODEL/REX Task Teams co-sponsor a workshop with GLOBEC at PICES XI to *Examine approaches for linking basin scale models to coastal ecosystem models*[2]. Participants recommended convening this joint workshop to complete hypothesis testing, and to continue parameterizing the western gyre models, in particular finalizing the boundary area for the gyre. It was also suggested, if possible, to calibrate and validate the NEMURO model using the data available for station A7, which is more appropriate for the western gyre.

[1] Became the BIO/FIS/CCCC Topic Session on *Responses of upper trophic level predators to variability in prey availability: An examination of trophic linkages*

[2] Deferred by the Science Board to PICES XII

Requests for travel

BASS requests support for 1 scientist to attend the inter-sessional BASS/MODEL Workshop in La Paz, Mexico, and 1 scientist to attend the joint BASS/MODEL/REX Workshop at PICES XI.

Other business

One conclusion of the BASS/MODEL modeling exercise is that it is very clear that scientists have a poor understanding of the life histories and interrelationships of key species inhabiting the subarctic Pacific gyres. Improved understanding of the factors that control abundances requires additional research.

Election of Co-Chairmen

Dr. McFarlane (Canada) will remain as the BASS Co-Chairman for the coming year to provide continuity during the final phase of BASS/MODEL joint activities. Participants requested the Co-Chairmen of CCCC to approach member countries for nominations for a second Co-Chairman to replace Dr. Krovnin (Russia).

BASS Endnote 1

Participation List

Members:

Gordon A. McFarlane (Canada, Co-Chairman)
Masahide Kaeriyama (Japan)
Andrey S. Krovnin (Russia, Co-Chairman)
Thomas Loughlin (U.S.A.)
Akihiko Yatsu (Japan)

Observer

Richard J. Beamish (Canada)
Paul J. Harrison (Canada)
Hidehiro Kato (Japan, Co-Chairman of MBMAP)
Jacquelynne R. King (Canada)
Shigenobu Takeda (Japan, Co-Chairman of IFEP)

BASS Endnote 2

BASS Meeting Agenda

1. Review accomplishments in 2001
2. Overview of joint BASS/MODEL Workshop on *Quantification of a food web model for the subarctic gyre systems* in Honolulu, U.S.A. (March 2001)
3. Overview of joint BASS/MODEL Workshop at PICES X
4. Report of Iron Fertilization Experiment Panel
5. Review of other inter-sessional activities
6. Discuss plans for 2002
7. BASS workshop theme for 2002
8. Discuss need for joint workshop(s) with MODEL/REX
9. Proposed inter-sessional activities
10. Requests for travel to future meetings
11. Discuss possible joint activities with GLOBEC Modeling FOCI at the GLOBEC Open Science Meeting in Qingdao
12. Other new business
13. Election of new Co-Chairmen

BASS Endnote 3

Proposed BASS/MODEL Workshop

Title: BASS/MODEL Workshop on *Using models to test hypotheses on effects of climate change on the North Pacific subarctic gyre system*

Convenors: Gordon A. McFarlane (Canada) and Bernard A. Megrey (U.S.A.)

Date/Location: April 2002, La Paz, Mexico (in conjunction with the Symposium on *North Pacific transitional areas*)

Objectives/justification: As the CCCC Program enters its synthesis phase, modeling will play a more prominent role in CCCC activity. BASS and MODEL have successfully determined that using ECOPATH/ECOSYSTEM as a modelling approach is a viable tool for organizing our understanding of the marine ecosystems of the subarctic gyres. Joint BASS and MODEL activity has successfully established working linkages between NEMURO and ECOPATH/ECOSIM and is poised to begin testing ecosystem hypotheses. In preparation for a possible joint PICES/GLOBEC session in Qingdao at PICES XI, BASS and MODEL would like to convene a joint workshop to use models to test hypotheses on effects of climate change and variability on the North Pacific subarctic gyre system.

Specific objectives include examining:

- decadal-scale forcing or productivity in the two gyres and the effects on abundance;
- effects of management (i.e. fishing) scenarios on the decadal-scale forced productivity; and
- effect of climate change scenarios on trophic relationships and productivity in both gyres.

Locating the venue in La Paz, Mexico, in conjunction with the symposium on *North Pacific transitional areas* is seen as a cost-effective way to assure wide participation, and would lead to a more balanced scientific representation from the nations of the North Pacific. Mexico is a potential new PICES member, and holding the meeting in La Paz would provide an early opportunity to draw Mexican scientists into PICES activity.

BASS Endnote 4

Report of Iron Fertilization Experiment Advisory Panel

The meeting was held from 08:30-17:30 hours on October 6, 2001. The Co-Chairman, Dr. C.S. Wong, called the meeting to order and welcomed the participants (*IFEP Endnote 1*). The Advisory Panel reviewed the draft agenda and it was adopted (*IFEP Endnote 2*). The meeting focused mainly on the results of the successful Japanese iron enrichment experiment in July 2001, and planning for the Canadian SOLAS iron enrichment experiment to take place at Station P in July 2002.

Summary of Japanese iron enrichment experiment in the western subarctic Pacific

A preliminary iron enrichment experiment was conducted during the FRV *Kaiyo-maru* cruise in June-August 2001. The next larger scale experiment in the western gyre is planned for August-September 2003.

Five goals of the overall project were:

1. to measure the response of bacteria, phytoplankton, and zooplankton in terms of species, standing stocks and rate processes to the iron addition;
2. to measure the draw-down of CO_2 and the carbon export flux;
3. to study the interaction between biogeochemical processes in the surface water during the phytoplankton bloom and the production of climate gases in the atmosphere;
4. to study the relationship between phytoplankton (diatom) production and the higher trophic level (salmon); and

5. to assess the influence of atmospheric iron supply on the characteristics of the plankton ecosystem in the western subarctic Pacific.

This first iron enrichment experiment was rather rushed since funding was received in February 2001, the ship allocated in April, and the experiment conducted in June. It included only 16 scientists. The experiment provided the most dramatic phytoplankton response of any of the HNLC iron enrichment experiments done to date.

Overview of the Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study (SEEDS 2001)

Experiment

An *in situ* iron enrichment experiment was conducted in the western subarctic gyre of the North Pacific (48.5°N, 165°E) from July 18 to August 1, 2001. The experiment consisted of a single addition of 350 kg of iron as $FeSO_4$ with an inert tracer gas SF_6, over an 8 x 10 km patch with a mixed layer depth of 10 m. The iron release track was up and down along a north/south line generating a radiator pattern relative to the central buoy due to surface currents. The injection was completed on July 19, and followed by two weeks of observations. The patch moved ~ 100 km from the beginning to the end. Drogues were used to follow the patch for ~ 24–48 h, and were repositioned every two days.

Iron

Prior to release, dissolved iron concentrations in the ambient surface seawater were extremely low (<0.05 nM). At the first underway transect throughout the patch after the iron release, significant increase of dissolved iron (1.9 nM, mean value calculated using all measurements of first underway transect in the patch; maximum 6.0 nM) was observed, and most of dissolved iron was in the colloidal fraction in the mixed layer. Dissolved iron concentrations subsequently decreased rapidly, and the loss rate gradually decreased. High particulate iron concentrations (>1 nM) were observed throughout the experiment.

Biological responses

The first biological response to the iron enrichment was the increase in photochemical quantum efficiency (Fv/Fm) of phytoplankton on day-3 from the enrichment. Chlorophyll *a* increased from day-6 and reached 20 mg m^{-3} on day-10. The maximum differences between outside and inside the patch were 19.5 mg m^{-3} in chlorophyll *a*, and 11.7 μM in nitrate. Dominant phytoplankton species before the fertilization and outside the patch was pennate diatom *Pseudoniztschia pungens*. But in the patch, phytoplankton rapidly increased and large-sized (>10 μm) centric diatoms, mainly *Chaetoceros debilis*, were observed. Non-depletion in nitrate until the end of the observation, and shallower euphotic layer depth than the mixed layer observed on day-12, suggested that phytoplankton was light-stressed at the end of the experiment. Salmons and small squids abundance, collected by trawl sampling, were not changed between inside and outside of the patch, but northern mackerels were abundantly collected only in the patch.

pCO_2

The underway pCO_2 system with high measurement frequency (1-minute interval data logging) with real-time monitor facilitated tracing the enrichment patch with biological draw down of pCO_2. The pre-experiment condition of the iron enriched area showed uniform pCO_2. The change of pCO_2 inside the patch was observed after 5 days of the iron enrichment. The draw down of pCO_2 expanded up to 146 μatm after 11 days of the enrichment.

Export flux

Export flux was measured using drifting sediment traps (Knauer type). The depths of the traps were 20, 40, 60, 100 and 200 m from the sea surface. The trap inside the patch was applied and recovered at about 2-day intervals. The reference trap outside the patch was applied and recovered at about 4-day intervals. The majority of the trapped material was fecal pellet of zooplankton. Increase of export flux was observed after 7 days of the enrichment. Wind-driven deviation of the inside-patch trap occasionally occurred, which made it difficult to

estimate the export flux accurately, however, the increasing of the export flux inside the trap was apparent. Longer observation of the iron-enriched patch is needed to see the fate of accumulated organic carbon after the end of diatom blooming.

Bottle incubation experiments

Bottle incubation experiments on board were also conducted to elucidate the effects of iron concentration and temperature on the growth of phytoplankton and nutrient utilization. Subsurface seawater samples taken on day-2 were spiked with $FeCl_3$ ranging from 0 to 2 nM, and incubated at 5, 9, 13 and 18°C for 14 days. The bottle incubation revealed that the increase in chlorophyll *a* was almost the same between *in situ* and *in vitro*, but the draw-down of nutrients was much faster *in vitro* than *in situ*. The specific growth rate increased with the amount of spiked $FeCl_3$, and was also the function of incubation temperatures.

Planning session for Canadian SOLAS iron enrichment experiment in July 2002

Key issues to focus on in this experiment are:

1. What is the influence of Fe enrichment on the production of climate active gases? This is the central novelty of the Canadian SOLAS iron enrichment project.
2. What is the fate of carbon and carbon export? This question is also central to SOLAS because of CO_2 flux, and it is of general interest because of poorly restrained export in previous iron enrichment experiments.
3. What is the plankton community's (ecosystem) response to iron enrichment?
4. What happens with iron chemistry, ligand production, and fate of iron?

Discussions centered on technical preparations such as iron and SF_6 tanks, drogues, iron injection and following the patch.

Overview of NSF proposal

Scientists from U.S.A. would like to take part in both the east and western gyre iron enrichment experiments. The highlights of the proposal submitted to NSF are as follows:

- Characterize the community and water chemistry within and adjacent to the iron-enriched patch over a time period of several weeks (20-50 days) after the initial enrichment;
- Test a series of sub-hypothesis using on-deck incubation studies;
- Assess the phenotypic differences of newly-isolated dominant subarctic Pacific diatoms in laboratory culture experiments; and
- Model the planktonic response to changes in iron concentrations and chemical speciation in the iron-enriched patch over a time period of several weeks after the initial fertilization.

Should we establish a SOLAS component of PICES?

Discussions focused on a proposal for an iron working group since the iron work was underway, and would benefit from a North Pacific coordinated effort leading to conclusive results and inter-gyre comparisons in the next three years. The idea of an iron working group was presented to the CCCC Implementation Panel, but it was not put forward to the Science Board.

IFEP Endnote 1

Participation List

Members:

Robert Bidigare (U.S.A.)
William Cochlan (U.S.A.)
Paul J. Harrison (Canada)
Isao Kudo (Japan)
Vladimir Shulkin (Russia)
Atsushi Tsuda (Japan)
Shigenobu Takeda (Japan, Co-Chairman)
Mark Wells (U.S.A.)
C.S. Wong (Canada, Co-Chairman)

Observers:

Melissa Chierici (Canada)
John F. Dower (Canada)
Agneta Fransson (Canada)
Keith Johnson (Canada)
Andrew Leising (U.S.A.)
Maurice Levasseur (Canada)
Patricia Livingston (U.S.A., SB Chairman)
Adrian Marchetti (Canada)
Yukihiro Nojiri (Japan)
Wendy Richardson (Canada)
Hiroaki Saito (Japan)
Nelson D. Sherry (Canada)
Nes Sutherland (Canada)
Charles Trick (Canada)
Frank Whitney (Canada)
Emmy Wong (Canada)

IFEP Endnote 2

IFEP Meeting Agenda

1. Round-table introduction of attendees
2. Adoption of agenda
3. Adoption of first Panel Report of IFEP held in Tsukuba, Japan
4. Review of relevant background work, e.g. eddy transport of iron
   - Where is HNLC water? ENSO factor
   - Iron distribution and possible transport to HNLC waters
   - CO_2 uptake/Fe enrichment in an eddy
5. Review of time-table of international Iron Enhancement Experiments in the subarctic Pacific
6. Review of July Canadian SOLAS iron enrichment planning meeting
7. Summary of Japanese Iron Enrichment Experiment results (SEEDS 2001)
8. SOLAS preparations at IOS
9. Overview of NSF proposal by Wells et al.
10. Should we establish a SOLAS component of PICES?
11. Planning session for the Canadian Fe enrichment in July 2002