MODEL/REX WORKSHOP TO DEVELOP A MARINE ECOSYSTEM MODEL OF THE NORTH PACIFIC OCEAN INCLUDING PELAGIC FISHES

(Co-conveners: Bernard A. Megrey and Michio J. Kishi)

Summary

A 4-day MODEL/REX workshop made several significant achievements:

1. Assembled an international team of marine biologists, fisheries biologists, and physical oceanographers who collectively achieved a consensus on the structure and function of a PICES Climate Change and Carrying Capacity (CCCC) prototype lower trophic level (LTL) ecosystem model for the North Pacific Ocean that included pelagic fishes, and named it "*NEMURO.FISH*";
2. Developed a computer simulation model of fish bioenergetics and growth;
3. Coupled the fish model to the NEMURO lower trophic level model;
4. Adapted the fish bioenergetics model to Pacific herring (*Clupea harengus pallasi*) in the eastern North Pacific, and Pacific saury (*Cololabis saira*) in the western North Pacific;
5. Made recommendations for future modeling activities.

The significance of these achievements will ultimately be evaluated by how well the CCCC Program effectively utilizes and embraces these models as a basis of future modeling activity.

1.0 Workshop overview

Introduction

The North Pacific Marine Science Organization (PICES) organizes and promotes an international science program, CCCC, in the temperate and subarctic regions of the North Pacific Ocean. Ecosystem modeling is one of five key research activities defined by the CCCC Implementation Panel. The PICES CCCC MODEL Task Team is given the role to encourage, facilitate and coordinate modeling activities within the member nations with respect to the goals and objectives of the PICES-CCCC Program. At the 2000 Nemuro Workshop, the MODEL Task Team developed NEMURO, a lower trophic level marine ecosystem model. NEMURO has been internationally recognized, and recently, the Max Planck Institute has adopted the use of NEMURO.

At PICES IX in Hokkodate, the REX and MODEL Task Teams met and agreed it would be useful to extend NEMURO to include higher trophic level components. Based on some presentations there, we agreed to try Pacific herring as a candidate higher trophic level species and plans began for a joint workshop. Dr. Michio Kishi prepared a proposal to the Heiwa-Nakajima foundation of Japan to help fund attendance to the workshop. The proposal was successful and planning began to hold the next workshop in Nemuro, Japan in 2002.

Goals and objectives of the Workshop

The goals of the 2002 Nemuro PICES workshop were to (1) develop a bioenergetics-based fish model for Pacific herring (*Clupea harengus pallasi*) and Pacific saury (*Cololabis saira*) and (2) to couple this model with output from the NEMURO lower trophic level model developed at the 2000 Nemuro PICES workshop.

Organizing Committee, participants, sponsors and venue

Drs. Michio J. Kishi, Bernard A. Megrey and Francisco E. Werner organized the meeting. Drs. Megrey and. Kishi served as workshop co-chairmen. The Heiwa-Nakajima foundation of Japan, PICES, and the city of Nemuro provided financial support and access to excellent meeting rooms in the City Hall. The Nemuro Support Committee supplied local logistical support.

The venue was set at the Multi Purpose Hall, a large octagon-shaped room, in the Nemuro City Cultural Center. The hall had a local area network which included a server workstation, laser and color printers, and another personal computer connected to the Internet. A classroom style table was arranged in the center of the room for the plenary session. A set of LCD projectors and screens and AC power outlets for participants' laptop computers were available and were arranged in each work area to make group work more effective.

Twenty six scientists from China, Korea, Russia, Japan, Canada and the United States (Fig. 1) convened in Nemuro, Japan, between January 25 and January 27, 2002, to participate in a modeling workshop focused on developing a coupled lower trophic level-higher trophic level model of the marine ecosystem. Most scientists arrived with their own laptop computers. Participants (Appendix 1) consisted of plankton scientists, modelers, and individuals with biological knowledge of herring and saury. Key regional data sets were also provided by many workshop participants. The workshop was continued at the Frontier Research System for Global Change (FRSGC) facilities in Yokohama on January 29, 2002.

Fig. 1 Nemuro Workshop participants. Left to right –Top Row: Douglas Hay, Tomokazu Aiki, Masakatsu Inada, Daiki Mukai, Lan S. Smith, Vadim V. Navrotsky, Alexander V. Leonov, Francisco E. Werner, Robert A. Klumb, Bernard A. Megrey, Toshio Katsukawa, Takeshi Okunishi, Yasuhiro Yamanaka, Tomonori Azumaya. Bottom Row: Chul-hoon Hong, Sanae Chiba, Yuri I. Zuenko, Daji Huang, Masahiko Fujii, Kazuaki Tadokoro, Shin-ichi Ito, Shoichi Hamaya (Nemuro City Supporter), Michio J. Kishi, Makoto B. Kashiwai.

Workshop schedule

Date: January 25th-29th, 2002

Venue: Nemuro City Culture Center* (25-27 Jan. 2002), FRSGC (28,29 Jan. 2002)

Conveners: Michio J. Kishi (Hokkaido University), Bernard A. Megrey (NOAA), Francisco E. Werner (University of North Carolina)

Workshop Co-Chairmen: M. Kishi and B. Megrey

Agenda

January 25th, Friday

18:00	Opening ceremony
19:00	Welcome reception

January 26th, Saturday

09:00-09:10	Remarks by M. J. Kishi
09:10-09:30	Review of NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography) developed by PICES MODEL Task Team in 2000 (Michio Kishi)
09:30-10:30	Review of NEMURO FORTRAN code (Yasuhiro Yamanaka)
10:30-11:00	Fish bioenergetics/biomass modeling: an application to Pacific herring (Bernard Megrey)
10:30-11:00	Review of NEMURO FORTRAN code (Yasuhiro Yamanaka)
11:00-11:30	Review of Clupeid biology with emphasis on energetics (Robert Klumb)
11:30-12:00	Analysis of change in Pacific herring distributions (Douglas Hay)
12:00-13:00	Lunch
13:00-13:30	Review of Pacific saury (*Cololabis saira*) study under VENFISH (Shin-ichi Ito)
13:30-17:00	Grouping of scientists ("team herring" and "team saury")

January 27th, Sunday

09:00-12:00	Continue working in teams
12:00-13:00	Lunch
13:00-15:30	Discussion on the results and modification of model
15:40-16:00	Closing ceremony
16:30-	Press conference (Megrey, Kishi, Werner)
18:30-20:30	Farewell party by Nemuro city (at hotel)

January 28th, Monday

Move to Frontier Research System for Global Climate Change

January 29th, Tuesday

09:00-12:00	Discussion on the results of new model and future strategy
12:00-13:00	Lunch
13:00-17:00	Seminar at FRSGC
13:00-13:30	Zuenko
13:30-14:00	Navrotsky
14:00-14:30	Huang
14:30-15:00	Klumb
15:00-15:30	Hong
15:30-16:00	Tea break
16:00-16:30	5-minute speech of Japanese participants
16:30-17:00	Discussion of future work

Workshop activity

After an opening ceremony with the people of Nemuro and a welcome party held the day before, the participants convened at the venue to start the workshop.

On the first day, the workshop officially opened with a welcome to all who had endured a long journey to come back to Nemuro. In the morning session, individual presentations were made on the NEMURO LTL model, a review of the FORTRAN program to execute NEMURO, the proposed fish bioenergetics model, and presentations on herring and saury biology as outlined in the agenda. During the afternoon session, the workshop participants split into two groups, to adapt the generalized fish bioenergetics model for Pacific herring ("team herring") and Pacific saury ("team saury").

The second day was taken up primarily with the two working groups dealing with their specific tasks. Results of the Pacific herring and saury

applications were presented for discussion in the afternoon. Also on the second day the coupled lower trophic level-higher trophic level model was named NEMURO.FISH (North Pacific Ecosystem Model for Understanding Regional Oceanography.For Including Saury and Herring). Robert Klumb suggested the name.

The participants received closing remarks from the vice-chairman of the Nemuro Supporting Committee where appreciation was extended to have brought into being such a productive workshop. These feelings were amplified during a Sayonara Party, which was full of warm hospitality by the people of Nemuro city.

The third session was held at the Frontier Research System for Global Change in Yokohama. The group discussed the structure and organization of the final report, made writing assignments, generated a list of workshop recommendations, discussed where the MODEL Task Team should be going next, and the possibility of holding future workshops. Several individual seminars were presented by workshop participants dealing with their personal research topics.

2.0 Workshop presentations

This section contains abstracts, extended abstracts, or fully prepared reports and workshop summaries given at the workshop. The reports that follow are organized by authors, according to the schedule provided in the agenda. The authors whose last name is in underline and bold font made the presentation. Model versions referenced in these reports are described in Megrey *et al.* (2000).

2.1 A generalized fish bioenergetics/biomass model with an application to Pacific herring

Bernard A. Megrey[1], Kenny Rose[2], Francisco E. Werner[3], Robert A. Klumb[4] and Douglas Hay[5]

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We chose to use bioenergetics/biomass modeling to represent fish growth because (1) the theory is based on the Law of Thermodynamics, (2) outputs must equal inputs, *ie.*, the energetic budget must balance (Law of Conservation of Mass), (3) terms in the equations are simple to biologically interpret, (4) fish physiological terms are well known and in general can be directly measured, and (5) this modeling approach allows users to focus on important external regulators such as temperature and diet composition. Model formulation and parameters for Pacific herring followed the approach used by Rudstam (1988) for Atlantic herring (*Clupea harengus*).

The growth rate of an individual Pacific herring (non reproductive) is calculated as weight increment per unit of weight per time and is defined by: