

APN Final Activity Report

Project Title

WORKSHOP ON THE CAUSES AND CONSEQUENCES
OF CLIMATE-INDUCED CHANGES
IN PELAGIC FISH PRODUCTIVITY IN EAST ASIA
(APN 2001-07)

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Summary of entire project

A GLOBEC-SPACC workshop on the causes and consequences of climate-induced changes in pelagic fish productivity in East Asia, supported by APN (Asia-Pacific Network for Global Change Research), was held in Kobe, Japan, August 25-27, 2001. It involved 30 participants from China, Japan, Korea, Malaysia, Russia and USA. The objectives of the meeting were: (1) to review our knowledge on decadal fluctuations of small pelagic fish populations in East Asia, and determine the existence of regional synchronies in these fluctuations, (2) to initiate regional synthesis on the factors controlling the productivity of small pelagic fishes in East Asia, and (3) to develop a strategic plan for SPACC in East Asia identifying ongoing activities and critical gaps in our knowledge.

The workshop lasted for three days, with about a day and a half of presentations, and a day and a half of working group discussions and a final plenary session. The presentation sessions provided a forum for presentation of research activities in East Asia primarily on climate-induced changes in pelagic fish productivity. At the latter part of the workshop, two working groups were assigned depending on the area of study: Tsushima Warm Current regions (East China Sea, Yellow Sea, Japan Sea/East Sea) and Kuroshio regions (Northwestern Pacific). In the end, identifying common goals, possibility of mutual cooperation in East Asia was discussed in more detail, and future direction toward developing a regional science plan to be implemented throughout East Asia was proposed.

The present status of GLOBEC-SPACC projects of each country was well documented. In 1990s, there have been several ongoing research projects on the productivity of small pelagic fishes in relation to decadal/multi-decadal changes in climate and ocean environment. It was confirmed that there existed apparent regional synchronies in the time-series of the productivity, implying that it will be of great value to promote the cooperative work and make a regional synthesis of the time-series data. Through working group discussions, major target species and their stock compositions were identified, and research subjects to be investigated in near future were recognized for each of above two regions.

As a follow-up activity, coordinated research cruises and future workshops aiming to produce comparable data sets in a common format, and to initiate the analysis of those data are proposed. Focus of the next workshop would be on small pelagic fish productivity in three major ecosystems of East Asia: East China Sea, Sea of Japan (Korean East Sea), and Kuroshio-Oyashio regions.

Introduction/Background

Small pelagic fish (sardines and anchovies, etc.) constitute a great portion of the fisheries catch in Japan, Korea, the East Coast of China and the Pacific coast of Russia. Young fish recruit in the coastal areas of the Yellow Sea, the Sea of Japan (Korean East Sea) and the Pacific coast of Japan, and the adults expand to occupy the region from Sakhalin (Russia) to the south coast of China. Dramatic and synchronic fluctuations in their catches have occurred in the above four countries in the last few decades. Research up to date suggests that these stock fluctuations are caused by changes in ocean climate. Understanding how the productivity of small pelagic fish stocks is linked to ocean climate and predicting the productivity cycles of the ocean is essential to avoid overexploitation when the ocean shifts to a period of low productivity. As the populations move freely across national boundaries under the influence of a common ocean climate, it is essential to conduct joint research and develop a concerted synthesis of the factors controlling the productivity of small pelagic fish stocks in the region. To initiate this synthesis, it is considered timely to hold the first regional workshop to overview the status in each country, and to seek for the possibility of mutual cooperation in East Asia.

In such a context, the Workshop on the causes and consequences of climate-induced changes in pelagic fish productivity in East Asia took place in Kobe, Japan, August 25-27, 2001, as a part of Small Pelagic Fishes and Climate Change (SPACC) program of IGBP-GLOBEC (Global Ocean Ecosystem Dynamics). It involved 30 participants from China, Japan, Korea, Malaysia, Russia and USA. The objectives of the meeting were: (1) to review our knowledge on decadal fluctuations of small pelagic fish populations in East Asia, and determine the existence of regional synchronies in these fluctuations, (2) to initiate regional synthesis on the factors controlling the productivity of small pelagic fishes in East Asia, and (3) to develop a strategic plan for SPACC in East Asia identifying ongoing activities and critical gaps in our knowledge.

Detailed information of activities conducted

The workshop lasted for three days, with a day and a half of presentations, and a day and a half of working group discussions and a final plenary session. The presentation sessions provided a forum for presentation of research activities in East Asia along the following lines:

- What decadal and multi-decadal changes have occurred in the area of study in anchovy/ sardine and other small pelagic fish populations?
- What decadal and multi-decadal changes have been observed in the marine productivity of the region?
- What processes have been identified to link ocean climate, atmospheric climate and global environmental change?
- What are the economic implications of the climate-induced changes in the productivity of small pelagic fishes and the shifts in species dominance?

The presentations were ordered by general categories: 1) Present status of GLOBEC-SPACC project of each country; and 2) Scientific reviews/remarks on climate-induced changes in pelagic fish productivity, including decadal changes in climate and ocean, time-series of plankton biomass, time-series of stock abundance in relation to ocean and climate dynamics, and technical development and modelling.

The present status of GLOBEC-SPACC project of each country was summarized in Table 1. In 1990s, there have been several ongoing research projects on the productivity of small pelagic fishes in relation to decadal/multi-decadal changes in climate and ocean. In addition, it should be noted that there could exist regional synchronies in the time-series of the productivity, implying that it will be of great value to promote the cooperative work and make a regional synthesis of the time-series data.

In the session on decadal changes in climate and ocean, long-term fluctuations in the oceanic regime in the northwestern Pacific were mainly discussed in relation to biological productivity, reproduction and migration of small pelagic fish. In particular, hydro-meteorological characteristics and bimodality of the Kuroshio were recognized as a most informative index representing the climate and ocean regime and possibly affecting biological processes in the northwestern Pacific.

Regarding the time-series of plankton biomass, interannual variations in zooplankton biomass from 1965-1998 was described in relation to sea water temperature in the Korean waters. It was noticeable that the zooplankton biomass, especially that of chaetognaths, euphausiids and amphipods, increased after the late 1980s, corresponding to a warm regime of ocean climate. In the China-GLOBEC programme, the calanoid copepod *Calanus sinicus* was selected as a key species for the marine food web research in the Bohai Sea, the Yellow Sea and the East China Sea, and detailed data on the distribution, egg production, and diel vertical migration have been accumulated in recent years.

In the session on time-series of stock abundance, the stock conditions of small pelagic fishes such as sardine, anchovy, herring, mackerel, Jack mackerel, Spanish mackerel, common squid, etc. in relation to environmental factors were described in Chinese, Japanese and Korean waters. In 1990s, fish catches in Chinese pelagic fisheries have rapidly increased reaching the highest production in 1998, while many stocks except for Spanish mackerel and common squid showed low recruitment in the southwestern Japan. Off the southern Korea, the proportion of small pelagic fish showed an increasing trend through the 1980-1990 period, and warm water temperature in the early 1990s seemed to be favorable for the recruitment of mackerel and anchovy stocks. Hokkaido-Sakhalin herring, a cold water species, showed an inter-decadal fluctuation in total length, catch-at-age, and length-at-age during 1910-1950. The total length at age 4, which had a positive correlation with mean total length at age 5-10, did not depend on the year-class strength, while Japanese sardine stock showed a strong density dependency. Species replacement of dominant small pelagic fishes in the northwestern Pacific was reviewed and discussed in relation to oceanic environment and predator abundance. In addition, economic and societal implications of stock fluctuation of small pelagic fish were discussed in terms of supply/price relationship in the use for non-food, focusing mainly on the implications of dominance alternation of sardine and anchovy.

A possible scenario on the fluctuation of common squid (*Todarodes pacificus*) stocks was presented. The late 1980s regime shift (a cool to warm regime) could be closely

related to the stock increase, including that of fall and winter spawning groups. Another time-series on body size and abundance of the common squid during 1970s-1990s interestingly suggested that the size fluctuation was apparently density independent and possibly related to water temperature regimes. Higher stability of water temperature and less influence of cold water could result in good fishing conditions of the common squid in the Korean water.

The multi-decadal scale variations with a 55-65 year-period in the stocks of small pelagic fishes including sardine and anchovy were exemplified and linked to several climate indices in the Pacific region. This may enable us to foresee the fish stock change for 10-20 years ahead.

In the session on technical development and modelling, examples of the application of EOF analysis to spawning habitat dynamics and a numerical model to egg and larval transport from spawning habitats to nurseries were demonstrated in relation to the recruitment of small pelagic fish. These new techniques should be a powerful analytical tool for understanding physical-biological interactions responsible for the fish recruitment when they are applied in combination with a well-designed field study. Some future tasks related to the verification of these models by field data were also discussed.

At the latter part of the workshop, two working groups were assigned depending on the area of study: Tsushima Warm Current regions (East China Sea, Yellow Sea, Japan Sea/Korean East Sea) and Kuroshio regions (North-western Pacific). Lastly, identifying common goals, the possibility of mutual cooperation in East Asia was discussed in more detail, and future direction toward developing a regional science plan to be implemented throughout East Asia was proposed.

The agenda and participant list of the workshop are attached in the end of this report for reference.

Outcomes/Products

The present status of GLOBEC-SPACC projects of each country was well documented. In the 1990s, there have been several ongoing research projects on the productivity of small pelagic fishes in relation to decadal/multi-decadal changes in climate and ocean environment. It was confirmed that there existed apparent regional synchronies in the time-series of productivity, implying that it will be of great value to promote the cooperative work and make a regional synthesis of the time-series data. Through working group discussions, major target species and their stock compositions were identified, and research subjects to be investigated in the near future were recognized for each of the two aforementioned regions.

Future directions/follow-up work

As a follow-up activity, coordinated research cruises and future workshops aiming to produce comparable data sets in a common format, and to initiate the analysis of those data are proposed. Focus would be on small pelagic fish productivity in three major ecosystems of East Asia: East China Sea, Sea of Japan (Korean East Sea), and Kuroshio-Oyashio regions. Several venues are also suggested for the next workshop, including (a) GLOBEC/PICES meeting in Qingdao, China, in October 2002, and (b) the 40th Anniversary of the Japanese Society of Fisheries Oceanography, Tokyo, Japan, in December 2002.

Workshop agenda

APN/GLOBEC-SPACC Workshop on the Causes and Consequences of Climate-induced Changes in Pelagic Fish Productivity in East Asia (at New Otani Hotel in Kobe, Japan, 25-27 August 2001)

AGENDA

Saturday, 25 August

09:00-09:30 Registration

09:30-10:20 Opening

Welcome by APN (R. Yatsu)
GLOBEC-International (T. Sugimoto)
PICES-GLOBEC (T. Wada)
GLOBEC-SPACC and Meeting objectives (H. Nakata)

10:20-10:40 <Coffee Break>

1. Present status of GLOBEC-SPACC project of each country

10:40-11:00 CHINA

Q. Tang: Status of China GLOBEC-SPACC

11:00-11:20 KOREA

S. Kim: Present status of GLOBEC-SPACC project of Korea

11:20-11:40 RUSSIA

V. A. Belyaev and V. B. Darnitskiy:
Perspectives of the North-west Pacific pelagic fish investigations in
connection with their abundance dynamics and climate changes

11:40-12:00 US-WEST COAST

D. Checkley:
Investigations of the spawning habitat of small, pelagic fish in the
Eastern Pacific

JAPAN

12:00-12:20 Y. Oozeki: Activities and goals of the VENFISH program

12:20-12:40 S. Kimura: GLOBEC/SPACC research in Japanese universities

12:40-14:00 <Lunch>

2. Scientific reviews/remarks on climate-induced changes in pelagic fish productivity

2.1 Decadal changes in climate and ocean

14:00-14:20 T. Sugimoto:

Interannual-interdecadal variations in plankton biomass and the physical
environment in the North West Pacific

14:20-14:40 A. D. Nelezine and V. B. Dalnitskiy:

Long-term seasonal variability of the thermodynamic water structure
in the Kuroshio Current region

14:40-15:00 E. I. Ustinova, V. A. Belyaev, Yu. D. Sorokin, and A. A. Mednikova:

Interannual variability of the meteorological and hydrological
conditions in the reproduction and migration areas of the Kuroshio
Current mass pelagic fishes

15:00-15:20 Ku Kassim Ku Yaacob:

Sea surface temperature and water circulation of the South China Sea and the effects on fisheries

15:20-15:40 <Coffee Break>

2.2 Time-series of plankton biomass

15:40-16:00 Y. S. Kang:

Interannual and seasonal variations in zooplankton in the Korean waters

16:00-16:20 S. Sun, G. Zhang and F. Zhang:

The Calanus sinicus research in the China-GLOBEC.

2.3 Time-series of stock abundance in relation to ocean and climate dynamics

Major target species: Sardine, Anchovy, Saury, Jack Mackerel, Mackerel, Herring, Squids

16:20-16:40 L. B. Klyashtorin:

Cyclic change of climate and main commercial species production in the Pacific. Possibility of forecasting

16:40-17:00 S. Kang, R. H. J. Lu, J. Wiggert, and S. Kim:

Relationship between chub mackerel (*Scomber japonicus*) population and climate variability in the East China Sea

Sunday, 26 August

2.3 Time-series of stock abundance in relation to ocean and climate dynamics (continued)

09:00-09:20 J. Y. Kim:

Spawner-recruit relationship of mackerel and anchovy and their environmental factors in the southern waters of Korea

09:20-09:40 L. Tong and Q. Tang:

The status of small pelagic fisheries in the Chinese waters

09:40-10:00 Y. Hiyama:

The status of small pelagic fish resources in the East China Sea and Japan Sea

10:00-10:20 Y. Watanabe, S. Takayanagi, and C. Watanabe:

Inter-decadal fluctuations in catch, population, and size-at-age of Hokkaido-Sakhalin herring in Japan

10:20-10:40 T. Wada: (TBD)

10:40-11:00 <Coffee Break>

11:00-11:20 Y. Sakurai, H. Kiyofuji, S. Saitoh, J. Yamamoto, and T. Goto:

Stock fluctuation of squid (*Todarodes pacificus*) related to recent climate change

11:20-11:40 J. H. Park:

The Relationship between fishing conditions of common squid (*Todarodes pacificus* STEENSTRUP) and water temperature during summer in the East Sea of Korea

11:40-12:00 H. Kidokoro:

Fluctuations in body size and abundance of Japanese common squid (*Todarodes pacificus*) in the Sea of Japan

12:00-12:20 A. Yatsu and H. Nakata: Species Replacement of Dominant Small Pelagic Fishes and Common Squid and Related Environmental Indices in the Northwestern Pacific Ocean

12:20-12:40 T. Wada:

Economic and societal implication of population fluctuation of small pelagic fishes

12:40-14:00 <Lunch>

2.4 Technical development and modeling

14:00-14:20 G. Rebstock:
EOFs of Pacific sardine and northern anchovy eggs in T-S space: an approach to analysing unevenly sampled time-series

14:20-14:40 A Kasai:
Modeling the transport and survival of fish eggs and larvae

14:40-15:00 <Coffee Break>

3. Working group (WG) discussion on common goals, existing gaps in our knowledge, and possible future cooperation

15:00-17:30

WG-1: Tsushima Warm Current regions (East China Sea, Yellow Sea, Japan Sea/East Sea) (Chairpersons: K. Asano, S. Kim and Q. Tang)

WG-2: Kuroshio regions (Northwestern Pacific) (Chairpersons: A. Yatsu, V. A. Belyaev and D. Checkley)

Monday, 27 August

3. Working group (WG) discussion (continued)

09:00-10:30

WG-1: Tsushima Warm Current regions (East China Sea, Yellow Sea, Japan Sea/East Sea) (Chairpersons: K. Asano, S. Kim and Q. Tang)

WG-2: Kuroshio regions (Northwestern Pacific) (Chairpersons: A. Yatsu, V. A. Belyaev and D. Checkley)

10:30-11:00 <Coffee Break>

4. Discussion on the cooperative research plan

11:00-12:40

4.1 Report from each WG

4.2 Possibility of mutual cooperation

- Regional networking / Joint symposium / Training workshop
- Co-ordinated research cruises
- Routine monitoring transects/stations

12:40-14:00 <Lunch>

14:00-15:00

4.3 Development of a regional science plan to be implemented throughout the East Asia

5. Discussion on the workshop report and recommendation

15:00-16:00

16:00 Closing

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