REPORT OF THE 1999 MONITOR TASK TEAM WORKSHOP

Introduction

Bruce A. Taft, 10580 NE South Beach Drive, Seattle, WA 98110, U.S.A. E-mail: bat65@aol.com
Yasunori Sakurai, Faculty of Fisheries, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan 041. E-mail: sakurai@pop.fish.hokudai.ac.jp

The Task Team met in Vladivostok October 8-10, 1999. The first day was devoted to a workshop on the relationship between planning of a monitoring system for the subarctic N. Pacific within PICES and the international planning activity taking place within the Global Ocean Observing System (GOOS) community. The report is divided into two sections: the first section presents abstracts of papers delivered in the workshop, and the second section summarizes subsequent discussion of issues raised in the workshop and other matters. The second section includes recommendations.

Section I. Workshop Abstracts

Purpose of the MONITOR Workshop on PICES and GOOS

Patricia Livingston
Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-0070, U.S.A. E-mail: Pat.Livingston@noaa.gov

The Global Ocean Observing System (GOOS), sponsored by IOC, WMO, UNEP, and ICSU, is a scientifically-based, long-term international program that seeks to provide practical benefits to society through the collection and timely distribution of oceanic data and products, including assessments, assimilation of data into numerical prediction models, the development and transfer of technology, and capacity building. "Operational oceanography" is a term that has been used in international GOOS discussions.

GOOS recently held its first International Agreement Meeting in which there was strong international support for at least some of the GOOS modules, which presently include Climate, Health of the Oceans (HOTO), Living Marine Resources, Coastal, and Services modules. In the North Atlantic, ICES has recently formed a steering group on GOOS that has developed a set of recommendations with regard to their involvement in GOOS activities. PICES nations in the western Pacific are involved in one of the most advanced regional components of GOOS, North-East Asian Regional GOOS. Presently, PICES scientific committees and the CCCC Program are involved in activities that are related to GOOS. We need to begin discussions of how we should move towards advancing a North Pacific GOOS program that meets the needs of PICES member countries. This one-day discussion, held during the PICES CCCC MONITOR Task Team Workshop provided a forum for PICES scientists to learn about GOOS and to develop recommendations for PICES future involvement.

It was certainly appropriate to have held this workshop as part of the PICES GLOBEC CCCC MONITOR Task Team effort. GLOBEC recognizes that some of the monitoring efforts initiated under the GLOBEC umbrella will be considered candidates for long-term monitoring under GOOS. At the regional level, PICES nations are beginning GOOS strategic planning and activities related to the NEAR-GOOS effort, so it is important for us to learn from those efforts but also for us to bring our ecosystem perspective to these programs. There is a great deal of activity and planning going on in the international front and PICES needs to see where these efforts are going. Some of these efforts such as HOTO require that we bring in the expertise and perspectives of our MEQ Committee to discuss their relevance and importance to PICES. The data sharing aspects of GOOS may provide practical benefits to PICES nations as they seek to understand and predict the state of the ocean – a task that requires the sampling efforts and data of more than one nation.

International Global Ocean Observing System Program

Ned Cyr
Ocean Science & Living Resources, Intergovernmental Oceanographic Commission, UNECO, 1 rue Miollis, 75732 Paris Cedex, Fance. E-mail: n.cyr@unesco.org

The Global Ocean Observing System (GOOS) is a sustained coordinated international system for gathering ocean data. GOOS is also a system for processing the data to enable the generation of beneficial products and services as well as the research and development on which such services and products depend for their improvement. Information arising from this long-term, multidisciplinary monitoring will be used to assess present and future states of the oceans in support of their sustainable use, contribute to the prediction of climate change and variability and meet the needs of a wide range of users. GOOS will differ from most present observing systems in the following ways: (1) modeling and forecasting is a part of its mandate as well as data collection; (2) the approach is holistic, integrated and interdisciplinary rather than narrow or sectoral; and (3) it is designed to deliver useful products for both decision-makers and the scientific community.

Planning for GOOS is conducted through four modules: Climate; Living Marine Resources; Coastal and Health of the Oceans. For each module, a strategic design panel has been established to define the requirements of the system in its area. In addition to the observational requirements, the panels also specify the products required by users and the capacity building and data management infrastructure necessary to support the module. The climate and HOTO modules are most advanced with regard to specifying system requirements.

The GOOS Initial Observing System (IOS) is already bringing together relevant international programs under the aegis of GOOS. These ongoing programs are consistent with GOOS design principles. Examples are the TAO array of buoys, the Coral Reef Monitoring Network and the Continuous Plankton Recorder Survey of the Sir Alister Hardy Foundation for Ocean Science. In addition, countries are encouraged to identify national programs which could be considered relevant contributions to GOOS.

Several pilot projects are also being planned to take forward aspects of the GOOS design, including the Global Ocean Data Assimilation Experiment (GODAE) the Array for Real-Time Geostrophic Oceanography (ARGO) and the Pilot Research Array in the Tropical Atlantic

(PIRATA). The main GOOS pilot project, GODAE, is designed to demonstrate the power of integrating satellite and *in situ* data using model data assimilation and the value of a global system capable of working in real time. GODAE is needed for open-ocean analyses and forecasts and to establish boundary forcing for regional models to improve forecasting in coastal systems.

Although the GOOS system is intended to exist indefinitely, the planning phase will be completed by 2010. The strategic design plans should be completed by 2001, during which time a data and information management system also will be developed. From 2000 to 2010 GOOS will be implemented progressively, including the addition of more national and international observing systems and the establishment of additional pilot projects.

There is ample opportunity for closer cooperation between PICES and GOOS. It is suggested that PICES can contribute to GOOS in the following ways: (1) identify existing relevant ocean observations in the subarctic Pacific which could contribute to GOOS; (2) develop an integrated PICES-GOOS plan based on existing routine observations and augmented with new observations as required; and (3) develop a plan to identify and implement transition of relevant North Pacific research activities to routine observations and ultimately data products.

LMR Module of GOOS

Warren S. Wooster
University of Washington, School of Marine Affairs, 3707 Brooklyn Avenue, Seattle, WA 98105-6715, U.S.A. E-mail: Wooster@u.Washington.edu

The LMR Panel met in March of 1998 (Paris) and March 1999 (Montpelier), and is scheduled to meet in Talcahuano, Chile, in December 1999. Initially, the Panel focused on offshore ecosystems, but after the second meeting, coastal fisheries were also assigned to the LMR module (previously they were to be considered by the coastal Panel). Present GOOS plans call for the LMR module to be combined with coastal GOOS and other modules some time in 2000.

Work of the LMR-GOOS Panel is not so advanced as that of other panels because of the relative difficulty of determining which parameters most effectively define the state of a marine ecosystem and which of them can be routinely monitored in a cost-effective way. Monitoring the physical state of the ocean is much easier to conceptualize, development of the technology of the measurements is far advanced, and there are already operational systems in place. In the case of living marine resources, on the other hand, there are few present observing systems on which to build, many of the desired variables are difficult to measure in a routine fashion, and there are few agreed linkages between measured physical and biological variables and desired products such as forecasts of abundance and availability of living marine resources. The latter will depend on improved ecosystem understanding which should result from the work of GLOBEC and other relevant research.

Relevant measurements for LMR range from physics and nutrients up through the various trophic levels to fish, sea birds and marine mammals. A generic table of categories of desired measurements has been developed and is being elaborated to a more specific list in selected regions, for example the Chilean coast. The observing system to determine such parameters must, to the extent possible, depend on remote sensing and on ships of opportunity, since dedicated observing systems will be difficult to fund on a continuing basis.

In the development of the LMR module, some existing monitoring programs have been nominated as components of the Initial Observing System (IOS), and several in the Pacific and Southern Ocean are under consideration. There are also pilot projects, such as the CPR program that is now funded in the northeast Pacific. PICES can help to identify other components of the IOS and other pilot projects in its region, can furnish suggestions for the list of desired measurements and preferred methods of making them, and can otherwise assist in the further development of the Living Marine Resources module.

NEAR-GOOS

Jihui Yan
National Marine Environmental Forecast Center, SOA, 8 Dahuisi Road, Haidian District, Beijing, P.R. China 100081. E-mail: yanjh@axp800.nmefc.gov.cn

NEAR-GOOS is a regional project of GOOS in the western Pacific region that was initiated in 1996. The present participating countries are the People's Republic of China, Japan, the Republic of Korea and the Russian Federation. The aims are to demonstrate the usefulness of a regional observing system in GOOS, to promote free exchange of oceanographic data in real time over the Internet to be used to create daily maps of sea conditions in the marginal seas of the northwestern Pacific and to distribute ocean data to a wide range of marine scientists. At present, the marine environmental data included in the system are physical data such as temperature, salinity, and ocean currents and waves. In the future, biological and chemical variables will be added to the system. Other high priorities are the expansion of the number of contributors and users, development of a uniform data format and improvement of data quality submitted to NEAR-GOOS. NEAR-GOOS collaborates with other relevant programs such as NEAR-HOTO and NOWPAP, and organizations such as PICES.

Status of ICES-GOOS

Robin Brown
Ocean Science and Productivity Division, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2. E-mail: brownro@dfo-mpo.gc.ca

ICES has established a Steering Group on the Global Ocean Observing System (SGGOOS). The task of the SGGOOS is to prepare an action plan for how ICES should take an active and leading role in further developments and implementation of GOOS at a North Atlantic regional level with special emphasis on operational fisheries oceanography. In order to help formulate the action plan, a workshop was held in March 1999, in Bergen, Norway. The terms of reference for the workshop were as follows: (1) identify existing ocean observing activities within ICES that are relevant to GOOS; (2) investigate how observations already being made routinely could be combined and enhanced and incorporated within a common plan: (3) propose a possible design for an ICES regional GOOS component; and (4) develop a draft implementation plan for ICES-GOOS. The next steps to be taken by ICES are: (1) to ensure that ICES is represented (formally) at the highest levels in GOOS (I-GOOS and GSC) and to invite

IOS-GOOS representatives to relevant ICES meetings; and (2) to obtain representation on the GOOS Living Marine Resources Panel and thereby influence the planning and in particular to provide assurance that fish are properly incorporated in the panel's activities.

Japan GOOS Program

Takashige Sugimoto
Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo, Japan. 164-8639. E-mail: sugimoto@ori.tokyo.ac.jp

The Real-Time Data Base (RTDM) and Delayed-Mode Data Base (DMDB) in Japan are operating successfully. These extensive systems were developed at the Japan Oceanographic Data Center (JODC) prior to GOOS and have a long history of use in Japan. The Japan Meteorological Agency (JMA) produced a Japanese version of the NEAR-GOOS brochure, which will help to promote the development of NEAR-GOOS. A five-year research program is now being implemented by Japanese universities. As part of this study, real-time monitoring of the volume transport and path of the Kuroshio will be carried out, and chemical and biological data in the northwest Pacific will be collected by ships and satellites. The basic goal of this study is to improve understanding of ocean processes through forecasting of temperature, salinity, currents, chemical substances and biological productivity in marginal seas of the western Pacific. It is expected that many of these measurements will become long-term components of GOOS.

Russian GOOS Program

Vyacheslav B. Lobanov
Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041. E-mail: pacific@online.marine.su

The Russian national GLOBEC plan is not finally designed and approved. However, GLOBEC-like ecosystem studies of various agencies are included in the list of priority science and development programs adopted by the Ministry of Science and Technologies for the post-perestroika period. One of the major programs among them is the Ecosystem Dynamics project that has been implemented mostly by the institutes of the Russian Academy of Sciences. Other agencies such as the Hydrometeorological Committee, the Committee on Fisheries, the Naval Hydrographic Service and the Ministry of Education (universities) carry on ecosystem studies in accordance with their ministry programs. Because of a lack of funding, the number of monitoring programs were considerably reduced over the last few years, particularly within the last two agencies.

The Hydrometeorological Committee is officially responsible for the monitoring and assessment of environment quality including the marine environment. It maintains a net of meteorological stations and observations along standard hydrographic sections located in the Okhotsk and Japan seas. Data archival and methodological support is provided by the Far Eastern Regional Hydrometeorological Research Institute (FERHRI) (contact: Dr. Yuriy Volkov, Director -

hydromet@online.ru). The Hydrometeorological system provides data on physical forcing related to the oceanic and atmospheric conditions. Observations of temperature, salinity, hydrochemistry at standard levels from the surface down to 1000-1500 m and marine meteorology were obtained along repeated fixed sections since the late 50s; however, by the end of the 90s, a number of operational coastal stations were eliminated and the hydrographic sections program was terminated because of funding cutbacks.

Ecosystem studies by the Committee on Fisheries are focused mostly on higher trophic level organisms and physical forcing. The main organizations dealing with monitoring programs in the North Pacific are the Pacific Research Fisheries Center (TINRO-Center), Sakhalin Research Institute of Fisheries and Oceanography (SakhNIRO) and Kamchatka Research Institute of Fisheries and Oceanography (KamchatNIRO). In the 80s, the TINRO-Center (contact: Dr. Lev Bocharov, Director - root@tinro.marine.su) started regular assessment of demersal/pelagic fishes and invertebrates, zooplankton and ichthyoplankton distribution as well as hydrographic and hydrochemical conditions in the Bering, Okhotsk and Japan seas and Kuril Isl. area. Some cruises also sample nekton, primary production, bacteria and protozoa. CTD measurements are typically done down to 500 m, trawl and acoustic sampling is used to obtain fish distribution data at a typical 30 mi spacing. The surveys cover quite large areas and are repeated annually at particular seasons: March-May - northwestern shelf of the Okhotsk Sea (pollock survey); May-July - western Kamchatka shelf (crab survey); July-September - western Bering Sea (pollock survey); and July-October - Okhotsk Sea (salmon survey). Hydrographic observations are also made along two fixed sections through the Japan Sea (0-200 m) and along a section across the Kamchatka Strait (0-1500 m).

Observations and sampling by SakhNIRO (contact: Dr. Felix Rukhlov, Director - okhotsk@tinro.sakhalin.ru) are very similar to those made by TINRO. Monitoring is principally in a region within 100 mi of Sakhalin Is. in the Okhotsk Sea and Tatar Strait. Hydrography and plankton are observed twice per year along standard sections down to 500-1500 m depth. An annual survey of fishery resources includes juvenile distribution of pollock, herring and cod. Monitoring of salmon is also implemented at fishery plants.

At least three institutes of the Russian Academy of Sciences are engaged in ecosystem monitoring: the Pacific Oceanological Institute (POI), the Institute of Marine Biology (IMB) and the Institute of Automation and Control Processes (IACP). POI (contact: Prof. Victor Akulichev, Director - poi@eastnet.febras.ru) conducts studies of physical forcing and lower trophic levels at various areas of the North Pacific. Long-term monitoring of the water mass and current structure of the western boundary of subarctic gyre (Kuril-Kamchatka area) began in 1990 as the INPOC project, and was then followed by joint surveys with TINRO (1994) and SakhNIRO (1996). The results indicate indicate circulation changes in the area over the 90s which should produce a notable response of higher trophic level organisms. It is expected the survey will be continued on an annual basis. Another area of planned monitoring is the Peter the Great Bay and the adjacent northwestern part of the Japan Sea. Circulation and water exchange in the coastal area, mesoscale eddies and their input to fluxes and ecosystem dynamics are the main topics of the POI studies that are to be conducted as a part of the CREAMS-II program.

The Institute of Marine Biology (contact: Dr. Vladimir Kasiyanov, Director - inmarbio@-mail.primorye.ru) monitors both the lower and the higher trophic levels of the Peter the Great Bay ecosystem. The area of the study is bounded by the Tuman river mouth (Tumangan project) and Amursky Bay.

Inter-Institute Center for Satellite Monitoring of the Environment (contact: Dr. Emil Herbeck herbeck@iapu2.marine.su) has been recently established by IACP, POI and TINRO. This center will maintain monitoring of the Japan and Okhotsk seas based on NOAA AVHRR and

SeaWiFS thermal and ocean color imagery measurements.

In relation to Russian plans for ecosystem monitoring, the following issues should also be discussed: feasibility of implementation, methods of observations and data quality control, and data accessibility. In many cases, even when the project is approved, its implementation depends on funding availability. Even if the allocated funds do not allow full implementation, partial implementation is often possible. Special attention should be given to the methods of measurement, sampling design, analysis and data quality control. This is especially critical in the construction of long time series. Data availability for the international oceanographic community may also be a serious issue. Information on some physical and hydrochemical parameters in some areas of marginal seas may be restricted for international exchange.

Besides national plans, Russia is already involved in international projects related to monitoring of the North Pacific such as NEAR-GOOS and NOWPAP (contact: water@unep.org). The NEAR-GOOS project is the North-East Asian Regional component of the Global Ocean Observing System (GOOS) initiated by the IOC Sub-Commission for Western Pacific (WESTPAC). Participating countries are China, Japan, Korea and Russia. The area of interest covers Japan, and the East-China and Yellow seas. The scope of the project is to facilitate the exchange of marine environmental data through a system of real-time and delayed-mode data base that should provide free internet access for any user. The environmental parameters included in the system are so far focused on physical data in order to ensure the successful initiation of the operation. With the operation of the system well underway and given the requirements of the user community, it is necessary to extend the variables included in the system to include chemical and biological data. At present the Russian contribution to the NEAR-GOOS data exchange system includes marine meteorological data which are being contributed to the Real Time Data Base by FERHRI. POI has made available previously classified data from 13,628 oceanographic stations for international data exchange under the IODE/GODAR project. These data may now be contributed to the NEAR-GOOS Delayed Mode Data Base. For further development of the NEAR-GOOS program in Russia, it is required (a) to determine the regulations for international data exchange for the NEAR-GOOS program at the national level; (b) to provide necessary funds for NEAR-GOOS activities; and (c) to improve the telecommunication system in the country. The last one is extremely important in order to involve more users and contributors to the NEAR-GOOS data base (NEAR-GOOS contact: http://www.unesco.org/ioc/goos/neargoos.htm).

An additional international project which has similar objectives as NEAR-GOOS covers a similar geographic area and involves the same countries, but covers a much wider range of marine, coastal and associated fresh water environments, is the Action Plan for Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (Northwest Pacific Action Plan - NOWPAP). It was established in 1994 under the United Nations Environment Program as one of the components of its Regional Seas Program. NOWPAP includes a sub-project focused on the establishment of a collaborative, regional monitoring program that is developing jointly with IOC/WESTPAC. The last Inter-governmental Meeting on NOWPAP suggested the establishment of a regional monitoring center to co-ordinate activity of participating countries (contact - water@unep.org).

In summary, Russia still has plans for large-scale ecosystem monitoring of the Northwest Pacific and marginal seas. Its execution depends on the economic situation in the country and availability of national funds. Russia can offer resources for cooperation with the international marine science community, which includes experienced research groups, individual scientists and a large research fleet.

Contributions to this report by Drs. Yury Zuenko and Gennady Khen of TINRO and Gennady Kantakov of SakhNIRO are highly appreciated.

People's Republic of China GOOS Program

Jihui Yan
National Marine Environmental Forecast Center, SOA. 8 Dahuisi Road, Haidian District, Beijing, P.R. China 100081. E-mail: yanjh@axp800.nmefc.gov.cn

Data are collected at 14 coastal observation stations distributed between Xiaochangshan in the Bohai Sea and Zhelang in the East China Sea. This data base includes waves, SST and marine meteorological parameters. Real-time data can be accessed by all users via the Internet.

USA GOOS Program

Bruce A. Taft
10580 NE South Beach Drive, Seattle, WA 98110, U.S.A. E-mail: bat65@aol.com

The primary focus of the USA GOOS Climate Module Committee has been the execution of program ARGO (Array for Real-time Geostrophic Oceanography). This program was originally proposed by a group of USA scientists and is now in the process of being developed as an international program under the GOOS banner. The plan is to deploy globally a large number of Palace floats to measure profiles of temperature and salinity in the upper 2000 m of the ocean. In addition, measurements of velocity are obtained at the level where the floats drift before they periodically ascend to the surface to broadcast profile data to a satellite receiver. The resulting data set will be used to estimate the geostrophic component of the velocity field.

The Committee is presently working on the following aspects of the program: (1) develop algorithms to calculate salinity from the temperature, conductivity and pressure data; (2) consider development of an improved system for preparing and telemetering the profile for ultimate assimilation into numerical models; and (3) the transports in the narrow western boundary currents will not be measured by the floats and a supplemental system needs to be designed.

The present plan is to obtain 3×3 degree coverage in space with a 10 day time step. Initial deployments would begin in the SE Pacific. On this schedule the Subarctic Pacific would be seeded in 2-3 years. Commitments to the global program are currently 80-85% of what will be needed.

Canada GOOS Program

Robin Brown
Ocean Science and Productivity Division, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2. E-mail: brownro@dfo-mpo.gc.ca

GOOS Climate Module

Canada has discussed in some detail potential contributions to the GOOS/GCOS climate module, but recommendations at this point are not matched with funding resources. Highest priority has been given to the following projects: (1) five geocentrically positioned tide gauges (two on the east coast, including one new gauge on the Labrador coast, two on the west coast and a new gauge in the Arctic); (2) continuation of the research-based time series on Line P and at the site of the OWS P in the Pacific, at the site of OWS Bravo, and on an annual section across the Labrador Sea; and (3) a substantial (possibly 5% of the global array) contribution of profiling floats to the ARGO program. Canada would consider providing floats in regions outside areas adjacent to the Canadian coast, should the contributions of other nations provide regional coverage in areas of particular Canadian interest. Slightly lower priority has been given to carrying out one transocean section off both the east and west coasts every eight years for the assessment of the inventories and transports of heat, salt and carbon.

Enhancements to GOOS Climate and Coastal Modules

This contribution involves augmentation of the physical ocean observing system. (1) Seasonal sampling of the water properties on Canada's continental shelves and marginal seas (including the Arctic), using hydrographic sections and time series stations (roughly 12 sections and 8 time series stations on the east coast, 9 sections and a moored climate station on the west coast and an annual hydrographic survey in the Beaufort Sea region of the Arctic Ocean). (2) Enhancement of the tide gauge network, some of which would be geocentrically positioned (roughly 6 gauges on the east coast, 4 gauges on the west coast and 1 in the Arctic). These gauges would be in addition to those designated for the climate module. (3) Direct measurement of the volume transport on the Labrador shelf and through the Canadian archipelago. (4) Observations of sea-ice concentration, extent and velocity both off the coast of Labrador, in the Gulf of St. Lawrence and in the Canadian Arctic. The extent to which these measurements will contribute to the GOOS observing system depends on the final design of the climate module monitoring system.

Living Marine Resources (LMR) and Health of the Ocean (HOTO) Modules

Potential Canadian contributions to the HOTO and LMR modules are less clear than for the case of the Climate module because of the generally less advanced state of both GOOS and Canadian planning in these areas. However, under the "Canada Oceans Act", Canada has placed considerable emphasis in developing coastal zone management strategies and designating various ecologically sensitive areas as "Marine Protected Areas". Furthermore, Canada does have operational programs in these areas, especially as they relate to fisheries, fish habitat and overall marine environmental quality. In an effort to evaluate the effectiveness of current monitoring programs in meeting Canada's ecosystem objectives for integrated ocean management and conservation, a Canadian workshop will be held in the fall of 1999. It is expected that, in addition to addressing Canadian issues, this workshop will clarify Canada's input to the design of the LMR module and better indicate how Canada could most effectively contribute to this aspect of GOOS.

INTERNATIONAL PROGRAMS RELATED TO GOOS

International Data Buoy Cooperation Panel

Robin Brown
Ocean Science and Productivity Division, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2. E-mail: brownro@dfo-mpo.gc.ca

The Data Buoy Cooperation Panel (DBCP), which was formally established in 1985, is an official joint body of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). It is a part of the WMO Marine Program and is planned for integration within the Global Ocean Observing System (GOOS) as a GOOS existing system. The Panel members are representatives of all members of WMO or member states of IOC which are interested in participating in its activities (present representatives are from Australia, Canada, France, Greece, Iceland, Ireland, Netherlands, New Zealand, Norway, South Africa, United Kingdom and U.S.A.).

Principal objectives of the DBCP are: (1) review and analyze requirements for buoy data; (2) co-ordinate and facilitate deployment programs to meet requirements; and (3) initiate and support action groups; (4) improve quality and quantity of buoy data distributed on the Global Tele-communication System (GTS); (5) information exchange and technology development; and (6) liaison with relevant bodies and programs.

The next DBCP meeting will be held in Wellington, New Zealand, on October 26-30, 1999. Canada will be hosting a DBCP meeting in Victoria, B.C., on October 16-20, 2000. PICES members involved in oceanographic or meteorological programs, particularly involving drifting or moored buoys, are invited to attend.

PICES CCCC Program, MONITOR Task Team and the CPR Initiative

David W. Welch
Department of Fisheries & Oceans, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6. E-mail: WelchD@pac.dfo-mpo.gc.ca

It is well known that there are large changes in the size of commercial fish populations in the subarctic North Pacific on decadal time scales. These changes are associated with changes in the atmospheric forcing (displacement and change of strength of Aleutian and Arctic lows) and sea-surface temperature in the region. In order to understand the dynamics of the responses of the biological populations to large-scale air-sea interaction it is necessary to measure the changes in productivity of the ecosystem. A recent example from the N. Atlantic system illustrates the problem. Studies have shown that there is a strong statistical relationship between the phase of the North Atlantic Oscillation (NAO) and plankton abundance (Fromentin and Plaque, 1996). However, in 1996-97 there was a strong phase shift in the NAO without a concomitant change in the plankton population (Planque and Reid, 1998). Without the data from the N. Atlantic Continuous Plankton Recorder (CPR) survey of zooplankton, it would have been incorrectly presumed that the plankton populations also changed in the previously established way.

In its first meeting, the PICES MONITOR Task Team recommended that systematic, large-scale measurements of interannual variability of N. Pacific zooplankton composition and abundance be initiated. It was pointed out that there was a continuing observational program in the N. Atlantic which had successfully measured large-scale plankton variability that was significantly correlated with physical climate signals. The collection device is the CPR which is towed by ships-of-opportunity on monthly transects of the N. Atlantic. The CPR was first used in 1931 and its sampling characteristics are well documented.

In 2000, a two-year pilot CPR sampling program will be started in the N. Pacific under the leadership of Drs. David Welch (Canada) and Sonia Batten (UK). Two lines of sampling will be run: a north-south run (line A) from Prince William Sound, Alaska, to Long Beach, California; and an east-west run (line B) on a great circle route between Vancouver, British Columbia, and Yokohama, Japan (Fig. 1). Line A (proceeding southward) samples Prince William Sound, the offshore region feeding the shelf downwelling zone, the center of the Gulf of Alaska Gyre, the Subactic Transition Zone and finally crosses the CALCOFI grid off California. Line B (proceeding westward) runs parallel to Canadian Line P, cuts across the shelf at the tip of the Alaska Peninsula and then runs northward of the Aleutians before it returns to the N. Pacific near the dateline. The short-term research objective is to obtain data on the time and spatial structure of the near-surface plankton variability along these tracks. The data set will be used to help in the design of a long-term zooplankton sampling program for the N. Pacific which will be able to monitor climate change variability. Of course, there will be advances over time in the technology of estimating plankton abundance. Future plankton monitoring schemes will incorporate these improvements.

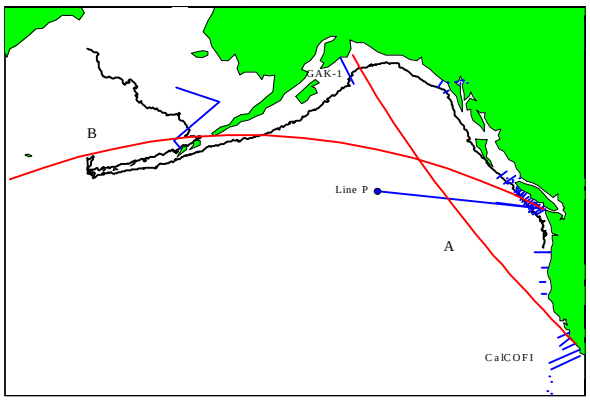

Fig. 1 Funded CPR transects. Line A is an oil tanker route, and Line B is a container ship route. Line A will be run 5 times in 2000 and again in 2001. Line B will be run once each year.

The CPR measurements represent the present best choice to collect a time series that will provide insights into the statistical characteristics of basin-scale climate change variability. PICES investigators would like to see this program imbedded in the initial GOOS plan and expect to work with GOOS to develop a long-term strategy to develop a climate change plankton data base for the subarctic N. Pacific.

Responsibility for the CPR program resides presently with the two leaders and a Scientific Advisory Board. The Board members are Drs. Michael M. Mullin, Charles B. Miller, Jeffrey M. Napp (U.S.A.), David L. Mackas (Canada) and Richard D. Brodeur (U.S.A.).

Section II. Summary of Task Team Discussion and Recommendations

1. Status of shipboard sampling in the subarctic Pacific

David W. Welch
Department of Fisheries & Oceans, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6. E-mail: WelchD@pac.dfo-mpo.gc.ca

In order to determine the present subarctic observational programs that are being carried out that contribute to the climate observing system, a survey was undertaken. This study serves two functions: (1) gaps in time and space coverage of the physical, chemical and biological climate variability are clearly identified; and (2) specific efforts can be made to ensure that key elements of present monitoring work are identified and supported within GOOS. The sampling carried out on these ships generally covers physical, chemical and biological variables.

There are significant differences in the east-west coverage and sampling is not uniform among the various ships and surveys because different measurement techniques are employed on different ships (Fig. 2). Nevertheless, the broad outline of Pacific monitoring programs is clear, with the western Pacific near Japan being much more intensely covered than the eastern Pacific, reflecting the long-term programs initiated and carried out by the Japanese. Similar programs occur in the eastern Pacific (California Current survey (CalCOFI, U.S.A.), Ocean Station PAPA line (Canada), and the GAK line south of Seward, Alaska (U.S.A.)) but the overall coverage is lower. The only substantial open ocean monitoring effort is the Canadian Line P program, with most other monitoring work confined to coastal or near-coastal waters.

A significant difference in the level of monitoring is evident when monitoring locations are restricted to locations where sampling occurs at least twice per year (Fig. 3). These observations are particularly important because shifts in seasonality are likely to be detected only when multiple samples are taken. Wintertime observations are less frequent than summer observations because of the difficulties of operating most research vessels in heavy weather. Ship-of-opportunity (SOP) lines are less dependent on weather and may be able to provide more data in winter.

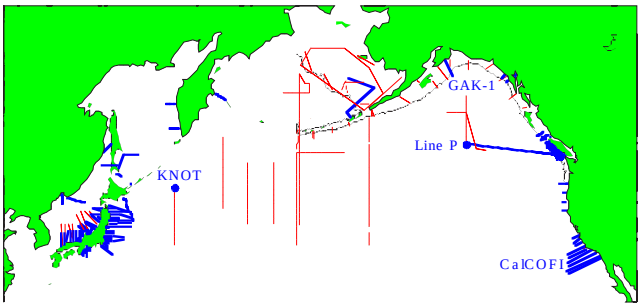

Fig. 2 Summary of on-going monitoring efforts in the PICES arena. The figure shows all locations sampled at least once per year.

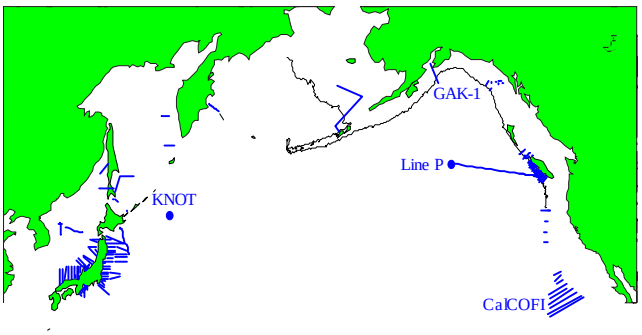

Fig. 3 The same chart as Figure 2, but restricting the definition of monitoring to sampling that occurs two or more times per year. Very little of the North Pacific is adequately monitored if seasonal variation occurs.

2. Time series stations in the subarctic North Pacific

a. Moored measurements in the eastern subarctic Pacific

Bruce A. Taft
10580 NE South Beach Drive, Seattle, WA 98110, U.S.A. E-mail: bat65@aol.com

There are a number of ecological problems that require high time-resolution measurements of physical and biophysical variables. Because the time scales of many biological processes are relatively short, it is necessary to resolve the high-frequency fluctuations in order to accurately represent the longer time-scale variability. Moored instruments are required to obtain the needed data sets. Shipboard sampling is too coarse in time and satellite measurements do not represent the vertical structure of the variability. In the subarctic the conditions are harsh and new mooring designs are required to withstand the extreme environmental stresses. In addition, new sensors need to be designed and evaluated to measure biophysical and chemical variables. Some prototype instruments capable of being moored do exist (pCO_2, nitrate, transmissometer, and fluorometer).

The Task Team was supportive of the pilot studies which have been initiated to moor suites of meteorological and oceanographic instruments in the subarctic. The measurements are relayed to satellite daily. A two-year program has been undertaken by the Pacific Marine Environmental Laboratory of NOAA near OCEAN Station PAPA (50°N 145°W). The first mooring was deployed in September 1998, and replaced with another in September 1999. In 1999 a second mooring was placed to the south in a more benign region in the subtropical gyre at 35°N 165°W. The subsurface measurements were successful on the first mooring but the surface instruments (largely meteorological) were lost in a severe storm after six months.

The Task Team concludes that there will be a large scientific payoff for these efforts and recommends that these scientific and engineering studies be continued until the engineering problems are solved. Mooring time series are necessary to successfully diagnose the relationships between meteorological forcing and physical and biological response in the ocean. Moorings are expensive and vast arrays are not possible. The best use of the technique is to measure the vertical distribution of the variables in a region where the horizontal currents and advection are weak, under these conditions the pattern of time evolution of events below the surface can be documented and the processes surmised.

b. Time series measurements in the western subarctic Pacific

Yukihiro Nojiri
Global Warming Research Laboratory, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki, Japan. 305-0053. E-mail: nojiri@nies.go.jp

A new Japanese time series was begun by NIES/JST (Japan Science and Technology Corporation) in June 1998. The station is referred to as KNOT (Kyodo North Pacific Ocean Time Series). The station is located at 44°N 155°E in the western region of the eastward-flowing Subarctic Current. The time series is maintained by Japanese research ships-of-

opportunity occupying the KNOT station when passing near the site. The suite of physical, chemical and biological measurements made depends on the capability of the scientific party aboard the vessel. The station was occupied by 13 visits from June to December 1998, and 10 visits from May to October 1999. In the future, sediment traps will be deployed at KNOT.

3. Measurement of temperature/salinity profiles with PALACE floats

Robin Brown
Ocean Science and Productivity Division, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2. E-mail: brownro@dfo-mpo.gc.ca

Planning for a global program to measure the distributions of temperature and salinity in the upper 2000 m is now underway. The technique is to deploy an array of PALACE (profiling ALACE) floats on a 300×300 km grid. The Palace float is designed to sink to a depth of 2000 m where it will drift with the current until its buoyancy is internally modified so the float will rise to the surface; a CTD is mounted on the float which measures the profiles of temperature and salinity on the ascent. At the surface, the float is programmed to send the temperature and salinity data to a satellite. The position of the float at the time of transmission is determined so that an estimate of the current at 2000 m can be determined from the displacement of the float over the time interval of submersion. After the data has been transmitted, the float sinks to 2000 m to begin another cycle. With these data, the geostrophic current can be calculated. The time between ascents will probably be 10 days. The measurement system is termed APEX (Autonomous Profiling Explorer). The array is referred to as ARGO (Array for Real-time Geostrophic Oceanography).

These data will be assimilated into a general circulation numerical model in support of the GODAE (Global Ocean Data Assimilation Experiment) which is a component of the global climate observing system now being planned. The goal of GODAE is to demonstrate the feasibility of routine, real-time global ocean data assimilation and prediction.

The present communication system uses System Argos; new improved satellite systems are under consideration. Transmissions are lost if weather is poor (40% data loss occurs in rough weather). Since the data are transmitted many times, the chance of successful transmission is high. Deployment from high speed commercial ships-of-opportunity is straightforward. System Argos positions are accurate to 150 m. The accuracy of the deep velocity measurement depends on the rate of the rise of the instrument and the parking time of the float at depth. If the float is left at the surface for one inertial period, useful measurements of surface current can be made. Cost of the instrumented floats is about $14K. In the early days salinity measurements were of poor quality because of fouling of the conductivity cell by biological organisms. The use of anti-fouling paint appears to have alleviated this problem for periods up to 3 years.

Commitments to fund ARGO have been forthcoming. At present countries expected to supply floats are U.S.A., Canada, Japan, Australia, United Kingdom, France and Germany. The deployment strategy and the development of a tracking and data distribution facility are presently being worked out.

PICES will benefit greatly from the existence of an ARGO array in the subarctic Pacific. In particular, the availability of a well-measured salinity field will make it possible to look at a large number of scientific questions that at present cannot be addressed because of the lack

of knowledge of the vertical density structure. The Task Team recommends that PICES volunteers to assist in the deployment of the float by offering platforms from which the floats can be launched. PICES is in a unique position to help this program because its member nations operate a number of research vessels in remote parts of the subarctic region.

4. Calibration studies of sampling gear

Stewart M. McKinnell
PICES Secretariat, c/o Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C. Canada. V8L 4B2. E-mail: mckinnell@ios.bc.ca

A wide variety of sampling gear has been used historically to measure zooplankton abundance. In order to create high-quality climate time series of zooplankton abundance, systematic errors that arise by combining measurements made with different sets of gear must be addressed. Calibration of various systems must be undertaken to resolve this source of error. The Task Team is undertaking a survey of the scope of the problem. At the 1999, meeting results of a comparison of the performance of the NORPAC and SCOR plankton sampling nets (differing mouth size and same mesh size) were presented. Results of this study show that on the order of 40 pairs of measurements were needed to estimate quantitatively the difference in sampling characteristics of the two systems. It is clear that significant ship-time resources will be required to deal with the multiplicity of systems that have been used historically to collect zooplankton samples in the North Pacific. The Task Team will facilitate further critical comparison studies.

5. Revising of MONITOR Task Team Terms of Reference

Patricia Livingston
Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-0070, U.S.A. E-mail: Pat.Livingston@noaa.gov

Discussions at the PICES GOOS workshop held October 8-9, 1999, led to the following recommendation to modify the terms of reference of the MONITOR Task Team. The new activities of MONITOR will focus on developing an action plan that will assist in the implementation of GOOS at a North Pacific level and will assist in the transition of PICES GLOBEC monitoring activities to long-term monitoring activities of PICES-GOOS. It was also decided that the action plan would: (1) identify existing ocean observations in the coastal and open N. Pacific that are relevant to GOOS; (2) develop a PICES-GOOS implementation plan based on existing routine observations and augmented by new observations as appropriate; and (3) provide a structured plan on how to move relevant CCCC Program activities to a PICES-GOOS program.

TERMS OF REFERENCE

1. Review existing activities of PICES member nations and to suggest improvements in the monitoring of the Subarctic Pacific to further the goals of the CCCC Program;

2. Consult with REX, BASS and MODEL Task Teams and TCODE on the scientific basis for designing the PICES monitoring system. Questions of standardization and inter-calibration of measurements, particularly in the area of biological collections, should be addressed;

3. Assist in the development of a coordinated monitoring program to detect and describe events, such as El Niño, that strongly affect the Subarctic;

4. Develop a PICES-GOOS action plan for how PICES should take an active and leading role in the further development and implementation of GOOS at a North Pacific level. The action plan would:

   i. identify existing ocean observations in the coastal and open North Pacific that are relevant to GOOS;
   ii. develop a PICES-GOOS implementation plan based on existing routine observations and augmented by new observations as appropriate;
   iii. provide a structured plan on how to move relevant CCCC Program activities to a PICES-GOOS program.

5. Advise and support the CCCC Implementation Panel and Science Board on GOOS-related matters, including representing PICES at key GOOS planning meetings.