DRAFT FY 2005 Accomplishments and FY 2006 Plans

FY 2005 Accomplishments

In the broadest terms, North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) in FY 2005 helped the United States understand how varying climate conditions affect marine ecosystems of the North Pacific Ocean. NPCREP's mission is to conduct research on climate variability and ecosystem response in the North Pacific, focusing initially on the productive waters of the eastern Bering Sea and western Gulf of Alaska. The intent of this research is to improve scientific understanding and guidance for resource managers. NPCREP has two long-term goals that address its mission. The first goal is to observe, understand and predict relationships between climate and ecosystems. The second goal is to aid protection and management of marine resources.

PRIORITIES

For FY 2005, NPCREP established the following priorities:

- Establish an observation network.
- Develop tools to synthesize/integrate large numbers of indices or metrics.
- Increase understanding of mechanisms.
- Incorporate environmental data into forecast/stock assessment models.

ACCOMPLISHMENTS

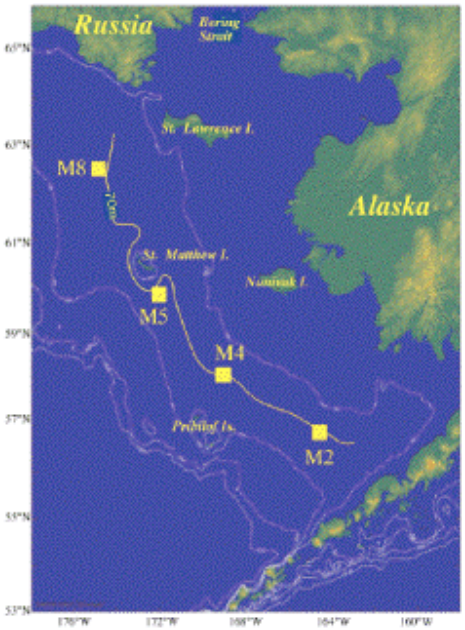
Specifically during 2005, NPCREP worked to accomplish the following tasks, generally classified into broad categories of *observe*, *understand*, *predict* and *advise and inform*.

Observe

NPCREP preserved and expanded the existing biophysical observing system to detect climate impacts. The following tasks were completed.

- Deploy and recover middle shelf moorings.

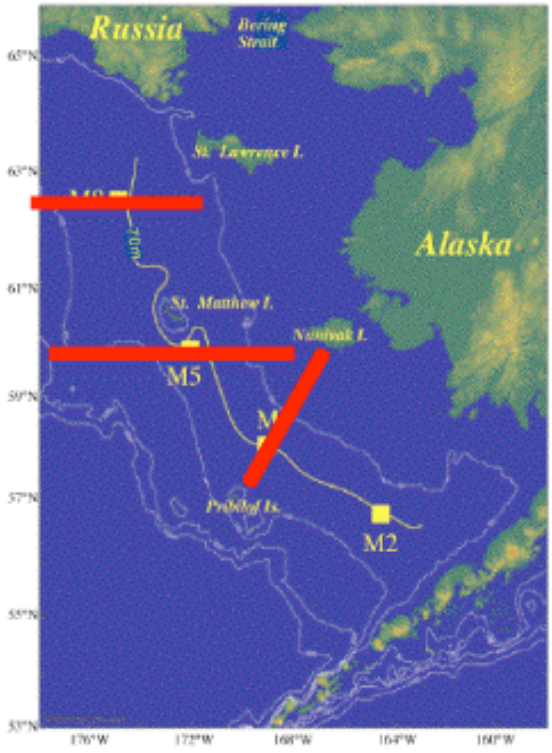
  In September and October 2004, biophysical moorings were deployed at M2 and at M4 (right). In April and May 2005, these moorings were recovered, and moorings were deployed at M2, M4, M5 and M8. This is the first time that four biophysical moorings have been deployed on the Bering Sea middle shelf along the 70-m isobath. These moorings will be turned around (recovered and redeployed) in September and October. Each of these moorings measures temperature, salinity, fluorescence, nutrients and currents throughout the water column. Funding for the moorings was supplied by a number of sources, with NPCREP funding two of the moorings, NPRB funding one and a half and SEARCH the remaining half. All

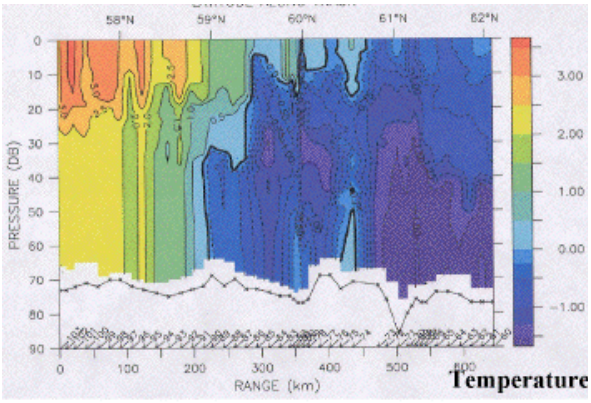


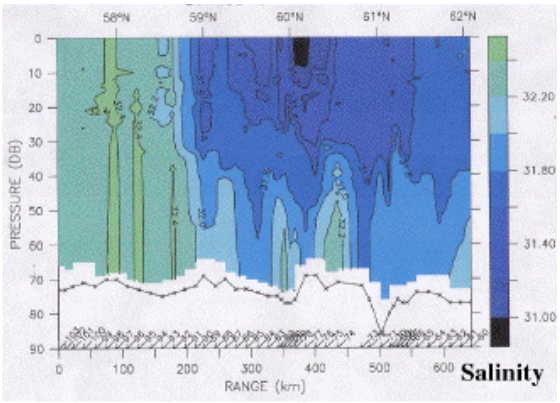
ship time was provided by FOCI, as was most of the equipment used on the moorings. In addition, zooplankton was sampled at the moorings and along the 70-m isobath in the spring and fall of 2005.

- Initiate a spring biophysical survey of the Bering Sea shelf.

On May 12, 2005, the R/V *Thompson* transited from Seward, Alaska, to the Bering and began a 13-day (May 16-28) biophysical survey of the Bering Sea shelf. Personnel completed 117 CTD casts, with 5-7 nutrient samples and 5-6 chlorophyll samples at each cast. In addition, 43 bongo tows sampled the zooplankton communities. The surveys were done on the three red lines (right) and along the 70-m isobath. A fourth line through M2 was not completed because of bad weather. This is the first time that a complete survey has been done over the entire eastern Bering Sea shelf. All previous biophysical surveys focused on a particular sub area. Temperature and salinity data along the 70-m isobath revealed the sharp contrast between the cold, fresh northern Bering shelf (left sides of the figures below) and the warmer, saltier southern Bering Sea (right sides).







- Conduct a pilot summer plankton survey in the Bering Sea.

This goal was partially completed during FY 2005. We inspected the charter vessels that were under contract and learned that even though they had equipment to tow our nets, it would not be safe to do so. We therefore determined design criteria (specifications) for

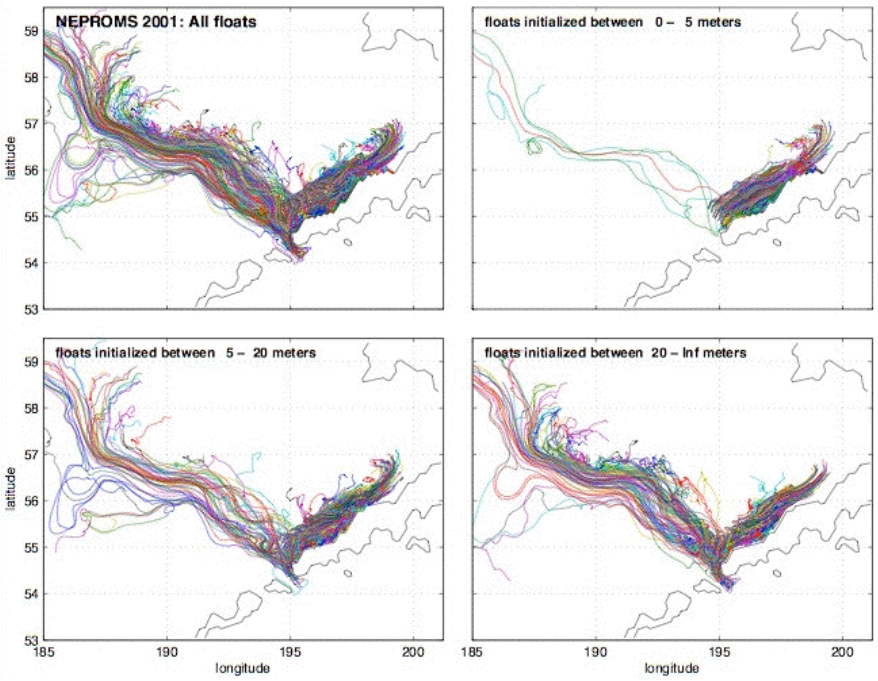
our own winch/gantry system and solicited bids for (2) portable winches with hydraulic takeoffs. The contract was awarded and the new winches should be delivered in January 2006. During the first part of FY 2006, we will complete the design of the winch gantry and award that contract. The AFSC will be soliciting bids for a new 5-yr contract for the charter vessels, and our needs will be built into the solicitation specifications. Discussions with the AFSC Groundfish Assessment Group about the best way to collect the plankton samples continue, and the group has agreed to take one NPCREP scientist on the first leg of FY 2006 to do the tows and training.

Understand

For FY 2005, NPCREP advanced towards a mechanistic understanding of climate-ecosystem interactions. Work elements included

- Study transport of larvae within the shelf.

Transport of Bering Sea fish larvae is thought to explain a significant amount of the variability in recruitment success. For example, early wind-driven models of surface currents on the Bering Sea shelf appeared to transport larvae of three flatfish species (northern rock sole, flathead sole, and arrowtooth flounder) to Bristol Bay during a decade of predominantly successful year classes. Similarly, the modeled currents transported larvae away from Bristol Bay during the decade of poor recruitment by these species. This early modeling effort assumed that the larvae were all found near the surface, and that the wind-driven component of the current was dominant. NPCREP is improving and testing our understanding of larval transport by obtaining actual measurements of larval fish depth distribution and using a physical model that includes both wind-driven and geostrophic currents. The NEPROMS physical model is forced by climate, and our recent spring cruises to the Bering Sea have been used, in part, to release drifters to validate the physical model. We now have model runs for the six years 1999-2004 (right). Initial insight into the vertical distributions of fish larvae was obtained from our larval fish collections. More recently, we have used NPCREP piggyback ship time for directed, depth-discrete sampling of fish larvae in the Unimak area. The model output is being combined with data on the vertical distribution



of northern role sole to determine if the early story of successful recruitment still holds. A manuscript describing results is in preparation.

- Explore the role of eddies in cross-shelf flux.

It has been hypothesized that eddies in both the Gulf of Alaska and Bering Sea play an important role of introducing nutrients to the shelf and extracting iron from the shelf into the basin, thus increasing primary productivity in both areas. It also is thought that the number and strength of eddies formed in the gulf are modified by year-to-year variability (e.g., ENSO cycle) and by longer decadal patterns (related to such patterns as the Pacific Decadal Oscillation). NPCREP is in the process of corroborating these hypotheses, partly by analyzing results from a dedicated cruise. From April 26-May 8, 2005, we explored four eddies along the west coast of Canada and Alaska on the R/V *Thompson*. We were joined on this cruise by a group of Canadian scientists. During this cruise, 61 CTD casts (measuring temperature, salinity, fluorescence, dissolved oxygen measured light transmission) were completed. In addition, 300 extracted chlorophyll and ~850 nutrient samples were analyzed. To obtain zooplankton samples 23 MARMAP Bongo were taken. Seven GO-FLO casts were made, with sampling to 800-m depth (115 samples bottles in all) to measure trace metals, particularly iron. This cruise improves our understanding of dynamics of eddies and their role in productivity. We learned, for example, that the location of eddies with respect to the shelf is an important factor in their ability to transfer properties between basin and shelf.

- Build a conceptual model for the eastern Bering Sea.

Since 2000, there has been a marked warming (~3°C) of the southeastern Bering Sea. Coupled with this warming are decreases in the concentration, duration and extent of sea ice over the southeastern shelf. The presence of ice determines the timing of the spring phytoplankton bloom, and the temperature of the water column influences the range of many species. For instance, warmer water has contributed to the northward retreat of many arctic species and the northward advance of subarctic species. It is clear that the observed warming and decrease in sea ice are linked.

Shifts in the physical environment of the shelf can be attributed to a combination of mechanisms. First, a strong, northward wind anomaly has persisted since 2000. A shorter ice season caused by a later fall atmospheric transition and/or an earlier spring atmospheric transition has affected the shelf environment. Additionally, a wintertime increase of water flow through Unimak Pass has introduced warm Gulf of Alaska water onto the southeastern shelf. Also apparent is the development of a feedback mechanism whereby warmer ocean temperatures during the summer delay the southward advection of sea ice during winter. While the relative importance of these four mechanisms is difficult to quantify, a conceptual model has been developed that includes each. Conceptually, the northward shift in the direction of the winter winds is the primary mechanism in reducing ice cover. The shortening of the ice season and the feedback loop of a warmer shelf are secondary, while warmer flow through Unimak Pass is the least important of these mechanisms.

We are continuing to build upon the Oscillating Control Hypothesis to expand our conceptual model of how the southeastern Bering Sea ecosystem functions. Our most recent accomplishment in this arena was extension of the model into controls of plankton dynamics during the summer. It is at this time that (commercially exploited) planktivorous fishes, (protected) marine mammals and seabirds must find sufficient food to lay lipid stores for the following winter and feed their young for the summer. A "budget" of the sources of zooplankton mortality demonstrated that at the present biomass levels of predators and prey, planktivorous fishes and protected marine mammals can easily deplete their prey resources during the summer. Given recent declines in summer zooplankton biomass, there is some concern that large pelagic predators (e.g., the endangered Pacific right whale) are competing with other planktivores for a limited resource. Our NPZ and ecosystem models will need to incorporate these new findings.

- Undertake retrospective analyses of Gulf of Alaska larval fish.

Our retrospective analyses focused on six fish species chosen for their dominance in our ichthyoplankton collections and their ecological niche in the Gulf of Alaska ecosystem. Pacific cod (*Gadus macrocephalus*), arrowtooth flounder (*Atheresthes stomias*) and starry flounder (*Platichthys stellatus*) are important components of the groundfish resources in the Gulf of Alaska. Capelin (*Mallotus villosus*), Pacific sandlance (*Ammodytes hexapterus*) and northern lampfish (*Stenobrachius leucopsarus*) are ecologically important forage fish. These species represent a diversity of life history strategies. The study reviewed details of the biology, life history traits and ecology of these six species, and evaluated their individual adaptation and vulnerability to prevailing and fluctuating climate-forced oceanographic conditions in the Gulf of Alaska. A manuscript ("Life history strategies of selected Gulf of Alaska fish species with reference to recruitment vulnerability under fluctuating environmental conditions") is being prepared for submission to an international marine science journal: A poster with this title was presented at the 29th Annual Larval Fish Conference (American Fisheries Society, Early Life History Section) in Barcelona, Spain, July 11-14, 2005. A poster of the same title will also be presented at the PICES Fourteenth Annual Meeting in Vladivostok, Russia, October 3-9, 2005, in a special session titled "The comparative response of differing life history strategists to climate shifts." Initial indications from these studies are that relationships between weather and species distribution and abundance are complex and probably dependent on climate regimes.

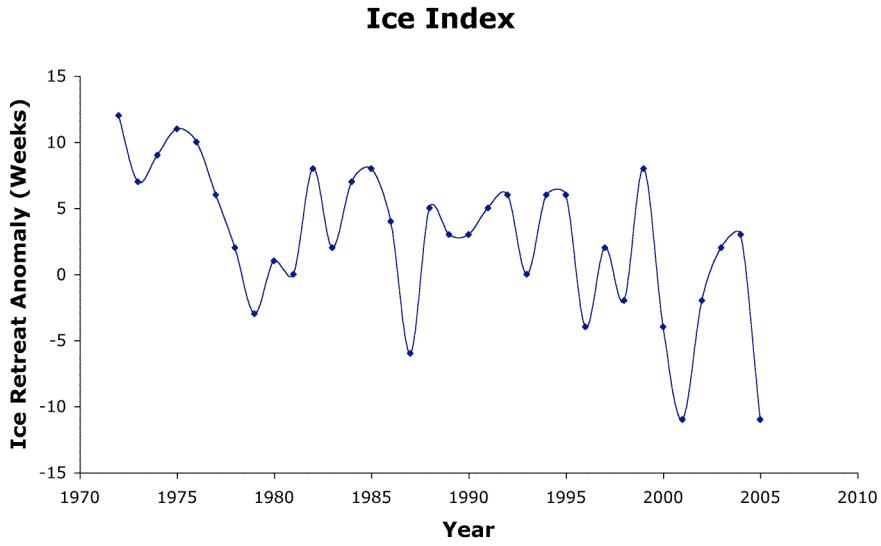
Predict

NPCREP took initial steps to develop an ecosystem approach to management that includes climate. These steps for FY 2005 were to

- Develop and refine ecosystem indicators.

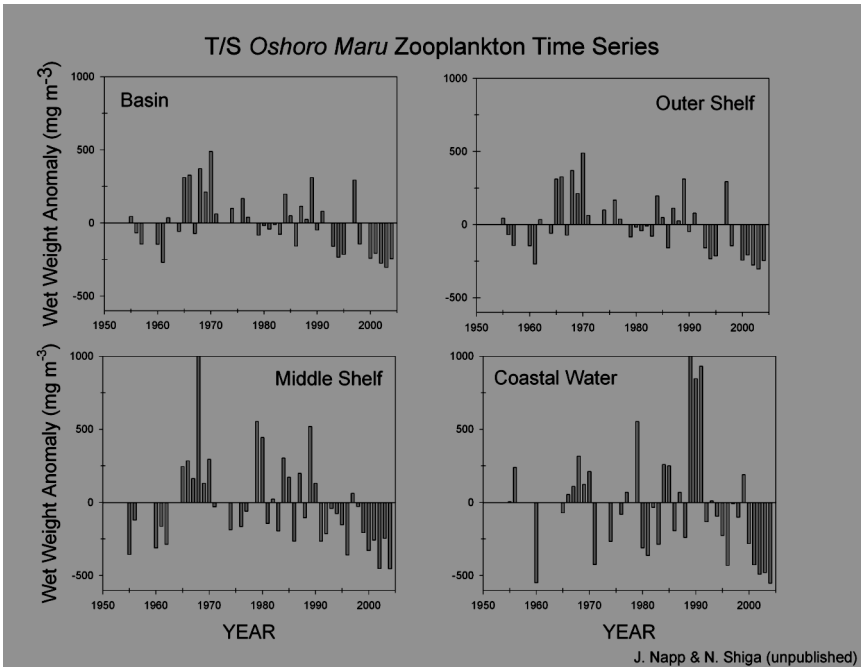
NPCREP developed a new sea ice index. To better predict changes in the ocean temperature, salinity, the timing of the spring bloom and ecosystem structure, we are using an index of the timing of ice retreat over the southern shelf. Sea ice cover, a

defining characteristic of any Arctic system, is decreasing in duration and concentration over the Bering Sea shelf. Reliable measurements of ice concentrations began in 1972 with the advent of satellite imagery. NPCREP has analyzed ice images to develop an index of ice retreat, shown below. We focused on the band stretching from the Alaskan



coast to the shelf break and from 57°N to 58°N. Specifically, we defined ice retreat as the latest week during the winter or spring that ice concentration fell below 10% within this band. Because mid March is a critical time in the relationship between sea ice and productivity, the index is the number of weeks before (negative) or after March 15 that the ice retreat occurred. If ice concentrations never exceeded 10% during the year, then the index is set at -11. Such changes in the physical environment are capable of reorganizing the ecosystem, and there is evidence that this ecosystem is changing. For instance, certain cold-water species (e.g., Greenland turbot and certain amphipods) are no longer found in great numbers in the southern Bering Sea. There has been a shift from the northern Bering Sea to the Chukchi Sea in the central feeding location of the grey whale and a decline in the productivity and overall abundance of benthic standing stock over the northern Bering Sea. One of the direct impacts of the impact of ice on the ecosystem is at the base of the food web. If ice is present after mid March, then an ice-associated phytoplankton bloom occurs, otherwise, the bloom occurs in May or June. An early bloom supports benthic communities, while a later bloom supports pelagic communities. Thus, the timing of ice retreat plays an immense role in the structure of the food web.

The program developed a second new index during FY 2005. Under NPCREP sponsorship, we updated the T/S *Oshoro Maru* summer Bering Sea zooplankton time series and transformed it into a zooplankton anomaly time series that is shown on the next page. This ecosystem indicator was delivered to AFSC in time for inclusion in the annual Ecosystems Consideration chapter. Of particular concern to us are the recent declines in zooplankton biomass that led to five straight years of negative zooplankton biomass anomalies. This decline is coincident with the recent warming of the eastern Bering Sea. The time series (expressed as biomass rather than biomass anomaly) was



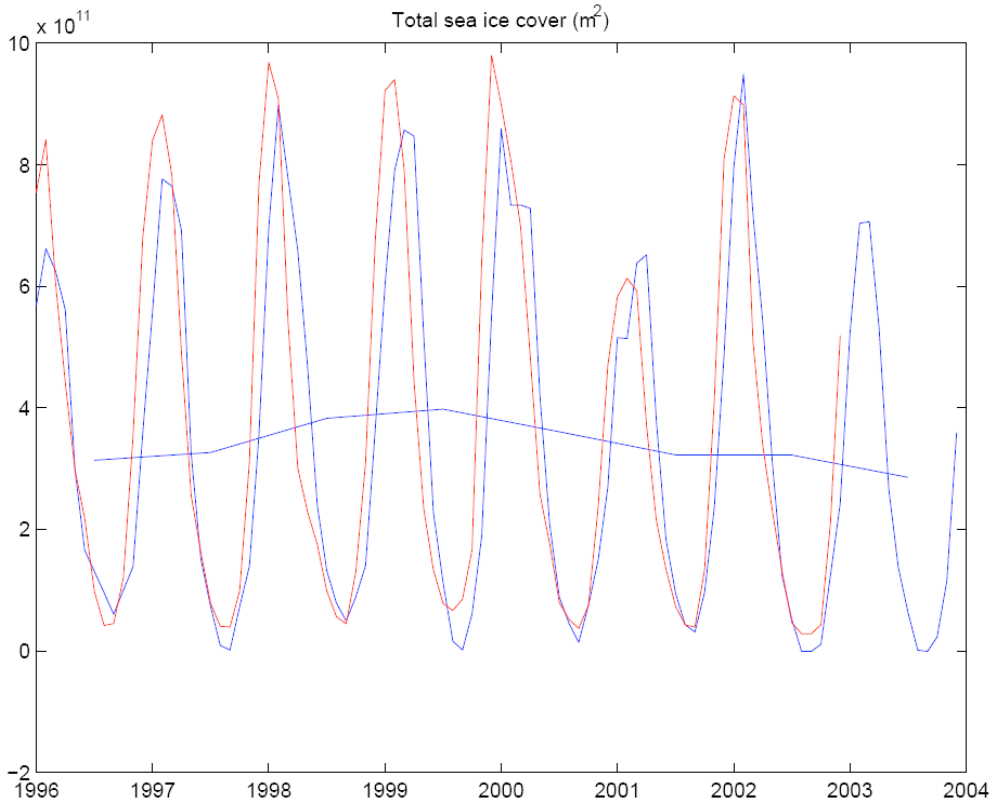
also used in a manuscript submitted to the special issue of Progress in Oceanography reserved for articles focusing on climate variability and the ecology of subarctic seas (GLOBEC – ESSAS). Support from NPCREP is acknowledged in that manuscript.

FY 2005 MILESTONE: Develop two new indices that demonstrate how changes in ocean productivity are linked to climate variability.		
Index	**Range**	**Significance**
Ice retreat index	**±15**	**Ocean temperature, salinity, timing of the spring bloom and ecosystem structure**
Bering zooplankton anomaly	**~±1000**	**General ecosystem health indication of food available for living marine resources**

NPCREP is in the process of completing a recruitment action through the Joint Institute for the Study of Atmosphere and Ocean (JISAO) to hire a scientist to develop aggregate indices and ecosystem metrics. The scientist will expand and improve on AFSC's Ecosystem Considerations chapter of the SAFE. At the time of this writing, applicants had been screened, and the short-listed candidates were interviewed by phone. We are awaiting their letters of recommendation before making our choice. This position will be the lead in developing new indices and to refine our present list of indicators. The position is funded by our FY 2005 and FY 2006 appropriations.

- Begin modeling.

The modeling component of NPCREP is developing a circulation model for the Bering Sea that will permit examination of ecosystem processes involving sea ice. The model uses a 10-km resolution that spans the entire Bering Sea. This fine-scale model is nested within two broader-scale models of the same type spanning the entire North Pacific Ocean. The model is based on the Regional Ocean Modeling System (ROMS), a primitive equation, free-surface model constructed with curvilinear-orthogonal horizontal coordinates and stretched vertical coordinates (utilized for enhanced resolution of both surface and bottom boundary layers). The Bering Sea model has been expanded to include ice dynamics. It is running in hindcast mode, driven by NCEP winds and heat fluxes, with corrections to the NCEP shortwave flux based on meteorological mooring data from the Bering Sea. We have developed model hindcasts (red lines, below) for the



period 1996-2003 that do an excellent job of capturing the observed (blue lines) interannual variability of ice cover in the Bering Sea. Recently we completed hindcasts for 1960-1970. Related simulations have been used for Lagrangian tracking of fish larvae. A finer-scale (3-km) version of the Bering Sea model will be developed in the coming year, contingent on the availability of funds. This newer version will include tidal dynamics.

NPCREP is in the process of completing a recruitment action through JISAO to hire a modeler. At the time of this writing, applicants had been screened, and the short listed

candidates were interviewed by phone. We are awaiting their letters of recommendation before making our choice. This position will be the lead in developing our first prediction or assessment model that incorporates climate. The position is funded by our FY 2005 and FY 2006 appropriations.

Advise and inform

The target audience for results from NPCREP research is the members and committees of the North Pacific Fishery Management Council. NPCREP provided essential information on climate and ecosystems to the council and other stakeholders during FY 2005.

- Improve climate-ecosystem advice to the North Pacific Fishery Management Council.

NPCREP personnel participated in a spring 2005 discussion of products for this year's Ecosystems Considerations chapter of the Stock Assessment and Fishery Evaluation (SAFE) report. During the summer and fall, NPCREP contributed climate/ecosystem indices and discussion to the SAFE chapter. To streamline the flow of information between NPCREP and the council, a council liaison was established through Diana Stram, Plan Coordinator for the council staff and member of three of the four Plan Teams. In the spring, Diana informed the council's Ecosystem Committee about NPCREP, increasing Council understanding and interest about on-going initiatives and how they are related to stock assessments and management. NPCREP's directors are invited to speak to the council's Science and Statistical Committee during February 2006.

- Develop an NPCREP website.

During FY 2005, AFSC and PMEL undertook a complete makeover of the FOCI website, including addition of dedicated NPCREP pages. The makeover is still in progress, and the NPCREP link and target are viewable through the PMEL Intranet at *http://corona.pmel.noaa.gov/~sullivan/ecofoci/*.

- Support the Bering Climate web site *http://www.beringclimate.noaa.gov/*.

NPCREP provided partial support for the scientist who maintains the Bering Climate web site.

- Begin development of a Gulf of Alaska climate web site.

The Bering Climate web site (see above) proved to be popular with the North Pacific Fishery Management Council, and last year the council requested a similar tool for the Gulf of Alaska. During FY 2005, NPCREP held discussions with the Bering Climate web master to plan development of a Gulf of Alaska Climate site during the coming year.

CHALLENGES

During FY 2005, NPCREP experienced challenges in accomplishing these tasks. Mentionable among these were the following

- Stable level of funding and adequate ship time.

When NPCREP was approved as a NOAA project under the Climate Goal, there was a plan to increase finances annually to an ultimate level that would allow for deployment of a complete observing system and development of area-wide ecosystem forecasts to

benefit the North Pacific Fishery Management Council. Even without funding increases, NPCREP activities have needed subsidies from other programs. For example, in 2005, NPCREP was only able to supply two of the four needed biophysical moorings for the Bering Sea. NPCREP's planned funding increases are no longer on schedule, forcing personnel to spend more time in search of additional funds through the proposal process.

Similarly, access to ships to fulfill NPCREP objectives has been an ongoing difficult process. NPCREP provides no ship time, and we must piggyback on cruises funded by other sources. This year, NPCREP was unable to conduct a planned fall ichthyoplankton survey because one of the ship time suppliers, OAR, was unable to provide September ship time. NPCREP was able to participate on 97 sea days during FY 2005. About 40 more sea days are needed to meet NPCREP's field objectives.

- New technology to achieve real-time reporting of *in situ* observations.

NPCREP is actively working to apply advanced sampling technologies in our program. One such technology is satellite remote communications with our moored instruments. Using leveraged IOOS funds from NMFS S&T, we contracted with an engineering firm to design a system for remote communication with our underwater moored instruments. The design was bench tested over the summer, and late in the fiscal year, a field test was accomplished in Lake Washington. Pending the full results of that test, we plan to do our pilot program in the spring of 2006 from M2 in the southeastern Bering Sea. The first two data streams to be transmitted in near real time will be temperature and zooplankton acoustic returns. Once successful, this will be a giant step for our remote measurements, enabling us to supply data products to our stakeholders in near real time.

FY 2006 Plans

STATEMENT OF WORK

North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) will help the United States understand how varying climate conditions affect marine ecosystems of the North Pacific Ocean. It is NPCREP's mission to conduct research on climate variability and ecosystem response in the North Pacific, focusing initially on the productive waters of the eastern Bering Sea and western Gulf of Alaska. Research will improve scientific understanding and guidance for resource managers. NPCREP has two long-term goals that address its mission. The first goal is to observe, understand and predict relationships between climate and ecosystems. The second goal is to aid protection and management of marine resources.

PRIORITIES

For FY 2006, NPCREP has priorities similar to the previous year:

- Continue development of observation network.
- Develop and refine tools to synthesize/integrate large numbers of indices or metrics.
- Increase understanding of mechanisms linking climate and ecosystem productivity.
- Incorporate environmental data into forecast/stock assessment models.

Specifically during 2006, NPCREP will work to accomplish the following tasks, generally classified into broad categories of *observe*, *understand*, *predict* and *advise and inform*.

Observe

NPCREP will preserve and expand the NPCREP portion of existing biophysical observing system to detect climate impacts. Tasks are

- Deploy and recover middle shelf moorings.
- Integrate observations from additional regional (non-NPCREP) sources, e.g., NMFS surveys.
- Initiate observations of the Bering Sea shelf's ice-edge ecosystem.

FY 2006 MILESTONE: Conduct a Bering Sea ice-edge ecosystem study.

- Conduct a pilot summer plankton survey in the Bering Sea.

Understand

For FY 2006, NPCREP will complete a second year to study to achieve a mechanistic understanding of climate-ecosystem interactions. Work elements include

- Continue to study transport of larvae within the shelf.
- Begin to synthesis of effects of eddies on coastal ecosystems.
- Build on the existing conceptual model for the eastern Bering Sea by adding ice-edge processes.

FY 2006 MILESTONE: Expand understanding of the physics of ice edges and the relationships among physical processes and marine resources of the ice-edge ecosystem.

Predict

NPCREP will continue steps to develop an ecosystem approach to management that includes climate. These steps for FY 2006 are to

- Develop and refine ecosystem indicators by forming aggregate indicators with high explanatory capacity.
- Develop "timing of spring bloom" index from 1-dimensional Bering Sea shelf model.

FY 2006 MILESTONE: Develop an index relating Bering Sea climate to the base of the marine food chain.

- On receipt of extra-mural (non-NPCREP) funding, begin NPZ modeling for Bering Sea snow crab.

Advise and inform

The target audience for results from NPCREP research is the members and committees of the North Pacific Fishery Management Council. NPCREP will provide essential information on climate and ecosystems to the council and other stakeholders during FY 2006.

- Deliver real-time climate and ecosystem data to program scientists, NMFS stock assessors, NPFMC and other users through the NPCREP web site.

FY 2006 MILESTONE: Deliver limited real-time information from biophysical moorings via Internet to stakeholders.

- Develop integrated access to currently segregated biological and physical databases.
- Hold discussions with the North Pacific Fishery Management Council to improve climate-ecosystem advice.
- Support the Bering Climate web site *http://www.beringclimate.noaa.gov/* and the to-be-developed Gulf of Alaska Climate web site.

CHALLENGES

During FY 2006, NPCREP expects challenges to accomplishing these tasks. Mentionable among these are the following

- Secure funding support and ship time.
- Integrate climate-ecosystem data from a variety of sources into a single, easy-to-use data tool.

BUDGET $1,777,000

Item	Cost (K$)	
	AFSC	PMEL
Labor	161.1	100.0
Travel	75.0	28.5
Transportation	10.0	15.0
Rent, communications, utilities	0.0	12.0
Printing, reproduction	6.0	15.0
Contracts	72.0	75.0
Supplies, materials	84.4	205.0
Capital equipment	55.0	110.0
Grants	425.0	328.0
TOTAL	888.5	888.5

BUDGET JUSTIFICATION

AFSC Project Costs

Labor ($121.1K): NPCREP funds 1.5 FTEs plus overtime for scientists on all ocean observation system (OOS) and climate processes cruises: These are two spring cruises, one summer and one fall cruise, all to the Bering Sea.

Travel ($72.2): The majority of NPCREP travel funds will support travel to and from the cruises mentioned above. A smaller fraction will be used for travel to and from scientific meetings. At these meetings researchers will present results from current climate and ecosystem projects and learn what other researchers/institutions are doing in the area of research (e.g. PICES "Mechanisms of climate and human impacts" and the GLOBEC "Climate Variability and Ecosystem Impacts in the North Pacific Ocean" symposium).

Transportation ($10.0K): Funds are necessary to transport equipment and samples between Seattle and Alaska for our OOS and process cruises and between Seattle and Poland for plankton sample processing.

Printing/Reproduction ($6.0K): A small amount of funding is reserved to pay for publication costs of manuscripts that are relevant to climate and ecosystems.

Contracts ($72.0K): Funds for contracts will support verification of zooplankton samples processes in Poland, archival of ichthyoplankton samples at UW and other miscellaneous expenses associated with our climate and ecosystems research.

Supplies/Materials ($84.4 K): These funds will be used to purchase expendable supplies in support of the OOS cruises and laboratory work. This includes, but is not limited to: bottles, preservatives, sample labels, filters, chemicals, nets, sieves, etc.

Capital Equipment ($15.0K): Equipment funds will be used to complete the building of two portable winch systems for use collecting zooplankton from charter fishing vessels on the summer AFSC Bering Sea groundfish survey.

Grants ($425.0K): These funds will be used to support:

- Extend the term of (1) UW-JISAO Research Associate working on climate/ecosystem aggregate indices to two full years.
- Extend (1) the term of (1) UW-JISAO Research Associate working on incorporating climate indices into ecosystem and population models to two, full years.
- Support (2) UW-JISAO employees who work with the AFSC Food Habits group and generate the data for a fisheries predator-prey time series in the Bering Sea.
- Support the NOAA Joint Studies Agreement with the Polish Plankton Sorting and Identification Center to process all ichthyo- and zooplankton samples collected by NPCREP.

PMEL Project Costs

Labor ($100.0K): Salary (salary+benefits+overhead) is requested for mooring support (designing, building, deploying and recovering of moorings, and for preparing the equipment). Moorings are deployed in the spring, recovered and redeployed in the fall with new equipment.

Travel ($28.5K): The majority of NPCREP travel funds will support travel to and from the mooring cruises and the three process cruises ton that PMEL scientists will participate. A smaller fraction will be used for travel to and from scientific meetings and workshops. At these meetings researchers will present results from current climate and ecosystem projects and learn what other researchers/institutions are doing in the area of research (e.g. Advances in Ecosystem Modeling Symposium).

Transportation ($15.0K): Funds are necessary to shipping equipment, mooring hardware and samples between Seattle and Alaska for cruises.

Rent, communications, utilities ($12.0K) Most of these funds are for computer charges – connection ot the laboratories commuter network

Printing/Reproduction ($15.0K): These charges are to support publication of articles in scientific journals.

Contracts ($75.0K): Funds for contracts will support NPCREP web page development and support one-person part time for cruise coordination (cruise instructions, cruise reports, cataloguing/managing the cruise archival system). This also includes the cost for calibration of various instruments. This also includes Argos charges.

Supplies/Materials ($205.0K): These funds will be used to purchase hardware for moorings, cables for the towed vehicle and satellite-tracked drifters. This includes preparation costs for equipment to deployed on moorings and on the ship's sea chest (e.g. batteries, seals, paint, chemicals, labels, storage and shipping containers, etc.).

Capital Equipment ($110.0K): The majority of these funds are for replacement of damaged or lost instruments deployed on moorings, and for purchase of new instrumentation as it becomes available. Some funds will be for new equipment needed on our towed vehicle (U-Tow) and for modifications to the FOCI CTD.

Grants ($328.0K): These funds will be used to support UW-JISAO Research Associates to improve/maintain the PMEL/FOCI database, cruise and program web pages, process data and develop climate indices. Research associates will also participate on research cruises, attend scientific meetings and publish results in scientific journals. Some of these funds will support a modeler for the hydrodynamic (ROMS with sea ice) model for the Bering Sea.