

FY 2006 Accomplishments and FY 2007 Plans

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FY 2006 Accomplishments

In the broadest terms, North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) in FY 2006 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.

NPCREP works with other NOAA marine research programs such as Fisheries-Oceanography Coordinated Investigations under the banner of EcoFOCI (Ecosystems & Fisheries Oceanography Coordinated Investigations). Many NPCREP accomplishments are leveraged by activities within other EcoFOCI sectors.

PRIORITIES

For FY 2006, NPCREP had the following priorities:

- Continue development of the EcoFOCI 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.

ACCOMPLISHMENTS

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

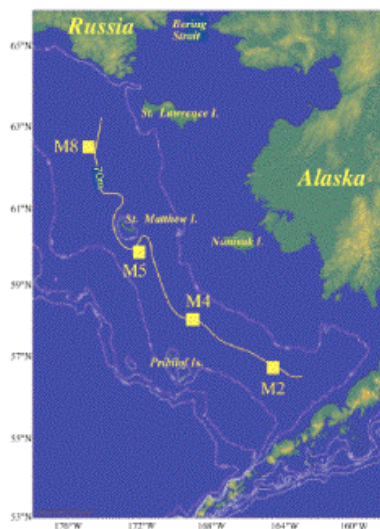
Observe

NPCREP preserved and expanded the NPCREP portion of EcoFOCI's existing biophysical observing system to detect climate impacts. Tasks were

- Deploy and recover middle shelf moorings.

With the help of EcoFOCI partners, NPCREP began the second year of monitoring with four biophysical moorings on the Bering Sea middle shelf along the 70-m isobath.

EcoFOCI Bering Sea middle shelf monitoring sites. Biophysical measurements are made from an array of moorings on the middle shelf. During ship operations, supporting measurements are made near the moorings and along the 70-m isobath.



bath. These moorings were turned around (recovered and redeployed) in April 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 all of M8, all of M2 except nitrate measurements, and half of M4 and M5. NPRB provided the funds for the nitrate sensor and the remaining costs for M4 and M5. All ship time was provided by NPCREP and FOCI on integrated cruises. Most equipment used on the moorings was funded by non-NPCREP EcoFOCI projects. In addition, zooplankton was sampled at the moorings and along the 70-m isobath in the spring and fall of 2006.

Away from the Bering Sea, EcoFOCI maintained four moorings across Amukta Pass in the Aleutian Islands, three moorings across Shelikof Strait, Gulf of Alaska, and two moorings in Southeast Alaska at Cross Sound and Chatham Strait. These are FOCI- and AOOS-funded expansions to the observing system that will benefit NPCREP.

- Integrate observations from additional regional (non-NPCREP) sources, e.g., NMFS surveys.

NPCREP continues to work with other research programs in the region to share and integrate data sets. The Alaska Ocean Observing System and North Pacific Ecosystem Metadata Database were prime partners during the year.

- Initiate observations of the Bering Sea shelf's ice-edge ecosystem.

FY 2006 MILESTONE: Conduct a Bering Sea ice-edge ecosystem study. (Completed Q3).

This milestone was completed from April 12 through May 13, 2006, when NPCREP personnel participated in an expedition to the edge of seasonal ice in the Bering Sea (<http://www.pmel.noaa.gov/foci/ice06>). Two vessels, NOAA ship *Miller Freeman* and R/V *Thomas G. Thompson*, cooperated in addressing goals to measure the physical and chemical properties (temperature, salinity, nutrients) of sea ice and water, to sample phytoplankton and zooplankton and examine their role in the food web, to map fish abundance at the ice edge using hydroacoustic methods, and to observe the birds and mammals that need the spring ice environment for their existence and reproduction. EcoFOCI personnel from AFSC and PMEL were joined by other AFSC researchers from Seattle, including personnel from the National Marine Mammal Laboratory, and Auke Bay, and by scientists from the University of Washington, University of Alaska and Duke University. Two Native Alaskans and one Russian scientist participated in marine mammal projects. Operations were documented by a journalist and a photographer from the Seattle Times and by Summerhays Films. Cruise reports for each vessel may be found at http://www.pmel.noaa.gov/foci/operations/2006/MF0605/MF0605_rpt.pdf and http://www.pmel.noaa.gov/foci/operations/2006/TN193/TN193_Cruise_Rept_F.pdf. Table 1 presents a summary of operations and samples collected.

NORTH PACIFIC CLIMATE REGIMES AND ECOSYSTEM PRODUCTIVITY

Surveying the Bering Sea ice edge. *Clockwise from upper left:* Observing the ice-edge marine ecosystem from buoys, ships, and in-water exploration by divers and ship-mounted platforms provides scientists with information to aid understanding of environmental structure and processes. Knowing the linkages between climate, weather, the microscopic base of the food chain, fish, birds, and marine mammals ultimately will enable development of ecosystem forecast models to optimize and maintain strategic supplies of commercially valuable fish, such as walleye pollock (*center*).

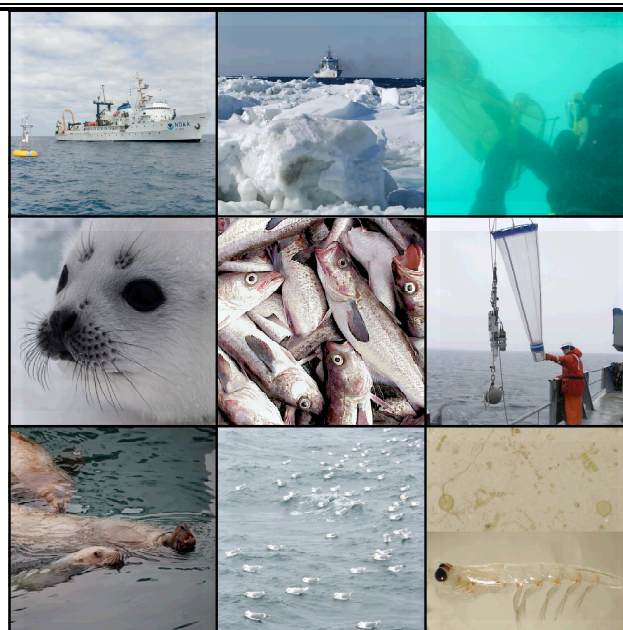


Table 1. Summary of operations and samples collected during the ice expedition.

Sample	Freeman	Thompson
SeaCat CTD casts		122
Seabird CTD casts	40	110
20/60 cm bongo tows	1	95
Moorings recovered	10	
Moorings deployed	12	
Satellite-tracked drifters deployed		4
Salinity samples	38	
Seawater samples preserved using Lugol's solution		30
Chlorophyll samples	207	671
Nutrient samples, PMEL	211	951
Nutrient samples, UAF	197	
Stimulated fluorescence collected during CTD casts		112
Collection of live organisms for experiments		12
Alkalinity from CTD bottles		126
Dissolved inorganic carbon		78
Photosynthetically Active Radiation data collected during CTD casts	40	111
Phytoplankton samples collected from CTD casts and preserved in formalin		20
Quantitative tows preserved in formalin		261
Rough count of pollock larvae		42
Method tows	6	
CalVET tows		6
Ice cores		9
Hydroacoustic lines, km	~1000	
Diving operations	2	
Towed vehicle deployments	3	
Bird and cetacean observations, track-lines, km	453	3008
Birds observed	2277	21949
Cetaceans observed	10	48
Seals observed		759
Seals instrumented with data recorders		18

Information collected during the ice expedition will be part of the focus for this coming year's research to expand understanding of the physics of ice edges and the relationships among physical processes and marine resources of the ice-edge ecosystem.

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

NPCREP scientists took part in a summer survey of plankton in the Bering Sea. The survey was conducted by the Hokkaido University Fisheries Training Ship *Oshoro-maru* from June 19th to June 26th.

Predict

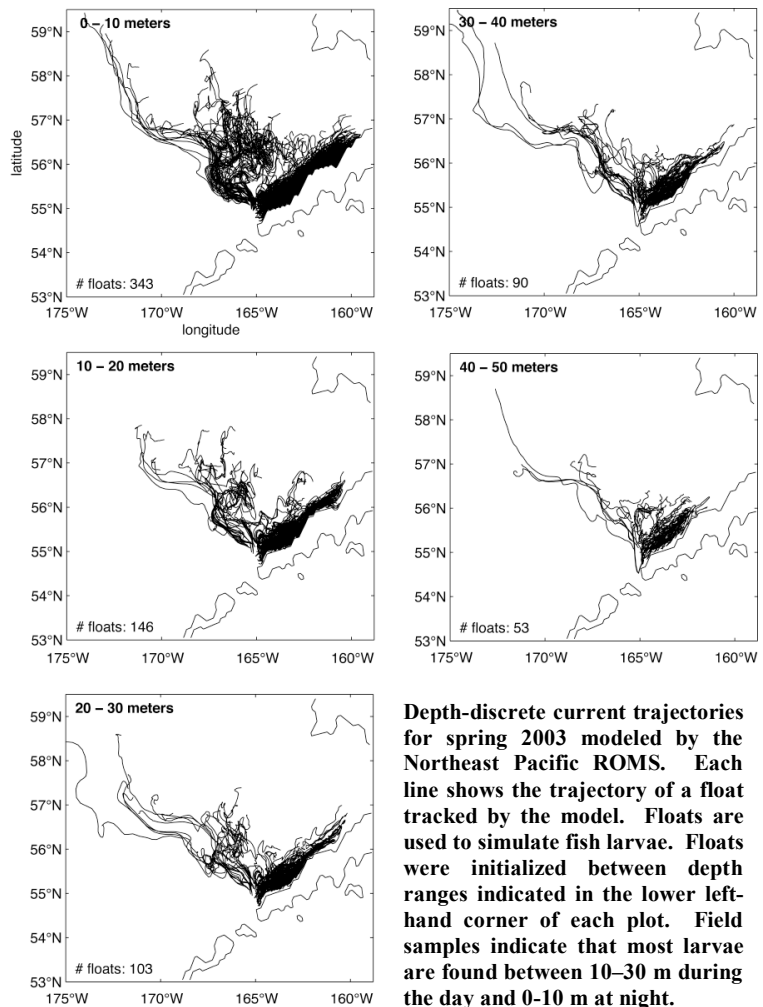
NPCREP continued steps to develop an ecosystem approach to management that includes climate. The primary accomplishment for FY 2006 was to

- Incorporate effects of climate into living marine resource assessments for the Bering Sea.

**FY 2006 MILESTONE:
Begin development of a model to incorporate the effects of climate into living marine resource assessments for the Bering Sea. (Completed Q2)**

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This milestone was fully accomplished by the end of the 2nd quarter of FY 2006. NPCREP is assembling components for a Bering Sea ecosystem forecast model that incorporates effects of changing climate. Basic components are a physical hydrodynamic model of ocean circulation, temperature and salinity, and biological models for trophic levels, species and processes. For FY 2006, a team of NPCREP and AFSC assessment scientists integrated larval fish biology into a Bering Sea Regional Ocean Modeling System (ROMS) hydrodynamic model to assess transport of an economically important flatfish from the Bering Sea – northern rock sole. Transport of larvae to particular nursery areas is hypothesized



Depth-discrete current trajectories for spring 2003 modeled by the Northeast Pacific ROMS. Each line shows the trajectory of a float tracked by the model. Floats are used to simulate fish larvae. Floats were initialized between depth ranges indicated in the lower left-hand corner of each plot. Field samples indicate that most larvae are found between 10–30 m during the day and 0–10 m at night.

to determine the likelihood of successful recruitment. The model uses the vertical distribution of rock sole larvae in the water column to determine the effects of interannual and climatic variability on larval trajectories to suitable or non-suitable nursery grounds. This modeling system is available for application to other species with pelagic larvae. Further, the hydrodynamic model has been upgraded to include seasonal sea ice, making it more effective at simulating varying climate conditions.

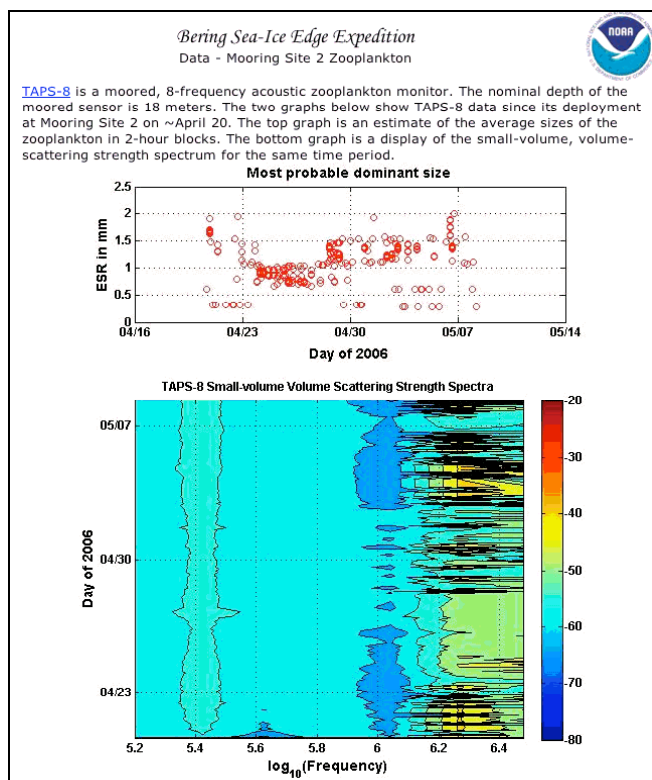
Advise and inform

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 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 bio-physical moorings via Internet to stakeholders. (Completed Q3)

This milestone was accomplished successfully during the 3rd quarter of FY 2006. NPCREP is actively working to apply advanced sampling technologies. One such technology is satellite remote communications with our moored instruments. Last year, 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, and late in FY 2005, a field test was accomplished in Lake Washington. This spring, NPCREP successfully executed a pilot data delivery program from mooring site M2 and the UNOLS R/V *Thomas G. Thompson* during an ice-edge expedition to the southeastern Bering Sea. Data products from both sources were delivered to a wide audience via the Internet on the expedition's web site at <http://www.pmel.noaa.gov/foci/ice06/>. The first products to be transmitted in near real



Real-time product delivery via Internet. In spring and summer 2006, NPCREP successfully telemetered zooplankton data from mooring site M2 in the Bering Sea and displayed it through the Internet as a data product.

time were M2 temperature and salinity at 1 m and 17 m depth and zooplankton acoustic returns from 18 m. Additionally, NPCREP delivered along-track plots of temperature, salinity and chlorophyll/fluorescence from the *Thompson*. Presently, NPCREP is migrating its Internet delivery to PMEL's web farm, and our information service has been interrupted to meet national IT security requirements. We anticipate that service will resume in spring FY 2007, when a surface buoy is installed again at M2.

- Develop integrated access to currently segregated biological and physical databases.

AFSC and PMEL still do not have on-line access to each other's databases. We are hoping that future computer security designs will enable us to begin development of a one-stop web interface that will permit access to and manipulation of biological and physical data.

- Hold discussions with the North Pacific Fishery Management Council to improve climate-ecosystem advice.

NPCREP's directors, Jeff Napp and Phyllis Stabeno, met with the Science and Statistical Committee (SSC) of the North Pacific Fishery Management Council in February 2006. They provided an overview of projects funded through NPCREP. These include monitoring efforts in the Bering Sea to continue and expand existing time series such as Mooring 2 on the southeastern Bering Sea shelf, statistical approaches to develop and refine aggregate ecosystem indices for the Bering Sea and Gulf of Alaska, attempts to incorporate such indices into stock assessments, and a project to make real-time data available to stakeholders through the Internet. The SSC was impressed with the range of modeling activity conducted by EcoFOCI researchers and recognized the value of these models for incorporating observations and producing indices of physical processes (such as transport or mixing processes) and biological indices such as recruitment indices for pollock or flatfish. The SSC expressed concerns over the adequacy of data used to parameterize and tune models, or for "ground truthing" existing and new models. Like all models, these models are only as good as the data going into them. Thus, there is a critical need to maintain existing time series to verify models and to collect new data as needed. Also, there is a need for additional field studies on the biology, life history, and ecology. The SSC felt that improved coordination between modelers, field researchers and the user community is required to improve physical and lower trophic level models and increase their utility in a management context. For example, existing models should be used to inform new scientific programs, such as BEST.

- Support the Bering Climate web site <http://www.beringclimate.noaa.gov/> and the to-be-developed Gulf of Alaska Climate web site.

NPCREP again supported the Bering Climate web site. Discussions held the previous year about development of a parallel site for the Gulf of Alaska have not yielded results. Funding for this position is no longer available.

CHALLENGES

During FY 2006, NPCREP was challenged to meet its four originally declared milestones. Mentionable among these challenges are the following

- Secure funding support and 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 2006, NPCREP was only able to supply three 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. NPCREP received about \$0.5M less than budgeted during FY 2006. This forced a revision of milestones from the original four declared in last year's Accomplishments and Plans report

- 1) Conduct a Bering Sea ice-edge ecosystem study.
- 2) Expand understanding of the physics of ice edges and the relationships among physical processes and marine resources of the ice-edge ecosystem.
- 3) Develop an index relating Bering Sea climate to the base of the marine food chain.
- 4) Deliver limited real-time information from biophysical moorings via Internet to stakeholders.

to the three milestones highlighted in this report.

Similarly, gaining access to research ships to fulfill NPCREP objectives has been an ongoing difficult process. NPCREP provides no direct ship time, and we must rely on NOAA integrated FOCI and NPCREP cruises, and piggyback on cruises funded by other sources.

- Integrate climate-ecosystem data from a variety of sources into a single, easy-to-use data tool.

Developing and refining Ecosystem Approach to Management and Recruitment Prediction require scientists to have easy access to geographically registered environmental and biological data through cross-LO data retrieval systems with common front ends that search separate databases in real time and return data to users in standard format. Presently, separate IT security requirements of the two line offices have prevented development of such a system in Seattle between AFSC and PMEL. Recognition of the need and problem at the highest levels of respective LOs would encourage IT Administrators to work with program scientists to develop common access to relevant data without compromising NOAA IT systems. Benefits include faster development of new recruitment forecast methods, stock assessments that include ecosystem information and faster delivery of data to stakeholders, including IOOS. This issue has been recommended by NPCREP for an upcoming workshop to better coordinate OAR and NMFS research endeavors.

FY 2007 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 2007, NPCREP has priorities similar to the previous three years:

- 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 2007, NPCREP will work to accomplish the following tasks, generally classified into broad categories of *observe*, *understand*, *predict* and *advise and inform*.

Observe

NPCREP monitors changes in coastal and marine ecosystems through a network of *in-situ* and remote observing systems. For FY 2007, NPCREP will continue the NPCREP portion of EcoFOCI's existing biophysical observing system to detect climate impacts. Tasks are

- Continue climate and ecosystem monitoring.

FY 2007 MILESTONE: Continue NPCREP's climate and ecosystem observing network.

NPCREP will maintain the number and functionality of biophysical moorings, drifters, ship surveys, remote sensing activities and observations of upper ocean physics and biology. If budget increases are realized, NPCREP will add an additional research cruise to the eastern Bering Sea in the fall of 2007 to observe the evolution of the cold pool and its front with respect to distribution of young-of-the-year walleye pollock. Extra funding also would permit NPCREP to expand real-time data delivery from the Bering Sea shelf biophysical mooring at site M2 to include near-bottom temperature and salinity, and to deliver real-time zooplankton acoustic observations from site M4. Project performance will be measured by successful deployment and recovery of moorings, deployment of drifters, completion of all planned cruises, and delivery of real-time data to stakeholders via the Internet.

NORTH PACIFIC CLIMATE REGIMES AND ECOSYSTEM PRODUCTIVITY

- Integrate observations from additional regional (non-NPCREP) sources, e.g., NMFS surveys.
- Continue observations of the Bering Sea shelf's ice-edge ecosystem.
- Conduct a summer plankton survey in the Bering Sea.

Understand

For FY 2007, NPCREP will complete a fourth year of study to achieve a mechanistic understanding of climate-ecosystem interactions. Work elements include

- Continue to study transport of larvae within the shelf.
- Continue 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 2007 MILESTONE: Develop mechanistic understanding of ice-edge ecosystem processes.

NPCREP will synthesize results from spring 2005 and spring 2006 ice-edge cruises to develop mechanistic understanding of ice-edge ecosystem processes. NPCREP will examine the formation of frontal structure from ice melt and the resulting division of the eastern Bering Sea shelf into subarctic and arctic communities. Results of spring and summer hydroacoustic and groundfish surveys will be incorporated into the analyses. Project activity will be summarized in an NPCREP seminar "Climate Forcing in the Marginal Ice Zone of the Eastern Bering Sea" to be given at NOAA Headquarters by 30 June 2007.

Predict

NPCREP develops biophysical indicators and models that meet the needs of marine resource managers to adapt to predicted climate-induced changes in coastal and living marine resources. In FY 2007, NPCREP will continue steps to develop an ecosystem approach to management that includes climate.

- Continue to develop and refine ecosystem indicators by forming aggregate indicators with high explanatory capacity.
- Produce a Bering Sea ecosystem forecast to guide the North Pacific Fishery Management Council.

FY 2007 MILESTONE: Conduct a "Bering Sea Ecosystem Forecast" workshop to produce an ecosystem forecast.

NORTH PACIFIC CLIMATE REGIMES AND ECOSYSTEM PRODUCTIVITY

NPCREP and AFSC's Resource Ecology and Ecosystems Modeling (REEM) Program jointly will conduct a Bering Sea Ecosystem Forecast workshop. Participants will use current-year climate and ecosystem observations to forecast general ecosystem status and potential impacts to specific living marine resources of the eastern Bering Sea. This forecast will be incorporated into the Ecosystems Considerations chapter of the SAFE documents and delivered to the NPFMC by 30 September 2007. If budget increases are realized, NPCREP also will hire a joint institute post-doctoral fellow to begin work on methods of incorporating climate data into population assessments. Issue of a workshop report and delivery of a timely forecast to NPFMC, as well as successful recruitment of a qualified individual to accomplish the assessment project, provide measures of performance.

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 2007.

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

CHALLENGES

During FY 2007, NPCREP expects challenges to accomplishing these tasks. Mentionable among these are the following

- Adequate and stable funding
- Adequate ship time.

BUDGET \$1,984,000

Item	Cost (K\$)	
	AFSC	PMEL
Labor	302.9	250.0
Travel	110.0	55.0
Transportation	10.0	17.0
Rent, communications, utilities	0.0	40.0
Printing, reproduction	6.0	10.0
Contracts	100.0	10.0
Supplies, materials	80.1	160.0
Capital equipment	35.0	100.0
Grants	348.0	350.0
TOTAL	992.0	992.0

NORTH PACIFIC CLIMATE REGIMES AND ECOSYSTEM PRODUCTIVITY

BUDGET JUSTIFICATION

AFSC Project Costs

Labor (\$302.9K): NPCREP funds 2.5 FTEs (salary and benefits) plus overtime for scientists on all ocean observation system (OOS) and climate processes cruises. Planned for FY07 are one winter cruise, two spring cruises, one summer and two fall cruises, all to the Bering Sea. This is two more cruises than was accomplished during FY 2006

Travel (\$110.0): The majority of NPCREP travel funds will support travel to and from the six 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 and institutions are doing in the area of research.

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 (\$100.0K): Funds for contracts will support verification of zooplankton samples processes in Poland, archival of ichthyoplankton samples at UW, two outside researchers working on issues relevant to climate and life histories of fishes, and lease of flow cytometer time at UW for a project investigating starvation by fish larvae in ice and non-ice years.

Supplies/Materials (\$80.1K): 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, and flow meters.

Capital Equipment (\$35.0K): Equipment funds will be used to finish assembling two portable winch systems for collecting zooplankton from charter fishing vessels on the summer AFSC Bering Sea groundfish survey, and for obtaining better samplers to work in and around ice in the Bering Sea.

Grants (\$348.0K): These funds will:

- Extend the term of (1) UW-JISAO Research Associate working on climate/ecosystem aggregate indices to two full years.
- Hire a UW-JISAO Research Associate to work on incorporating climate indices into ecosystem and population models.
- 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.
- Pay a UW-JISAO Research Associate to complete a project on categorizing a fish species' vulnerability to climate regimes shifts by examining the attributes of its early life history.

NORTH PACIFIC CLIMATE REGIMES AND ECOSYSTEM PRODUCTIVITY

PMEL Project Costs

Labor (\$250K): NPCREP funds the equivalent of 2.0 FTEs plus overtime for scientists on all ocean observation system (OOS) and climate processes cruises. There are two spring cruises and two fall cruise in 2007, all to the Bering Sea.

Travel (\$55): 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 (e.g., PICES, Alaska Symposium and GLOBEC PI meetings). At these meetings, researchers will present results from current climate and ecosystem projects and learn what other researchers and institutions are doing in the area of research.

Transportation (\$17K): Funds are necessary to transport equipment and samples between Seattle and Alaska for our OOS and process cruises.

Rent, communications, utilities (\$40K): This is used to help support communications at sea, charges for our iridium phone that is used to communicate with the field scientists, and Fed-Ex charges. In addition, connection charges for PMEL's computer network are requested.

Printing/Reproduction (\$10K): A small amount of funding is reserved to pay for publication costs of manuscripts that are relevant to climate and ecosystems.

Contracts (\$10K): Funds for contracts will support miscellaneous expenses associated with our climate and ecosystems research.

Supplies/Materials (\$160 K): These funds will be used to purchase expendable supplies in support of the OOS cruises, moorings and laboratory work. This includes, but is not limited to: bottles, filters, chemicals, mooring hardware, and satellite-tracked drifters.

Capital Equipment (\$100K): Equipment funds will be used to complete the instrumentation of the towed vehicle and to purchase equipment for moorings for the real-time system.

Grants (\$350K): These funds will be used to partially support a number of JISAO scientists, including web master, nutrient chemist, equipment engineer, modelers and sea-going scientists.