FY 2012 Accomplishments and FY 2013 Plans

October 2012

Alaska Fisheries Science Center and

Pacific Marine Environmental Laboratory

FY 2012 Accomplishments

North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) in FY 2012 helped NOAA and 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 on the productive waters of the eastern Bering Sea, Gulf of Alaska, and the Chukchi Sea. The intent of this research is to improve scientific understanding and provide guidance for resource managers on strategies for climate adaptation. 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 help society plan for and mitigate potential impacts of climate change on our living marine resources.

NPCREP is a highly collaborative program that works with other NOAA marine research programs such as Fisheries-Oceanography Coordinated Investigations (FOCI), Ocean Acidification (OA), Bering-Aleutian Salmon International Survey (BASIS), extramurally funded programs such as the Gulf of Alaska Integrated Ecosystem Research Program and Arctic Ecosystem Integrated Survey. This includes programs funded by other Federal partners (BOEM) and involves researchers from a number of institutions such as the University of Washington, University of Alaska, Fairbanks, Oregon State University, and University of Pennsylvania.

PRIORITIES

For FY 2012, NPCREP established the following priorities:

- Maintain long-term observation network
- Increase our understanding of climate change in the Arctic
- Incorporate environmental data into forecast and stock assessment models

ACCOMPLISHMENTS

Specifically during 2012, NPCREP worked to accomplish the following tasks, generally classified into broad categories of *observe*, *understand*, and *predict*.

Observe

FY 2012 MILESTONE: Maintain the NPCREP Climate and Ecosystem Observing Network, and distribute data to our stakeholders.

NPCREP maintained NOAA's only existing Arctic biophysical observing system to detect climate impacts on marine ecosystems in FY 2012. The following tasks were completed:

- Delivered to our stakeholders long-term observations of the Bering Sea using biophysical moorings (M2, M4, M5, M8), and shipboard measurements of physical, chemical, and biological variables important to ecosystem health and to the recruitment of commercial fin- and shellfish stocks of the eastern Bering Sea. This year, 2012, marks the 18th consecutive year of these observations, further strengthening our understanding of both quasi-decadal and annual trends in atmospheric forcing, oceanography and fisheries recruitment in the Bering Sea. It also continues to be one of the only sources of data for physics, climate and lower trophic levels available for an integrated ecosystem assessment.
- NPCREP continues to partner with NOAA/PMEL's Ocean Acidification group to include a pCO_2 sensor in the Arctic on mooring M2. However, the sensor failed before it could be deployed in FY12. We plan to include the sensor next year.

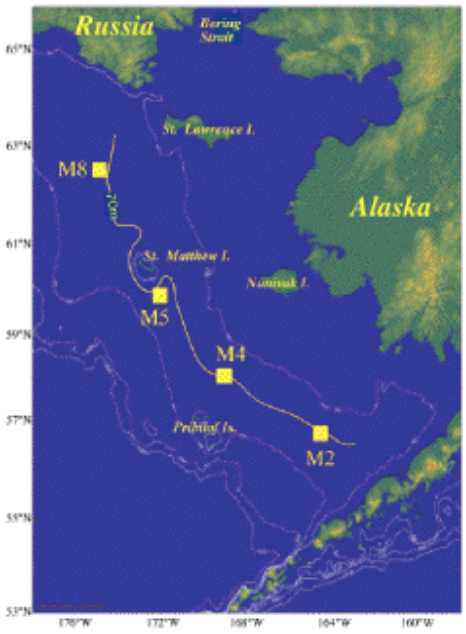

Figure 1. NPCREP's 4 sentinel moorings in the eastern Bering Sea located along the 70m isobath.

Understand

FY 2012 MILESTONE: Increase our understanding of the effect of climate variability on Alaska's Arctic Large Marine Ecosystems

High latitude ecosystems respond to climate change with rapid and fundamental alterations. In 2012, summer sea ice in the Arctic Ocean reached a minimum not observed in recorded history, breaking the previous record low set in 2007. Multiple models predict the complete loss of summer sea ice by the year 2030. NPCREP and its partners have accomplished four distinct research goals in FY 2012 that increase our understanding of climate change in Arctic LMEs:

1. **Characterize ecosystem differences during warm and cold years in the eastern Bering Sea** (Stakeholders = North Pacific Fishery Management Council, North Pacific Research Board, NOAA Alaska Regional Office, university, state and federal agency, NGO scientists).

As part of the BEST-BSIERP programs (http://bsierp.nprb.org/), NPCREP synthesized our knowledge of ecosystem conditions during warm and cold years, in both the northern and southern eastern Bering Sea. Because BEST-BSIERP only sampled "cold" years during their 4-year field season, the synthesis would not have been possible without NOAA's support of previous and current programs such as BS FOCI, SEBSCC and NPCREP. These NOAA programs provided valuable data and interpretation expertise to assemble the hypotheses for what happens in warm and cold years.

The Bering Sea is a subarctic sea and as such sits on the boundary of the Arctic. These high latitude seas are very sensitive to changes in climate. We continue to monitor the Bering Sea through a series of biophysical moorings and research cruises. The data from these sources have been used to examine the changes that have occurred as a result of changing climate and to anticipate what the impacts on the ecosystem would be with the predicted warming. Our results are presented in a series of eleven manuscripts that explore the occurrence of warm and cold years in Bering Sea during the last several decades and their impact on the Bering Sea ecosystem. These papers have been published in the Bering Sea special issue of *Deep-Sea Research II*. NPCREP will also have contributed papers to the second and third special issues.

Bacheler, N.M., L. Ciannelli, K.M. Bailey, and V. Bartolino (2012): Do walleye pollock exhibit flexibility in where or when they spawn based on variability in water temperature? Deep-Sea Res. II, 65-70, 208-216.

De Robertis, A., and E.D. Cokelet (2012): Distribution of fish and macrozooplankton in ice-covered and open-water areas of the eastern Bering Sea. Deep-Sea Res. II, 65–70, 217–229.

Hollowed, A.B., S. Barbeaux, E. Farley, E.D. Cokelet, S. Kotwicki, P.H. Ressler, C. Spital, and C. Wilson (2012): Effects of climate variations on pelagic ocean habitats and their role in structuring forage fish distributions in the Bering Sea. Deep-Sea Res. II, 230–250.

Ladd, C., and P.J. Stabeno (2012): Stratification on the Eastern Bering Sea Shelf revisited. Deep-Sea Res. II, 65–70, 72–83.

Lomas, M.W., S.B. Moran, J.R. Casey, D.W. Bell, M. Tiahlo, J. Whitefield, R.P. Kelly, J.T. Mathis, and E.D. Cokelet (2012): Spatial and seasonal variability of primary production on the eastern Bering Sea shelf. Deep-Sea Res. II, 65–70, 126–140.

Mordy, C.W., E.D. Cokelet, C. Ladd, F.A. Menzia, P. Proctor, P.J. Stabeno, and E. Wisegarver (2012): Net community production on the middle shelf of the Eastern Bering Sea. Deep-Sea Res. II, 65–70, 110–125.

Overland, J.E., M. Wang, K.R. Wood, D.B. Percival, and N.A. Bond (2012): Recent Bering Sea warm and cold events in a 95-year context. Deep-Sea Res. II, 65–70, 6–13.

Smart, T.I., J.T. Duffy-Anderson, J.K. Horne, E.V. Farley, C.D. Wilson, and J.M. Napp (2012): Influence of environment on walleye pollock eggs, larvae, and juveniles in the southeastern Bering Sea. Deep-Sea Res.II, 65-70, 196-207.

Stabeno, P.J., E. Farley, N. Kachel, S. Moore, C. Mordy, J.M. Napp, J.E. Overland, A.I. Pinchuk, and M.F. Sigler (2012): A comparison of the physics of the northern and southern shelves of the eastern Bering Sea and some implications for the ecosystem. Deep-Sea Res. II, 65–70, 14–30.

Stabeno, P.J., N.B. Kachel, S.E. Moore, J.M. Napp, M. Sigler, A. Yamaguchi, and A.N. Zerbini (2012): Comparison of warm and cold years on the southeastern Bering Sea shelf and some implications for the ecosystem. Deep-Sea Res. II, 65–70, 31–45.

Wang, M., J.E. Overland, and P. Stabeno (2012): Future climate of the Bering and Chukchi seas projected by global climate models. Deep-Sea Res. II, 65–70, 46–57.

An additional paper was published in a separate volume:

Danielson, S., E. Curchitser, K. Hedstrom, T. Weingartner, and P. Stabeno (2011): On ocean and sea ice modes of variability in the Bering Sea. J. Geophys. Res., 116(C12), C12034, doi: 10.1029/2011JC007389. [PDF Version]

2. Conduct baseline ecosystem studies in the Chukchi Sea
(Stakeholders = North Pacific Fishery Management Council, BOEMRE, Department of the Interior, Alaska Regional Office, other scientists, coastal communities)

The Chukchi and Beaufort Seas contain part of the U.S. Exclusive Economic Zone (EEZ). At present there is a moratorium on commercial fishing in this region, although there is subsistence harvest of finfish, shellfish, and protected species. NPCREP has begun to study the structure and function of the Chukchi Sea ecosystem to better manage this LME and understand the potential impacts of climate change and associated human activities in the region.

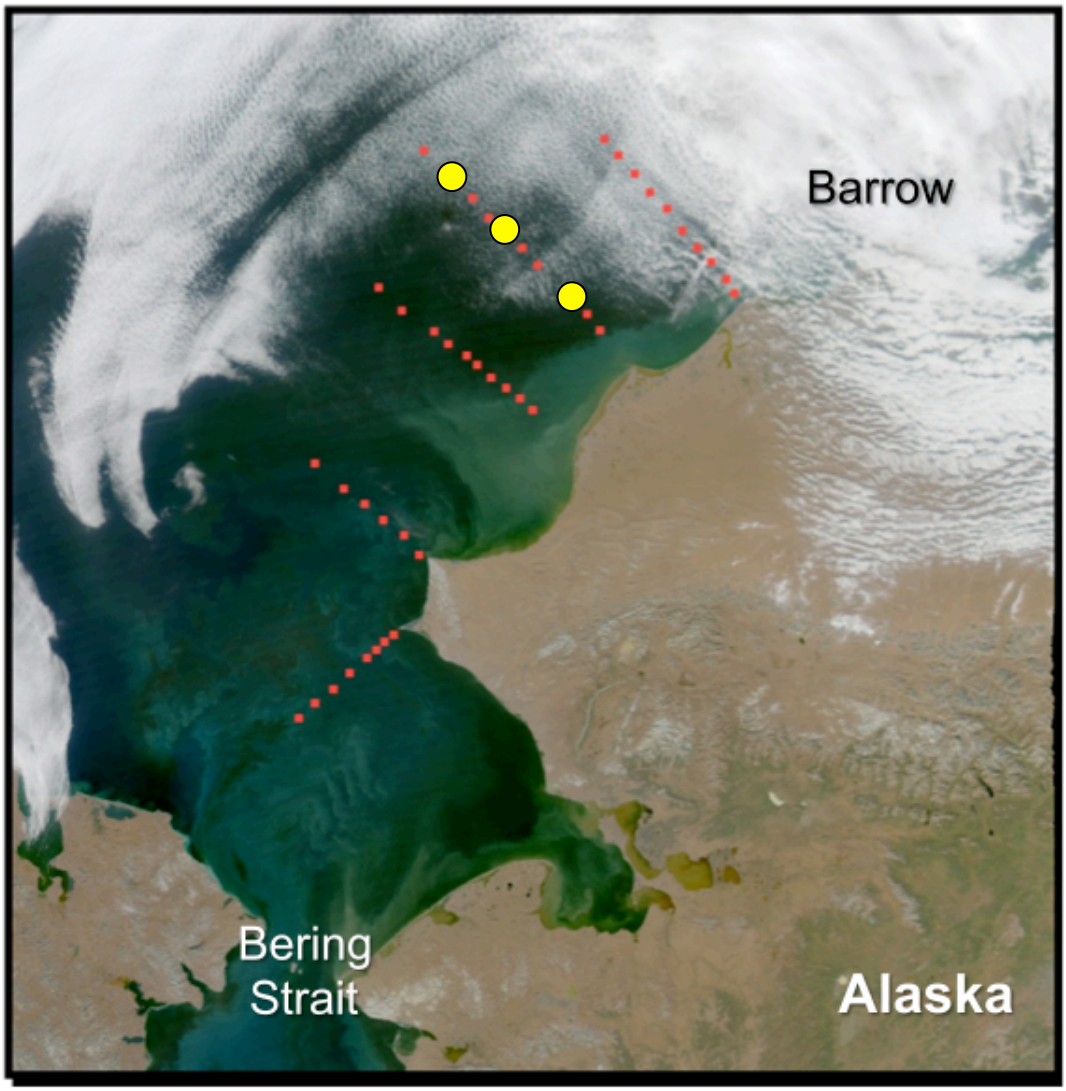

Figure 2. True color satellite image of the Chukchi Sea showing mesoscale variability in ocean color (sediment and chlorophyll). NPCREP survey stations (●), Biophysical moorings (●).

In 2012, we continued the baseline measurement of the physics, chemistry, and plankton biology of the Chukchi Sea off the North Slope of Alaska with support from NOAA and the Bureau of Ocean Energy Management (BOEM; Fig. 2). These studies will provide necessary data for an Arctic Fishery Ecosystem Plan, future environmental impact statements related to oil and gas exploration in the region, and future definitions of critical habitat for protected species that use this region.

In August of FY12, we recovered all moored instruments that were deployed along a cross shelf transect at Icy Cape, and deployed a new mooring at the head of Barrow Canyon to determine the timing and magnitude of intrusions of deep water on to the shelf. Transect lines begun in 2010 at Point Hope, Cape Lizburne, Point Lay, Icy Cape, and Wainwright were repeated to characterize the habitat, and examine inter-annual variability in physical, chemical, and

biological oceanographic properties. We deployed 12 satellite-tracked drifters in August of FY12 to measure near-surface flow (http://www.ecofoci.noaa.gov/efoci_drifters.shtml).

NPCREP successfully built and calibrated two additional active acoustics instruments for deployment on moorings in 2012. This instrument, patterned after the TAPS-6NG (Tracor Acoustic Profiling System), has 6 acoustic transducers between 104 and 735 kHz to detect scattering by euphausiids in a shallow water column (ca. 40 m). The two newly constructed TAPS-6NG instruments were deployed in August 2012; one on the Icy Cape Line and one near the head of Barrow Canyon.

Two mooring sites were occupied in 2012 for the ARCWEST project (see FY13 Milestone below).

3. **Characterize summer and cross-shelf transport of larval fishes in the eastern Bering Sea**
   (Stakeholders = North Pacific Fishery Management Council, North Pacific Research Board, other university, federal and stage agency, and NGO scientists).

We initially characterized summer transport of fish larvae across the outer and middle shelf using 5 years of data collected from the T/S *Oshoro Maru.* During El Niño years, the larval fish assemblage over the shelf included many more offshore species indicating enhanced onshelf transport. A subsequent analysis now includes an additional 5 years, and spans years of warm and cold temperatures. Generalized Additive Model (GAM) analyses indicated that abundances of walleye pollock larvae increased with water column temperature up to 5 °C and then became level; higher abundances of Pacific cod larvae were found in years with the greatest percent sea ice cover. Thus oceanographic conditions, notably temperature and sea ice, have a significant effect on the larval abundances of two commercially important gadid species. This piece of work is still evolving. A draft manuscript was submitted for in house review at the end of FY12.

We continue to examine the cross-shelf transport of a number of larval fish species, comparing and contrasting strategies of late winter/slope spawners with early spring/shelf spawners. Commercial species of interest are Greenland halibut, walleye pollock, Pacific cod, and Pacific halibut. Greenland halibut is an example of a late winter/slope spawner. There have been no directed field studies examining spawning areas and transport of Greenland halibut early life stages in the Bering Sea, nor is it known how large-scale oceanographic forcing modulates specific physical mechanisms of delivery. Results from this project have been accepted for publication to a peer-reviewed journal. Project results from this and other transport projects continue to become available for peer review. For the spring/shelf spawners, one of the interesting results was the transport of eggs to juvenile walleye pollock over the shelf in warm and cold years. In cold years, all of these early stages are found over the Outer Shelf Domain, while in warm years they are found over the Middle Shelf Domain. This differential transport in warm and cold years implies less cross-shelf transport in cold years (assuming that spawning area is fixed) and has large consequences on the types and availability of prey for the larvae.

Examples of Products:

Cooper, D.W., J.T. Duffy-Anderson, Norcross, B, Holladay, B., and Stabeno, P. Northern rock sole (*Lepidopsetta polyxystra*) nursery areas in the eastern Bering Sea. In revision for Marine Ecology Progress Series.

Cooper, D.W., J.T. Duffy-Anderson, W.T. Stockhausen, and W. Cheng (2012): Modeled connectivity between northern rock sole (*Lepidopsetta polyxystra*) spawning and nursery areas in the eastern Bering Sea. J. Sea Res. doi: 10.1016/j.seares.2012.07.001

Duffy-Anderson, J.T., D.M. Blood, W. Cheng, L. Ciannelli, A.C. Materese, D. Sohn, T.C. Vance, and C. Vestfals (2012): Combining field observations and modeling approaches to examine Greenland halibut (Reinhardtius hippoglossoides) early life ecology in the southeastern Bering Sea. J. Sea Res. doi: 10.1016/j.seares.2012.06.014

Parada, C., B. Ernst, S. Hinckley, J.M. Orensanz, D.A. Armstrong, E.N. Curchitser, and A.J. Hermann (2012): Patterns of connectivity and potential settlement regions of snow crab (Chionoecetes opilio) larvae in the eastern Bering Sea. Prog. Oceanogr. [Accepted]

Vestfals, C., L. Ciannelli, J.T. Duffy-Anderson, and C. Ladd (2012): Seasonal and inter-annual variability of along-shelf and cross-shelf transport in the eastern Bering Sea. Deep-Sea Res. II. [In preparation]

4. **Create guidelines for plankton sampling survey design to optimize surveys (minimize the variance) and give scientists the best possible chance of detecting climate-mediated changes in these environments**
   (Stakeholders = NMFS, other scientists)

Sampling efficiency for zoo- and ichthyoplankton is an important goal in this time of shrinking ship budgets. Multiple programs within NMFS engage in plankton sampling either as part of an annual stock assessment or to provide data on ecological factors that affect the recruitment of commercial and protected species. Very few guidelines exist for how these studies should be conducted with reference to number and spacing of stations. Often these are determined solely by logistical considerations (number of vessel days, speed of vessel, area to be sampled).

In FY11, NPCREP scientists began a numerical simulation exercise to examine the statistics of these sampling efforts using actual larval fish and plankton distributions collected on eastern Bering Sea and Chukchi Sea cruises. The statistical simulations performed for this work were key to developing an FY12 midwater survey of the Chukchi Sea for NOAA's Loss of Sea Ice initiative. Although the results were sufficient for planning the Arctic Eis survey (Fig. 3), more data are required before a more general case can be constructed and published. This work was also invaluable when trying to negotiate a master grid of stations for the Gulf of Alaska Integrated Ecosystem Research Program (GOA IERP; Fig. 4). The master sampling grid was established in FY11 and benefited from the results and experience of NPCREP's examination of sampling variability.

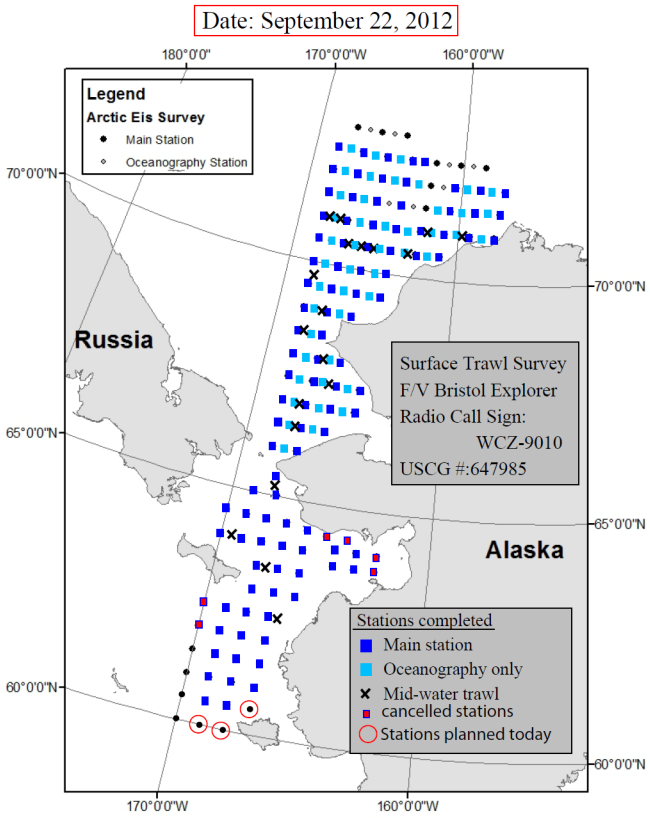

Figure 3. The Arctic Eis sampling grid for 2012 is comprised of the stations above the Bering Strait.

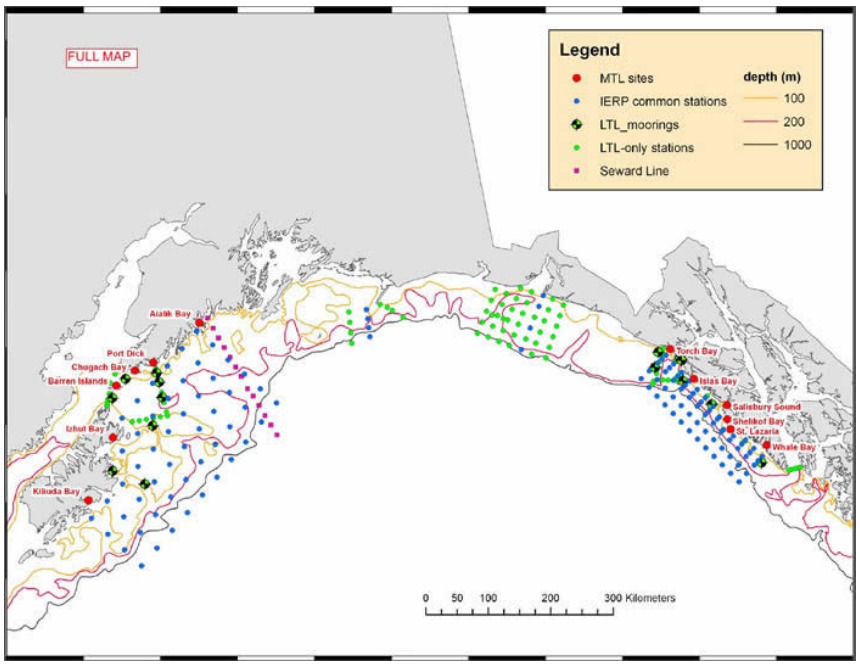

Figure 4. GOA IERP Sampling Grid showing eastern and western regions

FY 2012 MILESTONE: Develop and utilize models to better understand ecosystem dynamics in the Gulf of Alaska, Bering Sea, and Arctic

NPCREP used both existing models and developed new models in FY 2012 to explore the physical and biological dynamics of Alaska's Large Marine Ecosystems. Specifically we:

- Used models to explore climate-mediated nutrient replenishment on the SE Gulf of Alaska shelf, and to explore differences in current dynamics between warm and cold years. We utilized a regional model to investigate mechanisms that result in parts of the Gulf of Alaska being highly productive (Cheng et al.).
- Continued development of five individual-based models (IBM) for the commercially important walleye pollock, Pacific cod, Pacific ocean perch, and sablefish, and the ecologically important arrowtooth flounder in the Gulf of Alaska
- Evaluated models and used where appropriate to understand climate-mediated cross-shelf fluxes in SE Alaska
- Published four papers that utilized models to improve our understanding of the Ecosystems of the Gulf of Alaska (Cheng), Bering Sea (Wang a), and Arctic Ocean (Overland, and Wang b), and submitted a fifth (Hermann), which uses observations to better quantify performance of a regional model, and then uses that model to make forecasts.
    - Three of these papers utilize the output from large climate models to better predict how warming will change sea ice ecosystems – these changes will greatly impact the ecosystems

Examples of products:

Cheng, W., A.J. Hermann, K.O. Coyle, E.L. Dobbins, N.B. Kachel, and P.J. Stabeno (2012): Macro- and micro-nutrient flux to a highly productive submarine bank in the Gulf of Alaska: A model-based analysis of daily and interannual variability. Prog. Oceanogr., 101(1), 63–77.

Coyle, K.O., W. Cheng, S.L. Hinckley, E.J. Lessard, T. Whitledge, A.J. Hermann, and K. Hedstrom (2012): Model and field observations of effects of circulation on the timing and magnitude of nitrate utilization and production on the northern Gulf of Alaska shelf. Prog. Oceanogr., 103, 16–41.

Overland, J.E., M. Wang, J.E. Walsh, J.H. Christensen, V.M. Kattsov, and W.L. Chapman (2012): Climate model projections for the Arctic. Chapter 3 in *Snow, Water, Ice and Permafrost in the Arctic*, AMAP, Oslo.3.1-3.18.

Parada, C., S. Hinckley, J.K. Horne, M. Dorn, A.J. Hermann, and B.A. Megrey (2012): Comparing simulated walleye pollock recruitment indices to data and stock assessment models from the Gulf of Alaska. Mar. Ecol. Prog. Ser. [In review]

Hermann, A.J., G.A. Gibson, N.A. Bond, E.N. Curchitser, K. Hedstrom, W. Cheng, M. Wang, P.J. Stabeno, L. Eisner, and K.D. Cieciel (2012): A multivariate analysis of observed and modeled biophysical variability on the Bering Sea shelf: multidecadal hindcasts (1970-2009) and forecasts (2010-2040). Deep-Sea Res. II. [In preparation]

Wang, M., J.E. Overland, and P. Stabeno (2012a): Future climate of the Bering and Chukchi seas projected by global climate models. Deep-Sea Res. II, 65–70, doi: 10.1016/j.dsr2.2012.02.022, 46–57. [PDF Version]

Wang, M., and J.E Overland (2012b): A sea ice free summer Arctic within 30 years-an update from CMIP5 models. Geophys. Res. Lett., 39, L18501, doi: 10.1029/2012GL052868. [PDF Version]

FY 2012 MILESTONE: Seasonal comparison of larval fish mortality and survival in the Gulf of Alaska and Bering Sea

NPCREP formed a new partnership with NOAA's Bering-Aleutian Salmon International Survey (BASIS) group in FY12 to begin a seasonal comparison of larval fish distribution and mechanisms that promote survival from eggs to age-1. These investigations will alternate between the Gulf of Alaska and the Bering Sea. In FY12 the surveys focused on the eastern Bering Sea and were conducted from 16 August – 14 October (Figure 5).

This research area is focused on improving and reducing uncertainty in stock assessment models of important commercial fish species in the Bering Sea through the collection of fisheries oceanographic indices. Data were collected at the end of FY12 and the beginning of FY13. In addition to the station grid, the historical 70 m isobath transect was occupied. All hydrography data were sent to NOAA/PMEL and will be processed by December 2012. Nutrient samples are also being processed at PMEL. An early winter cruise to assess the abundance, size, and condition of age-1 fish, necessary to examine overwinter mortality will most likely not occur due to lack of NOAA platform availability.

The joint cruises were highly successful in FY12 and provided NOAA with much-needed efficiency in ship time, personnel, and travel resources. However, this shared ship time results in a biennial focus on the Bering Sea and Gulf of Alaska ecosystems, which has its drawbacks. As with our other projects, the ultimate goal is to provide data and indices that can be directly used in the stock assessments.

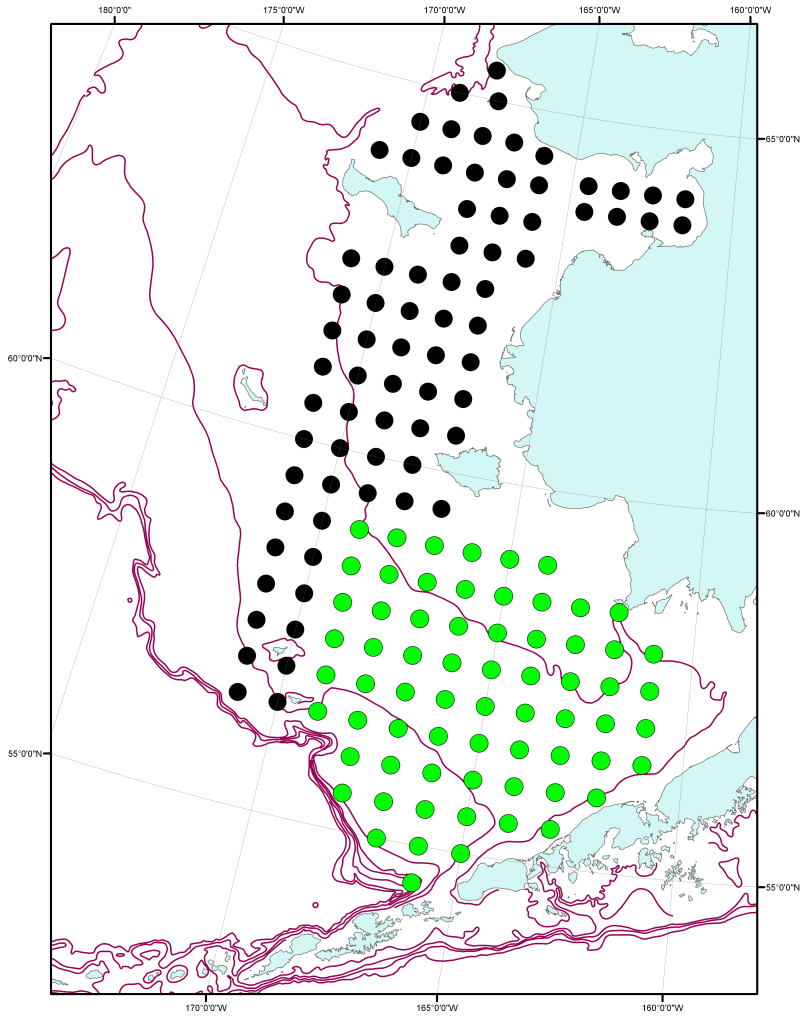

Figure 5. Survey stations in green were occupied for the collaborative BASIS/EcoFOCI research cruise along the eastern Bering Sea, August 16 to October 14, 2012 on board the FSV *Oscar Dyson*. Survey stations in black were occupied on board the F/V Northwest Explorer.

Advise and inform

The target audience for results from NPCREP research is the members and committees of the North Pacific Fishery Management Council. NPCREP continued to provide essential information on climate and ecosystems to the council and other stakeholders during FY 2012.

FY 2012 MILESTONE: Deliver an eastern Bering Sea ecosystem synthesis to the North Pacific Fisheries Management Council

At the end of FY 2010 we worked with the authors of the Ecosystem Considerations Chapter (ECC) to alter the format of the annual report as requested by the Science and Statistical Committee (SSC) of the Council. We worked with the lead authors of the chapter to adopt the Committee's suggestion to make the main focus of the chapter a text synthesis rather than a reporting of indices. The lead author on the Ecosystem Considerations chapter developed the synthesis in FY12. She used indices and material submitted by NPCREP as well as material for other sources.

Relevant Products:
Bering Sea Ecosystem Report Card: http://access.afsc.noaa.gov/reem/ecoweb/Index.cfm

In addition, NPCREP gave two presentations to fisheries managers this year. The first was to a working group of scientists from the Groundfish and crab Plan Teams. The Council asked us to repeat the presentation to the entire Groundfish Plan Team in the fall. The purpose of the presentation was to communicate what applied research NPCREP had accomplished and to receive advice on what research problems NPCREP could address in the future that would help resource management.

CHALLENGES

A major and growing concern for NPCREP remains ship time. The Program is a frequent user of OMAO and UNOLS vessels to maintain the observation network and to conduct process studies. With removal of the NOAA Ship *Miller Freeman* from the NOAA fleet, the only NOAA oceanographic/fisheries boat in Alaskan waters is the FSV *Oscar Dyson*. The *Dyson* consistently sails fewer days than the *Freeman* did, due to insufficient funds. Historically, we have used the NOAA West Coast Charter funds to supplement the decreasing NOAA ship time. These were funds granted to OAR to replace the three Class-I vessels retired from the fleet some years ago. This year all of the funds were transferred to OMAO and reprogrammed to supplement the NOAA fleet. The West Coast NOAA ships have fewer science bunks than the UNOLS fleet and lack the experience for many aspects of our interdisciplinary studies (e.g., radioisotope work, trace metal chemistry). We will be working with the NOAA fleet in FY 13 to overcome these challenges.

FY 2013 Plans

STATEMENT OF WORK

North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) in FY 2013 will continue to help NOAA and the United States understand how varying climate conditions affect marine ecosystems and living marine resources of the North Pacific Ocean and Arctic Ocean. NPCREP's mission is to conduct research on climate variability and ecosystem response in the North Pacific, focusing on the productive waters of the eastern Bering Sea, Gulf of Alaska, and most recently, the Chukchi Sea. The intent of this research is to improve scientific understanding and provide guidance for resource managers on climate adaptation. 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 help society plan for and mitigate potential impacts of climate change on our living marine resources.

NPCREP is a highly collaborative program that works with other NOAA marine research programs such as Fisheries-Oceanography Coordinated Investigations (FOCI), Ocean Acidification (OA), Bering-Aleutian Salmon International Survey (BASIS), extramurally funded programs such as the Gulf of Alaska Integrated Ecosystem Research Program and Arctic Ecosystem Integrated Survey. This includes programs funded by other Federal partners (BOEM) and involves researchers from a number of institutions such as the University of Washington, University of Alaska, Fairbanks, Oregon State University, and University of Pennsylvania.

PRIORITIES

For FY 2013, NPCREP has priorities that build upon our past successes:

- Operate our observation network and recruit new users and stakeholders.
- Increase understanding of mechanisms linking climate and ecosystem productivity.
- Incorporate environmental data into forecast/stock assessment models.

Specifically during 2013, NPCREP will work to accomplish the following tasks, generally classified into broad categories of *observe*, *understand*, 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 2013, NPCREP will continue the NPCREP portion of EcoFOCI's existing biophysical observing system to detect climate impacts.

FY 2013 MILESTONE: Maintain the NPCREP Climate and Ecosystem Observing Network, and distribute data to stakeholders.

Deliver to our stakeholders long-term observations of the Bering Sea ecosystem using biophysical moorings (M2, M4, M5, M8), and shipboard measurements of physical, chemical, and biological variables important to ecosystem health and the management of commercial fin- and shellfish stocks of the eastern Bering Sea. A single observation site has been established in the Chukchi Sea for year-round measurements.

This year (2013) will mark the 19th consecutive year of these observations, further strengthening our understanding of both quasi-decadal and annual trends in Bering Sea atmospheric forcing, oceanography and fisheries recruitment. It will also continue one of the only sources of data for atmosphere, physics, and lower trophic levels available for an integrated ecosystem assessment. The longer we are able to continue our time series, the more valuable they become and the more power we have to detect low frequency climate-mediated forcing of the ecosystem.

Specifically, in FY 2013 NPCREP will:

- Continue to operate the array of moorings in the Bering and Chukchi seas, NOAA's only biophysical observation network in the Arctic. Funding from Federal partners (BOEM) will allow an expansion of the Chukchi network in FY 13.
- Encourage other scientists to use the moorings as platforms of opportunity to leverage the amount and types of data collected at these sites
- Continue to operate a mooring in Chiniak Bay and another in Pavlof Bay (Gulf of Alaska)

Understand

FY 2013 MILESTONE: Increase our understanding of the effect of climate variability on Alaska's Arctic Large Marine Ecosystems

The climate of the Arctic is rapidly changing with major impacts on the Arctic Ocean ecosystem. In recent years summer sea ice in the Arctic Ocean has reached minima not previously observed in recorded history, with a new record low for Arctic sea ice in 2012. Multiple models predict the complete loss of summer sea ice by the year 2030. These changes are expected to have significant impacts on living marine resources of this region and the human communities that depend on them.

The Chukchi and Beaufort Seas contain parts of the U.S. EEZ. At present there is a moratorium on commercial fishing in this region although there is subsistence harvest of finfish, shellfish, and protected species. To better manage these ecosystems and understand the potential impacts of climate change and associated human activities in the region, NPCREP will continue to study the structure and function of the Chukchi Sea ecosystem. Progress will be documented by

manuscripts, reports, text, tables, and/or figures that demonstrate advances in our knowledge of climate mediated physical – biological interactions in the EEZ of the Chukchi Sea.

With the conclusion of the Bering Sea Project (BEST-BSIERP), NPCREP has become the only program making focused biophysical measurements in the Bering Sea.

Specifically, in FY 2013 NPCREP will:

For the eastern Bering Sea --

- Participate in an NSF-sponsored synthesis project. Begin the second level integrative synthesis of NOAA, NSF, and NPRB-sponsored climate-ecosystem research for the eastern Bering Sea.
- Submit new manuscripts to the third special BEST/BSIERP issue that describe new understanding of climate-mediate change in this productive.
- Begin analyses and writing for manuscripts targeted for the fourth special issue.
- Continue to provide guidance and oversight to future studies of the Bering Sea Ecosystem as members of the Science Advisory Board.

For the Chukchi Sea –

- Continue to monitor the Chukchi shelf at least three (and up to seven) locations using undersea moorings. Deploy additional moorings in August 2013 as part of the new BOEM supported Arctic Whale Ecology Study (ArcWEST) and the Hannah Shoal (CHAOZ extension) programs.
- Begin to synthesize results from three field years and contribute to the BOEM-supported Synthesis of Arctic Research (SOAR).
- Deploy 12 satellite-tracked drifters to help map the Lagrangian flow, which will provide us information on plankton drift.
- Complete ship-based fall research expeditions in the Chukchi Sea.

FY 2013 MILESTONE: Seasonal examination of ecosystem and climate variability in the Gulf of Alaska and Bering Sea

North Pacific Climate Regimes and Ecosystem Productivity Program (NPCREP) has formed a new partnership with the Alaska Fisheries Science Center's Ecosystem Monitoring and Assessment Program (EMA; http://www.afsc.noaa.gov/ABL/EMA/EMA_default.php). We also will enter into discussions with the Center's Resource Ecology and Ecosystem Modeling (REEM; http://www.afsc.noaa.gov/REFM/REEM/Default.php) Program on new ways to bring NPCREP data products and understanding into ecosystem-based fisheries management as practiced in the Alaska region.

In FY13 we will conduct a seasonal survey of larval fish survival in response to climate-driven environmental variability. The focus is a comparison of the western and eastern Gulf of Alaska, and the goal is to test the gauntlet hypothesis relating the timing, location, and transport of larvae from five focal species (walleye pollock, Pacific cod, arrowtooth flounder, sablefish, and Pacific Ocean Perch) to their eventual recruitment success. A series of cruises supported in part by NPCREP and in part by the North Pacific Research Board (NPRB) are planned for spring, mid and late summer 2013. NPCREP funding will be used to help support NOAA surveys during this year: April hydrography and lower trophic level processes cruise in SE Alaska; May hydrography and lower trophic level processes cruise in western Gulf of Alaska; May larval fish assessment survey in western Gulf of Alaska, 3 legs of a late hydrography and age-o fish assessment survey in the western Gulf of Alaska.

The goal of this project is to increase our understanding of the ways that climate variability influence the recruitment of focal species in the Gulf of Alaska. The improvements in our understanding of operative mechanisms affecting recruitment are targeted for the Gulf of Alaska Plan Teams and the NPFMC Science and Statistical Committee.

FY 2013 MILESTONE: Develop an experimental, near-term, atmosphere/ocean/plankton prognostic model for ecosystem dynamics in the eastern Bering Sea

As part of the new partnership between EcoFOCI, EMA, and REEM, we will begin to explore the feasibility of conducting operational forecasts for larval transport, feeding conditions and predator impact relevant to target species in the eastern Bering Sea and Gulf of Alaska. These forecasts will use our knowledge of climate regimes and local meteorological and oceanographic forcing to predict whether conditions in the present year were or were not recruitment-favorable.

In FY13 we will conduct a pilot study to develop a 1-year forecast of atmosphere and upper ocean conditions in the eastern Bering Sea. The forecast would be used to drive a Regional Ocean Modeling System (ROMS) and a Nutrient Phytoplankton Zooplankton (NPZ) model, and a model of euphausiid and juvenile fish distribution and abundance to predict conditions for the survival of selected fin- and shellfish species in the eastern Bering Sea.
The initial models have already been developed with funding from NPCREP and the NSF/NPRB funded Bering Sea Project. The pilot is needed to transition the use of the models from a research tool to a forecast tool.

The goal is to make this product available to the NPFMC's Plan Teams and to annually evaluate the degree of agreement between the forecast and the actual recruitment through the Ecosystems Considerations Report. The exercise is meant to test our understanding of the mechanisms regulating recruitment. The particular models used to make the forecast, will evolve as we test our understanding.