The Bering Sea: Current Status and Recent Events

by Jeffrey Napp

Current status of the Bering Sea ecosystem

The Bering Sea remained cool through the second half of 2008, with a substantial cold pool over the eastern Bering Sea shelf during summer (**Fig. 1**). The relatively low summer sea surface temperatures enabled the moderately rapid cooling of the shelf during the fall of 2008. At the time of this writing (early January 2009), 90% of sea ice has penetrated the coastal regions of inner Bristol Bay and over the middle and outer shelf. The ice edge is just south of 60°N at about 170°W (*i.e.*, at about the latitude of Cape Newenham). Drift vectors for the ice are headed east south east at about 15 nautical miles per 168 hr. Thus, 2008 was one of the most extensive ice years since the very cold period of the early 1970s, and was the third year in a row where both winter and summer conditions were cold relative to recent years (**Fig. 2**).

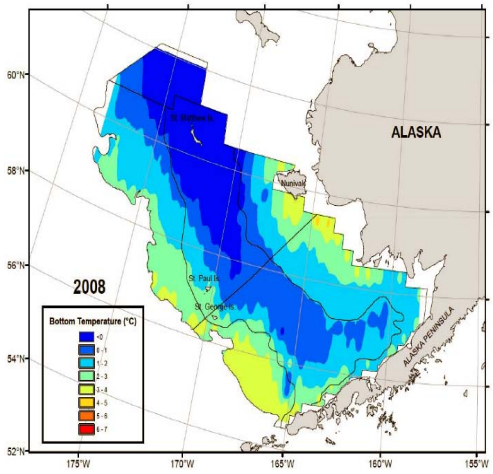

Fig. 1 Bottom water temperatures over the eastern Bering Sea shelf collected by NOAA's Alaska Fisheries Science Center (AFSC) during summer bottom trawl fish and crab surveys. The cold pool (water < 2°C) extended over most of the shelf. Figure courtesy of R. Lauth (NOAA-Fisheries, AFSC, RACE Division).

For the reviewed period, the sea surface temperatures (SSTs) of the entire Bering Sea and Sea of Okhotsk have either small positive or small negative anomalies, while SST anomalies off the west coast of North America were more strongly negative (**Fig. 3**). The monthly Pacific Decadal Oscillation index, (PDO, first EOF of North Pacific SSTs) was strongly negative from April through November 2008. The Multivariate ENSO Index (www.cac.noaa.gov/ENSO/ enso.mei_index.html) has been negative from July/August to the present, although equator SST anomalies were slightly positive from August to November, indicating that the former La Niña conditions at the equator that have persisted for the past 2 years have not completely disappeared. Given cold temperature anomalies and sea ice conditions in the Bering Sea, the coincidence of cold temperature anomalies throughout the North Pacific, and strong negative PDO since spring 2007, we do not anticipate that the Bering Sea is ready to shift back to warmer conditions within the next year.

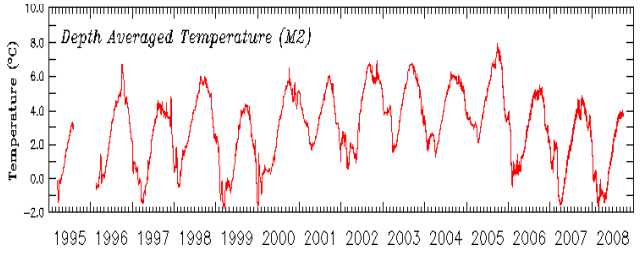

Fig 2 Average water column temperature for the last 14 years over the southeastern middle shelf. Temperatures measured at NOAA's mooring M2 (56.9°N, 164.1°W). Note that the maximum average water column temperature during the summer of 2008 (~ 4 °C) was one of the lowest during recent years. Data courtesy of P. Stabeno (NOAA's Pacific Marine Environmental Laboratory).

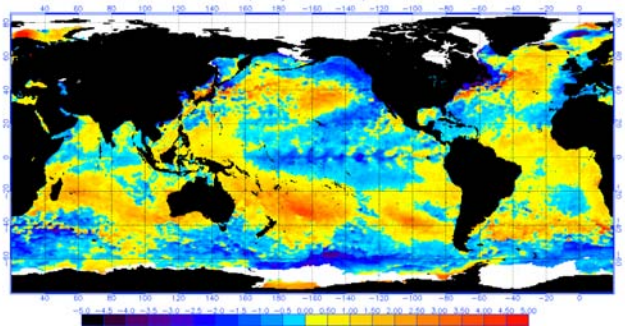

Fig. 3 NOAA/NESDIS sea surface temperature anomalies for January 5, 2009. White areas in the Bering Sea denote sea ice. Source: www.osdpd.noaa.gov/PSB/EPS/SST/data/anomnight.1.5.2009.gif.

Arctic IPY research

March 2007 to March 2009 was designated International Polar Year (IPY) by the International Council for Science (ICSU) and the World Meteorological Organization (WMO). Within PICES, scientists reported on their IPY activities during the workshop on "*Status of marine ecosystems in the sub-arctic and arctic seas - Preliminary results of IPY field monitoring in 2007 and 2008*" at the 2008 PICES Annual Meeting in Dalian, China. The workshop was sponsored by the MONITOR Technical Committee and ESSAS (a GLOBEC regional program on Ecosystem Studies of Sub-Arctic Seas). Presentations were made by scientists from most PICES member countries: Canada, China, Japan, Russia, and the United States. There were also invited talks from Great Britain and Norway. The workshop featured a great diversity of research subjects and approaches to the IPY studies, with a common theme of understanding the potential impacts of sea ice loss. It was encouraging to see the amount of effort that

PICES scientists were expending on IPY research in the waters north and south of Bering Strait. Copies of their presentations are available on the PICES website at http://www.pices.int/publications/presentations/default.asp. One of the presenters, Dr. Kohei Mizobata (Tokyo University of Marine Science and Technology, Japan) won the Best Presentation Award from the MONITOR Technical Committee for the paper entitled "*Japanese IPY activities in the western Arctic Ocean and the Bering Sea*" co-authored by K. Mizobata, K. Shimada, S. Saitoh, T. Hirawake and M. Hori.

BEST/BSIERP activities in 2008

The Bering Ecosystem Study (BEST) and Bering Sea Integrated Ecosystem Research Program (BSIERP) have been working hard to synthesize results from their first full field year (2008) in the eastern Bering Sea. Principle Investigators met twice this fall, once in October 2008 in Girdwood, Alaska, and again this January in Anchorage, Alaska. The result of the meetings was a compilation of "headlines" for each of the following five major themes or cardinal hypotheses that are used to organize the individual projects of the two programs:

- Climate-induced changes in physical forcing will modify the availability and partitioning of food for all trophic levels through bottom-up processes;
- Climate and ocean conditions influencing water temperature, circulation patterns and domain boundaries will impact fish reproduction, survival and distribution, the intensity of predator–prey relationships and the location of zoogeographic provinces through bottom-up processes;
- Later spring phytoplankton blooms are a result of early ice retreat and will increase zooplankton production, thereby resulting in increased abundances of piscivorous fish (pollock, cod, and arrowtooth flounder) and a community controlled by top-down processes (Oscillating Control Hypothesis);
- Climate and ocean conditions influencing circulation patterns and domain boundaries will affect the distribution, frequency, and persistence of fronts and other prey-concentrating features and thus the foraging success of marine birds and mammals largely through bottom-up processes;
- Climate–ocean conditions will change and thus affect the abundance and distribution of commercial and subsistence fisheries.

Each headline provides a new research result from this year and a figure describing this result (for example see **Fig. 4**). The results cover studies from physics to seabirds, and marine mammals, as well as humans, that rely on the ecosystem. These headlines will be publically available on the North Pacific Research Board website (bsierp.nprb.org/) by the time this issue of *PICES Press* is published, so that others can learn about conditions during 2008 (observation and process studies) as well as what progress has been made on retrospective studies, modeling and forecast capabilities.

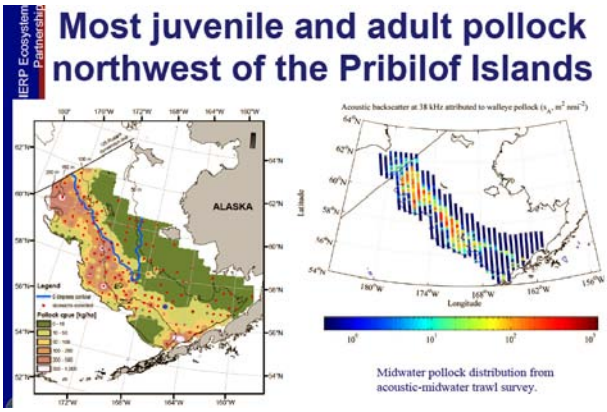

Fig. 4 One example of the many "headlines" from the 2008 BEST/BSIERP research effort in the eastern Bering Sea. This particular example is courtesy of C. Wilson and R. Lauth (NOAA-Fisheries, AFSC, RACE Division) and describes the summer distribution of walleye pollock based on the annual groundfish bottom trawl survey and the biennial mid-water acoustic assessment.

Bering Sea activities in 2009

Cruise and ship opportunities in 2009 are likely to be very similar to what occurred during 2008. BEST/BSIERP will continue to have several eastern Bering Sea spring ice breaker cruises and a mid-summer cruise aboard a U.S. UNOLS (University–National Oceanographic Laboratory System) vessel. The Alaska Fisheries Science Center intends to conduct its annual summer shelf groundfish bottom trawl survey. The biennial mid-water fish assessment will be in the Bering Sea again to support BEST/BSIERP, not the Gulf of Alaska, as it would normally. Other NOAA investigations of interest are: a July/August cruise with an autonomous underwater vehicle to look at skate nursery areas, a spring ice seal survey that will utilize unmanned aircraft systems to assess ice seal distribution and abundance (www.afsc.noaa.gov/nmml/polar/research/uastests.php) and an intensive look at the ecology of the endangered North Pacific right whale (Pacific Right Whale Evaluation Study, *aka* PRIEST, www.afsc.noaa.gov/Quarterly/jas2008/divrptsNMML3.htm) during August.

The RUSALCA (Russian–American Long Term Census of the Arctic) hydrographic, plankton and fisheries cruise, cancelled in 2008, is scheduled for late August 2009, to work in the northern Bering and Chukchi Seas. The T/S *Oshoro-maru* (Hokkaido University, Japan), winner of the first PICES Ocean Monitoring Service Award (POMA) will again spend summer in the Bering Sea. The R/V *Mirai* (JAMSTEC, Japan) will work in the western Arctic from late summer through early fall (www.iarc.uaf.edu/highlights/2007/chukchi_sea_cruise_07/). If there are major expeditions by other PICES member countries, please write to me and let me know so that I can include them in my next column.

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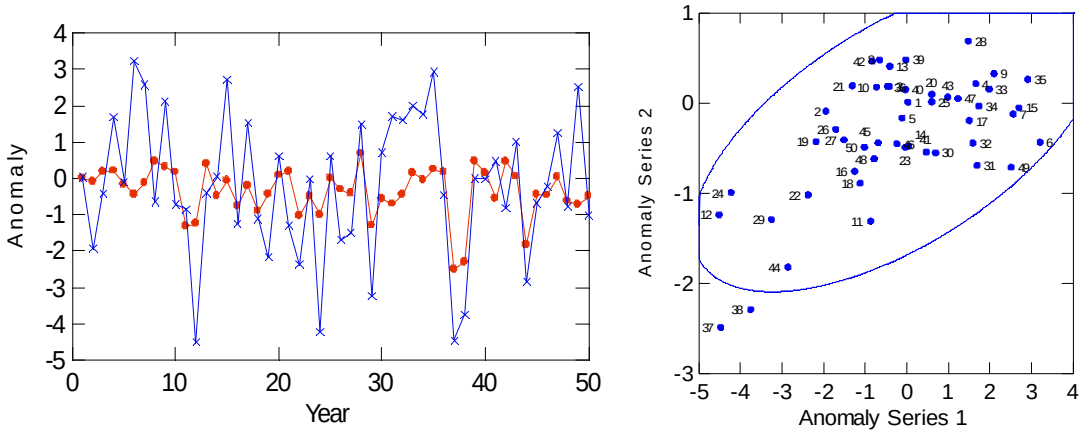

Fig. 2 Two arbitrary timeseries with a correlation of 0.61.

assess the nature of the dispersion pattern. Should there be additional value in showing the temporal order in a scatterplot, plot point labels can be added to indicate time. If the temporal evolution is also important, the points can be interconnected in sequence by a line.

The ability to assess a force and response of nature is particularly important if the arguments being made are causal in nature. In such cases, it is the outliers that become important. If you argue that it is colder when the wind blows by presenting timeseries observations of wind and temperature, most will judge the strength of your argument based on the presence or absence of departures from that model. A scatterplot immediately shows where the outliers can be found against the foundation of your argument—the diagonal running from upper left to lower right. If, in some years it is warm when the wind blows, these values will appear in the upper right quadrant of the figure. In timeseries plots, these outliers tend to be buried in the chatter of temporal variation so you need to look for them. This cannot be done easily in 45 seconds.

So, if you cannot completely give up on the concept of timeseries plots for inter-comparisons, please add a scatterplot on the side so that viewers are not left wondering about hidden outliers. The example in **Figure 2** shows that the relatively high correlation between these two timeseries is a consequence only of about 6 strong negative anomalies out of 50 points. There is no correlation between these timeseries in the other 44 points. This pattern is not revealed by the timeseries comparisons alone, particularly in the 45 seconds normally provided to make a judgment.

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New Bering Sea publication

A special volume of *Deep-Sea Research II*, "The Marine Ecosystem of the Pribilof Domain, Southeastern Bering Sea" edited by S.A. Macklin, Sharon Smith, Sue Moore and James Schumacher, was recently published (August 2008, Vol. 55, Nos. 16-17). The issue contains original research articles on aspects of ocean ecology from physics to halibut, seabirds and pinnipeds. An overview paper concludes the volume and integrates recent work from the southeastern shelf and updates our understanding about how a warmer Bering Sea might affect the abundance of zooplankton and the recruitment of fish, including walleye pollock.

Acknowledgements

Many thanks to the following PICEans who helped create this report: Drs. George Hunt, Jr., Kohei Mizobata, Robert Lauth, James Overland, Michael Sigler, Phyllis Stabeno, and Chris Wilson.

Dr. Jeffrey (Jeff) Napp (jeff.napp@noaa.gov) is a Biological/Fisheries Oceanographer at the Alaska Fisheries Science Center of NOAA–Fisheries. He is Head of the Recruitment Processes Program at the Center and co-leader (with Dr. Phyllis Stabeno) of NOAA's Ecosystems and Fisheries Oceanography Coordinated Investigations (EcoFOCI). His research is focused on physical and biological processes at lower trophic levels that affect recruitment variability in fish populations. Jeff was active as a Principal Investigator in past Bering Sea research programs (NOAA's Bering Sea FOCI, Southeast Bering Sea Carrying Capacity), and currently is a Principle Investigator on an NPRB-sponsored Bering Sea Integrated Ecosystem Research Plan (BSIERP) project. He formerly served on the BEST (Bering Ecosystem Study) Science and Implementation Plan Steering Committee. Jeff is also a member of the PICES Technical Committee on Monitoring.