The Bering Sea: Current Status and Recent Events

by Jeffrey Napp

Current status of the Bering Sea ecosystem

It was cold once again this past winter, but not as cold as in the most recent years (2009 and 2010). There were also signs that the weather may become more moderate in the near future. In some ways, the conditions during the winter of 2010/2011 were similar to 2006 (an average temperature year), although sea ice persisted later in 2011, and it was slightly colder than in 2006 (Fig. 1). During the winter of 2010/2011, sea ice extended to mooring M2 (56.87°N, 164.03°W), but was not solid (7/10 cover), and the front moved back and forth across the mooring (north and south) until April when the ice retreated. Unlike the spring of 2010, there were no sustained northerly winds in 2011 that retained ice on the middle shelf. By the end of May 2011, the ice front had retreated to St. Matthew Island. In early June, the ice cover was 2–4/10 north and west of St. Lawrence Island and 4–6/10 north and east of the island (Fig. 2). The late spring sea surface water temperatures in the southeastern Bering Sea were moderate to cold: 4–5°C over the outer shelf and 2–3°C over the middle shelf (not shown).

There have also been some changes in the coupled ocean–atmosphere systems that drive the North Pacific and marginal seas. For example, the Pacific Decadal Oscillation (PDO; 1st mode of the EOF on sea surface temperatures) changed from positive to negative in June 2010, and was moderate to strong from June to January, weakening in early 2011. On the equator, La Niña conditions weakened, and the ENSO (El Niño Southern Oscillation) index was expected to be neutral this summer. The multivariate ENSO index is still negative and has been strongly negative since July/August of 2010.

An important question to ask is — what will be the fate of the run of cold winter/spring conditions that began in 2007 and followed a string of very warm years from 2000 through 2005? The winter/spring of 2011 had a return to near average air temperatures over the southeastern Bering Sea and Alaska, and this was in sharp contrast to the cold air temperature anomalies for this season in 2010 (Fig. 3). Both years, 2011 and 2010, exhibited warm temperature anomalies in the northern Bering and Chukchi Seas that have remained an Arctic-wide feature since the beginning of the 21st century. The proximate cause of the near normal 2011 air temperatures over the southern Bering Sea was the weak pressure gradients over the southeastern Bering Sea (Fig. 4), with the position of the Aleutian Low shifted far to the west, just east of Kamchatka. This again was in sharp contrast to 2010 (and other recent cold years) when the Aleutian Low was stronger and positioned over the Gulf of Alaska (Fig. 4). The latter position favored northeasterly winds over the southeastern Bering Sea, bringing cold Arctic air into the region. Normally, a moderate El Niño (as in winter 2010) would have resulted in a warmer Bering Sea and La Niña in winter 2011, and weakening in spring would have supported cooler conditions. However, in recent years it appears that the location of the Aleutian Low had more influence on the Bering Sea in 2010 and 2011 than did the intensity of the low or the ENSO connection.

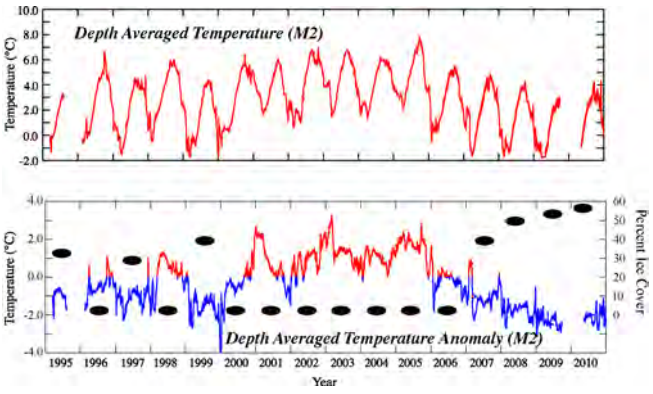

Fig. 1 Time series of water temperatures at the Bering Sea mooring M2 (56.87°N, 164.03°W). Top panel: Daily depth-averaged water column temperatures. Bottom panel: Daily temperature anomalies at M2 (blue = negative and red = positive, left ordinate) and the percent of ice cover over the mooring (ellipses, right ordinate). Figure courtesy of Phyllis Stabeno and Nancy Kachel, NOAA.

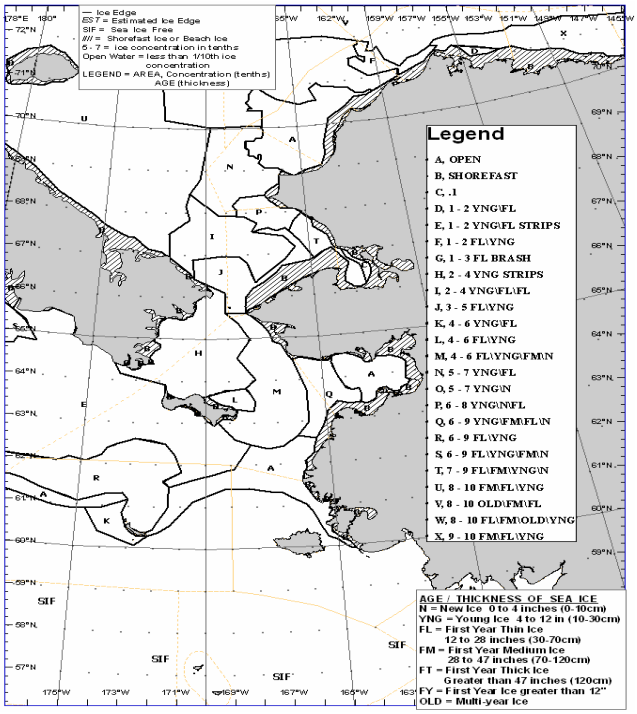

Fig. 2 Position and areal coverage of sea ice in the Bering Sea on June 2, 2011. Source: U.S. National Weather Service (http://pafc.arh.noaa.gov/ice.php).

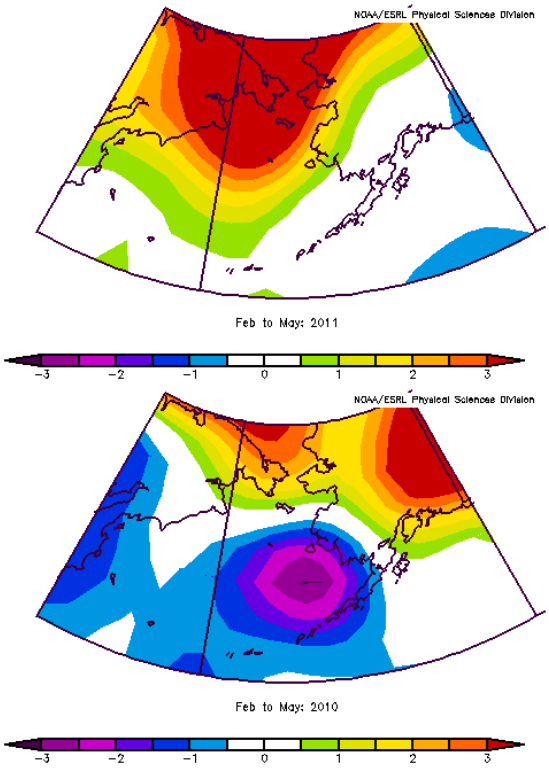

Fig. 3 Winter/spring 1000 mbar air temperature anomalies from the mean (1968–1996) over the Bering Sea for 2011 (top) and 2010 (bottom). Source: U.S. National Center for Environmental Prediction/National Center for Atmospheric Research.

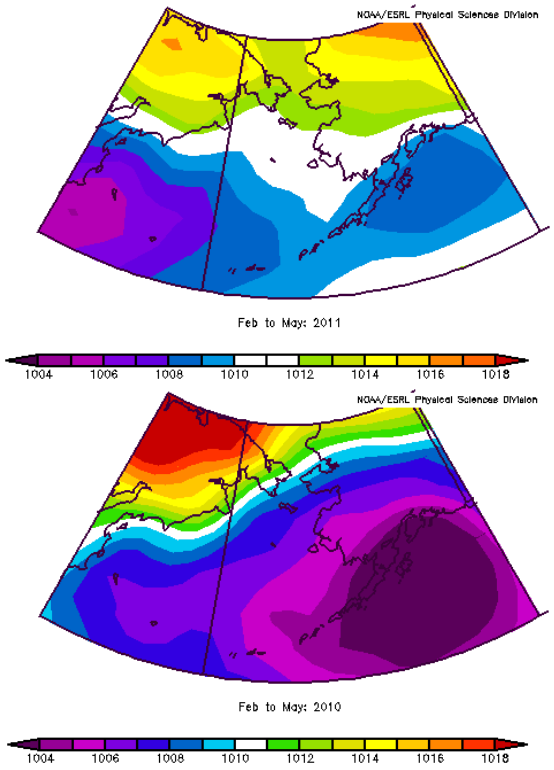

Fig. 4 Composite mean of sea level pressure (mb) for February to May 2011 (top) and 2010 (bottom). Source: U.S. National Center for Environmental Prediction/National Center for Atmospheric Research.

Arctic conditions

In the summer of 2010, the mean sea ice extent in the Arctic Ocean was 8.5×10^5 km^2, which was less than the average during the reference period of 1979–2000. However, in the spring of 2011 (April), the Bering Sea portion of the Arctic actually had more ice than average (Fig. 5). While there has been a rapid retreat of sea ice in the western Bering Sea, most of the western Arctic had been cooler than normal. A strong positive phase of the Arctic Oscillation (AO) characterized unusually low sea level pressures in much of the Arctic Ocean and drew warm air into the eastern Arctic.

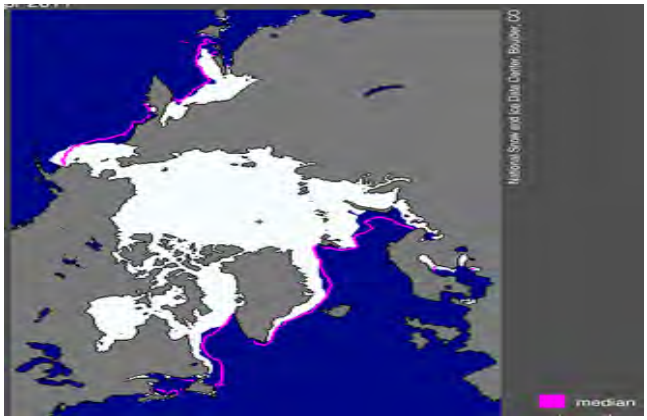

Fig. 5 Ice edge extent for April 2011 compared to median extent (pink line). Source: http://nsidc.org/arcticseaicenews/.

2011 Bering Sea field season

The amount of sea days for the eastern Bering Sea this year will be far less than previous years. The BEST/BSIERP partnership (http://bsierp.nprb.org) has concluded its field program, and the T/S *Oshoro Maru* (Hokkaido University, Japan) will not visit the eastern Bering Sea shelf in 2011. NOAA's Alaska Fisheries Science Center (AFSC) will conduct its annual summer groundfish assessment cruises (June and July), and the U.S. Coast Guard Icebreaker *Healey* will transit through the region on its way to the 2011 Arctic West Summer Expedition. NOAA's Pacific Environmental Laboratory (PMEL) has recovered and redeployed its Bering Sea shelf moorings for the summer.

New insights into the Bering Sea ecosystem

Several new and exciting results have been published within the last year and more are on their way in a forthcoming special issue of *Deep-Sea Research II* (2012).

A synthesis article on zooplankton and fish diet shows the affect of warm and cold years on the biomass of large and small zooplankton (Coyle *et al*., 2010. *Fish. Oceanogr*., Fig. 6).

The availability of large crustacean prey in late summer corresponds with whole body energy content of age-0

walleye pollock (Fig. 7). The survival of fish through their first winter appears to be strongly related to the energy density of fish captured in a surface trawl (kJ/fish). The recruitment anomaly of age-1 eastern Bering Sea pollock is a function of the average energy density of the sampled fish (not shown). These and other data were used to revise the Oscillating Control Hypothesis (Hunt *at al*. 2011, *ICES J. Mar. Sci*.).

Recently, PICES initiated a jellyfish working group (http://www.pices.int/members/working_groups/wg26.aspx) to address concerns about increases in jellyfish in the North Pacific. The potential impact of jellyfish on marine ecosystems was recently illustrated in *Science Daily*, where a group of researchers reported that jellyfish shunt food energy away from fish and shellfish and also disrupt the carbon cycle. AFSC has been measuring jellyfish biomass in the eastern Bering Sea during two different fish assessment cruises, the summer groundfish bottom trawl and late summer/autumn surface trawl surveys. Recent data from these surveys suggest that biomass has been increasing since 2007/2008 (Fig. 8). One hypothesis for the recent increase in jellyfish biomass is the increase in large crustacean zooplankton biomass co-incident with cold conditions over the shelf.

Science meetings

The 2nd ESSAS (Ecosystem Studies of Sub-Arctic Seas) Open Science Meeting (OSM) was held May 22–26, 2011, in Seattle, USA (the OSM summary is included elsewhere in this issue). New and exciting research results about the Bering Sea were presented in the session on "*New observations and understanding of eastern and western Bering Sea ecosystems*" as well as in other topic sessions.

Future meetings in 2011/2012 that may host sessions or talks of interest to scientists working in the Bering Sea include:

- PICES Annual Meeting (October 14–23, 2011, Khabarovsk, Russia);
- Alaska Marine Science Symposium (January 23–26, 2012, Anchorage, USA);
- AGU/Ocean Sciences Meeting (February 20–24, 2012, Salt Lake City, USA);
- ICES/PICES Early Career Scientist Conference (April 24–27, 2012, Majorca, Spain);
- 2nd Symposium on "*Effects of climate change on the world's oceans*" (May 15–19, 2012, Yeosu, Korea).

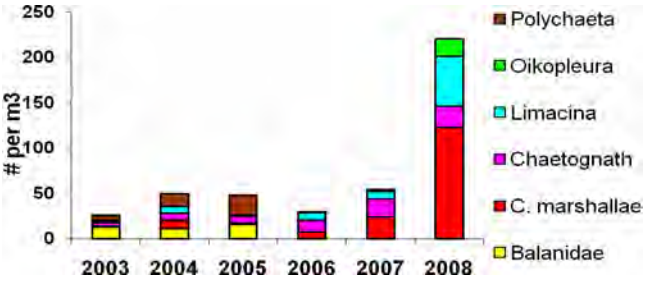

Fig. 6 Mean abundance (# per m^3) of large zooplankton within the southeastern Bering Sea shelf. Data from Bongo net tows with 505 µm mesh nets (figure courtesy of Lisa Eisner).

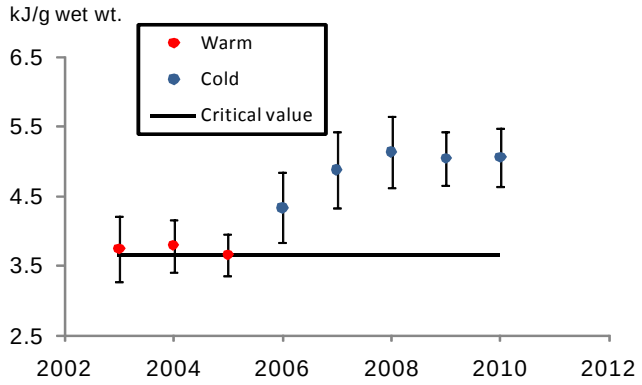

Fig. 7 Energetic status of age-0 walleye pollock during years with warm (red) and cold (blue) spring and summer sea temperatures on the eastern Bering Sea shelf. The critical value (horizontal line) is the energetic status of age-1 walleye pollock collected during spring (survived winter) in southeast Alaska (figure courtesy of Ron Heintz).

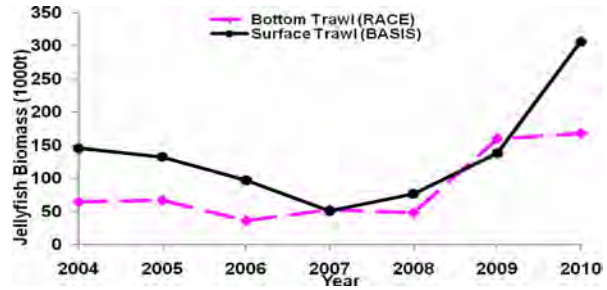

Fig. 8 Annual wet weight biomass of large jellyfish captured in fisheries trawls from the eastern Bering Sea (figure courtesy of Edward Farley).

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