X-27 West Bering Sea: LME #53

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The West Bering Sea LME lies off Russia's northeast coast and borders the Aleutian Trench. The LME has a surface area of nearly 2 million km^2, of which 2.90% is protected, and contains 0.51% of the world's sea mounts (Sea Around Us 2007). The bottom topography includes the deep Aleutian Basin, Kamchatka Basin and Bowers Basin. LME book chapters and articles pertaining to this LME are by Morgan (1989) and Ray & Hayden (1993).

I. Productivity

The LME is considered a Class II, moderately high productivity ecosystem (150-300 $gCm^{-2}y^{-1}$). The LME contains a variety of biological resources adapted to sea ice, including 450 species of fish, crustaceans and molluscs, and 25 species of marine mammals such as polar bears, whales, walruses and sea lions. The Bering Sea provides an important habitat for grey whales, endangered Steller sea lions and a variety of seabirds. The National Academy Press has produced a volume on the Bering Sea (available online), which provides additional information from an ecosystems perspective (National Academy Press 1996). The Pacific Oceanological Institute in Vladivostok provides on-line information about the LME's oceanography (www.pacificinfo.ru/en/). Over the past century, the extent of the winter pack ice has decreased. In the winter of 2001, the Bering Sea was effectively ice free.

Oceanic fronts (after Belkin and Cornillon 2003, Belkin and Cornillon 2005, and Belkin et al. (2009): A major northwestward current of the Eastern and Western Bering Sea shelves bifurcates upstream of Cape Navarin (Figure X-27.1). The northward branch flows toward the Bering Strait as the Anadyr-Chukotka Current associated with the Gulf of Anadyr Front (GAF). The southward branch flows first along the Koryak Coast, then along Kamchatka Peninsula, and is associated respectively with the Koryak Coast Current Front (KCCF) and the East Kamchatka Current Front (EKCF). The KCCF is very stable, apparently owing to a very steep upper continental slope and well defined sharp shelf break off the Koryak Coast that together steer this front. The East Kamchatka Current is by far the most important flow out of the West Bering Sea LME, exporting over 10^7 m^3s^{-1} of cold, low-salinity water.

West Bering Sea LME SST (after Belkin 2009)
Linear SST trend since 1957: 0.48°C.
Linear SST trend since 1982: 0.39°C.

The long-term cooling of the late 1950s-early 1970s culminated in the all-time minimum of 4.2°C in 1976. The North Pacific regime shift of 1976-77 (Mantua et al., 1997; Hare and Mantua, 2000) has transpired in the West Bering Sea with the utmost clarity and was extremely abrupt. It started as a 0.6°C SST rise in 1977, followed by a steady SST increase until present. Thus the regime shift of 1976-77 was a switch from a long-term cooling to a long-term warming, separated by a step-like SST increase. The all-time maximum of 1996 is bizarre since it occurred before the El Niño 1997-98 and before a similar warm event in the East Bering Sea. The cold event of 1999 occurred simultaneously across the entire Bering Sea. Most regime shifts are thought to be linked to the Pacific Decadal Oscillations, PDO. The SST regime shift of 1976-77 occurred simultaneously with a shift from negative PDO index to a positive PDO index.

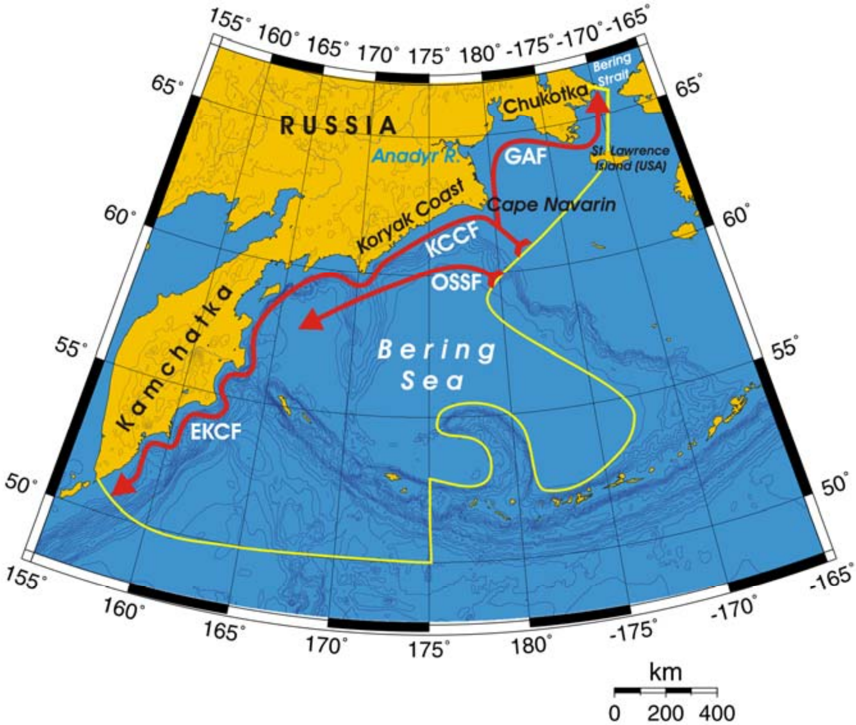

Figure X-27.1. Fronts of the West Bering Sea LME. EKCF, East Kamchatka Current Front; GAF, Gulf of Anadyr Front; KCCF, Koryak Coast Current Front; OSSF, Outer Shelf-Slope Front. Yellow line, LME boundary. After Belkin et al. (2009).

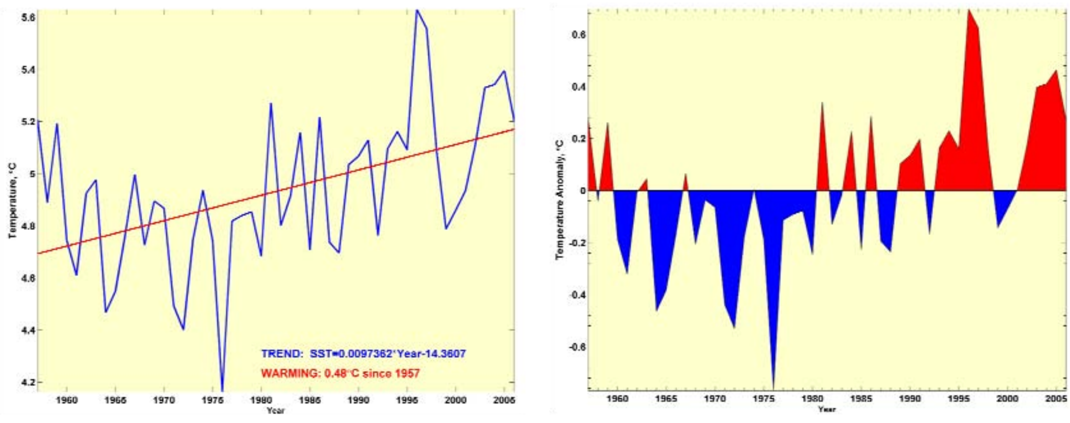

Figure X-27.2. West Bering Sea LME mean annual SST (left) and SST anomalies (right), 1957-2006, based on Hadley climatology. After Belkin (2009).

West Bering Sea LME Chlorophyll and Primary Productivity: The LME is considered a Class II, moderately high productivity ecosystem (150-300 $gCm^{-2}y^{-1}$).

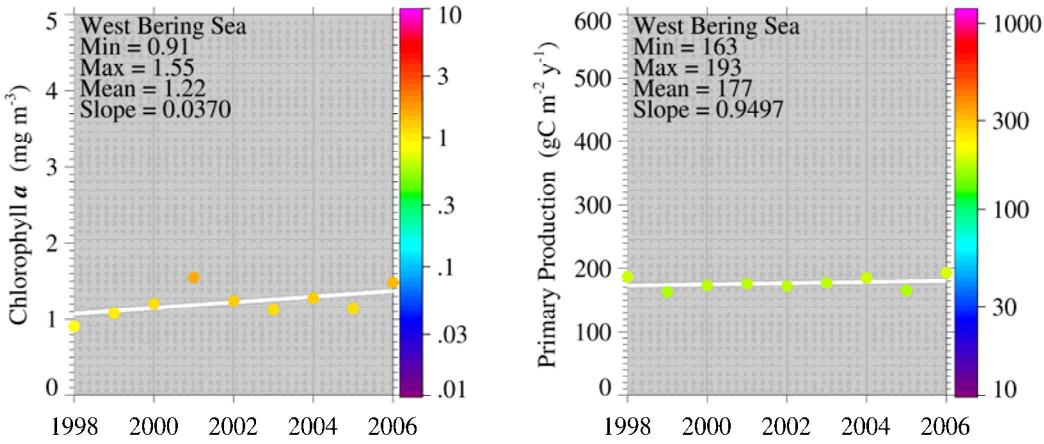

Figure X-27.3. West Bering Sea LME trends in chlorophyll *a* and primary productivity, 1998-2006. Values are colour coded to the right hand ordinate. Figure courtesy of J. O'Reilly and K. Hyde. Sources discussed p. 15 this volume.

II. Fish and Fisheries

The West Bering Sea LME has the largest biomass of cod-like fishes in the world. Other species fished include Alaskan pollock, Pacific saury, salmon, flatfish, rockfish, halibut, flounder, herring, squid and a variety of crab species and other crustaceans. There have been large and sudden population fluctuations in the stocks of these species. The Pacific Rim Fisheries Program of the Alaska Pacific University lists commercial fisheries quotas for the Russian Far East including the Bering Sea. Salmon and trout catches are declining. A major problem is unreported fishing in the West Bering Sea and in the 'Donut Hole', a high seas area that does not come under the jurisdiction of either Russia or the USA (Alaska). Catches have been illegally transferred to Russian carrier vessels bound for ports in Japan, South Korea, China, the U.S and Canada. There is evidence of fishing in prohibited areas. The rise of industrial fishing has also had a major impact. The Bering Sea Ecosystem volume (National Academy of Science 1996) has sections on higher trophic levels, fisheries and human use.

Total reported landings[1] recorded 960,000 tonnes in 1985 and 950,000 tonnes in 1988 but have since declined by more than half, with only 430,000 tonnes reported in the most recent year. (Figure X-27.4)[2].

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[1] Due to a recent adjustment to the boundaries of the West Bering Sea LME, the landings data presented here are based on the 1950-2003 data, computed using the boundaries defined in Figure X-27.1. Data for 1950-2004, based on the new LME boundaries, will be available online at www.seaaroundus.org.

[2] Information on the value of reported landings cannot be provided at this stage, due to the recent adjustments in LME boundaries (see note 1 above). Data for values using the newly adjusted boundaries will be available at www.seaaroundus.org.

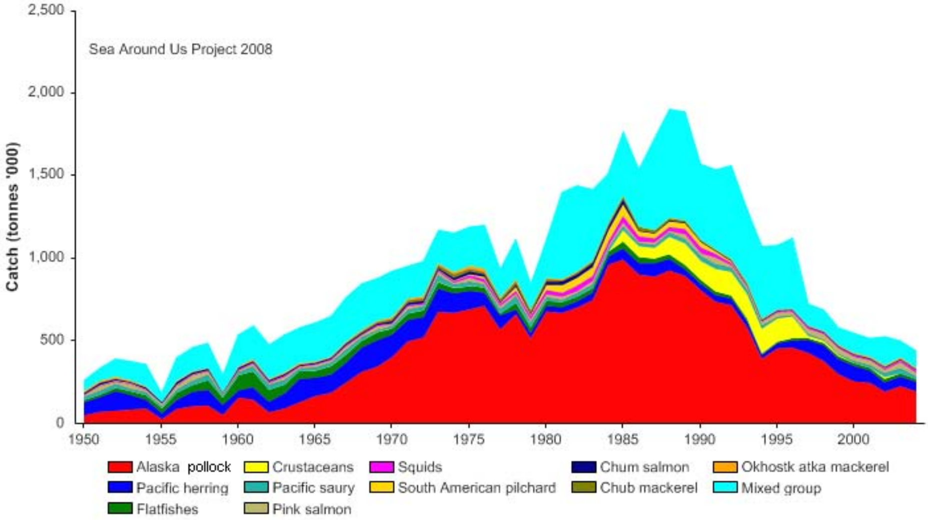

Figure X-27.4. Total reported landings in the West Bering Sea LME by species (Sea Around Us 2007).

The primary production required (PPR; Pauly & Christensen 1995) to sustain the reported landings in this LME reached 12% of observed primary production in the late 1980s, but has declined in recent years (Figure X-27.5). Russia has the largest share of the ecological footprint in the LME.

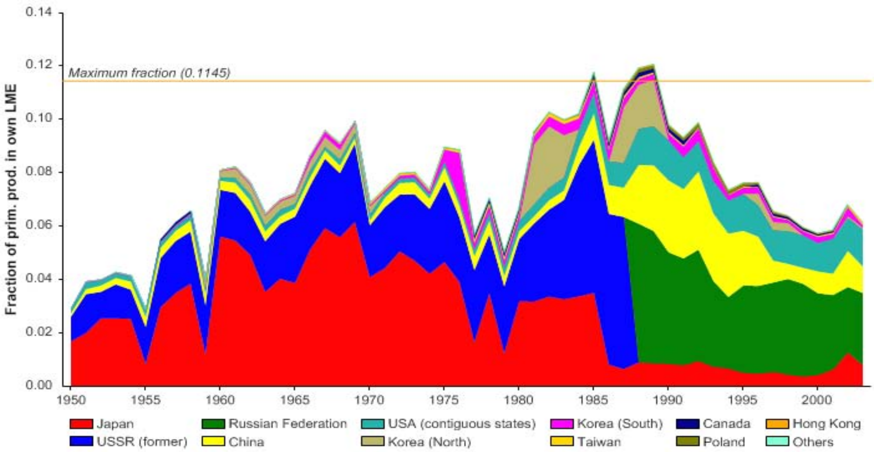

Figure X-27.5. Primary production required to support reported landings (i.e., ecological footprint) as fraction of the observed primary production in the West Bering Sea LME (Sea Around Us 2007). The 'Maximum fraction' denotes the mean of the 5 highest values.

The mean trophic level of the reported landings (i.e., the MTI; Pauly & Watson 2005) has declined from the early 1960s to the mid 1980s, suggesting a 'fishing down' of the food webs in the LME (Pauly *et al*. 1998; Figure X-27.6 top), though the decline in the mean trophic level appears to have been compensated for by the increased landings as evident in the positive trend of the FiB index (Figure X-27.6 bottom). Yet, as Alaska pollock, a high trophic species, increasingly dominated the landings in the LME in the 1990s, the mean trophic level began to increase despite the decline in the total landings, as indicated by the decline FiB index (Figure X-27.6 bottom).

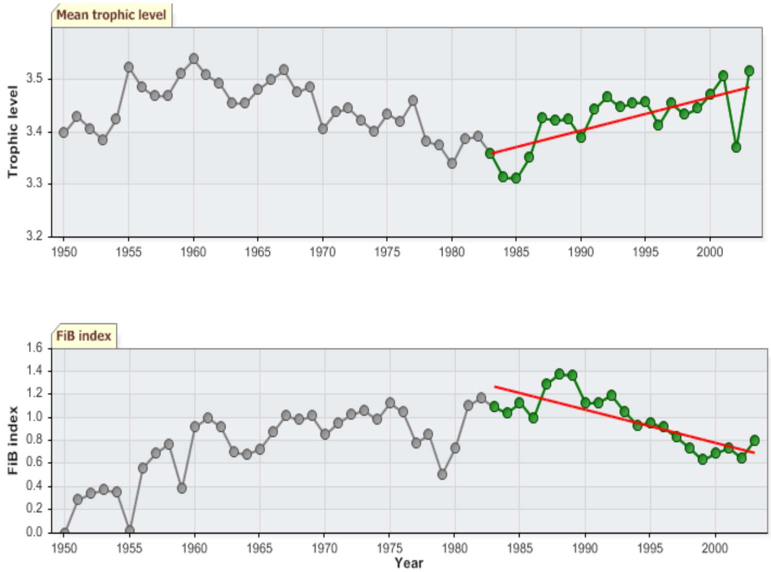

Figure X-27.6. Mean trophic level (i.e., Marine Trophic Index) (top) and Fishing-in-Balance Index (bottom) in the West Bering Sea LME (Sea Around Us 2007)

The Stock-Catch Status Plots indicate that more than 60% of the exploited stocks in the LME have collapsed, with another 30% overexploited (Figure X-27.7 top). The reported landings in the region are mostly supplied by overexploited stocks with 20% from the collapsed stocks (Figure X-27.7 bottom).

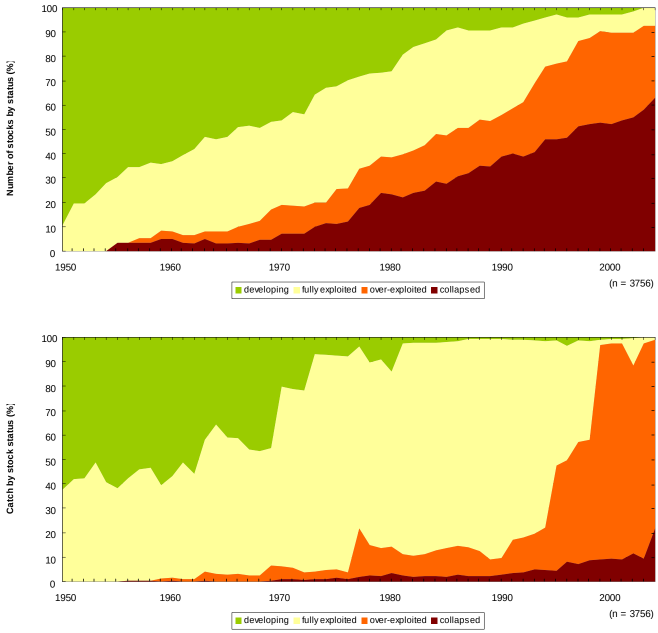

Figure X-27.7. Stock-Catch Status Plots for the West Bering Sea LME, showing the proportion of developing (green), fully exploited (yellow), overexploited (orange) and collapsed (purple) fisheries by number of stocks (top) and by catch biomass (bottom) from 1950 to 2004. Note that (n), the number of 'stocks', i.e., individual landings time series, only include taxonomic entities at species, genus or family level, i.e., higher and pooled groups have been excluded (see Pauly *et al*, this vol. for definitions).

III. Pollution and Ecosystem Health

Signs of ecosystem stress include the decline of the pollock catch and in numbers of the Steller sea lion and sea otter populations. The poaching of sockeye salmon for their eggs is preventing the salmon from reaching their spawning grounds in the Pacific. Petroleum and other contaminants have been found in marine mammals, a result of the growing industrialisation of the region. The West Bering Sea LME has low levels of toxic contaminants, but these have been rising over the last 50 years due to increased human activities (mining, fishing and oil exploration). This increase is linked to the long-range transport of contaminants through the ocean and atmosphere from other regions. Cold region ecosystems such as this are more sensitive to the threat of contaminants because of their slow breakdown in colder areas. Also, animals high in the food web with relatively large amounts of fat tend to have high concentrations of organic contaminants such as pesticides and PCBs. Today, Russia is faced with many environmental problems inherited from the Soviet Union. Russian regional authorities and multi-national oil companies are pushing for further oil exploration and development in these fragile ecosystems. However, the Russian Supreme Court has invalidated a governmental decree that would have allowed the marine discharge of toxic wastes from oil drilling off Russia's Far East coast.

IV. Socioeconomic Conditions

Fish and game have supported the lives of people of the West Bering Sea LME for many centuries. Marine mammal hunting has been a part of the traditional economy of the indigenous coastal populations. They are provided with an annual quota to harvest whales, ringed seals, and walruses. Marine mammals are used for food, skins and fat. In recent years, people have begun to migrate away from this region. Most of the area's population are immigrants from Russia and Ukraine. In more recent times, Russian and Ukrainian immigrants were attracted to the LME's coastal areas because of high incomes and the prospects of oil profits. Today, in the context of the new Russian economy, incomes are not higher than in other regions of Russia. With the decline of fish stocks and onshore fish processing in Kamchatka, local fishermen were losing their jobs and their profits.

Three Russian areas comprise the coastline of this LME—the Kamchatka Peninsula, the Koryak Autonomous Area and the Chukotka Autonomous Area. In October 2006, the *New York Times* reported that Kamchatka had selected protection zones for rivers "because fish runs are the best foundation for the peninsula's economy." The salmon fisheries' annual value is US$600 million. The Kol River has as many as five million returning salmon each year and will now be protected. Other areas now protected are the Oblukovina, Krutogorova, Kolpakova, Opala and Zhupanova rivers. The watersheds will be protected from habitat disruption while allowing traditional uses such as sport fishing, trapping and hunting. Each river will have a biological station to study the ecology of the river and the fish. All the rivers except the Zhupanova are to be designated as protected areas. In July 2007 a merger united the Russian Federation's constituent parts on the Kamchatka Peninsula.

V. Governance

The West Bering Sea LME is bordered by Russia. Other users of the marine environment such as the U.S. and Japan also impact the rich biological resources of the LME. Issues that are being addressed are conservation strategies, legal issues, fisheries economics and scientific monitoring. Coordination is critical for the sustainable use of the fisheries.

Attempts on the Russian side to deal with management issues and the poaching problem have failed due to a lack of appropriate legislation and weak enforcement. Stakeholders, who include fishermen, industry leaders, anti-oil activists and fisheries conservationists, must find collaborative solutions to some of these problems. There is a lack of transparency in fisheries policy decision-making, with the quota discussion remaining secret. Local environmental groups are opposing further oil exploration in the Bering Sea, fearing that oil exploitation would adversely impact Russia's vital fisheries economy, which supports many local communities. They also maintain that oil exploitation presents an environmental threat. More information is available on the 2001 Bering Sea Fisheries Conference with the U.S. and Russian organisations at www.pacificenvironment.org/.

The International Bering Sea Forum met in Kamchatka in 2006 and adopted the following resolutions:

- A resolution calling for a comprehensive network of Marine Protected Areas in the Bering Sea, based upon the best available science and local traditional knowledge;
- A resolution to defend Bristol Bay from threats presented by proposed offshore oil and gas development and the development of North America's largest gold and copper open pit mine; and
- A resolution calling for the reform of shipping safety standards in the Bering Sea.

Details of the meeting are available at www.beringseaforum.org/ 2006 meeting.html.

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