XI-32 East Siberian Sea: LME #56

S. Heileman and I. Belkin

The East Siberian Sea LME is a high-latitude Arctic LME off Northeast Russia. A topographical boundary with the Laptev Sea LME to the west is formed by the New Siberian Islands. This LME is a relatively shallow, marginal sea with an extensive continental shelf and a surface area of about 900,000 km^2, of which 3.4% is protected (Sea Around Us 2007). According to the Atlas of the Oceans (USSR Navy, 1980), the Eastern Siberian Sea has the surface area of 913,000 km^2, water volume of 49,000 km^3, and total water catchment area of 1,342,000 km^2. Climatic conditions are extremely severe, with major seasonal and interannual variation and ice cover for most of the year. The total river runoff exceeds 200 km^3/year, including Kolyma (135) and Indigirka (57) Rivers. A report pertaining to this LME is UNEP (2005).

I. Productivity

The East Siberian Sea is a Class I, high productivity ecosystem (>300 $gCm^{-2}yr^{-1}$). In situ data on primary production are absent. The summer plankton bloom is short but intense. The total monthly production in August-September is 2.5 million tonnes, while the annual production is just 7 million tonnes owing to the very short vegetation season since this LME encompasses the most ice-covered shelf sea in the Arctic (Vetrov and Romankevich 2004). Coastal erosion and river discharges provide a major source of suspended matter and nutrients to this LME. However, the availability of light and nutrients has been restricted by seasonal ice cover for most of the year, limiting production to a brief period after the ice melts in summer. Climate is the primary force driving biomass changes in the LME. The formation and melting of ice complicate the thermal, chemical, sedimentological and biological processes. The zooplankton of the East Siberian Sea LME is dominated by Pacific species of copepods. The zooplankton production in winter is less than 10 $mgCm^{-2}d^{-1}$, whereas in summer it varies between 25 and 65 $mgCm^{-2}d^{-1}$ (Vetrov and Romankevich 2004). Sea birds, ringed seal, walrus, beluga/belukha whale, Arctic fox and polar bear make up the varied and rich fauna at the edge of the drifting ice and on the shore. See the Barents Sea LME for additional information on the biodiversity and food web of Arctic Seas.

Oceanic fronts (Belkin et al. 2009)(Figure XI-32.1): The Siberian Coastal Current (SCC) is associated with a front (SCCF) that extends across the southern part of this LME (Figure XI-32.1). The front separates low-salinity coastal waters from offshore waters. The SCC carries huge amount of fresh water from great Siberian rivers such as Ob', Yenisey and Lena, and also Khatanga, Olenek, Indigirka, Yana, and Kolyma. The SCC transports these waters along the SCCF eastward through Long Strait into the Chukchi Sea. Estuarine fronts develop off the mouths of Indigirka and Kolyma, and also off Ayon Island.

East Siberian Sea LME SST (after Belkin 2009)(Figure XI-32.2)
Linear SST trend since 1957: 0.37°C.
Linear SST trend since 1982: 0.36°C.

The East Siberian Sea warming was moderate. Its interannual variability was very small, ~0.2-0.4°C. The only major event occurred in 1989-1990, when SST rose by 1°C in just two years, reaching -0.3°C in 1990, thus exceeding by 1.3°C the all-time minimum of -

1.6°C. This event nearly coincided with the largest increase of the Arctic Oscillation (AO) index on record since 1950 (Climate Prediction Center 2007).

Figure XI-32.1. Fronts of the East Siberian Sea LME. AF, Ayon Front; IF, Indigirka Front; KF, Kolyma Front; SCCF, Siberian Coastal Current Front. Yellow line, LME boundary. After Belkin et al. (2009).

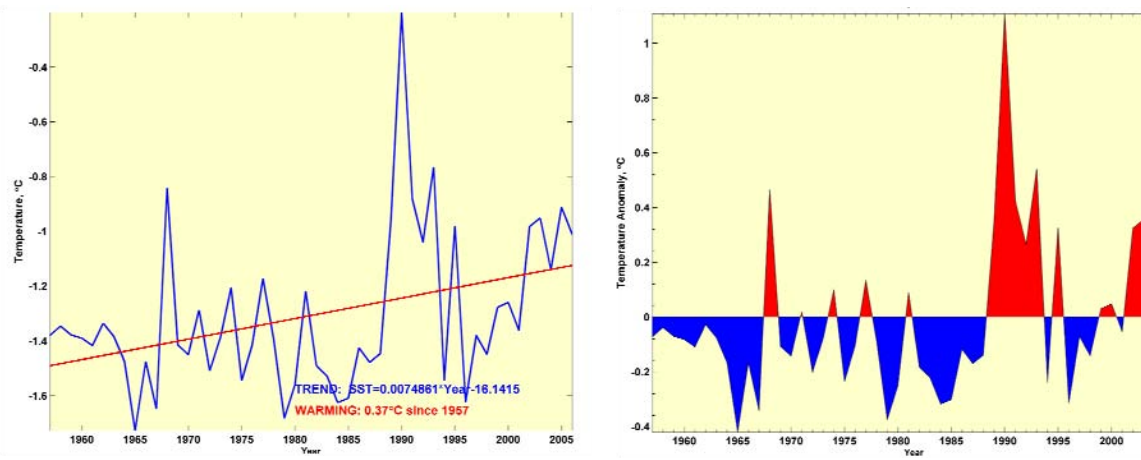

Figure XI-32.2. East Siberian Sea LME mean annual SST (left) and SST anomalies (right), 1957-2006, based on Hadley climatology. After Belkin (2009).

East Siberian Sea LME Chlorophyll and Primary Productivity: The East Siberian Sea is a Class I, high productivity ecosystem (>300 $gCm^{-2}yr^{-1}$).

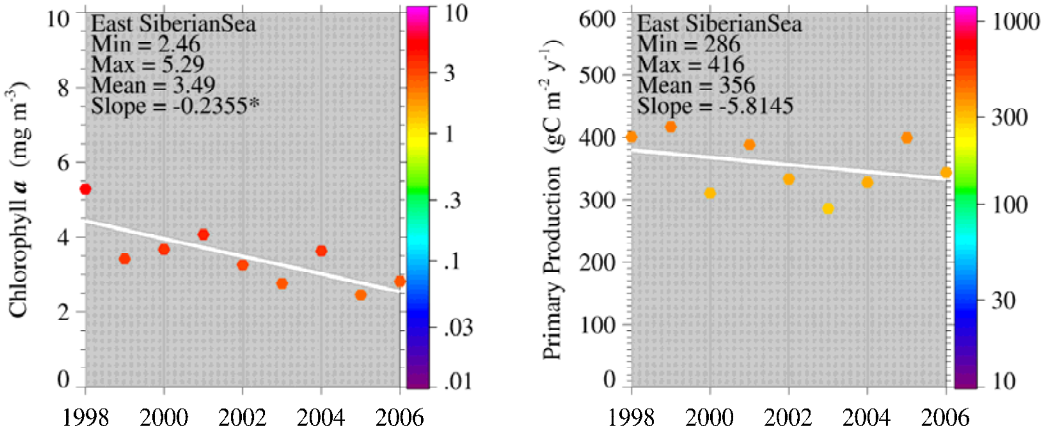

Figure XI-32.3. East Siberian Sea LME trends in chlorophyll *a* (left) and primary productivity (right) 1998 – 2006. Values are colour coded to the right hand ordinate. Figure courtesy of J. O'Reilly and K. Hyde. Sources discussed p. 15 this volume.

II. Fish and Fisheries

The number of species and stocks of biological resources in the East Siberian Sea LME is small. Several valuable fish species are found in this LME, but the largest stocks are generally concentrated in sub-estuarial zones. Much of the salmon catch is low-grade pink salmon that is canned and sold domestically. Valuable species such as pollock, halibut and crab are poised to play a more important commercial role. At present, overexploitation is not of concern in the LME (UNEP 2005).

As in the Kara and Laptev seas, whitefish species (genus *Coregonus*), called 'sig' in Russian, form the bulk of the fishery in this LME. However, detailed records are available only from the lower reaches of the Indigirka and Kolyma Rivers for the years from 1981 to 1990 (Larsen *et al.* 1996). These data, amounting to about 3,000 tonnes per year on average, do not show any consistent trend, unlike those from the Kara Sea. Pauly & Swartz (2007), in the absence of other data which may support an alternative estimation procedure, extrapolated backward to 1950 the mean catch of the first three years with data (1980-1982). Similarly, they extrapolated forward, from 1991 to 2004, the mean catch of the last three years with data. An additional 30% of 'other fish' was included, following Larsen *et al.* (1996). The time series of the estimated catches are presented in Figure XI-32.4.

Due the tentative nature of the East Siberian Sea LME catch estimates, no indicators based on these data will be presented (but see Sea Around Us 2007).

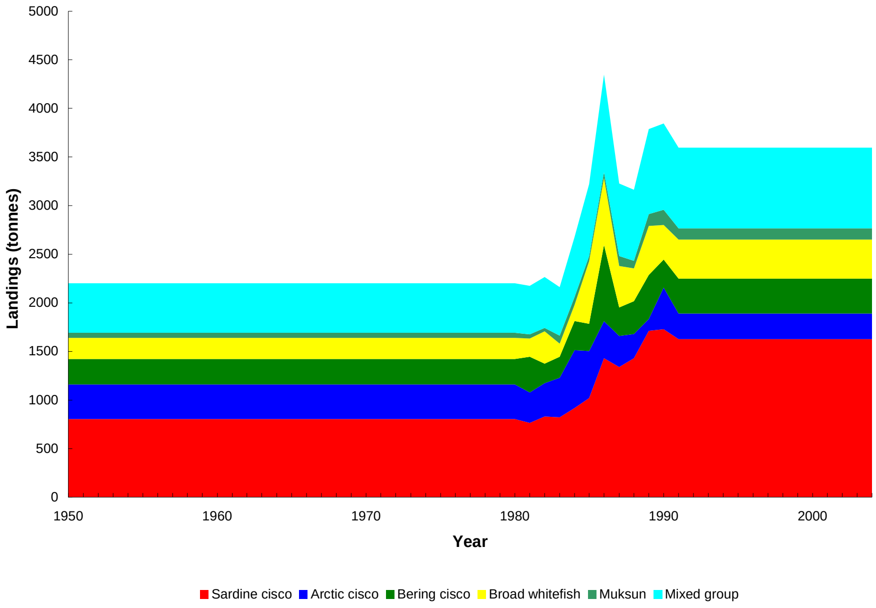

Figure XI-32.4. Total estimated catches (subsistence fisheries) in the East Siberian Sea LME (from Pauly & Swartz 2007)

III. Pollution and Ecosystem Health

Pollution: Runoff from industrial as well as agricultural areas in the Kolyma and Indigirka watersheds makes a significant contribution to pollution in this LME. However, overall, pollution is slight and attributed mainly to chemicals and spills, which are of greater concern in localised areas (UNEP 2005). According to chemical monitoring data of the Roshydromet network as well as the Arctic Monitoring Centre, several contaminants are found in the LME. A broad spectrum of trace metals was discovered in the water and bottom sediments. DDT, HCH and PCBs have been found in water samples, with maximum concentrations found in the areas of river discharge (GOIN 1996a-d, Roshydromet 1997-2002).

Particularly severe climatic and ice conditions increase the risk of pollution from shipping and spills. The maximum concentrations (up to 80 $\mu g l^{-1}$) of petroleum hydrocarbons were observed near the Novosibirsk Islands and Wrangel Island (GOIN 1996a). Some other hazardous contaminants (organochlorine compounds, heavy metals and radionuclides) can be found in snow, ice, seawater, sediments and marine organisms. The average concentrations of these contaminants are, however, very low. According to microbiological indices, the waters in some areas vary from relatively clean to lightly and moderately polluted (in localised zones in summer).

Habitat and community modification: Modification of habitats was assessed as slight (UNEP 2005). While there are no records of serious habitat loss in the region, there is evidence of localised degradation in some areas. Issues pertaining to the health of this LME are endangered marine species such as walruses and whales, the fragile marine ecosystem, which is slow to recover from disruptions or damage, and the thinning polar ice pack.

IV. Socioeconomic Conditions

A notable feature of this LME is the relatively low population density in the coastal areas. Some parts of the coast are almost uninhabited, with the few small settlements separated by long distances. The anthropogenic impact of these populations is thus considered to be low.

V. Governance

The Soviet era adopted special measures for the protection of the marine environment and the prevention of pollution in the Arctic areas adjacent to its northern coast. These provided for special navigational rules. Other issues pertain to the legal status of the Arctic areas. During the Soviet era, the East Siberian Sea was held to be internal waters. For ongoing bilateral and multilateral science projects, see International Science Initiatives in the Russian Arctic (ISIRA) under the auspices of The International Arctic Science Committee (IASC). The Arctic Research Consortium of the United States (ARCUS); the Arctic Ocean Sciences board (AOSB); Land-Ocean Interactions in the Coastal Zones (LOICZ); the Arctic Monitoring and Assessment Programme (AMAP) and Protection of the Arctic Marine Environment (PAME)--each under the aegis of the Arctic Council; The International Human Dimensions Programme on Global Environmental Change (IHDP) and the International Permafrost Association (IPA); the Canada-Russia Joint Action Plan for an Enhanced Bilateral Partnership; CNS, the Multilateral Nuclear Environmental Program in the Russian Federation and the Euro-Arctic Council are examples of international partnerships for scientific research and management in the Arctic..

References

Belkin, I.M. (2009) Rapid warming of Large Marine Ecosystems, Progress in Oceanography, in press.

Belkin, I.M., Cornillon, P.C., and Sherman, K. (2009). Fronts in Large Marine Ecosystems of the world's oceans: An atlas. Progress in Oceanography, in press.

Climate Prediction Center, National Weather Service (2007) Monitoring weather and climate, www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/season.JFM.ao.gif

GOIN (1996a). Annual of Marine Water Quality with Respect to Hydrochemical Indices for 1992. Obninsk, Russia. (In Russian).

GOIN (1996b). Annual of Marine Water Quality with Respect to Hydrochemical Indices for 1993. Obninsk, Russia. (In Russian).

GOIN (1996c). Annual of Marine Water Quality with Respect to Hydrochemical Indices for 1994. Obninsk, Russia. (In Russian).

GOIN (1996d). Annual of Marine Water Quality with Respect to Hydrochemical Indices for 1995. Obninsk, Russia. (In Russian).

Larsen, L.H., Palerud, R., Goodwin, H. and Sirenko, B. (1996). The marine invertebrates, fish and coastal zone features of the NSR area. INSROP Working Paper No 53, 42 p.

Pauly, D. and Swartz, W..(2007) Marine fish catches in northern Siberia (Russia, FAO Area 18). In: Zeller, D. and Pauly, D. (eds.) Reconstruction of marine fisheries catches for key countries and regions (1950-2004). Fisheries Centre Research Reports, FCRR, Vol 15(2).

Roshydromet (1997). Review of the Environmental Pollution of the Russian Federation for 1996. M. Roshydromet, Moscow, Russia. (In Russian).

Roshydromet (1998). Review of the Environmental Pollution of the Russian Federation for 1997. M. Roshydromet, Moscow, Russia. (In Russian).

Roshydromet (1999). Review of the Environmental Pollution of the Russian Federation for 1998. M. Roshydromet, Moscow, Russia. (In Russian).

Roshydromet (2001). Review of the Environmental Pollution of the Russian Federation for 2000. M. Roshydromet, Moscow, Russia. (In Russian).

Roshydromet (2002). Review of the Environmental Pollution of the Russian Federation for 2001. M. Roshydromet, Moscow, Russia. (In Russian).
Roshydromet 2000. Review of the Environmental Pollution of the Russian Federation for 1999. M. Roshydromet, Moscow, Russia. (In Russian).
Sea Around Us (2007). A Global Database on Marine Fisheries and Ecosystems. Fisheries Centre, University British Columbia, Vancouver, Canada. www.seaaroundus.org/lme/SummaryInfo.aspx?LME=56
UNEP (2005). Tsyban, A.V., Titova, G.D., Shchuka, S.A., Ranenko, V.V. and Izrael, Y.A. Russian Arctic, GIWA Regional Assessment 1a. University of Kalmar, Kalmar, Sweden. www.giwa.net/publications/r1a.phtml
Vetrov, A.A., and Romankevich, E.A. (2004) Carbon Cycle in the Russian Arctic Seas. Springer, Berlin etc., 331 pp.