XI-34 Laptev Sea: LME #57

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The Laptev Sea LME is topographically defined by the New Siberian Islands (Novosibirskie Ostrova) in the East and the Northern Land (Severnaya Zemlya) islands in the West. The LME is a continental marginal sea, most of which is shallow with a deeper northern section and a surface area of about 500,000 km^2, of which 5.6% is protected (Sea Around Us 2007). According to the Atlas of the Oceans (USSR Navy, 1980), the Laptev Sea (defined in the north by the shelf break) has a surface area of 475,000 km^2, water volume of 57,000 km^3, and total water catchment area of 3,643,000 km^2. Severe climatic conditions with major seasonal and annual changes, perennial ice cover over extensive areas, water exchange with the deep Arctic Ocean and freshwater input from Siberian rivers. The total river runoff exceeds 700 km^3/year, including Lena (532), Khatanga (105), Olenek (38), Yana (31), Anabar, and Kotuy Rivers.

I. Productivity

The Laptev Sea LME is a Class I, high productivity ecosystem (>300 $gCm^{-2}yr^{-1}$). The availability of light and nutrients is restricted by seasonal ice cover during part of the year, limiting production to a brief period after the ice melts in the summer months. Locally, primary production may exceed 800 $mgCm^{-2}d^{-1}$.in the southern part of this LME, with high values (>300 $mgCm^{-2}d^{-}1$) also observed in the north where the Laptev Sea waters meet the Atlantic waters (Vetrov and Romankevich 2004). The total biomass is 70 million tonnes, while the total annual production is 2.4 million tonnes of carbon (Vetrov and Romankevich 2004). Sea birds, ringed seal, beluga/belukha whale, walrus, Arctic fox and polar bear make up the top trophic level of the rich and varied fauna of this region, especially in the summer months when they can be found at the edge of the drifting ice and on the shore.

Oceanic fronts: (Belkin et al. 2009)(Figure XI-34.1): This area features a huge river runoff owing primarily to the discharge of the Lena River, as well as of the Khatanga (merger of Kheta and Kotuy), Popigay, Anabar, Olenek and Yana rivers. Estuarine offshore fronts develop as freshwater river plumes formed by Lena and Khatanga spread over the vast shallow shelf of Laptev Sea. Similar to the Mackenzie River plume, these plumes may contain multiple transient fronts that correspond to individual freshets.

The Siberian Coastal Current Front is less distinct in the Laptev Sea than in the East Siberian and Chukchi seas. This front separates low-salinity inshore waters from saltier offshore waters and acts as a conduit for the fresh waters on their route eastward. The Laptev Sea continental slope is relatively steep and the shelf break is well defined, therefore a shelf-slope front might exist along the shelf edge.

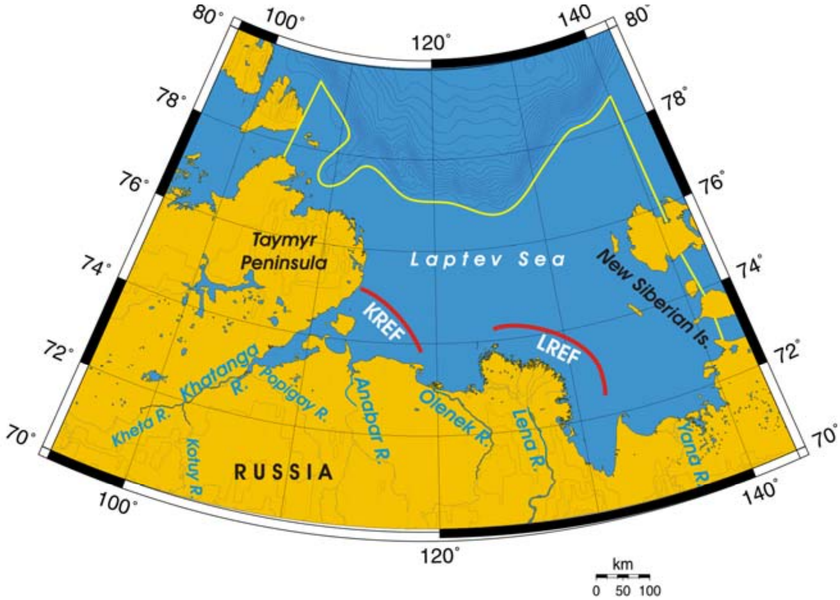

Figure XI-34.1. Fronts of the Laptev Sea LME. KREF, Khatanga River Estuarine Front; LREF, Lena River Estuarine Front. Yellow line, LME boundary. After Belkin et al. (2009).

Laptev Sea LME SST (Belkin 2009)(Figure XI-34.2)
Linear SST trend since 1957: 0.32°C.
Linear SST trend since 1982: 0.12°C.

The Laptev Sea warming was slow but steady, modulated by strong interannual variability. The largest interannual variability was observed between the all-time maximum of 0.0°C in 1995 and the all-time minimum of -1.3°C in 1996. The peak of 1995 occurred simultaneously in the adjacent Kara Sea; it was not observed elsewhere. Therefore the 1995 warm event was confined to just two contiguous LMEs, Laptev and Kara Seas. The warm episode of the late 1980s-early 1990s was positively correlated with the Arctic Oscillation index.

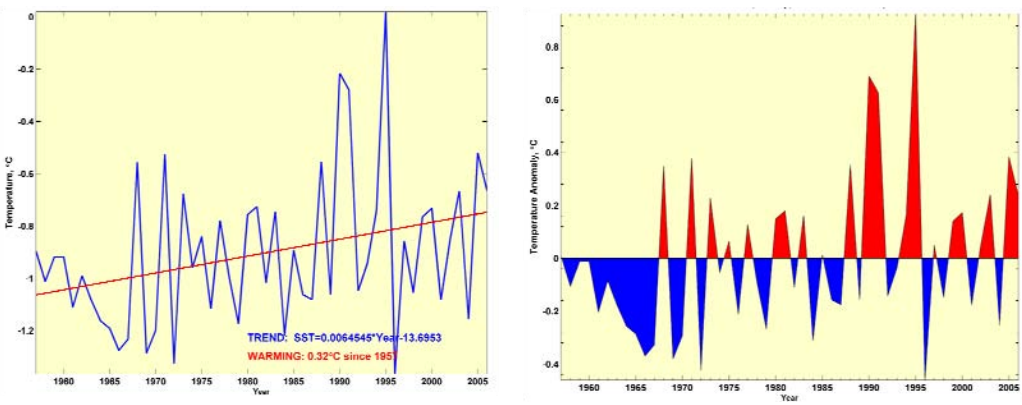

Figure XI-34.2a. Laptev Sea LME mean annual SST (left) and SST anomalies (right), based on Hadley climatology. After Belkin (2009).

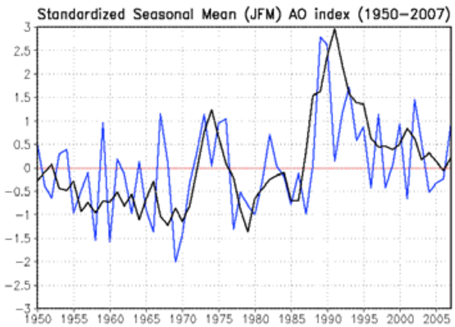

Figure XI-34.2b. The standardized seasonal mean Arctic Oscillation (AO) index during cold season (blue line) is constructed by averaging the daily AO index for January, February and March for each year. The black line denotes the standardized five-year running mean of the index. Both curves are standardized using 1950-2000 base period statistics (Climate Prediction Center, 2007).

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

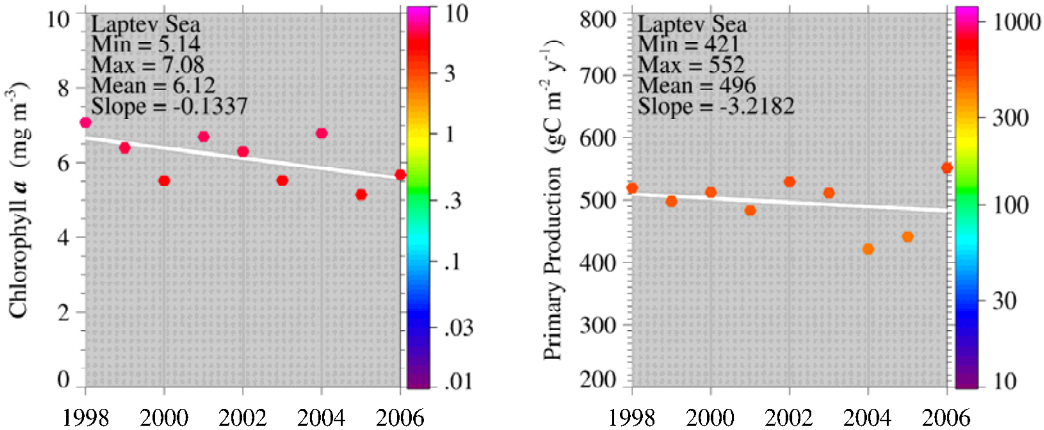

Figure XI-34.3 Laptev Sea LME trends in chlorophyll *a* (left) and primary productivity (right), 1998-2006. Values are colour coded to the right hand ordinate. Figure courtesy of J. O'Reilly and K. Hyde. Sources discussed p. 15 this volume.

I. Fish and Fisheries

The fish fauna of the Laptev Sea is extremely impoverished, as it is remote from both the Barents Sea to the west and Bering Sea to the east. As in the neighboring Kara and East Siberian seas, whitefish species (genus *Coregonus*), or 'sig' in Russian, form the bulk of the fisheries catch in this LME, but detailed records are available only from the lower reaches of the Lena and Yana rivers, and from Khatanga Bay for the years from 1981 to 1991 (Larsen *et al.* 1996). These data, amounting to about 3000 tonnes per year on average, do not show any consistent trend, unlike those from the Kara Sea. Pauly & Swartz (2007), in 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) and extrapolated forward, for 1992 to 2004, the mean catch of the last three years with data. An additional 20% of 'other fish' was included, following Larsen *et al.* (1996). The time series of the estimated catches are presented in Figure XI-34.4.

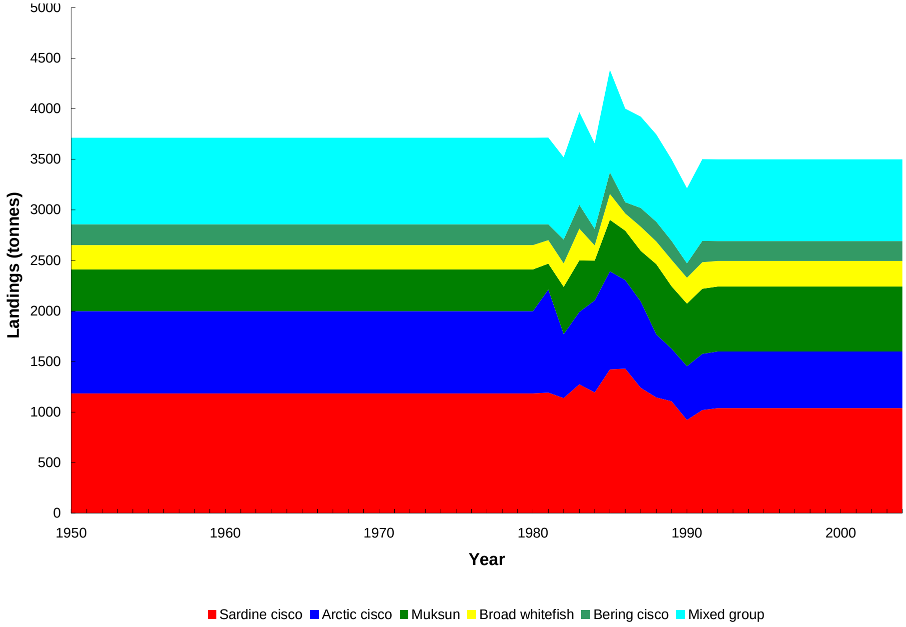

Figure XI-34.4. Total estimated catches (subsistence fisheries) in the Laptev Sea LME (see Pauly & Swartz 2007).

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

III. Pollution and Ecosystem Health

Pollution: Overall, pollution in the Laptev Sea LME was found to be slight and attributable mainly to chemicals and spills in localised coastal areas (UNEP 2005). The highest pollution levels are found in estuarine areas, in the Zarya Strait and near the Novosibirsk Islands. River runoff and atmospheric transport play an important role in marine pollution. Major sources of pollution on the shelf are the oil and gas industry, inland water and sea transport, ore mining and processing, accidental oil spills, and towns and settlements situated on the coast and along the rivers (UNEP 2005). The air, water and soil in industrial areas are polluted with harmful substances because of obsolete technologies and the lack of facilities for processing industrial waste. Some of the rivers are reportedly polluted with PCBs, DDT, heavy metals and viral contaminants. DDT, HCH, PCBs and heavy metals have been recorded in localised areas of the Laptev Sea LME (GOIN 1996a-d, Roshydromet 1997-2002). According to the chemical monitoring data of the Roshydromet network as well as observations by the Arctic Monitoring Centre, the phenol concentrations are higher than those in other Arctic seas, with the highest phenol concentrations attributed to floating and sunken wood being found in offshore areas.

Particularly severe climatic and ice conditions increase the threat of pollution from shipping and spills. In 1991, concentrations of petroleum hydrocarbons exceeded the Maximum Permissible Concentrations (MPCs) in some localised areas such as Tiksi Bay, Bugor-Khaya Firth and Olenek Bay. In 1992, concentrations of petroleum hydrocarbons varied within narrow limits (12-39 μgl^{-1}) but in Bugor-Khaya Firth (a shipping lane route) the maximum level reached up to 200 μgl^{-1} (GOIN 1996a). In 1993 the level of petroleum hydrocarbons did not exceed the MPCs (GOIN 1996b). In more recent years, the average concentration of petroleum hydrocarbons was 17.1 $\mu g l^{-1}$ in the open waters and up to 114 $\mu g l^{-1}$ in Bugor-Khaya Firth (GOIN 1996c-d, Roshydromet 1997-2002).

Habitat and community modification: There are no records of serious habitat loss in the region, but there is evidence of slight degradation in some localised areas because of pollution (UNEP 2005). The ecosystem state in the open sea as a whole can be characterised as favourable. The few ecosystem health issues include endangered marine species as well as the fragile marine ecosystem, which is slow to recover from perturbations, and the thinning polar ice pack.

IV. Socioeconomic Conditions

Economic activity in the Laptev Sea LME focuses on the exploitation of oil and natural gas, although there are fewer oil and gas reserves in this LME than in the other Siberian LMEs. Vast coastal areas remain practically unaffected by human activity. There are relatively low population densities in the coastal areas and the few small settlements are separated by long distances. In the entire Far Eastern Federal District of the Russian Federation, of which the Laptev Sea coastal area is a part, the population density is approximately one person per square kilometre and is currently declining. As a result, the environmental impact of these populations is considered to be low. (See the Chukchi Sea LME for more information.)

V. Governance

Special measures for the protection of the marine environment and the prevention of pollution in the Arctic areas adjacent to Russia's northern coast were adopted in the Soviet Era. These provided for special navigational rules on that coastline. There remain questions pertaining to the legal status of the Arctic areas. During Soviet times, the Laptev 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. See the Barents Sea LME (Chapter XIII-36) for more information on governance.

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