

# XI-30 Beaufort Sea: LME #55

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The Beaufort Sea LME is a high-latitude LME bordered by northern Alaska and Canada. It has a surface area of about 770,000 km<sup>2</sup>, of which 0.02% is protected, and contains 0.1% of the world's sea mounts (Sea Around Us 2007). An Arctic climate and extreme environment characterise the LME, which is driven by major seasonal and annual changes in Arctic climate conditions and is ice-covered for most of the year. The anticyclonic Beaufort Gyre forms a clockwise drift pattern. Carleton Ray & Hayden (1993), describe marine biogeographic provinces of the Bering, Chukchi and Beaufort Seas.

## I. Productivity

During much of the year light penetration is limited because of ice cover. Productivity is relatively high only in the summer when the ice melts. As a whole, the Beaufort Sea is considered oligotrophic. However, the coastal region supports a wide diversity of organisms, some of which are unique to this coast. The Beaufort Sea coastal areas provide habitat for ducks, geese, swans, shorebirds and marine birds. Many species of birds and fish rely on river deltas, estuaries, spits, lagoons and islands in the coastal waters for breeding, food, shelter and rearing their young. The Beaufort Sea LME is considered a Class II, Moderately productive ecosystem (150-300 gCm<sup>-2</sup>yr<sup>-1</sup>). An important question is how this productivity might change under an altered climatic regime. Melnikov et al. (2002) compared data from 1997-1998 with older data from 1979-1980 to find a drastically impoverished fauna of late. This change may have been associated with the high phase of the Arctic Oscillation in the early 1990s, accompanied by increased melting, runoff increase, and freshening of the upper layer. As a result, diatoms became scarce, replaced by freshwater green algae, while nematodes, copepods, amphipods and turbellarians all disappeared. It becomes clear that the biological community response to global change is most likely in the regions, where the sea ice retreat is rather remarkable, e.g., in the region of Beaufort Gyre. For data on selected invertebrates, fishes, birds and mammals, see Carleton Ray & Hayden (1993).

**Oceanic fronts** (Belkin et al. 2009): The Shelf Break/Shelf-Slope Front (SSF) is the most robust front within this LME (Figure XI-30.1). This front extends along the shelf break and upper continental slope. The front's stability is at maximum where the shelf break is best defined and where the upper slope is the steepest, e.g. off Cape Bathurst in the Canadian Beaufort Sea (Belkin *et al.*, 2003; Belkin *et al.*, 2009). This place is well known as the site of Cape Bathurst Polynya and also a "hot spot" of marine life where sea birds and marine mammals congregate. Transient fronts form at the dynamic boundary of the Mackenzie River plume and also within this plume (Belkin *et al.* 2009).

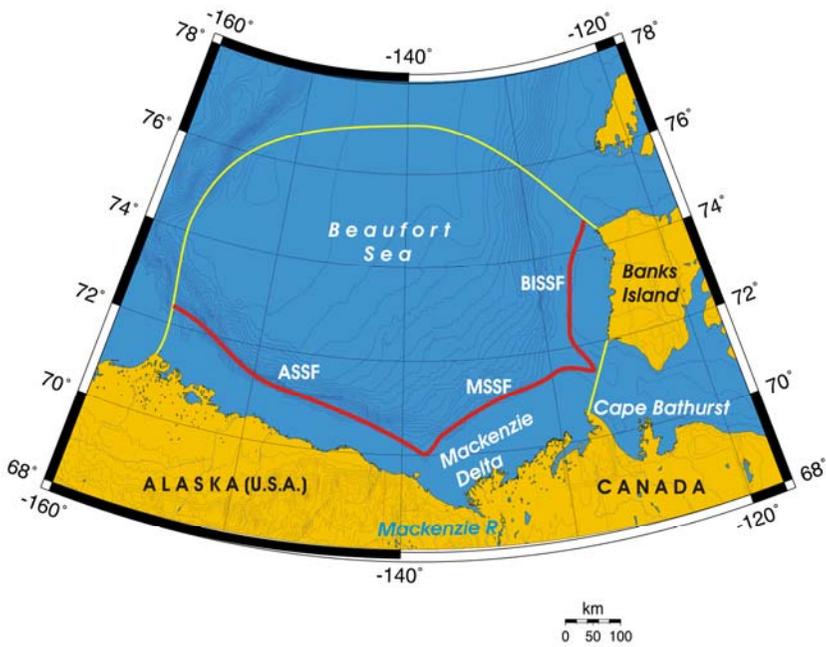


Figure XI-30.1. Fronts of the Beaufort Sea LME. ASSF, Alaskan Shelf-Slope Front; BISSF, Banks Island Shelf-Slope Front; MSSF, Mackenzie Shelf-Slope Front. Yellow line, LME boundary. After Belkin et al. (2009).

**Beaufort Sea LME SST** (after Belkin, 2009)

Linear SST trend since 1957: 0.17°C.

Linear SST trend since 1982: 0.34°C.

The Beaufort Sea warming was slow-to-moderate. Its annual variability was rather small, <0.5°C. The only significant event occurred in 1998, when SST peaked at -0.6°C, a whole degree above the all-time, 1974 minimum of -1.6°C. A comparison of the SST time series with the Arctic Oscillation (AO) index (Climate Prediction Center 2007) suggests a strong correlation between SST and the AO index, with negative SST anomalies corresponding to positive values of AO index.

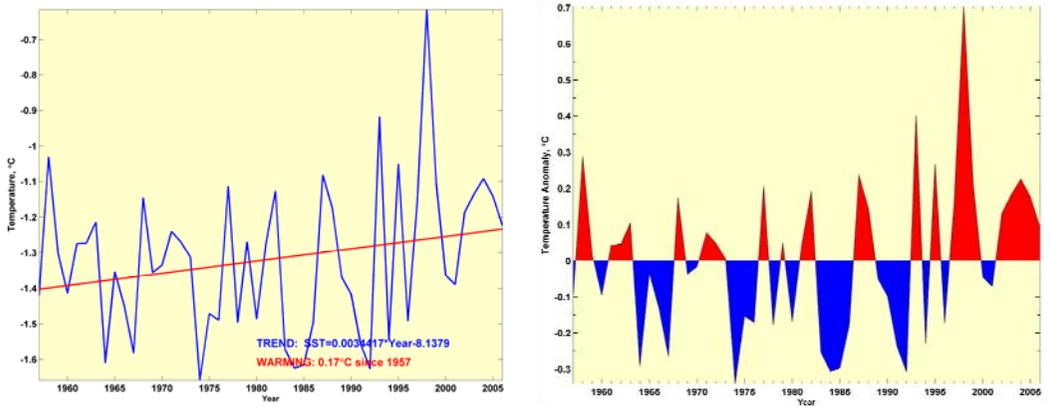


Figure XI-30.2a. Beaufort Sea LME Annual Mean Sea Surface Temperature (SST) (left) and Annual SST anomalies (right), 1957-2006, based on Hadley climatology. After Belkin. (2009).

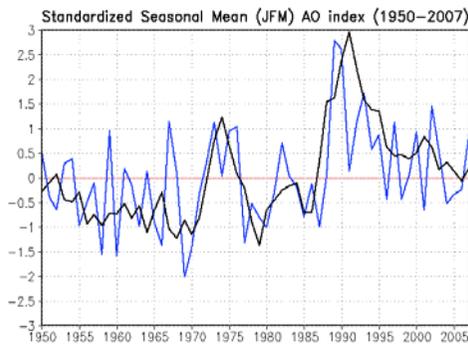


Figure XI-30.2b. The standardized seasonal mean Arctic Oscillation (AO) index during cold season (blue line) is constructed by averaging the daily AO index for January, February and March for each year. The black line denotes the standardized five-year running mean of the index. Both curves are standardized using 1950-2000 base period statistics (Climate Prediction Center, 2007).

**Beaufort Sea LME Chlorophyll and Primary Productivity:** The Beaufort Sea LME is considered a Class II, moderately productive ecosystem ( $150\text{-}300\text{ gCm}^{-2}\text{yr}^{-1}$ ).

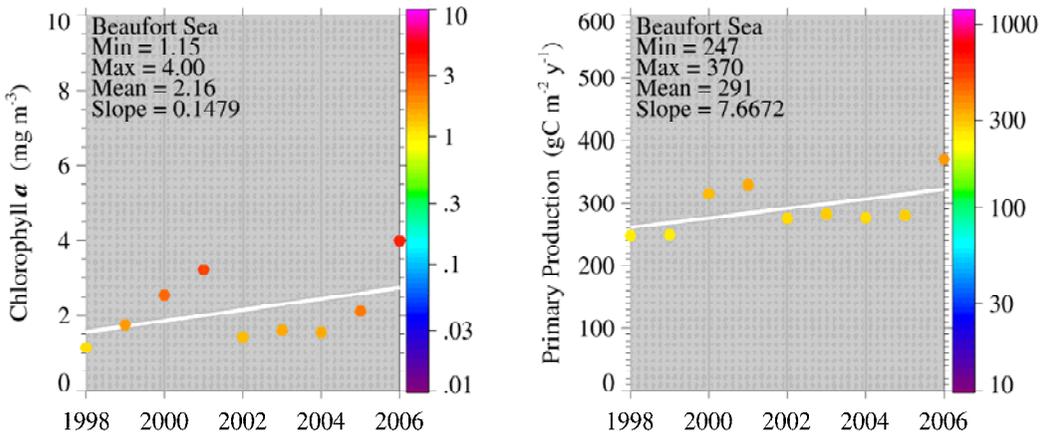
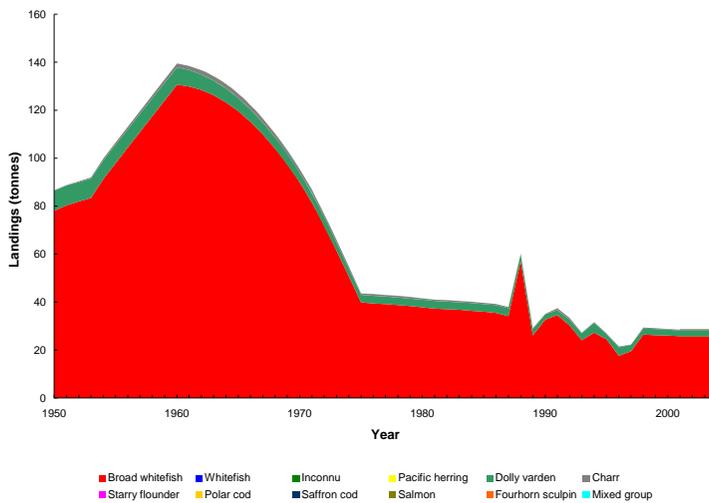


Figure XI-30.3. Beaufort Sea LME trends in chlorophyll  $a$  and primary productivity, 1998-2006. Values are colour coded to the right hand ordinate. Figure courtesy of J. O'Reilly and K. Hyde. Sources discussed p. 15 this volume.

## II. Fish and Fisheries

NOAA statistics on Alaska in 'Our Living Oceans' apply to all of Alaska, without a specific statistical breakdown for the U.S. section of the Beaufort Sea LME. For statistics on the beluga and other marine mammals in the Beaufort Sea, see NOAA (1999). There are three coastal communities (Tuktoyaktuk, Sachs Harbour and Kaktovik) and two inland communities (Aklavik and Inuvik) that make use of the Beaufort Sea, largely for subsistence, but also some commercial fisheries occur in Canadian waters. Catches in 1950 were estimated to be approximately 167 tonnes before peaking in 1960 at approximately 255 tonnes and in 2001 catches were estimated at approximately 58 tonnes. Important species include Dolly varden (*Salvelinus malma*), whitefish (Coregonidae) and two other species, Inconnu (*Stenodus leucichthys*) and Pacific herring (*Clupea pallasii*), of lesser importance.



**Figure XI-30.4. Total estimated catches (subsistence fisheries) in the Beaufort Sea LME (Sea Around Us 2007)**

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

The benthic offshore community includes Arctic cod, saffron cod, eelpouts and sculpins (Frost and Lowry 1983; Moulton and Tarbox 1987; Barber *et al* 1997; Jarvela and Thorsteinson 1999). Arctic cod is a particularly important component of the food web of the Beaufort Sea because they are prey for seals, seabirds and beluga whales (Bradstreet *et al.* 1986). Smelt are thought to be one of the most common pelagic marine fish in the Beaufort Sea and are prey for beluga whales, arctic cod and marine birds (Norton and Weller 1984). Large winter aggregations of Arctic cod have been recently discovered hydroacoustically under sea ice cover in Franklin Bay, SE Canadian Beaufort Sea (Benoit *et al.*, 2008). The estimated total biomass of cod would amply satisfy the requirements of predators, mostly seals. Thus, “dense accumulations of Arctic cod in embayments in winter likely play an important role in structuring the ecosystem of the Beaufort Sea.” (Benoit *et al.*, 2008).

### III. Pollution and Ecosystem Health

Valette-Silver, M.J. Hameedi, D.W. Efurud and A. Robertson reported in 1999 that, “surficial sediments in the western Beaufort Sea contained generally high concentrations of arsenic (up to 58 ppm as corrected for grain size), very low amounts of organo-chlorine compounds and concentrations of total polycyclic aromatic hydrocarbons (PAHs) ranging from 160 to 1100 ng/dry weight. Invertebrates contained higher concentrations of total PAHs than fish, with naphthalene being the largest contributor. “Diagnostic ratios of various PAH compounds in our samples do not suggest crude oil as the main source of PAHs.” Other sources of PAHs to the region include rivers outflow, coastline erosion, oil seeps, diagenesis, and long-range atmospheric transport. “Organochlorine contaminants were consistently found in our samples at concentrations generally lower than those found in other parts of the United States.” Cesium (Cs) was found in measurable amounts in all sediments and biota samples. Isotopic ratios showed that radionuclides originated most likely from global fallout. Compared to other coastal areas off Alaska, the Arctic, and the conterminous United States, Beaufort Sea contamination appears generally low.”

There is increasing global concern regarding the effect of changes in the Arctic climate on fish, marine mammals and associated wildlife, and regarding the socioeconomic impacts of these changes. Changes in water flow, the transport of nutrients through the Bering Strait and the loss of ice habitat caused by global warming will have an effect on all the living resources of this LME. Oil and gas exploration, extraction and transport, and new drilling projects targeting oil and gas in the Alaskan Beaufort Sea require constant monitoring. Recommended impact assessments include analyses of potential mortality in the event of spills, damage to food sources, production-related changes in marine mammal distribution, movement, and abundance, and additionally, the risks and effects of exposure of native people to contaminants in whales and other marine mammals from the oil industry. Pollution and acoustical disturbance from vessel traffic on the proposed Northern Sea Route are also concerns.

#### **IV. Socioeconomic Condition**

Economic activity is mostly concerned with the exploitation of natural resources (petroleum, natural gas, fish and seals). Fishing contributes to the economy and provides protein for the region's native people. The Inupiat catch fish and bowhead whales, while the Inuvialuit catch several species of marine mammals. Ringed seals were once important to the local cash economy, but the market for seal pelts has largely disappeared. Whaling, however, continues to be a key subsistence activity. Oil has been discovered in Prudhoe Bay, but offshore oil production costs are higher in the Arctic than elsewhere. The Northstar Project targets oil in the Alaskan Beaufort Sea, but scientists recommend that it should consider native hunters and consumers of whales in the area. Whales and other marine mammals are vulnerable to contaminants from the oil industry. Protection of the region's lifestyle is a major socioeconomic theme, as is the need to protect and preserve the Arctic wildlife, its environment and biological productivity.

#### **V. Governance**

The Beaufort Sea LME is bordered by Alaska (USA), the Yukon Territory, the Inuvik Region and part of the Northwest Territories (Canada). There are transboundary issues that need to be addressed by both countries. Fisheries governance in Alaska comes under the Alaska Department of Fish and Game. In Canada, self-government is being negotiated by two native groups, the Inuvialuit and Gwich'in, to ensure that they retain control over their inherent rights and preserve their cultural identity and values within a changing northern society. A Beaufort Sea Beluga Management Plan was developed in 1993 by the Fisheries Joint Management Committee. The goals of the plan were to maintain a thriving population of beluga whales and a sustainable harvest of beluga for the Inuvialuit people. In this volume, the Barents Sea LME (Chapter XIII-36) contains additional information on Arctic governance.

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