Lena River Delta (Russia)

118

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Contents

Abstract

The Lena delta is one of the world's largest river deltas (32,000 km^2) with average annual discharge of 513 km^3, 6,500 km of distributaries and about 30,000 lakes (predominantly of thermokarst and erosion origin). Mires consist mostly of vast areas of bogs with low-centered polygons and rarely, hillocky string bogs. Rivers, lakes, and bogs are normally interconnected by means of shallow tributaries and runoff troughs at the time of high water and spring to form a unified wetland complex. The coastal area abounds in small bays, while its lowest areas hold salty water lagoon lakes and foreland meadows. In coastal waters, materials washed away and carried over by distributaries have formed 0.5–5.0 m deep sandbars. The number of species of higher vascular plants, Bryopsida, lichens, fish, birds, and mammals is estimated at 316, 95, 51, 109, and 29 respectively. The endemic *Salvelinus jakuticus* inhabits the delta. Some species are presented by several

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ecological forms, e.g., four forms of the muksun *Coregonus muksun* are identified to occupy various ecological niches and have marked morphological differences. In 1985, the state natural zapovednik "Ust-Lenskyi" was established with a total area of 14,330 km^2. The delta has been included in the Ramsar shadow list. Being a place of fish reproduction and fattening, it supports the long-term viability of significant populations or stocks of the Siberian sturgeon *Acipenser baeri* and 12 salmonid species. Fishing technologies applied currently in the area are accompanied by mass take of the whitebait. The salmonid harvest has decreased 2.5 times from the 1940s up to the late 1970s.

Keywords
Tundra · Alluvial terrace · Lake · Lagoon · Mire · Zapovednik · Fishery · Siberian sturgeon · Salmonid

Introduction

The Lena delta (Fig. 1) is one of the world's largest river deltas. Located in northeastern Asia at the Laptev Sea coast (63°35′N, 125°9′E, altitude 1–114 m), the delta occupies a 400 × 100 km fan-shaped area with a total area of 32,000 km^2. Scientific data on the Lena delta's natural conditions were obtained in the early nineteenth century. The first special study of the delta was ichthyological research undertaken by the State Research Institute for Lacustrine and Riverine Fishery and Chief Directorate of the Northern Sea Route in the 1930s–1940s. A comprehensive biological study was carried out by the Yakut Biology Institute (USSR Academy of Science) alongside the West Siberian Survey Agency in designing the Ust-Lensky zapovednik (the highest federal level of protected area in Russia, usually referred to as a strict nature reserve) in 1982–1983. Following the zapovednik's establishment, studies were conducted by its scientific departments and the international biological station "Lena-Nordenscheld" in cooperation with Russian and foreign academic institutions and within international projects (Labutin et al. 1985; Grigoriev et al. 2000; Gukov 2001; Kirillov 2002).

Hydrology

The annual discharge reaching the delta averages 513 km^3 with its maximum in June and minimum in winter. The river breaks down into numerous branched distributaries by Tit-Ary island, the largest and longest (more than 100 km) of which are the Arynskaya, Trofimovskaya, and Bykovskaya. The latter two channels receive 90% of the annual water runoff. Only the Bykovskaya and Olenekskaya distributaries are navigable. The ice cover forms in October and lasts 220–230 days and is up to 2.0–2.5 m thick by spring breakup which occurs in late May. Ice drift is often accompanied by jams resulting in flooding of vast wetlands and terraces above

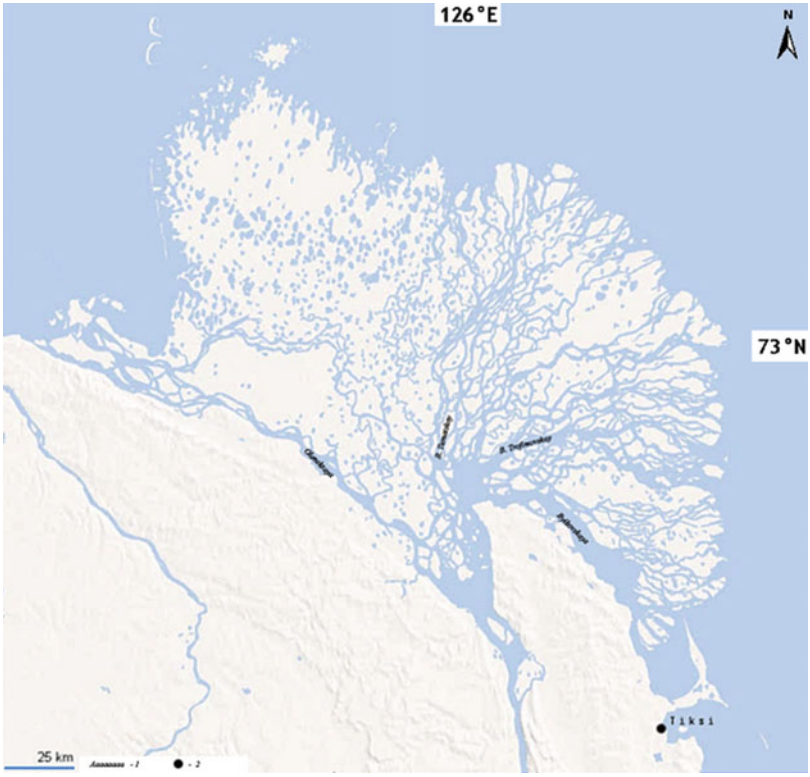

Fig. 1 Lena delta. *1* main distributaries, *2* villages (V. Degtyarev © Rights remain with the author)

flood plains. The fluctuation in water level amplitude decreases from 15 m to 6–9 m closer to the sea. Significant water level fluctuations (the maximal coastal amplitude being 2.5 m) are induced by onshore winds that often reach storm velocities. Mechanical and warming effects of the water runoff and abrasion bring about intensive erosion of delta distributary banks, formed by ice-saturated frozen rocks, and their resedimentation.

Wetland Ecosystems

The Lena delta is a lowland sloping slightly eastwards, consisting of ancient marine and late Pleistocene and Holocene alluvial terraces formed by permafrost rocks. That structure defines the distribution of the main wetness regimes: wet polygonal tundra on the first terrace, dry sparsely vegetated regime on the sandy second terrace, and the medium wetness regime of the third Yedoma terrace (Widhalm et al. 2015).

Water and mire areas include river flood plains, lake, and bog systems, as well as a coastal area. The total length of the delta distributaries reaches 6,500 km. Most of the delta is made up of shallow distributaries with slow currents and terraced valleys forming spits and sandbars in the sandy riverbed. About 30,000 lakes (predominantly of thermokarst and erosion origin), 22,000 of which are concentrated in its western part, are distributed over the delta. The greatest percentage (90%) of the lakes have an area of less than 0.25 km^2 and only 100 have a water surface exceeding 10 km^2. Mires consist mostly of vast areas of bogs with low-centered polygons and rarely, hillocky string bogs. Rivers, lakes, and bogs are normally interconnected by means of shallow distributaries and runoff troughs at the time of high water and spring snow melting to form a unified wetland complex. The coastal area abounds in small bays, while its lowest areas hold salty water lagoon lakes and foreland meadows. In coastal waters, materials washed away and carried over by distributaries have formed 0.5–5.0 m deep sandbars (Samoilov 1952; Zalogin and Rodionov 1969; Labutin et al. 1985; Grigoriev et al. 2000; Gukov 2001).

Biodiversity

The number of species of higher vascular plants, Bryopsida, and lichens occurring in the delta is estimated at 316, 95, and 51, respectively. Five types of vegetation and up to 100 plant communities have been identified. In delta waters 153 algae species have been found, and 43 fish species have been registered including marine, semi-migrating, migrating, and lacustrine species. The endemic *Salvelinus jakuticus* inhabits the delta. Some species are presented by several ecological forms, e.g., four forms of the muksun *Coregonus muksun* are identified to occupy various ecological niches and have marked morphological differences. Birds are represented by 109 species, of which 64% are water birds (mostly *Anseriformes* and *Charadriiformes*), the significant part of which find favorable conditions for breeding and molting. Mammals are represented by 29 species, of which less than 10 are resident. Historically, among marine mammals, the walrus *Odobenus rosmarus* and polar bear *Ursus maritimus* had close affinity with the delta (Labutin et al. 1985; Krivenko 2000; Gukov 2001; Kirillov 2002; Solomonov and Lukina 2009).

Conservation Status

In 1985, the state natural zapovednik "Ust-Lenskyi" was established in the Lena delta and its lower reaches with a total area of 14,330 km^2 consisting of two divided sectors ("Deltovyi" – 13,000 km^2 and "Sokol" – 1,330 km^2) and a buffer zone of 10,500 km^2. The delta has been included in the Ramsar shadow list. In the east of the delta is located the Lena delta regional reserve, established in 1996 (Krivenko 2000; Solomonov and Lukina 2009).

Ecosystem Services

The discharge of the Lena River divided among the distributaries of the delta has a significant effect on the Laptev Sea coastal zone. It results in the formation of vast freshwater and desalted zones. Being places of fish reproduction and fattening, these areas support the long-term viability of significant populations or stocks of the Siberian sturgeon *Acipenser baeri* and 12 salmonid species. Almost to the mid-twentieth century, the mode of life of indigenous peoples occupying the Lena's lower reaches was centered on utilization of the fish including their use in sled dog breeding. Currently, these stocks provide a major input into a substantial and commercial fishery in the Lena delta and its lower reaches and, correspondingly, secure employment of a significant amount of local people in the region's fish-processing industry. Up to the 1980s a significant part of the Bulunsky population of the reindeer *Rangifer tarandus* populated the delta and adjoining territories, but overhunting resulted in a 20-fold decrease and the species is currently not exploited here (Labutin et al. 1985; Krivenko 2000; Kirillov 2002).

Transportation of goods within the Lena basin and the Anabar, Yana, Indigirka, and Kolyma river basins is through the major navigable waterways of the Bykovskaya and Olenekskaya distributaries to the sea port of Tiksi, the outlet to the Northern Sea Route.

Threats and Future Challenges

Fishing practices are unsustainable as they do not adequately take into account basic scientific rationale for sustainable harvesting (current practices include overharvesting, high bycatch, high take in the desalted zone supporting the main stocks of salmonids for fattening). The salmonid harvest has decreased 2.5 times from the 1940s up to the late 1970s. Fishing technologies applied currently in the Lena delta are accompanied by mass take of the whitebait, being fished at a rate of up to 180 tonnes per 100 tonnes of conditioned fish taken. Intensive overfishing of recruitment stock makes it almost impossible to restore the delta stocks to any significant abundance values. An expected increase in navigation intensity will result in an acceleration of delta waterway erosion and levels of chemical and biological water pollution (Labutin et al. 1985; Krivenko 2000; Gukov 2001; Kirillov 2002).

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