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INFORMATION

Hydrologic–Hydrochemical Investigations in the Frontal Zone of the Gulf of Ob in September 2014

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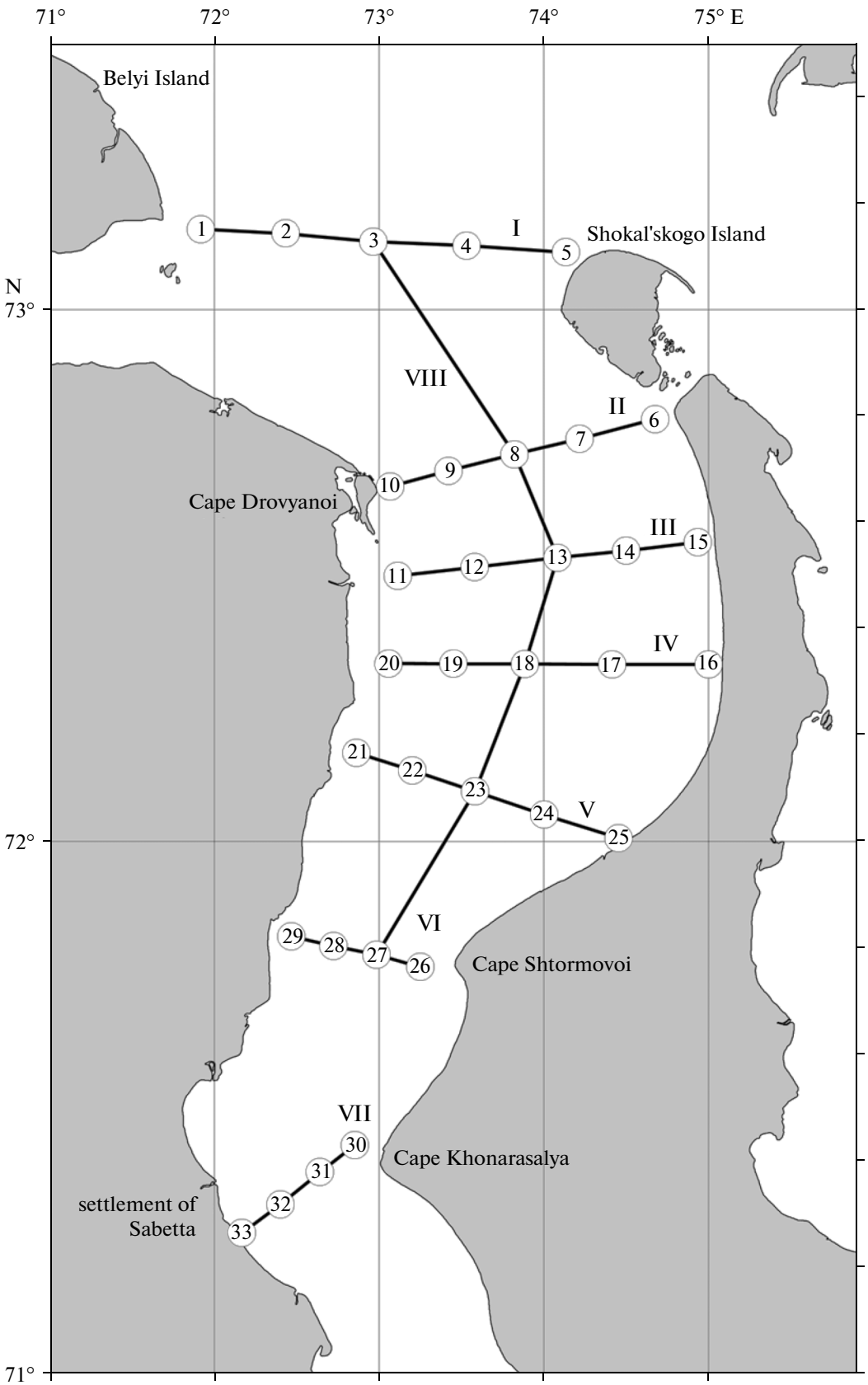
From September 13 to 21, 2014, the Russian Federal Research Institute of Fisheries and Oceanography (VNIRO) conducted a suite of hydrological–hydrochemical investigations in the frontal zone (characterized by active contact between river and marine waters) of the Gulf of Ob. The work was implemented in the framework of the program developed by the VNIRO in addition to the statutory requirements of industrial environmental control and monitoring, which are, in their order, implemented in the framework of the project "Construction of the Sea Port Objects in the Sabetta Settlement Area, Yamal Peninsula, Including the Construction of a Navigable Entrance Passage." For the period of investigation, the ordering organization (MEF Chistye Morya) provided a fishery vessel (*Briz* medium fishing freezer trawler).

The investigations were carried out in accord with the scheme of the hydrological–hydrochemical stations; the stations were located along seven cross sections in the northern Gulf of Ob: from the line joining Cape Shuberta on eastern coast of Belyi Island with the northern tip of Shokal'skogo Island to the traverse of the settlement of Sabetta. Two sections were located in the marine part of the gulf, north of the Ob bar; another two, in the river part, south of the bar; and the rest of the three sections completely covered the water area of the gulf above the bar (see figure). The number of stations in each sections was determined on the basis of bottom relief features and the factual (observed during the investigations) distribution of hydrological and hydrochemical parameters. In total, 33 stations were used, with some of them being performed twice in order to take the influence of weather on the environment into account.

Probing of water column was done by an YSI EXO-2 multiparametric CTD-probe with real-time control of measured parameters. A CTD-probe was also equipped with a pH-sensor and with a modern optical oxygen sensor. Water samples to determine the hydrological parameters were collected by a Van Dorn 5-L plastic bathometer from 87 horizons assigned after probing.

Hydrochemical analysis included the determination of the contents of dissolved oxygen, phosphate phosphorus, silicate silicon; nitrite, nitrate, and ammonia nitrogen; and total iron and organic carbon. Importantly, all hydrochemical parameters in the collected water samples were determined in ship-based laboratory immediately after samples collection; this undoubtedly increases the quality and accuracy of the investigations. Samples were treated by the techniques approved for the analysis of marine and fresh waters [6]. In the VNIRO stationary laboratory, we only treated samples for dissolved organic carbon (the TOC-VCPH instrument manufactured by Shimadzu company was used and the technique of high-temperature combustion was applied).

The performed investigations in the northern Gulf of Ob, in the zone of mixing of fresh water from Ob River and marine waters of the Kara Sea, are of high importance in both the applied and theoretical senses. The former is that the work in autumn 2014 is the latest in a series of investigations in the water area in natural conditions. The obtained results therefore reflect the background for estimating the changes in the ecosystem of the Gulf of Ob (these changes will unavoidably appear after the extensive artificial transformations of nature, or more precisely, after digging a 50-km navigable seaway about 300 m wide across the bar to join the deep marine basin and the river channel). In its theoretical aspect, the discussed investigations are the third, after the previous ones carried out in 2010 [4]. These investigations were aimed at studying the frontal zone of the Gulf of Ob, a key part of the complex gulf ecosystem. The first two expeditions revealed the state of the water environment in the periods of biological spring (immediately after ice retreat) and late autumn (before advance of ice), while the performed third expedition covered the intermediate, early autumn period. In the intermediate period, river flow still plays an important role in the frontal zone of the gulf and controls the entire upper profile above the salt-water cline (configuration of this cline is similar to its summer condition) [2]. In the water above the Ob bar,



Scheme showing the locations of cross sections (I–VII), longitudinal section (VIII), and the hydrologic-hydrochemical stations (1–33) in the northern Gulf of Ob.

higher concentrations of mineral nutrients are clearly observed: up to 72 μM of silicon silicate, up to 11.3 μM of nitrate nitrogen, and up to 10.1 μM of ammonia nitrogen. This takes place due to the destruction of freshwater diatom phytoplankton, which is transported by the current from the river part of the gulf (where it is produced in large amounts during biological spring) to the zone above the bar [1, 3]. We emphasize that the waters in the river part of the gulf in the studied period are highly depleted in biogenic elements (7–20 μM of silicon, 0–3 μM of nitrate nitrogen, and 1–2 μM of ammonia nitrogen). Thus, the midstream of the water flow of the Ob River above the frontal zone seemingly splits the zone with higher nutrient contents of in two. Analogously to the earlier studies [1, 3], the zone with maximal concentrations of regenerated nutrients was reported in the southeastern part of the gulf above the bar (stations nos 24 and 25), in a "flow shadow" where the effect of river discharge is minimal.

The important result of the autumn 2014 expedition is the recording of an intensive meridional (southward) surge: waters enriched in biogenic elements penetrated from the frontal zone along the eastern coast of the bay 50–60 km south, penetrating into the fresh water part of the gulf and shifting the river flow towards the western coast. A correct representation of this phenomenon explains how the northern, freshwater part of the gulf is enriched in nutrients and illustrates the process of the higher productivity zone in this water area.

Thus, the results of the autumn 2014 investigations in the northern Gulf of Ob have allowed us to verify and to develop the idea (proposed earlier by VNIRO researchers) of a high productivity zone formation in the Gulf of Ob, due to, in particular, the effect of the regeneration of nutrients in the frontal zone [1, 3, 5].

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