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Editorial

Observations and exploration of the Arctic's Canada Basin and the Chukchi Sea: The Hidden Ocean and RUSALCA expeditions

As one of the Arctic shelf seas, the shallow Chukchi Sea and its adjoining deep-sea area, the southern Canada Basin, are areas observed and predicted to be particularly influenced by climate warming (ACIA [Arctic Climate Impact Assessment], 2004). With several large previous research efforts on the Chukchi shelf and shelf break [e.g. OCSEAP (Hale, 1986), BERPAC (Tsyban, 1999), ISHTAR (McRoy, 1993), SBI (Grebmeier and Harvey, 2005) and a few studies in the Canada Basin (e.g. Arctic Ocean Transect 1994, SHEBA 1997/98)], an immense body of literature has accumulated in the last three decades. Nevertheless, there are still substantial gaps toward a solid understanding of biological diversity, ecosystem functioning and temporal variability of both these shelf and deep-sea systems. The biological, chemical and physical status quo of species inventories and ecosystem processes are essential benchmarks against which to measure responses due to climate change and projected increased human activities. To address these gaps, the US National Oceanographic and Atmospheric Administration (NOAA) supported two initiatives to improve baseline understanding of biological diversity in the Chukchi Sea, on the Chukchi Plateau and in the adjoining deep Canada Basin, as well as to better understand ecosystem processes on the Chukchi shelf.

RUSALCA

The Russian-American Long-term Census of the Arctic (RUSALCA), initiated by NOAA's Climate Program Office and the Russian Academy of Sciences, aims to collaboratively carry out long-term research to better understand causes and ecosystem consequences of climate change and the reduction of ice cover in Bering Strait and the Chukchi Sea. In these areas, steep thermohaline and nutrient gradients in the ocean coincide with strong atmospheric forcing (Aagard et al., 2006). Bering Strait as the only Pacific gateway into the Arctic Ocean is critical for heat flux between the Arctic and the world ocean and Herald Canyon in the north is the least known outflow area of shelf water and pelagic biota into the Arctic basin (Weingartner et al., 2005). Monitoring the flux of fresh and salt water and establishing benchmark information about the distribution and migration patterns of the pelagic and benthic biota in the Chukchi Sea and adjoining oceans are important information needed to establish a climate-monitoring network in this region (http://www.arctic.noaa.gov/aro/russian-american/). Particularly remarkable about the RUSALCA program is the coverage of both US and Russian waters, a logistical hurdle that few previous programs in the area have been able to overcome. The program plans to conduct ecosystem-scale cruises every 4–5 years, with an initial multidisciplinary cruise in 2004, and additional hydrographic surveys at annual intervals. Articles in this special issue report on leg 2 of the 2004 RUSALCA cruise onboard the Russian research vessel *Professor Khromov* from Nome to Nome (Alaska), 8–24 August. A total of 69 stations were occupied along three transects extending between Russia and Alaska and four high temporal-resolution transects across Herald Canyon (Fig. 1). The cruise combined 16 individual research projects of primarily bi-national science teams on physical oceanography, nutrient chemistry, pelagic and benthic biology, methane flux and atmospheric chemistry, and included the deployment of long-term moorings in the western part of the Bering Strait. Six articles in this issue report on some of the results of this work.

Investigation of water exiting the Chukchi shelf through Herald Canyon during RUSALCA 2004 revealed distinct parallel-flowing water masses in the southern part of the channel, which were mixed likely due to hydraulic activity at the northern end where water exited the canyon (Pickart et al., this issue). In addition to physical properties, nutrients, chlorophyll and primary productivity varied greatly over the RUSALCA domain (Lee et al., 2007). Zooplankton communities on the Chukchi shelf in 2004 were a mixture of holozooplankton and meroplanktic larvae, represented by six assemblages coinciding with prevalent thermohaline water mass characteristics (Hopcroft et al., this issue). Mitochondrial COI barcodes accurately discriminated and identified 43 known species of 10 taxonomic groups of Chukchi Sea and Canada Basin zooplankton (Bucklin et al., this issue). One of the numerically dominant genera in the Chukchi Sea, *Pseudocalanus*, consisted of three species, which also showed distinct spatial distribution patterns based on their biogeographic affinity (temperate, subpolar, Arctic) and water temperature (Hopcroft and Kosobokova, this issue), yet weight-specific egg production rates of all three species were similar. Like zooplankton, the inventory of fish (Mecklenburg et al., 2007) revealed that small demersal fishes and ichthyoplankton on the Chukchi shelf in 2004 also formed distinct regional assemblages (Norcross et al., this issue). These again coincided with temperature and salinity characteristics of major water masses, as well as with sediment type for small demersal fishes, resulting in a structure predominantly divided along a west–east gradient and less so along the south–north axis. Mean stable isotopic signatures in the benthic food web differed between the low-productive Alaska Coastal Water and the highly productive Anadyr Water (Iken et al., this issue). However, this difference was mainly driven by the isotopically

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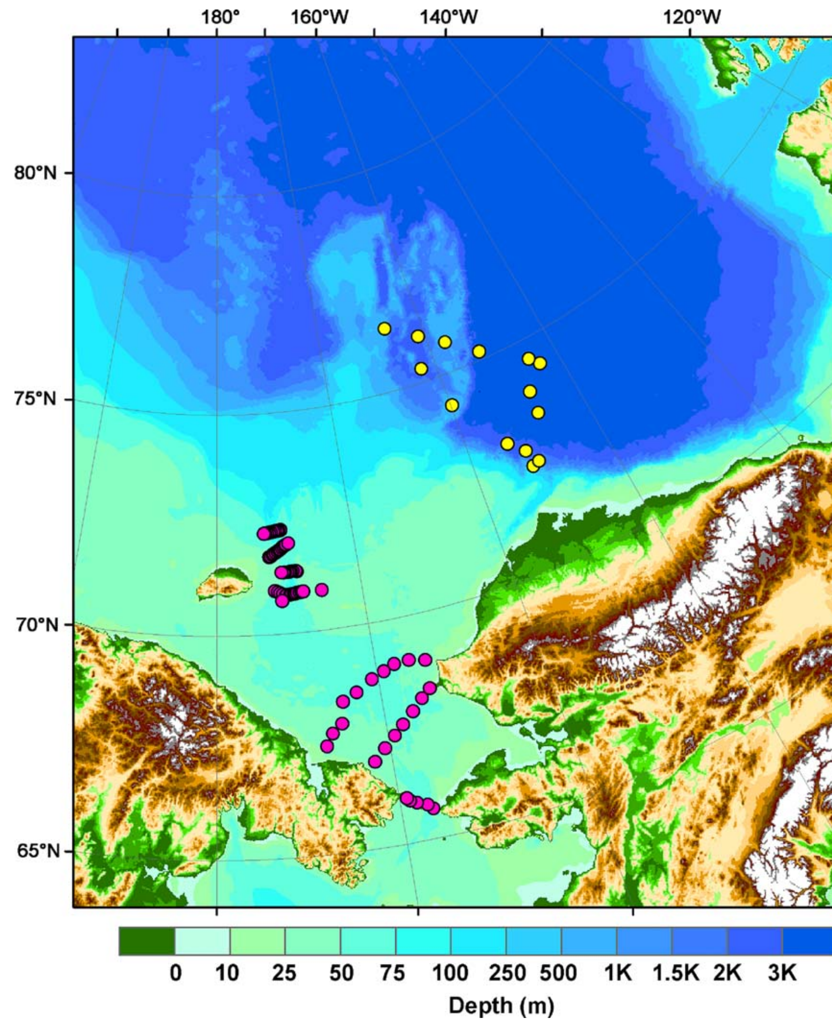

Fig. 1. Chukchi Sea and Canada Basin with sampling locations of leg 2 of the 2004 RUSALCA expedition (pink circles) and of the 2005 Hidden Ocean II expedition (yellow circles).

depleted particulate organic matter source in the Alaska Coastal Water, likely due to the influence of terrestrial materials, and food web length under different water masses was not different when isotopic differences in regional food sources were excluded.

Hidden Ocean II

The goal of the Arctic Ocean Hidden Ocean II initiative in 2005 (http://www.oceanexplorer.noaa.gov/explorations/05arctic/welcome.html), funded by NOAA's Office of Ocean Exploration, was to improve the biological baseline of the deep Canada Basin bordering the Chukchi Sea, one of the least explored regions in the Arctic Ocean. Receiving inflowing water from the Chukchi Shelf, the Canada Basin is also influenced by the nutrient-low waters of the Beaufort Gyre and, in its southwestern area, the bathymetry is highly complex. The southwestern Canada Basin, the focus area of the study, has also been an area of accelerated and intense ice melting in the last decade (Stroeve et al., 2007) with anticipated consequences for physical and biological processes and their linkages. Building on a pilot cruise by the same funding body conducted in 2002 (Gradinger and Bluhm, 2005), the main objective of the 2005 expedition was to obtain a biological census of all ocean realms (ice, pelagic, benthic), and to concurrently characterize the environmental conditions in these realms. This multidisciplinary, international research program was conducted during 27 June–26 July, 2005 onboard the US Coast Guard Icebreaker *Healy* from Barrow to Barrow (Alaska). It included studies on nutrient and food web dynamics, sea ice biota, pelagic and benthic communities, and marine mammal observations. The approach was to combine traditional sampling tools such as ice cores, pelagic nets and benthic box cores with modern imaging, acoustic and molecular tools to better evaluate spatial distribution patterns and diversity of organism groups typically underrepresented or missed in traditional sampling approaches. Fourteen stations were sampled along the cruise track from Point Barrow north up to 71°N–151°W in the Canada Basin, then north-westward onto the Northwind Ridge and Chukchi Plateau (76°N–163°W) with return back to Point Barrow (Fig. 1). Six articles in this issue report results from many of the studies conducted during this expedition.

In the Canada Basin, level sea ice during the Hidden Ocean expedition in 2005 contained ice meiofauna dominated by Acoela, Nematoda and Harpacticoidea, with low abundances likely due to flushing of the sea ice during advanced melting (Gradinger et al., this issue). Abundances of ice meiofauna and under-ice amphipods were significantly higher along deep-reaching keels of sea ice ridges, which likely protrude into higher-salinity water than encountered under level ice. The zooplankton community in the Canada Basin sampled with net tows contained 111 species dominated in abundance and diversity by copepods (Kosobokova and Hopcroft, this issue). Overall community structure was distinctly depth-stratified, and composition was similar to that found in other Arctic basin regions, with the exception of several Pacific expatriate copepod species present. More than 50 species of gelatinous zooplankton, mostly Cnidaria, were observed using a deep-water ROV with imaging and collecting ability (Raskoff et al., this issue). These observations included several new species and range extensions (e.g., a new narcomedusa and several unidentified cydippid ctenophores), with the depth-stratified distribution showing that shallower stations were dominated by siphonophores and ctenophores, while deeper stations were dominated by medusae. Gelatinous zooplankton fine-scale distribution patterns were further documented for the upper 100 m waters (Purcell et al., this issue). Large predatory scyphomedusae were most dominant in water depth coinciding with the chlorophyll maximum layer and highest copepod biomass, while other smaller species of cnidarians and ctenophores occurred directly underneath the sea ice. Consumption rates of copepods by various ctenophores was high and can likely exhibit a structuring force on the copepod community structure (Purcell et al., this issue). A combination of a benthic camera, trawls and box cores was used to analyze megabenthic and macrobenthic community composition, respectively (MacDonald et al., this issue). Abundance, biomass and diversity of benthic macrofauna declined with increasing water depth and clustered into groups characterized by depth and location (abyss, slope, Chukchi Cap). High abundance of the holothuroid *Kolga hyalina* characterized a presumed pockmark location on the Chukchi Cap, but no evidence for chemosynthetic activity was found. Descriptions of several of the at least six new invertebrate species records are published elsewhere or are in progress. During opportunistic visual surveys in the Canada Basin, six marine mammal species were encountered in relatively low numbers. No evidence of the cetacean target species, the bowhead whale, was acoustically recorded during the expedition, but some beluga whale calls were recorded (Moore et al., this issue). In contrast, permanent recordings closer to shore (northeast of Barrow) during 2003–2004 detected frequent bowhead calling activity mostly in October and then again in April.

Summary

Together, these 12 articles contribute significantly to the advancement of our understanding of the Amerasian Arctic. In particular, they form a detailed inventory of the biological communities in this region, describe the factors structuring the observed communities, and contribute essential baseline data against which any future surveys can be evaluated.

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