



Research papers

The offshore northeastern Chukchi Sea, Alaska: A complex high-latitude ecosystem



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ARTICLE INFO

Article history:

Received 5 July 2012

Received in revised form

8 February 2013

Accepted 12 February 2013

Available online 18 March 2013

Keywords:

Alaska
Chukchi Sea
Community
Ecosystem
Hanna shoal
Oceanography

ABSTRACT

We conducted an interdisciplinary ecological study in and near 3 nearby proposed exploratory oil and gas prospects in the offshore northeastern Chukchi Sea during the open-water seasons of 2008–2010. This region exhibits a classical pelagic–benthic dichotomy of food-web structure in ecological function. The Klondike study area borders the eastern edge of the Central Channel and functions as a pelagic-dominated ecosystem, whereas the Burger study area lies south of Hanna Shoal and functions as a benthic-dominated ecosystem. The Statoil study area, which is located north of Klondike and northwest of Burger, has both pelagic and benthic attributes, although it is more like Burger than like Klondike. Klondike has lower benthic density and biomass, a higher biomass of oceanic zooplankton, and more fishes and planktivorous seabirds than does Burger, which has benthic communities with high density and biomass, primarily neritic zooplankton, and higher densities of benthic-feeding marine mammals than Klondike; Statoil has characteristics of both ecosystems. Patterns of sea-ice retreat vary inter-annually; in some years, much of the northeastern Chukchi is ice-free by mid-May, leading to pelagic and ice-edge phytoplankton blooms, whereas heavy ice cover in other years leads to substantial within-ice production. The characteristics of this region during the open-water season are not consistent among years, in that Bering Sea Water impinges onto all study areas only in some years, resulting in interannual variation in the distribution and abundance of zooplankton, planktivorous seabirds, and pelagic-feeding seals. These interannual variations alter several aspects of this pelagic–benthic dichotomy, and some aspects of this region suggest unusual structure (e.g., replacement of benthic-feeding fishes in some areas by predatory invertebrates, a lack of benthic-feeding seaducks).

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1. Introduction

The Chukchi Sea forms an ecological transition zone between the boreal–arctic Bering Sea and the high-arctic Arctic Ocean (Grebmeier et al., 2006a). The high productivity of this region has been seasonally exploited by seabirds, marine mammals, and indigenous peoples for millennia and has been exploited commercially for selected species for nearly 2 centuries (Thompson and Person, 1963; Bockstoce, 1986). Although oceanographic

investigations in the region stretch back nearly a century, sampling has been sporadic and somewhat haphazard overall and most often has focused on specific components of the ecosystem until recent decades (Hopcroft et al., 2008). This absence of a systematic research program in the northeastern Chukchi Sea differs from that seen in the southern Chukchi (Walsh et al., 1989), possibly due to challenges associated with persistent seasonal ice-cover farther north. The only systematic interdisciplinary oceanographic sampling in and near the northeastern Chukchi was conducted during the Outer Continental Shelf Environmental Assessment Program of the 1970s to the early 1990s (e.g., Feder et al., 1994a, 1994b; Barber et al., 1997), the Western Arctic Shelf–Basin Interactions (SBI) Project of 2002–2004 that focused on the Chukchi shelf-break (e.g., Grebmeier and Harvey, 2005), the

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Russian–American Long-term Census of the Arctic from 2004 to the present (RUSALCA; <http://www.arctic.noaa.gov/aro/russian-american/>), and the Chukchi Sea Offshore Monitoring in the Drilling Area—Chemical and Benthos study of 2010 to the present (COMIDA—CAB; e.g., Dunton et al., 2012). As a consequence of the absence of a long-term, systematic research program, data collected to date have led to an imperfect understanding of how the extensive continental shelf in the northeastern Chukchi functions ecologically. This lack of understanding of how this system functions results in uncertainty about a region that is beginning to experience the effects of climate change (Grebmeier et al., 2006b), making predictions about potential effects of change on this area difficult at a time when it is simultaneously undergoing exploration for oil and gas reserves.

To increase our understanding of the northeastern Chukchi Sea ecosystem, we conducted an interdisciplinary ecological study in 2008–2010 in and near 3 proposed exploratory oil and gas prospects during the open-water season. Prior to the beginning of this study, available information suggested that the northeastern Chukchi would be a fairly simple ecosystem. It is a broad, shallow arctic shelf that appears to be a primarily benthic-dominated system without much spatial variation in ecology this far north (Grebmeier et al., 2006a). Although not all marine taxa show latitudinal variation in diversity (Gobin and Warwick, 2006), this area's high-latitude setting also suggested that it would be a fairly simple shelf ecosystem with limited diversity for several taxa (Levinton, 1982; Kendall and Aschan, 1993; Power, 1997; Willig et al., 2003; Hillebrand, 2004; Mecklenburg et al., 2011). Here, we

use the information collected by the Chukchi Sea Environmental Studies Program during 2008–2010 and presented in the other papers in this collection (Aerts et al., in press; Blanchard et al., in press-a, in press-b; Gall et al., this issue; Norcross et al., in review; Hannay et al., in press; Mathis and Questel, in review; Questel et al., this issue; Weingartner et al., in press) to describe the main ecological features of the offshore northeastern Chukchi Sea and to propose a conceptual model of the oceanography and ecology of this region. We propose that the different origins and characteristics of the three main water-masses (Bering Sea Water [BSW], Meltwater [MW], and Winter Water [WW]; *sensu* Coachman et al., 1975) in the study region, in conjunction with the physical oceanography of the area, create two adjacent ecosystems that have different biological and chemical properties, patterns of production, and food-web structure. In addition, we discuss several unusual aspects of the offshore northeastern Chukchi ecosystem.

2. Methods

2.1. Study area

This study was conducted on the continental shelf of the northeastern Chukchi Sea, Alaska, south and southwest of Hanna Shoal (Fig. 1). The general area is a shallow, broad shelf that ranges primarily from ~35 m to ~45 m in depth. Hanna Shoal forms the shallowest feature in the area, being only ~26 m deep at the summit. The study area lies ~100–200 km northwest of the village

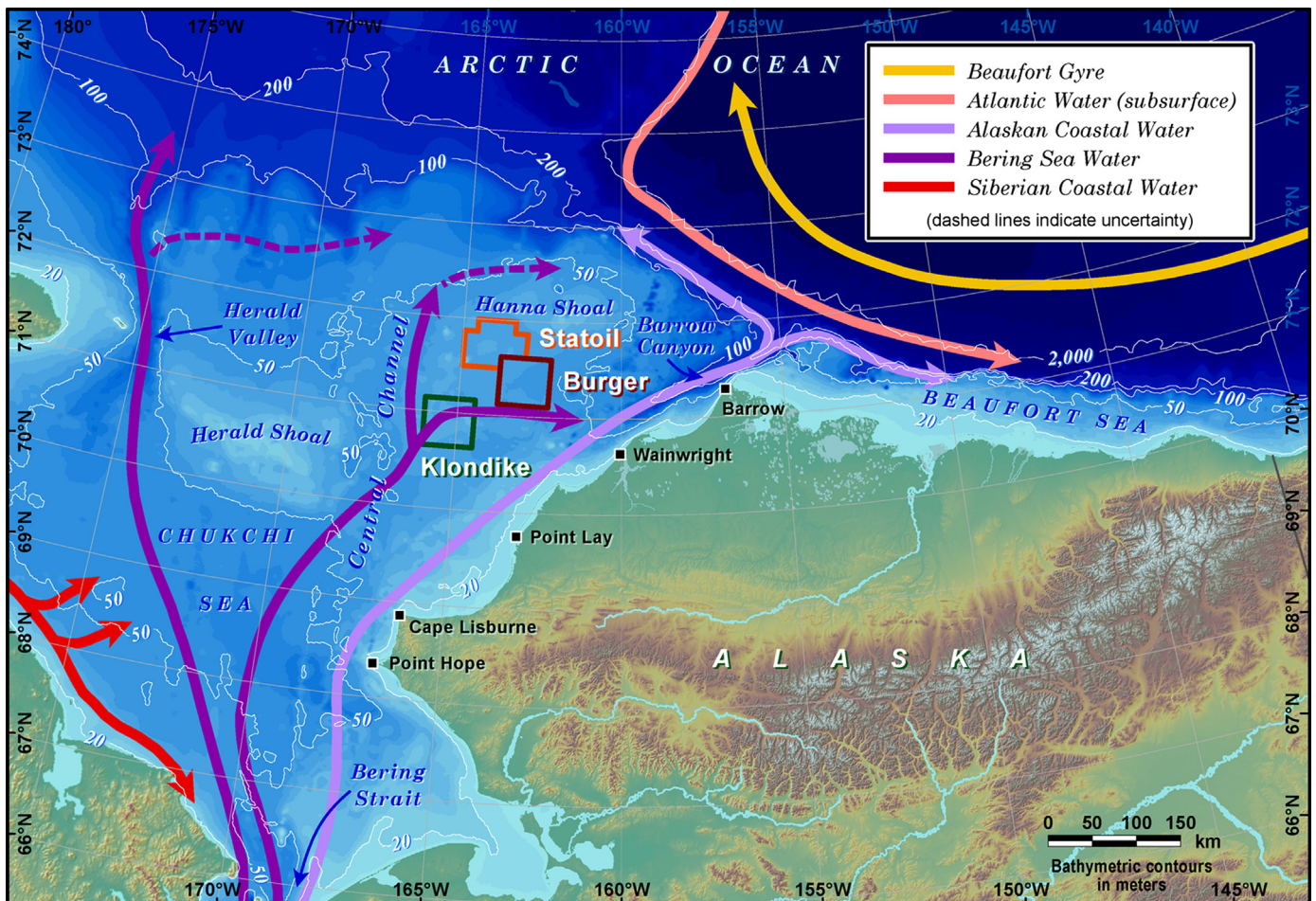


Fig. 1. Northeastern Chukchi Sea, Alaska, showing main features, schematic of the mean circulation, and study-area boxes. Currents modified from Weingartner et al. (2008).

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