Introduction

Multidisciplinary studies in the Chukchi Lease area by the industry-funded Chukchi Sea Environmental Studies Program (CSESP) have been establishing environmental baselines since 2008. In the 2011, the study region was expanded more than 3 fold in size, to encompass Hanna Shoal, and provide a better appreciation of the biological backdrop and mechanisms.

Methods

Core sampling conducted annually occurred within a 900 NM² grid for 3 survey areas: Burger, Klondike, and Statoil; with an expanded grid added in 2011 to provide broader context (Fig. 1). Each core survey had 22-25 stations that were sampled twice over the ice-free period. The expanded grid added 84 stations sampled only once. Inorganic macronutrients, phytoplankton (as chlorophyll) and zooplankton were sampled on each cruise. Phytoplankton and nutrients were collected with a CTD rosette at 6 depths each station. Smaller mesozooplankton were collected by a pair of 150-µm mesh nets hauled vertically from within 3 m of the bottom to the surface. To target larger, more mobile zooplankton, a 505-µm mesh Bongo net was deployed in a double oblique tow with the ship underway at 2 knots.

Environmental Backdrop

The 2011 sampling season was characterized by high sea surface temperatures in August related to early ice retreat over the sampling area (Fig. 2). In September, water temperatures remained warm in Klondike, but cooled moving toward the northeast. This gradient had large effects on the structuring of the planktonic communities.

In 2011, although surface temperatures were high, nutrients persisted in colder bottom waters. These nutrients supported elevated chlorophyll concentrations at depth that persisted into September/October (Fig. 2). This pattern was more pronounced compared to previous years.

Zooplankton

The zooplankton community during summer is composed primarily of species with strong affinity to the Bering Sea rather than those endemic to the Arctic. In 2011, the expanded survey revealed that the most common neritic (shelf-dwelling) copepod species tend to associate with warmer waters (Fig. 3). This pattern is most pronounced for species strongly advected into the region within Bering Sea water (i.e. Eucalanus & Neocalanus copepods, and euphausiids). The most interesting signal occurred within the resident larger-bodied Arctic copepod species (Fig. 4). Calanus glacialis is often common on the shelf, but is typically more important in deeper waters. Calanus hyperboreus inhabits the deeper basin waters and is rarely observed in the core study area. Metridia species are also oceanic and rarely observed in waters shallower than 50 m. In 2011, all three species occurred as expected north of Hanna Shoal, but were also over Burger and Statoil, often in relatively high numbers. These patterns conflict with the classical northward flow of water currents for this region.

A novel on-shelf transport mechanism

Standard oceanographic principles predict that water flowing along the northern edge of Hanna Shoal should follow the bathymetry and turn southward along its eastern edge. Upwelling, and reversal of flow, in Barrow Canyon have also been suggested as a mechanism to move oceanic waters onto the shelf, but observational support for both these possibilities has been weak.

The distribution of arctic copepods on the shelf corresponds to a period of strong and sustained upwelling in Barrow Canyon combined with eastward surface flow as documented by HF Radar (Fig. 5). Here we demonstrate the biological impact of such events, and illustrate an unappreciated mechanism capable of moving oceanic Arctic species far onto the Chukchi Shelf. Zooplankton thus serve as important tracers of water masses and their movements in the Chukchi region.

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