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Ichthyoplankton abundance, distribution, and assemblage structure in the Gulf of Alaska during September 2000 and 2001

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Abstract

Autumn ichthyoplankton assemblage structure in the Gulf of Alaska (GOA) region has not previously been characterized. Ichthyoplankton data from September 2000 and 2001 survey collections were analyzed to describe assemblages in the western GOA, to examine interannual variation in assemblages, and to relate observations to oceanographic conditions. Taxa with the highest frequency of occurrence (2000/2001) included Osmeridae (94/87%), *Hexagrammos lagocephalus* (57/45%), *Sebastes* spp. (35/47%) and *Bathymaster* spp. (27/57%). Through the use of clustering techniques and ordination, three identifiable larval assemblages common to both years were identified. Slope assemblages appeared well defined in both years, while nearshore and mid-shelf assemblages tended to be more loosely associated and variable between years. Analyses of environmental variables (temperature, salinity, water depth, distance from shore, and water transport) suggest ichthyoplankton assemblage structure is affected primarily by bathymetry and circulation. We demonstrate that early autumn ichthyoplankton assemblage structure in the GOA is fundamentally linked to variations in macro- (slope vs. shelf) and meso-scale topography (on-shelf proximity to land masses), and suggest that these intrinsic associations may be modified by spatial and temporal variations in local hydrographic conditions.

Keywords: ichthyoplankton; assemblage; bathymetry; circulation; autumn; Gulf of Alaska

1. Introduction

The Gulf of Alaska (GOA) is an important region for commercially valuable marine fish and shellfish populations and supports some of the most productive fisheries in the United States. It is also an important spawning area for many fishes and supports a diverse array of larval fish species throughout the early spring to late autumn months. The shelf region southwest of Kodiak Island is characterized by a complex bottom topography, including numerous banks and troughs and an abrupt shelf break (Fig. 1). Circulation in this region is dominated by two southwestward-moving currents. The nearshore Alaska Coastal Current (ACC) dominates flow along the coast and shelf, and obtains surface speeds of up to 25–100 cm s^{-1} (Royer, 1981; Stabeno et al., 1995). This current usually reaches its maximum transport in the autumn (September/October), and is driven primarily by winds and coastal runoff. It receives pulses of freshwater flux along the entire coast from May to October, with freshwater runoff generally peaking in October (Royer, 1982; Wilson and Overland, 1986). The other major current in this region is the

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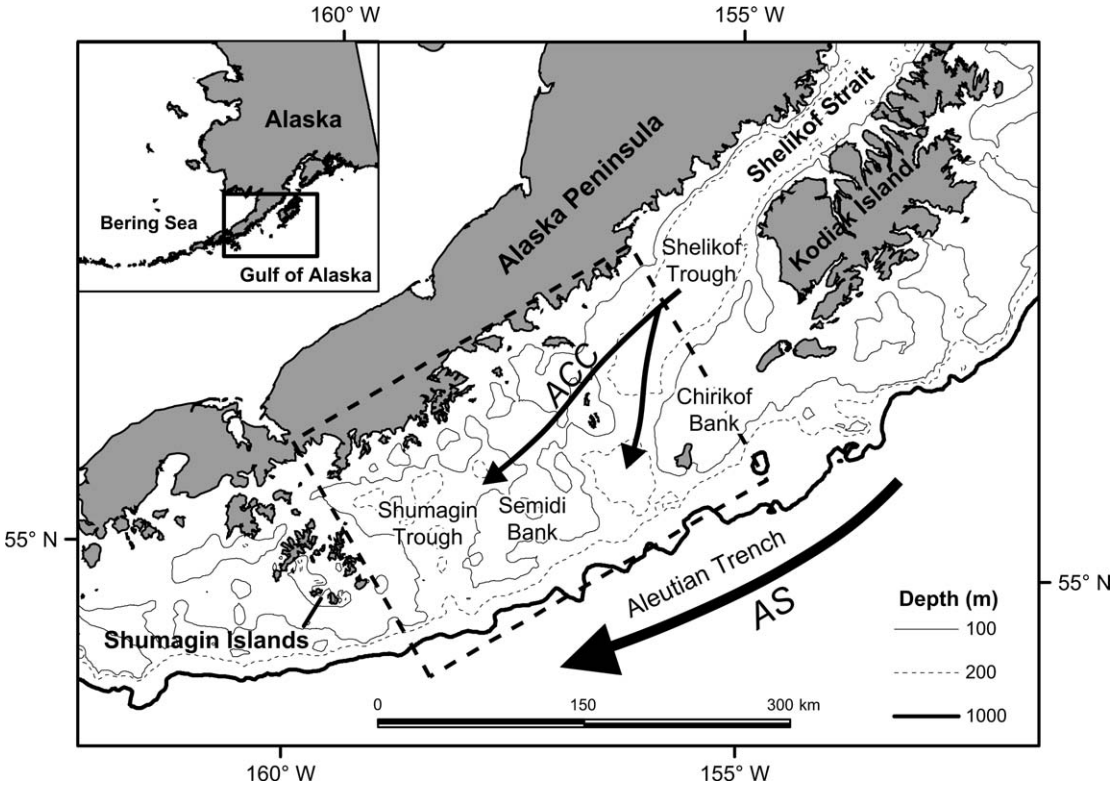

Fig. 1. Study area in the Gulf of Alaska (dashed box outline). Black arrows indicate the Alaska Coastal Current (ACC) and Alaska Stream (AS).

Alaska Stream (AS), which runs roughly parallel to the shelf-break, dominates offshore circulation along the slope and remains relatively constant at speeds of 50–100 cm s^{-1} (Reed and Schumacher, 1986).

Spring ichthyoplankton abundance and diversity in the GOA is well characterized (Brodeur and Rugen, 1994; Doyle et al., 2002); however, comparatively little is known about factors affecting larval fish assemblages in the early autumn. Kendall and Dunn (1985) reported species-specific ichthyoplankton distribution and abundance data in the GOA in autumn, but no data are available on autumn larval fish assemblages for this area. Many species whose larvae are present in autumn (e.g. capelin) provide a food source for commercially and ecologically important fishes, birds and mammals in this area (Baird, 1990; Hansen, 1997; Byrd et al., 1997; Merrick et al., 1997). Knowledge of the distributions and associations of these larvae with key hydrographic features and other biotic components of the ecosystem is needed to help understand factors influencing the distribution of adults. The ecology of larval assemblages present during early autumn may be particularly relevant since, compared with spring-spawned species, these summer-spawned individuals have relatively less time for growth prior to the onset of their first winter, a critical interval influencing survival and recruitment to the juvenile stage.

The objectives for this study were to describe ichthyoplankton abundance, distribution and assemblage structure in the GOA in early autumn (September); examine interannual variations in these factors between 2000 and 2001; and relate evident patterns to oceanographic conditions.

2. Materials and methods

2.1. Study area and sampling procedure

The geographic region of focus for this study was the GOA shelf southwest of Kodiak Island along the Alaska Peninsula (Fig. 1). Samples characterized as early autumn were collected during two research cruises conducted from 2 to 20 September 2000, and 2 to 19 September 2001. Samples examined included 109 collections from 2000, and 93 from 2001. A 1-m^2 Tucker trawl was used to collect samples on a fixed grid of stations (33 km apart) from near-shore to the outer shelf in the area between Shelikof Strait and the Shumagin Islands. Oblique samples were obtained by opening and closing the two Tucker nets (333-μm mesh). Net one fished from 200 m or 10 m above bottom (whichever was shallowest) to just below the thermocline, and net two fished from the thermocline to the surface. Each station was sampled during both daylight and dark hours. In