

Estimating potential habitat for chum salmon (*Oncorhynchus keta*) in the Western Arctic using a bioenergetics model coupl

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Chum salmon (*Oncorhynchus keta*) are distributed widely in the Northern Pacific and are an important commercial fisheries resource in North Pacific countries. Chum salmon can be divided into North American and Asian groups, and the Asian groups can be divided further into Japanese and Russian groups, which show different migration routes. Japanese and Russian chum salmon stocks are predominant in the Bering Sea during summer and fall. However, recently, several studies reported different tendency. Higher densities of chum salmon were observed within the vicinity of the Bering Strait and the Chukchi Sea than the eastern Bering Sea on September 2007 and alike Japanese chum salmon migrated to northern areas in the Bering Sea on August 2009. Sea surface temperature in the Arctic marginal seas has increased since the mid-1960s, especially since 2000. We speculated that SST increase affect to salmon northing directly. Therefore, we focused on chum salmon migrating northward to the Western Arctic. We estimated the potential habitat for chum salmon in the Western Arctic using a bioenergetics model coupled with a three-dimensional lower trophic ecosystem model (3-D NEMURO). The model domain contained the entire Chukchi Sea and the southern area of the Canada Basin. The horizontal resolution was about 2.5 km, and there were 25 vertical levels (surface to 4000 m). We assumed chum salmon move to a depth where the growth rate is the maximum within 100 m, because chum salmon migrate vertically to below 100 m depth for controlling their body temperature and searching for prey. The model was run for nine months from March to November 2003, thus representing the entire months chum salmon are distributed in the Bering Sea from June to November. In the bioenergetics model, the growth rate of an individual chum salmon was calculated as a function of water temperature, salinity, and prey density, which were obtained from the 3-D NEMURO model results. We calculated the growth rates of chum salmon of 100 gWW to 4000 gWW and defined 'Potential habitat' as 'an area where chum salmon can grow up (i.e., the growth rate is positive)'. The potential habitat reflected the warm and nutrient-rich Pacific water inflowing from the Bering Strait. That was restricted to the southwestern Alaskan coast on June and expanded to the Chukchi Sea and along the Alaskan northwestern coast from July to September and reduced from October. The main limiting factor was the water temperature on June and November and the prey density on July to October. For global warming scenario, we used the modeled monthly water temperature anomaly between 2005 and 2095 under the IPCC SRES-A1B scenario. Under the global warming scenario, the potential habitat for chum salmon increased during early summer and autumn due to the water temperature increase, whereas during summer the potential habitat for smaller chum salmon increased but that for larger chum salmon decreased because the water temperature exceeded the optimal condition, especially in the southern Chukchi Shelf and near the Bering Strait. The water temperature limitation was relaxed with a water temperature increase on June and November, but regionally the water temperature was the main limiting factor during summer.

Keywords: Arctic, marine ecosystem model, Chum salmon