Influence of Marine Feeding Area on Lipid Accumulation in Juvenile Coho Salmon

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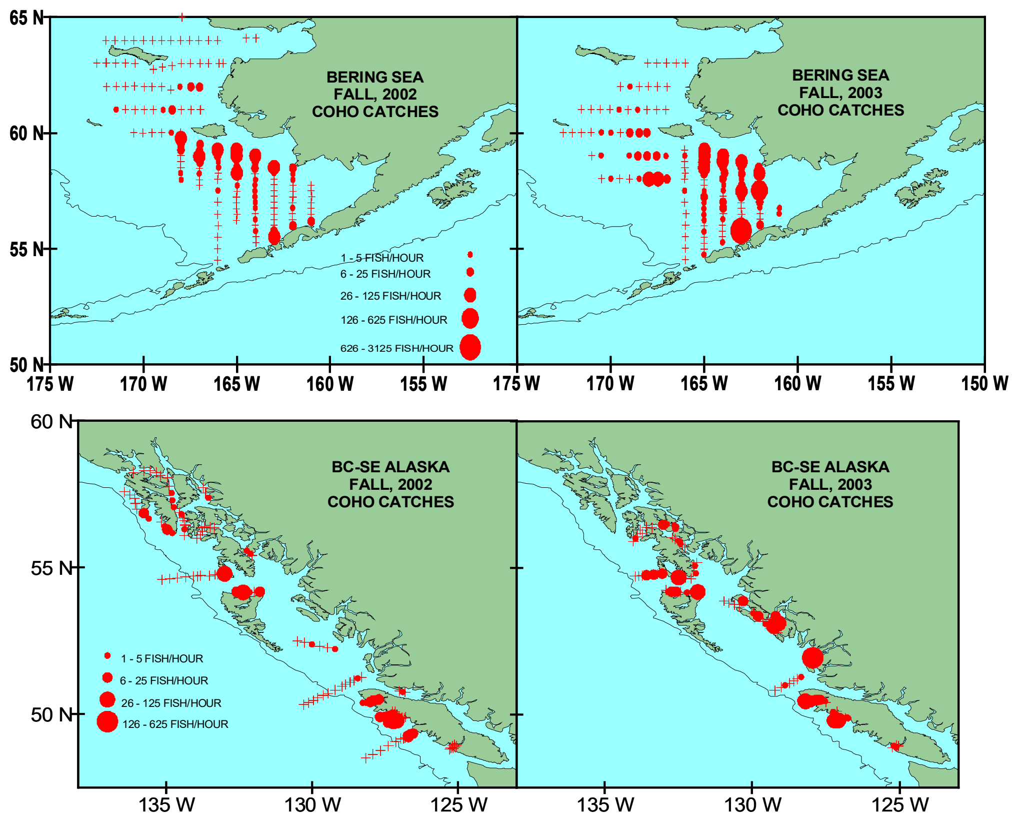
The succession of seasons is accompanied by predictable changes in the environment. In general, food production increases in the spring to reach a maximum during summer, and then declines in the fall before reaching minimal values during winter. Hence, fish often face food shortages during winter and must rely on the reserves accumulated during summer to fuel their metabolic functions. As the duration of winter increases with latitude in the northern hemisphere, fish living at the northern end of their distribution must accumulate higher lipid reserves during the growing season to survive over winter (Conover and Present 1990). Here, we tested the hypothesis that lipid accumulation in Pacific salmon increases with latitude during summer.

Juvenile coho salmon (*Oncorhynchus kisutch*) were collected in the Eastern Bering Sea (BS), in southeastern Alaska (SEA), and on the west coast of Vancouver Island (WCVI) using a rope trawl in September–November 2002–2003 (Fig. 1). Growth rates of juvenile coho salmon were estimated assuming that WCVI, SEA, and BS coho smolts migrated to sea at an average size of 100 mm on May 1, May 15, and June 1, respectively, as coho smolts generally migrate to sea later in the spring in northern latitudes (Sandercock 1991). In this study, percent dry weight

Fig. 1. Distribution of the juvenile coho salmon collected in the Bering Sea, southeast Alaska, and on the west coast of Vancouver Island in September-November 2002-2003. Salmon were collected with the FV *Sea Storm* in the Bering Sea, and with the CCGS *W.E. Ricker* in southeast Alaska and on the west coast of Vancouver Island. Catches are expressed in the number of fish caught per hour.



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in the whole fish was used as an indicator of lipid contents, as lipids and caloric contents are strongly positively correlated to percent dry weight in juvenile coho salmon (Trudel et al. 2005). Percent dry weight (*PDRY*, %) can be converted to lipid contents (*LIP*, %) using the following equation derived on ocean caught coho salmon (Trudel et al. 2005): $LIP = -10.3 + 0.55 \cdot PDRY$.

BS coho were larger in 2003 than in 2002 (Fig. 2). The opposite pattern was observed for WCVI and SEA coho (Fig. 2). Juvenile coho salmon grew faster in the BS than in WCVI or SEA, with growth rates approaching 2 $mm \cdot d^{-1}$ compared to 1.2 $mm \cdot d^{-1}$ for southern regions. In addition, percent dry weight was also higher in the BS, averaging around 25% (Fig. 3). Lipids represented about 3.5% of the wet weight of BS coho, compared to about 3% for SEA and WCVI. These results support the hypothesis that lipid accumulation and growth varies inversely with the length of the growing season in salmon. This may be an adaptive response to survive more severe winter conditions in northern latitudes where temperature is colder and day length is shorter. Alternatively, this may reflect differences in prey lipid contents among regions, as lipid contents is generally higher in northern than southern copepods (Båmstedt 1986).

Several years of observations will be needed to understand the mechanisms regulating salmon populations in the Bering Sea. Until these long term data set become available, the comparative method used in this study may provide valuable insight for assessing the effects of ocean conditions and climate on juvenile salmon in this area.

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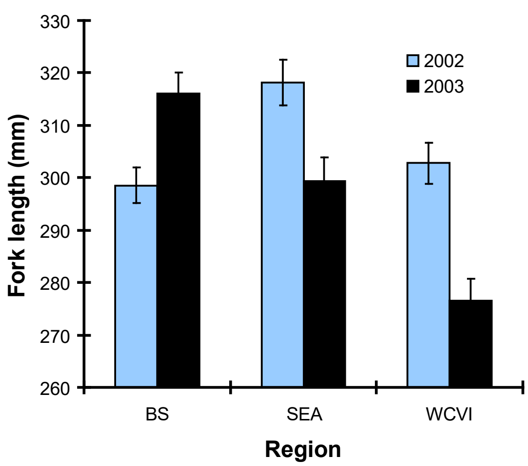

Fig. 2. Average fork length of juvenile coho salmon collected in the Bering Sea (BS), southeast Alaska SEA), and on the west coast of Vancouver Island (WCVI) in September–November 2002–2003. The average fork length varied significantly among years ($F = 7.1$; $p < 0.01$) and regions ($F = 13.2$; $p < 0.0001$). The error bar represents ± 1 SE.

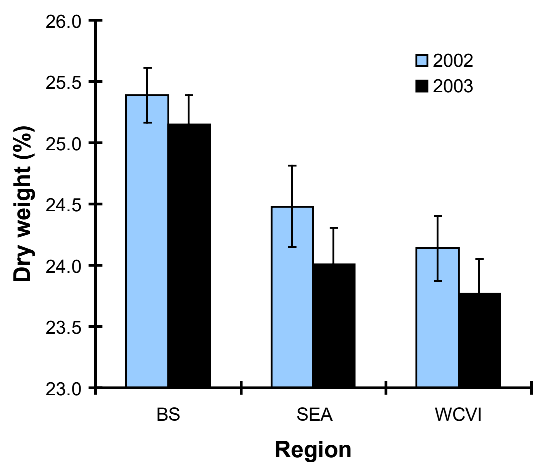

Fig. 3. Average dry weight (% of wet weight) of juvenile coho salmon collected in the Bering Sea (BS), southeast Alaska SEA), and on the west coast of Vancouver Island (WCVI) in September–November 2002–2003. Percent dry weight varied significantly among regions ($F = 12.9$; $p < 0.01$), but not between years ($F = 2.4$; $p > 0.1$). The error bar represents ± 1 SE.

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