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Stock-specific Migration Pathways and Size of Juvenile Sockeye Salmon (*Oncorhynchus nerka*) in Nearshore Waters and in the Gulf of Alaska

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Individual identification of sockeye salmon (*Oncorhynchus nerka*) caught in Washington, coastal British Columbia, southeast Alaska, and Gulf of Alaska sampling sites during 1996-2011 was estimated through an analysis of microsatellite variation. Variation at 14 microsatellites was analyzed for over 10,000 juvenile sockeye salmon obtained from coastal and Gulf of Alaska surveys. A 387-population baseline spanning Japan, Russia, Alaska, Canada, and Washington State was used to determine the individual identification of the fish sampled, with individuals identified to approximately 35 stocks of origin. We outlined the migration paths and size variation of juvenile sockeye salmon ranging from the Columbia River to southeast Alaska. The study extends the results initially reported by Tucker et al. (2011), by increasing the number of populations or stocks identified from 14 regional stocks to 50 populations or stocks, and by increasing the number of juvenile sockeye sampled from 4,062 individuals to 10,500 individuals.

Determination of juvenile sockeye salmon migration routes was dependent upon accurate identification of individuals to specific populations or stocks of origin. Analysis of a known-origin sample indicated that individuals from 50 populations or stocks of sockeye salmon were estimated with a high degree of accuracy, indicative of little error in the estimated stock compositions. Therefore, reported differences in juvenile fork length and migration routes among populations should accurately reflect differences in juvenile size and migration behaviour among stocks.

Stock compositions of the mixtures analyzed increased in diversity of origin in more northern sampling locations, indicative of a general northward movement of juveniles. The primary migration route of Columbia River and Washington stocks was northward along the west coast of Vancouver Island, with a majority of the juveniles subsequently migrating through Queen Charlotte Sound and Dixon Entrance. During the same sampling month and location, Columbia River and Washington juveniles were consistently larger than those from British Columbia and Alaska. Fraser River stocks migrated principally through the Strait of Georgia and Johnstone Strait. Some Fraser River populations, such as Cultus Lake, appeared to have spent little time rearing in the Strait of Georgia, as individuals from this population were primarily observed in July samples from Hecate Strait, Dixon Entrance, and southeast Alaska. Other Fraser River populations, such as Chilko Lake and Quesnel Lake, were widely distributed in July surveys, being observed from the Gulf of Alaska to the Strait of Georgia. In a population or stock, juveniles of larger body size were observed in more northern sampling regions compared to those sampled in more southern regions, and this trend was consistent across all seasons of sampling. For example, larger individuals from the Chilko River stock in the Fraser River drainage were observed in more northerly locations compared with those in the Strait of Georgia, and mean juvenile body length increased over time during the first year in the ocean (Fig. 1).

There was substantial diversity in body size and juvenile migration pattern displayed by populations and stocks within the Fraser River drainage. There may be a relationship between timing of northward migration from the Strait of Georgia and juvenile body size, with larger-sized individuals migrating earlier than smaller- sized individuals. Body size can influence timing of juvenile northward migration, and the degree to which juveniles utilize coastal waters for rearing during the fall and winter of their first year in the ocean, forgoing rearing in the Gulf of Alaska or the North Pacific Ocean. There was considerable variation among Fraser River populations and stocks in location and timing of capture of juveniles. Some populations moved rapidly through the Strait of Georgia to begin their northward migration. Conversely, some populations or stocks reared for a period of time in the Strait of Georgia before beginning their northward migration. For example, individuals from the South Thompson River stock were abundant in the Strait of Georgia in June (n = 411) and July (n = 85), and this stock constituted 31.3% of all individuals sampled in the Strait of Georgia during summer. Although individuals from this stock were widespread geographically in summer, ranging from the Strait of Georgia to off Kodiak Island, summer captures of this stock were concentrated in more southern sampling regions

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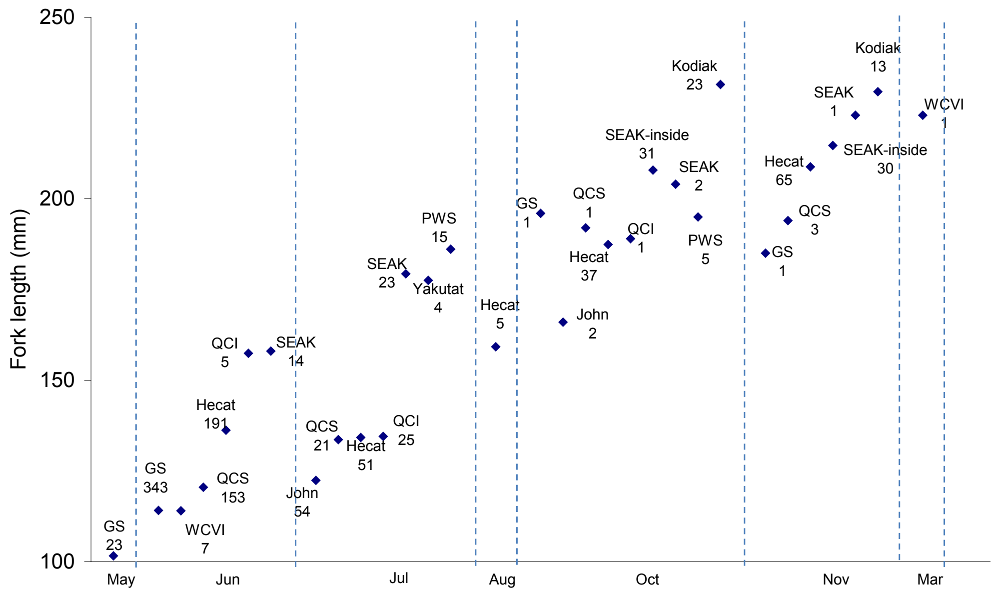

Fig. 1. Mean fork length (mm) by month of juvenile Chilko Lake sockeye salmon from the Fraser River drainage caught in 11 regions during their first year of ocean residence. Region codes are listed, along with sample size for the regional mean length. Region codes are GS (Strait of Georgia), WC (West coast Vancouver Island), JS (Johnstone Strait), QCS (Queen Charlotte Sound), Hecat (Hecate Strait and Dixon Entrance), QCI (Haida Gwaii), Inside (Southeast Alaska inside), SEAK (Southeast Alaska), Yakutat (Yakutat), PWS (Prince William Sound), and Kodiak (Kodiak Island).

Juveniles from Great Central Lake stock on the west coast of Vancouver Island were consistently smaller than those from other west coast of Vancouver Island stocks. For British Columbia central coast and Owikeno Lake stocks, not all individuals migrated northward in the summer, with some individuals still present in local areas in the fall and winter after spring entry into the marine environment. Juvenile Fraser River sockeye salmon dominated the catch of juveniles in the Yakutat, Prince William Sound, Kodiak Island, and Alaska Peninsula sampling locations. Not all Fraser River stocks displayed the same trends in relative abundance with respect to coastal Gulf of Alaska sampling groups, perhaps indicative of differential initial rearing environments. Overall, there was a wide divergence among stocks in juvenile size and dispersion among sampling locations.

Determination of stock-specific winter rearing areas, such as reported by Farley et al. (2011), may prove to be very useful in understanding the migration routes and rearing areas of sockeye salmon, perhaps being of predictive value for subsequent juvenile survival. Determination of the location and timing of specific stocks of sockeye salmon in the Gulf of Alaska and North Pacific Ocean can be obtained through the application of DNA technology.

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