

# DNA-Based Stock Identification of Coastal Sockeye Salmon: Evidence for Stock-Specific Migration Behaviour of Central Coast (Rivers Inlet) Sockeye Salmon

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Sockeye salmon (*Oncorhynchus nerka*) stocks from the Central Coast of British Columbia (Rivers and Smith Inlet) formed the second most valuable salmon fishery in British Columbia until the late 1970s. Over a 20 year period these stocks then collapsed, with the Rivers Inlet stock falling to approximately 1/1,000th of its initial abundance by the late 1990s (McKinnell et al. 2001). Although the specific cause of the collapse has not been established, a review panel concluded that “*The drastic declines in abundance appear to be due to an extended period of poor marine survival*” and that the parallel collapses in both nearly pristine and logged watersheds “...*is convincing evidence that the cause of the declines does not lie in freshwater habitat disturbance*” (Holtby et al. 2000).

The collapse of central coast sockeye stocks is particularly puzzling because Fraser sockeye migrate up the coast directly past Rivers and Smith Inlets, but do not show the long-term decline in productivity since the 1970s that is evident for the Rivers-Smith Inlet sockeye. It would generally be expected that the poor marine survival affecting Rivers or Smith Inlet sockeye would therefore also influence Fraser River sockeye. This difference could be explained in three possible ways:

- (1) Fraser sockeye do not initially migrate north into the central coast region and remain sheltered within the Strait of Georgia for extended periods.
- (2) Fraser and Rivers Inlet sockeye migrate north along the shelf at equivalent speeds, thereby forming spatially separated discrete groups as they migrate.
- (3) Rivers Inlet sockeye remain as local residents of some coastal region while Fraser River sockeye migrate past them in on their northern migration.

We examined the changes in stock composition of juvenile sockeye caught in DFO trawl surveys using DNA stock identification techniques. All juvenile sockeye were caught in coastal waters. We define juvenile salmon as those caught during their first year of marine life. The sampling survey extended from 1997 to 2003, and was conducted in various months from May through February, thus allowing us to reconstruct changes in stock composition for a number of regions along the shelf for different seasons of the year. For convenience, we refer below to Rivers Inlet sockeye to also include the Smith Inlet sockeye except where explicitly identified.

We found that in early summer (May–June) catches in the various regions are dominated by sockeye from nearby river systems, as expected. For example, Nass and Skeena River sockeye (northern British Columbia stocks) dominated the catches made in the Dixon Entrance–Southeast Alaska area, and Vancouver Island sockeye initially predominated in the catches made off Vancouver Island and Queen Charlotte Strait. However, the stock composition changed substantially as the season progresses, indicating rapid migration northward along the coast of at least some stocks.

By mid-summer (June–July) Fraser River sockeye made up 50–77% of the trawl-caught sockeye in central and northern coastal regions of British Columbia, and 27–52% of sockeye caught off Southeast Alaska. In October, Fraser River juveniles formed 50% of the sockeye catch off Kodiak Island and 82% of the sockeye catch off Southeast Alaska, but still formed only a small proportion of the sockeye caught off the Alaskan Peninsula in November, where Nass and Skeena River stocks still predominated. There is thus evidence for some stocks remaining as spatially segregated units during their migration, although some mixing is also evident. Thus the Fraser River sockeye rapidly moved north along the continental shelf. In contrast, the Rivers and Smith Inlet sockeye formed only small and statistically insignificant proportions of the sockeye catch in the summer (reflecting their low abundance), but increased in October to form 37% of the Hecate Strait sockeye catch and 97% of the Queen Charlotte Sound sockeye catch.

Although Fraser sockeye migrate up the coast directly past the ocean-entry point of Rivers and Smith Inlets, they do not show as serious a decline in productivity as is evident for Rivers-Smith Inlet (their productivity has, however, been reduced in the 1990s as well). This difference can be explained if Rivers Inlet sockeye remain

resident in southern areas of the continental shelf for prolonged periods, while Fraser River sockeye migrate quickly through the region of poor growth and survival.

Overall autumn catch rates for sockeye dropped sharply relative to the summer, while the proportional abundance of Rivers and Smith Inlet sockeye increased. We therefore conclude that Fraser River sockeye migrated to the north along the coast while the central coast sockeye remained resident in the coastal region off their rivers of origin. We thus reject our first two hypotheses and accept the third. This difference in marine migration behaviour thus leaves Rivers-Smith Inlet sockeye particularly vulnerable to poor ocean conditions that developed in the south-central British Columbia coastal region for extended periods of time. In contrast, Fraser River sockeye that migrate through this region are not exposed to poor marine conditions for extended periods. Thus stock-specific differences in marine migration pathways coupled with regional variation in ocean conditions apparently led to the collapse of central coast sockeye stocks but not that of sockeye stocks to the south.

## REFERENCES

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