Optimizing the production of Chinook salmon in the Strait of Georgia as the ecosystem changes

Final Report to the Pacific Salmon Commission

Richard J. Beamish, Chrys M. Neville, Rusty M. Sweeting and Krista Lange.
Fisheries and Oceans Canada

In this report, we summarize the results and interpretation of our study of the productivity and survival of chinook salmon in the Strait of Georgia. We have given a number of presentations on our study and have one peer reviewed paper accepted for publication (Beamish et al. 2011). Other publications are in progress.

In July, the average abundances of juvenile Chinook salmon in the Strait of Georgia are approximately 4-5 million. The stock composition in the open Strait of Georgia shown in Figure 1A is typical of our observations from 2008 to 2010. However, the stock composition within the Gulf Islands is dominated by Cowichan River Chinook salmon (Figure 2A). Cowichan River Chinook salmon are rarely found in the open Strait of Georgia, leading to the conclusion that they are resident within the Gulf Islands. By September, there is a dramatic change in the stock composition in the open Strait of Georgia (Figure 1B). Approximately 70-80% of the stocks that were present in July are no longer present and are replaced by the 14 South Thompson River stocks. Within the Gulf Islands, Cowichan Chinook are still abundant, representing up to 61% of the catch (Figure 2B).

It might seem logical to conclude that the stocks present in the Strait of Georgia in July had migrated out of the strait. However, of the 178 acoustic tags that were inserted in Chinook salmon in July 2008, only 2 were recorded as leaving the Strait of Georgia (Neville et al. 2010). There could be substantial mortality resulting from the tagging, there could be a major detection problem within the POST receiver array or there could be high mortality of the juvenile Chinook salmon in July with the majority not surviving to leave the Strait of Georgia. It seems to be counterintuitive that so many fish would die between the July and September survey, however this is our preliminary interpretation. The South Thompson Chinook salmon that replace the other stocks enter the Strait of Georgia in early to mid July and probably leave in October-November. The marine survival of South Thompson Chinook salmon has been substantially higher than other populations, resulting in an increasing trend in adult returns. There is little doubt that the late ocean entry life history strategy is the explanation for the improved production (Beamish et al. 2010). It is important to recognize that this same life history strategy is the reason that Harrison River sockeye salmon are surviving better than the majority of other stocks.

Within the Gulf Islands, the Cowichan Chinook salmon experience an early marine mortality from ocean entry in about mid-May to mid-September of about 98.7% for hatchery fish and 69% to 92% for wild fish (Beamish et al 2011). There is little doubt that the declines in productivity of the Cowichan Chinook are largely a consequence of the mortality of the juveniles within the first four months in the Gulf Islands. In recent studies of Chinook salmon in other areas, there is evidence that the period critical for

survival is the first four weeks (McFarlane 2010). There is a significant difference in the survival of the hatchery and wild Chinook salmon from the Cowichan River. We estimated that wild Chinook survive 6 to 24 times better than hatchery Chinook in this early marine period. The final, total survival estimates for the brood year entering the Gulf Islands area in 2008 (2007 brood year) will not be known until 2011-2012. It will be most interesting to compare early marine survival estimates with total survival estimates. This also means that it will be 2012 or 2013 when the final interpretation of our studies can be published. A preliminary interpretation of the reason for the declining productivity of Cowichan Chinook is that there is competition for food with other salmon, particularly chum and pink salmon and there appears to be a loss of giant kelp in their early marine rearing area. All salmon must find food and grow quickly when they first enter the ocean. Kelp forests provide important habitat for juvenile salmon attracting their preferred food and providing protection from predators. If our speculation about the loss of kelp is correct, one method of improving Chinook production would be to find a way of improving kelp productions.

In 2008, we noted that the later hatchery releases were more abundant in our catches in June, July and September. Our preliminary interpretation is that the later releases survived better (Figure 3) as we observed for the South Thompson Chinook salmon. However, we need to wait until all adults return to compare hatchery and wild survival and the survival from the early and late releases from the hatchery.

In 2010, we carried out two, three-week purse seine surveys throughout the Strait of Georgia and Gulf Islands. All DNA has not been analyzed. The survey in early June was important as it provided a comparison of stock composition and location for comparison with the early July trawl survey. The purse seine study also allowed us to collect scales which cannot be sampled from trawl-caught fish. The scales were used to determine ocean type and stream type life histories for comparison with life history type that is assume from the DNA stock identification. The preliminary results indicate that ocean type fish are found in populations that are thought to be exclusively stream types. This is critical information if we want to understand differences in marine survival between stocks.

Our study on the early life history of Chinook salmon in the Strait of Georgia is the first major study since Healey's work in the late 1970s. There is no doubt that the dynamics of juvenile Chinook salmon have changed dramatically. It will take at least one year to finish analyzing and reporting the data collected to date. It will take until about 2012 to finalize the interpretation of the Cowichan Chinook data. Chrys Neville will continue with the field program. Dick Beamish will retire on May 27, 2011, but remains as an Emeritus Scientist. He will work with Chrys Neville to finalize the reporting and will work with the Pacific Salmon Foundation on future juvenile Chinook salmon research if they receive funding.

Literature Cited

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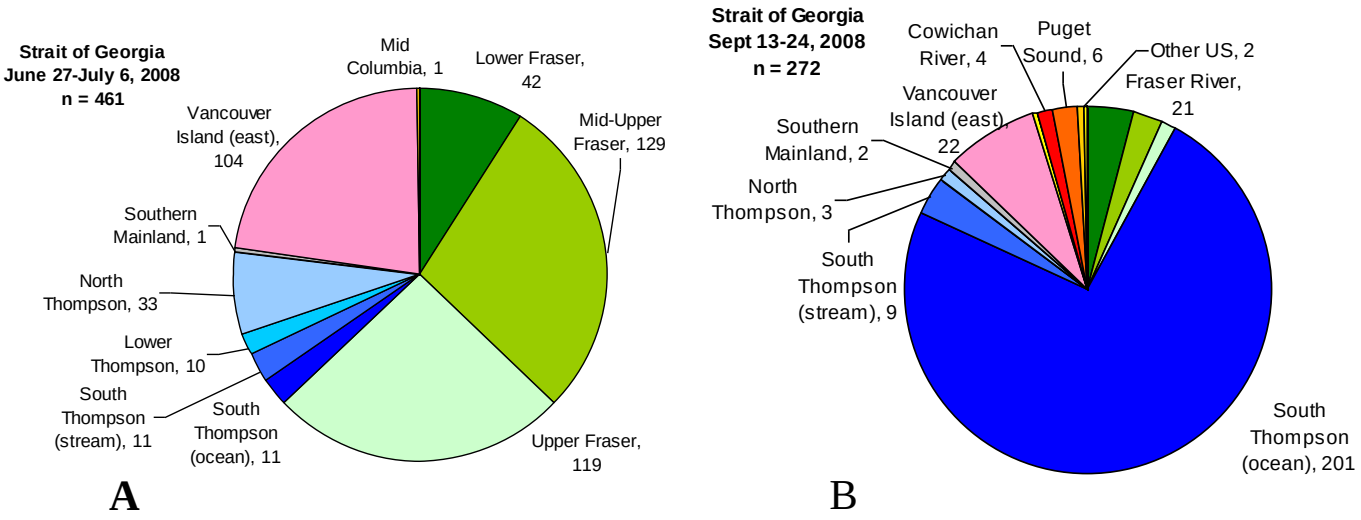

Figure 1. Stock composition, based on DNA analysis, of juvenile chinook salmon in the Strait of Georgia in the (A) June 27 to July 6, 2008 survey and (B) September 13-24, 2008. This is typical of the mixed stock of Chinook salmon observed in the Strait of Georgia in the both the early summer and fall between 2008 and 2010

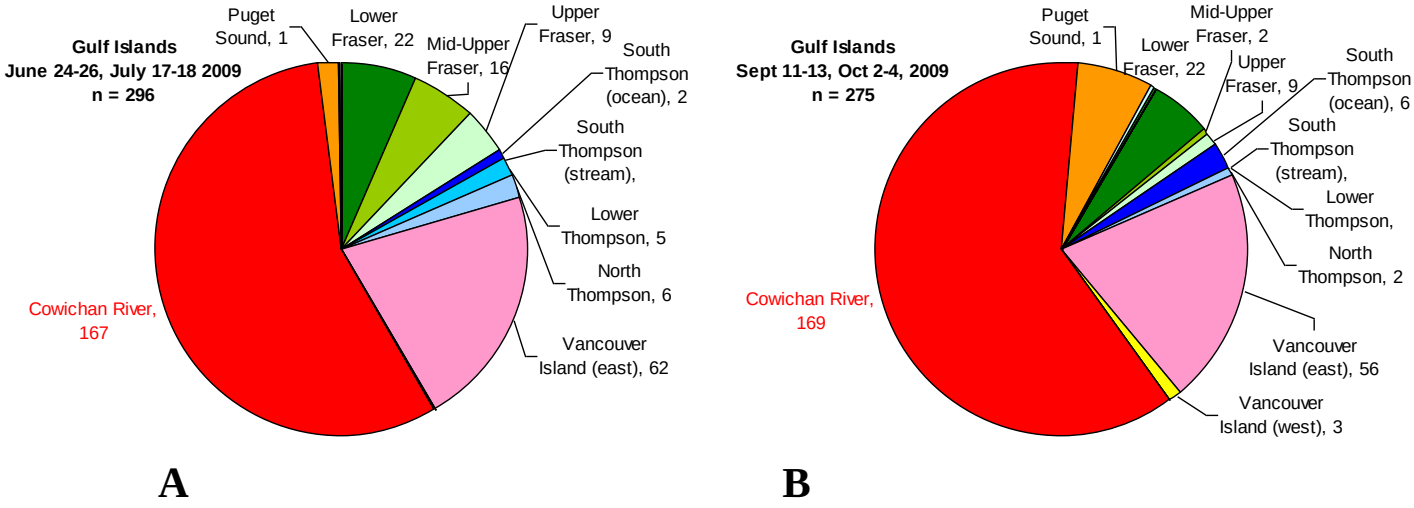

Figure 2. Stock composition, based on DNA analsyis, of juvenile Chinook salmon in the Gulf Island in the (A)June/July 2009 survey and (B) September/October 2009 survey.

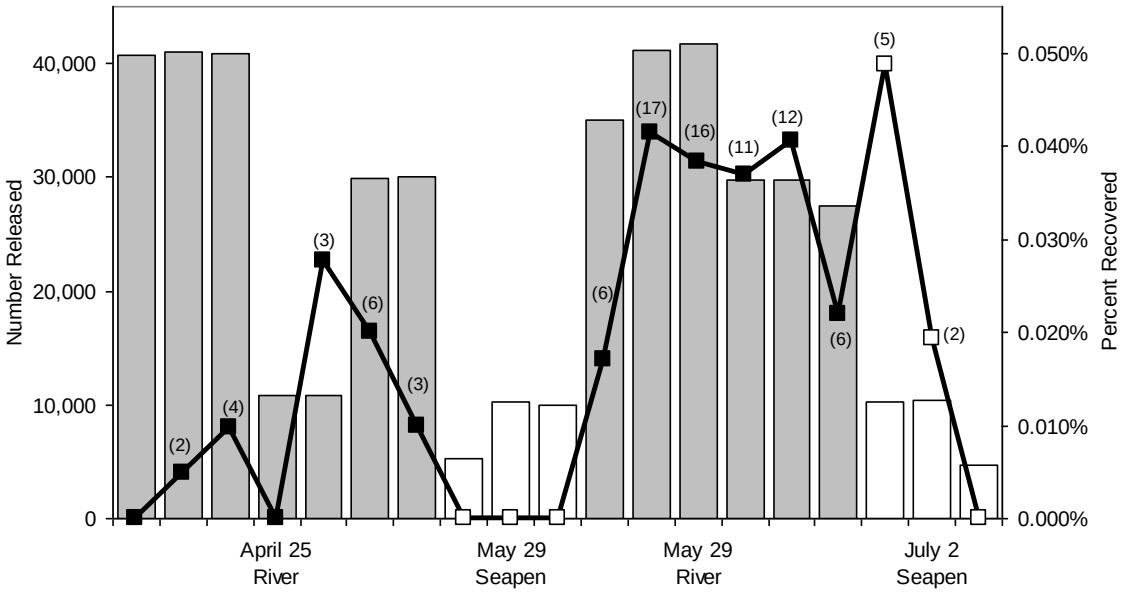

Figure 3. The number of fish released (bars) and the percentage of CWTs recovered (—) for each group of fish produced by the Cowichan River Hatchery in 2008. The number of CWTs recovered is shown in brackets. Each group of fish (bars) had a unique tag code (From Beamish et al. 2011).