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Watershed Talk

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PRELIMINARY REPORT ON SOCKEYE FRY IN QUESNEL AND SHUSWAP LAKES IN 2003

By Jeremy Hume, Ken Shortreed, and Steve MacLellan

In 2002, the sockeye escapement of 5.5 million to Shuswap Lake was the highest ever recorded. Of this number, 2.9 million were females which spawned successfully (effective female spawners - EFS). In Quesnel Lake in 2002, a direct estimate of spawner numbers was obtained only for the Mitchell River. However, based on the Mitchell River escapement relative to the Horsefly River and other spawning areas in the previous year, we estimated the total escapement to Quesnel Lake in 2002 was 3.8 million. A slightly lower total escapement estimate of 3.1 million was developed by the Pacific Salmon Commission (PSC) using DNA analysis of Quesnel sockeye collected in the lower Fraser River at Mission (Steve Latham, PSC, personal communication). In this report, we used the PSC estimate of 3.1 million. Using this estimate as well as the EFS and prespawning mortality proportions in the Mitchell River in 2002, we estimate the total EFS to Quesnel Lake in 2002 was 1.3 million. For a number of years we have been performing hydroacoustic and trawl surveys on Shuswap and Quesnel lakes to obtain estimates of numbers of juvenile sockeye in the lakes. These estimates are used through PSARC in stock forecasting (Cass et al. 1995 and Cass 1996 annually). They have also been used to develop and test fry-based and habitat-based (PR model) empirical models which predict rearing capacity of the lakes and the optimum escapement required to maximize production (Hume et al. 1996; Shortreed et al. 2000). Given the high escapements to both lakes in 2002, we expected that fry recruitment to the lakes in 2003 would be very high, and would possibly greatly exceed the productive (rearing) capacity of both lakes. To test this, we obtained juvenile sockeye salmon population estimates by conducting acoustic and trawl surveys on Quesnel Lake in the summer (July 29) and fall (Sept 23) of 2003 and on Shuswap Lake in the fall (Oct 23) of 2003 (as in Hume et al 1996). These surveys provided abundance, distribution, survival, size, and diet information of sockeye fry from the 2002 escapement. In conjunction with this study, we also carried out a limnological investigation of Quesnel Lake to determine the effects of the high escapements on lake productivity. In addition, the Provincial Ministry of Water, Land, and Air Protection (MWLAP) has been conducting surveys of the kokanee and rainbow trout in Quesnel Lake and have reported preliminary results (Sebastian et al. 2004). In this report, we compare the 2003 juvenile sockeye data with similar data collected from both these lakes for up to19 previous years, which include a wide range of spawner escapements.

Shuswap Lake

The escapement of 2.9 million EFS to Shuswap Lake was one million greater than in the previous record year (1990), but did not produce any more fall sockeye fry than in many years of lower escapements (Fig. 1). Densities were high in some parts of the lake (12,600/ha in one part of Salmon Arm) and were higher than previously observed in areas such as Anstey Arm, where densities are usually low. In the fall of 2003, we estimate there were a total of 123 million fry (+/- 95% C.I. = 20%) in Shuswap and Mara lakes. The data indicate that in Shuswap Lake, fall fry abundance peaks at escapements of about 1.0 million EFS (~2.0 million total escapement) and that fall fry numbers are the same or lower at all higher escapements (Fig. 1). While we didn't obtain a summer estimate in 2003, summer estimates from previous years also indicate no increase in fry abundance above an EFS of around 1.0 million. In Shuswap Lake, fall fry size changes relatively little over a wide range of spawner numbers (Fig. 3). Average size is about 2.3 g at escapements over 0.6 million EFS. In 2003, fry averaged 2.0 g, within the range of sizes previously observed.

Quesnel Lake

The estimated escapement of 1.3 million EFS to Quesnel Lake was the largest subdominant escapement ever recorded to that lake and it followed the highest dominant escapement ever recorded to Quesnel Lake. We estimate there were a total of 76.2 million fry (+/- 95% C.I. = 22%) in the lake in the summer of 2003 and 51.3 million fry (+/-95% C.I. = 22%) in the fall. Sockeye were distributed throughout the lake at moderate densities (max = 6,000/ha) and in some areas such as the East Arm, fish densities were higher than previously observed. The data indicate that in Quesnel Lake, maximum fry abundance is reached at an escapement of 0.75-1.0 million EFS (~1.5 to 2 million total escapement) (Fig. 2). Beyond these escapements, summer and fall fry numbers do not increase. In

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Quesnel Lake, fall fry average about 3.5 g at moderate escapements. At higher escapements, size is more variable (Fig. 3). Fry collected in the fall of 2002 and 2003 were among the smallest ever recorded (2.7 and 1.9 g, respectively) from Quesnel Lake. However, fall fry from the 1993 brood year, a year with a similar high escapement, averaged 4.0 g, larger than the long-term average fall fry size.

Discussion

Recent escapements to Shuswap and Quesnel lakes have been the highest or amongst the highest ever observed. The decomposing carcasses from these escapements have returned significant amounts of marine derived nutrients (MDN) to the South Thompson and Quesnel river watersheds. Carcasses in the Shuswap watershed will have increased nutrient loading to the lake somewhat but nutrients from carcasses in the Adams River (63% of the total in 2002) are mostly diverted downstream by prevailing currents into Little Shuswap Lake and the South Thompson River, where they mostly benefit species other than sockeye. In contrast, almost all MDN in the Quesnel system circulates in the lake for some time and will directly affect lake productivity. Our limnological study of Quesnel Lake has shown increased productivity and biomass of lower trophic levels as a result of the recent very high escapements (Shortreed et al in prep). Increases in phytoplankton and zooplankton biomass were observed in 2003 but there were no detectable increases in juvenile sockeye abundance or size. There are a number of possible reasons for this apparent “uncoupling” of fish production from the increased productivity of lower trophic levels. These could include spawning ground limitation, the high abundance of a phytoplankton species that is resistant to grazing by zooplankton, unusually warm water in the summer of 2003, or carry-over effects from the high fish densities in 2002. Further data and analysis are needed to better understand both this and the longer-term effects of the high escapements on Quesnel and Shuswap Lakes.

IN A NUTSHELL: A SUMMARY DISCUSSION OF THE AFOREMENTIONED TECHNICAL REPORT

By Jason Yarmish

First of all, I would like to commend the Department of Fisheries and Oceans and particularly the staff involved for completing this important research. Though the above technical summary report is not too complicated, I will summarize it further.

In a nutshell, the higher than average escapements to both the Quesnel and Shuswap Lakes did not result in increased juvenile production and the average size of juvenile sockeye sampled was smaller than in years of lower levels of adult escapement. That seems fairly straight forward. But is this production ceiling real? Maybe, maybe not. We need to remember that the higher than average escapement in 2002 was just a single event. And considering sockeye stocks have been depressed due to commercial activity for nearly 100 years, it may take many successive large escapements to these systems to increase overall productivity.

The other difficulty posed by this large single event, lies in the assessment of other benefits. For example, with large escapements, spawning gravels not utilized for some time are cleaned, old spawning habitats used again, and portions of watersheds may be re-colonized. Let us not forget about other benefits, too, from the nutrient delivery to the shoreline vegetation right on up to the birds and bears. It is almost impossible to calculate these types of benefits, especially when we consider that virtually no baseline data exists (i.e. has the number of bears significantly declined as a direct result of reductions in numbers of fish to terminal areas?). Who knows!

This technical report cannot answer these types of questions; it is merely a useful snapshot of what happened as a result of the 2002 escapements. It is the responsibility of managers to ensure that this type of information is not used to prevent large escapements in the future, for without successive larger than average escapements, we will never be able to fully predict their impact.

UPCOMING MEETINGS

March 30, 2004: Tier One Meeting: Location TBA.