An Overview Of Foreshore Fish Habitat In Shuswap Lake, With Particular Reference to The Salmon Arm

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1.0 FISHERIES RESOURCE

The Shuswap Lake system and its tributaries, support four species of Pacific salmon: sockeye (*Oncorhynchus nerka*), chinook (*O. tschawytscha*), coho (*O. kisutch*) and pink (*O. gorbuscha*). Rainbow trout (*O. mykiss*), lake trout (*Salvelinus namaycush*) and other species of fish are also present. In addition, 35 of its 37 tributaries support one or more stocks of sockeye, chinook, coho and pink salmon (Department of Fisheries and Oceans, 1995). In the twelve year period of 1981 to 1992 the average annual escapement of sockeye, chinook, coho and pink salmon to the tributaries and Shuswap Lake was 1, 025,378 sockeye, 22, 259 chinook, 9, 789 coho and 1, 259 pinks. The chinook contribute to a local sportfishery; the coho, sockeye and chinook contribute to local native fisheries; the coho, chinook, pink and sockeye contribute to both native, sport and commercial fisheries of the province.

The numbers of juvenile salmonids which enter and reside in the Shuswap Lake system can reach into the 100's of millions on some years. Juvenile salmonids utilize the foreshore areas for rearing and migration predominantly from mid April to mid July (Graham, et al., 1979). However, Russell et al., (1980) did find coho and chinook within these areas until August. Clemens, 1934 too found chinook utilizing the shoreline in July. The timing of departure for chinook and coho from the shoreline areas is considered to be related to increased water temperatures (Russell et al., 1980). Sockeye juveniles emerging from the lakebed within shoreline spawning sites also utilize the shallows as early as March. They too have been found within shoreline areas into August (Cooper, 1978), with the majority moving offshore into the deep water, pelagic, portion of the lake by the end of July (Williams, et al., 1989). In summation, juvenile salmonids can utilize the Shuswap Lake shoreline from March through August.

A juvenile salmonid distribution study was conducted in 1978 and 1979 throughout the lake by the DFO in which seining for juvenile salmonids was conducted along the shorelines (Russel, *et al.*, 1980). In the vicinity of Salmon Arm, the extensive shallows were characterized by turbidity and high temperatures. The authors concluded that this likely limits the use of the area to the April and May period before the salmonids migrate to other basins in the Shuswap Lake system. In 1978 coho and chinook were captured (inconsistently) from the beginning of April to the end of the first week of July. In 1979 coho and chinook juveniles were captured (inconsistently) from the end of May to the end of the first week of June. It was concluded that the south shore of the Salmon Arm of Shuswap Lake was considered to be an outmigration route for juveniles migrating to the ocean.

2.0 MARSH HABITAT ECOLOGY

Marshes are extremely productive types of habitat which support the fisheries resource in ocean, estuary, river and lake environments through a number of ways. In a lake they are the transitional habitat between terrestrial environments and the pelagic portion of the lake. To exist, they require a shoreline that has a gentle slope composed of fine substrates and protected from wave action. The areas go through an annual cycle of flooding and dewatering. Throughout this cycling, the process of regeneration and decay of plant material occurs which supports the detrital food chain and ultimately fish populations.

The detrital food chain is the biological pathway through which nutrients from dead and decaying matter are taken up by one level of organisms e.g. algae and fungi, which are then consumed by a higher level of organism e.g. invertebrates, which are then consumed by an even higher level of organism e.g. fish. A further extension of this chain would be humans who catch and eat the fish. A closer look at the cycle reveals that when water levels recede in the late summer and fall, marsh plants begin to break down with perennials such as bull rushes, sedges, and water parsnip going into senescence. This is the process of transferring nutrients from the vegetative canopy to the root system for storage overwinter. The vegetative remains, detritus, on the surface are then colonized by algae and fungi which further aid in the breakdown of the plant material as do freeze/thaw cycles in the winter and early spring. The detrital mat also serves a "mulching" function of both insulating the root system overwinter from extreme cold and through the summer from extreme heat.

In the spring when water levels inundate the dead vegetation, breakdown continues. Nutrients leach into the water column supporting productivity within the lake. The nutrients can be reabsorbed into the substrate, providing nutrients for plant growth or it can be taken up by free swimming microscopic plants (phytoplankton). This phytoplankton in turn becomes a food source for free floating animals (zooplankton). Zooplankton is an important food source for salmon. In addition, aquatic insects use the detritus, fungi and algae as a food source (Boulton, *et al.*, 1991). These detritus-consuming insects include mayflies *(Ephemeroptera)*, caddisflies (*Trichoptera)* and aquatic flies (*Diptera*), such as chironomids which are also important fish food items.

In the spring the perennials regenerate shoots from the nutrients stored overwinter in their root systems. These shoots, along with other plants such as horsetails and mare's tails, then create an overstory with a diversity of plant height and structure. This diversity creates habitat for the different types of invertebrates which extensively colonize these marshes, both within the substrate and upon the vegetation. The invertebrates include the aquatic insects mayflies, caddisflies and dipterans such as chironomids. In addition, certain zooplankton which use the shoreline vegetation and associated substrate, such as harpacticoid copepods, (Wetzel, 1973), will feed on the vegetation.

The timing of high water in the spring and early summer is synchronous with the use of the shoreline areas by juvenile salmonids. When lake levels rise and inundate the vegetation, juvenile salmonids are able to access these areas where they can then consume the resident invertebrates in their different life stages from the lake substrate, off of the vegetation and within the water column. The juveniles also find cover from predators when they are in amongst the vegetation. Gregory and Levings (1996) found that juvenile chinook salmon were preyed upon by fish significantly less in the presence of vegetation than in areas of no vegetation.

The root systems of the marsh plants also merit some discussion. In addition to functioning as an anchoring mechanism, nutrient absorption and storage site for the plants, they also benefit the ecosystem in other ways. The root systems can be quite extensive forming dense vegetative mats which stabilize the substrate. This helps to prevent erosion of the foreshore and sedimentation of the lake. This is important to both the plants and fish as the plants benefit from a substrate enhanced by decomposed vegetation and a more suitable substrate for recolonization of plants. The fish are provided a clear aquatic environment in which they can thrive.

From the above, it can be seen that marshes support fish populations by providing habitat for their food items, providing cover from their predators and preserving water quality.

3.0 RELEVANT SHUSWAP LAKE RESEARCH

Work undertaken in Shuswap Lake corroborates the supportive relationship discussed previously between marsh habitat and the fisheries resource plus the negative impacts associated with degrading this habitat.

In work on the Shuswap Lake, Hatfield Consultants found invertebrates, including zooplankton, more abundant within vegetated areas than non-vegetated areas (1996). An analysis of juvenile salmonid stomach contents indicated that the sampling sites within Shuswap Lake with the greatest species diversity and abundance of invertebrates also were the sites most frequented by juvenile salmonids (Russell, *et al.,* 1980).

Russel, *et al.,* (1980) examined food organisms found in the stomach contents of juvenile chinook captured in Shuswap Lake in 1978. Of the organisms identified, dipteran pupae and adults, daphnia spp., chironomid larvae, homopteran adults and mayfly nymphs occurred most often. Again, as discussed above, the dipterans, which include chironomids, and mayflies are characteristic of marsh vegetation. These results were interesting in that the percentage of organism occurrence in the fish stomach contents was not related to the prevalence of organisms found in the invertebrate samples, thus indicating preferential feeding.

In Shuswap Lake, Hatfield Consultants Ltd. found harpacticoid copepods and chironomid larvae and pupae within the stomachs of juvenile sockeye salmon (1996). In addition, they found in the stomachs of juvenile chinook salmon, harpacticoid copepods and mayfly nymphs and caddisfly larvae. As noted above, all of these invertebrates would be found in inundated marsh vegetation. ECL Envirowest Consultants Ltd. too reported juvenile chinook moving into reed canarygrass (*Phalaris arundinacea*) meadows and feeding on chironomids in Shuswap Lake (1989).

Juvenile sockeye salmon were also sampled within Tappen Bay in June, October and early April just prior to seaward migration (Cooper, 1978). Stomach sampling found that this area and the northern end of Anstey Arm were two distinct areas within Shuswap Lake where the fish were feeding primarily on insects, mainly the chironomid larval form which is detrivorous. This is interesting in that when sockeye juveniles move offshore into deeper waters throughout the rest of the lake, their diet usually consists predominantly of zooplankton.

A study undertaken by DFO in June of 1989 in Sicamous Narrows clearly showed some of the ramifications of reducing the productive capacity of these shoreline marsh habitats as a result of removing and derooting the living and dead marsh vegetation. At that time a comparison was made between three inundated marsh sites: one which had not been disturbed, the second which was shaded by a barge and the third which had been rototilled in April of 1989 while the site was above the water level of the lake. Vegetative colonization, substrate stability and invertebrate production was compared between the three. The differences were striking.

With respect to vegetative cover, the undisturbed Site 1 was lushly vegetated with reed canarygrass, horsetail, sedge and *Elodea sp.*. Reed canarygrass was dominant. In the shaded area, Site 2, the vegetation was predominantly horsetail with decaying reed canary grass and some sedge. In Site 3, the rototilled area, the reed canary grass was sparse with only two short shoots per square meter. In addition these shoots were poorly rooted.

There was an obvious difference between the stability of the substrate between the three sites as well. In Site 2, there was a siltier bottom than at Site 1 and at Site 3 the bottom was obviously disturbed and unconsolidated, unlike the other two sites.

The difference between invertebrate productivity within the three sites was also striking. Adams *et al.,* (1989) found Site 1 contained greater numbers and diversity of invertebrates than the other two sites. At Site 1, invertebrates numbers were 4 times that found in Site 2 and 7 times higher than that found in Site 3. Zooplankton was also found at Site 1, unlike the other two sites.

The above study showed that rototilling in a marsh almost extinguished the vegetative community thus destabilizing the substrate and reducing the production of fish food organisms.

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