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BRITISH
COLUMBIA

Embayment Enhancement Feasibility Study Williston Reservoir

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PART III

TECHNIQUES REVIEW

3.1 REVEGETATING DRAWDOWN ZONES

Description

The water level fluctuations typical of most storage reservoirs make it difficult for vegetation to become established in the drawdown zone. As a result, this area is often barren of vascular plants. The wave action, unstable soils, and the alternating periods of flooding and exposure prevent plant species from becoming established in this area. A number of revegetation experiments have been successful in introducing some species of plants in the drawdown zone. Successful revegetation of this zone can provide the cover, and invertebrate forage required by fish, as well as stabilizing the shoreline, increasing wildlife use and improving visual quality (Skeesick and Sheehan 1993).

Applications

There are a few ongoing experiments with a variety of shrubs, trees, grasses and sedges in B.C. and Oregon reservoirs (Carr and Moody 1992; Skeesick 1983; Skeesick 1986; Skeesick 1993; Skeesick and Sheehan 1993).

Oregon Reservoirs. In Oregon, there have been a series of revegetation experiments over the last 22 years (Skeesick 1983; Skeesick 1986; Skeesick 1993; Skeesick and Sheehan 1993). The first experiment was conducted in 1971, another was conducted in 1988-89 and another was conducted in 1991. In these experiments bald cypress, willows and sedges have survived regular flooding in reservoirs where the growing season is limited to six to ten weeks in late summer and fall. The first fall frost in this area occurs in mid-October. Of 46 species planted in 1971, four remain viable in 1992. Columbia sedge *(Carex apertd)* has persisted strongly from depths of O - 15 m below the full supply line with the plugs planted having coalesced into a solid row 1.5 - 4 m wide. The species is considered an unqualified success. Slough sedge *(Carex obnupta)* has spread extensively laterally at depths to 8 m, but has disappeared below that. Bald cypress *(Taxodium distichum)* has survived over a depth range of O - 15 m and has successfully dissipated wave energy and provided juvenile fish cover. The fourth species, silky dogwood *(Comm amomum)* persisted at depths less than 6 m to some degree.

A further ten shrubs and seven tree species were planted in 1988. Of these, green ash *(Fraxinus pennsylvanica)* and bald cypress *(Taxodium distichum)* showed the most promise with a survival rate of 90% at up to 8 m depth and 91% at up to 18m

depth after one season, respectively. Of the shrubs, rigid willow and purple willow had a 92% and 85% survival rate, respectively, at depths to 15 m after one season.

In an 1989 experiment, matts and wattles of willow whips were stacked to an unstable beach in various ways to test their effectiveness at preventing erosion. Willow mattings were found to be most effective at stabilization of the soil. They also provided a site acceptable to native pioneering species. The willow whips did not develop shoots and re-vegetate as was hoped however.

In another experiment conducted in 1991, Columbia sedge *(Carex aperta)* exhibited a 64% survival rate after two inundations (seasons) to a depth of 15 m and 80% at a depth of 8 m (Skeesick 1993).

Upper Arrow Lake Studies. An Upper Arrow Lake dust control program in B.C. has tested both the establishment of a temporary cover crop and a permanent wetland/riparian ecosystem (Carr and Moody 1992). The techniques were developed as methods for reducing soil erosion and dust problems in the drawdown zone but are also thought to provide benefits to local fish populations although this aspect has not been closely examined. Fall rye, planted in mid-March, reached heights of 1 m before inundation in late July, 1992. The fall rye resulted in successful reduction of both dust and soil erosion. It also led to increased nutrients in the lake and improved the visual aspect. The rye remained in place after one year of inundation as stubble and appeared to provide several benefits: increased surface roughness and soil protection until the next crop could be established; increased soil organic content and thus increased soil resistance to erosion; and it acted as a seed trap for native plant material. It was also found that drill seeding was more effective than helicopter seeding. While the experiment was solely designed to reduce dust and increase soil stability, the rye would provide cover and nutrients to fish and benthic fauna.

Planting trials conducted in Upper Arrow Lake using willows and wetland plant species have also shown promising results (Carr and Moody 1992). Of 14 species of wetland plants established in 1991, four showed reasonable survival rates through 1992. Of these, slough sedge *(Carex obnupta)* exhibited most success with a survival rate of 92% at approximately 4 m depth and 31% at 8 m. Water sedge *(Carex aquatilus)* had a 79% survival rate at 5 m depth and 25% at 8 m. Beaked sedge *(Carex rostrata)* and sitka sedge *(Carex sitchensis)* showed reasonable survival rates at depths to 7 m, but not at 8 m. Columbia sedge *(Carex aperta)* did not perform well at any elevation.

Four species of willows were planted in spring of 1991 with variable results (Carr and Moody 1992). Plumas sitka willow *(Salix sitchensis)* fared the best with a

Oliver, C.H. and C.A. Lewis. 1977. Reproduction of planted lake trout, *Salvelinus namaycush,* in Gamitagama, a small Precambrian lake in Ontario. J. Fish. Res. Bd. Can. 34(9): 1419 - 1422.

Oliver, G. 1979. A final report on the present fisheries use of the Wigwam River with an emphasis on the migration, life history and spawning behavior of Dolly Varden char, *Salvelinus malma* (Walbaum). Fisheries investigation in tributaries of the Canadian portion of Libby Reservoir, B.C. Fish & Wildlife Branch. Cranbrook, B.C.

Pardue, G.B. and LA. Nielsen. 1979. Invertebrate biomass and fish production in ponds with added attachment surface. *Pages* 38 - 43 *in* D.L. Johnson and R.A. Stein, [eds] Response of fish to habitat structure in standing water. North Central Div. American Fisheries Society Spec. Pub. 6.

Parkinson, E.A. and P.A. Slaney. 1975. A review of enhancement techniques applicable to anadromous gamefish. B.C. MOE, Fish. Wildl. Br., Mgmt Rept. 66.

Perrin, C.J., K.S. Shortreed and J.G. Stockner. 1984. An integration of forest and lake fertilization: transport and transformation of fertilizer elements. Can. J. Fish. Aquat. Sci. 41:253-262.

Prince, E.D. and O.E. Maughan. 1978. Freshwater artificial reefs: Biology and economics. Fisheries 3(1): 5-9.

Prince, E.D. and O.E. Maughan. 1979. Attraction of fishes to artificial tire reefs in Smith Mountain Lake, Virginia. *Pages* 11 - 17 *in* D.L. Johnson and R.A. Stein, [eds] Response of fish to habitat structure in standing water. North Central Div. American Fisheries Society Spec. Pub. 6..

Rawston, R.R. 1977. Effects of reduced bag limit and later planting date on mortality, survival, cost and yield of three domestic strains of rainbow trout at Lake Berrysea and Merle Collins Reservoir. Calif. Fish, Game. 63: 219 - 227.

Skeesick, D.G. 1983. Development of technology and methodology for introduction of terrestrial vegetation in reservoir drawdown zones. USDA Forest Service, Williamette National Forest, Eugene OR, 39 p. + app.

Skeesick, D.G., 1986. Terrestrial vegetation in the drawdown zone of flood control reservoirs in Oregon. *Pages* 49 - 59 *in* J.H. Patterson [ed] Proceedings of the workshop on habitat improvements, Whistler, B.C. May 8 - 10, 1984. Can Tech. Rept. Fish. Aquat. Sci. 1483. 219 p.

Skeesick, D.G., 1993. Sedge survival comparison test plots monitoring report - year 2 Blue River Reservoir. Draft report, Williamette National Forest, Eugene OR, 3 p.

Skeesick, D.G., and M. Sheehan, 1993. Blue River and Dorena Reservoir erosion control vegetation survival tests. Draft report, Williamette National Forest, Eugene OR, 40 p.

Slaney, P.A., and B.R. Ward. 1992 in prep. Experimental fertilization of nutrient deficient streams in British Columbia. International Symposium on Atlantic Salmon Development in Quebec: Rules for Success. Federation Quebecoise pour le Salmon Atlantique. Quebec, Quebec. 39 p.

Slaney, T.L., 1990. A review of fisheries techniques for B.C. reservoirs. Prep, for B.C. Hydro, Vancouver B.C., 49 p.

Stockner, J.G. and K.S. Shortreed. 1985. Whole-lake fertilization experiments in coastal British Columbia lakes: empirical relationships between nutrient inputs and phytoplankton biomass and production. Can. J. Fish. Aquat. Sci. 42:649-658.

Stuber, R.J., C. Sealing, and E.P. Bergensen. 1985. Rainbow trout returns from fingerling plantings in Dillon Reservoir, Colorado. 1975 - 1979. North Amer. J. Fish. Manage. 5: 471 - 474.

Swales, S. and K. O'Hara. 1980. Instream habitat improvement devices and their use in freshwater fisheries management, J. Env. Manage. 10: 167 - 179.

Taylor, G.D. 1986. Provincial stream habitat improvement. *Pages* 93 - 105 *in* J.H. Patterson [ed]. Proceedings of the workshop on habitat improvements, Whistler, B.C. May 8 - 10, 1984. Can. Tech. Rept. Fish. Aquat. Sci. 1483. 219 p.

Teskey, R.O. and T.M. Hinckley. 1978. Impact of water level changes on woody riparian and wetland communities. Vol. V: Northern Forest Region. U.S. Fish and Wildlife Serv., FWS/OBS-78/88.

U.S. Corps of Army Engineers. 1979. Flood tolerance in plants: a state of the art review. Waterways Experimental Stn. Vicksburg, Mississippi. Rept. No. TR E-79-2.

U.S. Forest Service. 1969. Wildlife habitat improvement handbook. Washington, DC. FSH2609.il

Ward, B.R. and P.A. Slaney. 1992 in prep. Experimental creation of fish habitat in some streams of British Columbia. International Symposium on Atlantic Salmon