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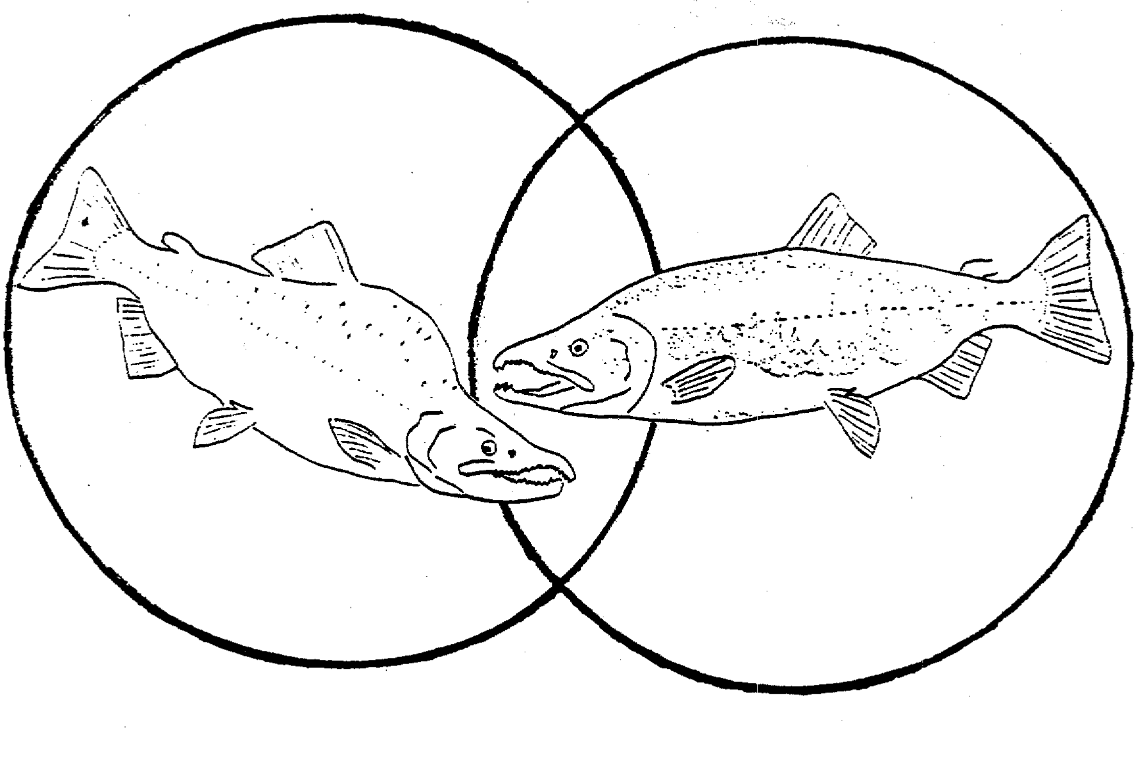

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Innovations and Guidelines for Alaskan Salmon Enhancement Channels

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Introduction

An apparent need in Alaskan salmon enhancement efforts is that of concentrating more effort and financial resources upon rehabilitation of presently depleted natural stocks. Present enhancement efforts by the state and private sectors are predominately geared to the construction and operation of salmon hatcheries. Although effective, they are expensive to construct and have high annual operation and maintenance costs. In contrast, the outstanding production of natural spawning areas under favorable environmental conditions is occasionally demonstrated by exceptional returns, i.e., the 1978 pink salmon returns to Tenakee Inlet, Peril Straits, and eastern Baranof Island in southeast Alaska.

An alternative salmon enhancement approach is that of using salmon enhancement channels, a collective term that includes spawning, incubation and dual-purpose channels, to assist in the restoration of depleted pink and chum salmon stocks in Alaskan streams. Technology for salmon spawning channels has reached its greatest development and application in British Columbia with excellent to outstanding results (Cooper, 1977). Although technology for incubation channels has been well developed, its practical applications are very limited and only the Pitt River Channel is operating on a production scale (Cooper, 1977, Kral, 1967, and Thomas and Shelton, 1969). The dual-purpose channel, a new, innovative approach, will be presented later as one means of increasing the use of enhancement channels in Alaska.

A combination of factors undoubtedly influenced the decisions not to use incubation and spawning channels in Alaska in recent years. The following factors may have contributed to its lack of use: 1) the high Alaskan construction costs and subsequent low benefit-cost ratios, 2) lack of favorable construction sites, particularly in southeast Alaska and Prince William Sound regions, 3) lack of success and notable failures in stateside channels, and 4) lack of familiarity with channels by personnel engaged in enhancement planning and construction. New innovations broadening applications and reducing costs will be necessary to break the wall of indifference toward channels. These may include one or more of the following: 1) the concept of the dual-purpose channel, 2) the use of the upper intertidal area of a stream for channel location, 3) substrate replacement in existing stream channels, and 4) combining groundwater with a channel.

Spawning channels

Historically the first two spawning channels, a converted rearing pond at Horsefly Lake, B.C. (International Pacific Salmon Fisheries Comm.) and a controlled flow side channel on Mill Creek, California (U.S. Fish and Wildlife Service) were constructed in 1953. Jones Creek, B.C. was the first one constructed in a conventional manner in 1954 (Department of Fisheries, Canada). Other early channels included Robertson Creek, B.C. in 1959 (Department of Fisheries, Canada), Seton Creek, B.C. in 1961 (International Pacific Salmon Fisheries, Comm.), and the Big Qualicum River, B.C. in 1963 (Department of Fisheries, Canada). These represent the early channels of which only Jones and Seton Creek channels are presently operational. The Big Qualicum channel was converted into a rearing channel for juvenile salmon and the present channel was constructed later.

A few spawning channels were constructed in Alaska in the 1960's, but interest in salmon enhancement approaches was lacking and none were built later. Present interest is limited. The first channel, a cooperative operation between the Fisheries Research Institute, University of Washington, and the U.S. Forest Service, was that at Indian Creek on Prince of Wales Island, southeast Alaska. It was started in 1960 and completed in 1961. Pink salmon utilized it in 1961 and 1962, but in both years severe flooding washed out facilities that were rebuilt the first year and then abandoned. The channel had been inadequately engineered for high flows, which occur annually. The Bureau of Commercial Fisheries built two spawning channels in southeast Alaska. The first was a small channel built in Auke Creek near the Auke Bay Fisheries Laboratory in 1961 and is still operative but needing maintenance and repairs. The second was an experimental channel constructed in Lovers Cove Creek near the Little Port Walter research station on Baranof Island in 1965 and operated until 1969. It was strictly for research purposes and discontinued after a series of spawner density experiments were completed.

Several major factors should be considered when one selects and evaluates a potential spawning channel site. These include 1) a minimum flow of 10 cfs. or greater, 2) gentle land gradient for construction purposes, 3) a channel density of spawners with 1.0 m^2/pair of chum or coho salmon, 4) that land and water requirements are greater than for an incubation channel, 5) initial cost per million eggs capacity is greater than an incubation channel, 6) annual operation and maintenance costs will be less than for an incubation channel, and 7) a natural selection of mates provides for genetic diversity.

Incubation channels

Although an efficient means of propagating salmon, the incubation channel concept has not had nearly the successes that spawning channels have attained. The first channel was for experimental use only on Abernathy Creek, Washington was constructed in 1959 and operated until 1970 or 1971 (U.S. Fish and Wildlife Service). A series of experiments were conducted using fall chinook and chum salmon. The Idaho Department of Fish and Game constructed a total of seven channels during the years 1962, 1964 and 1965 and used them for propagation of steelhead trout and coho and chinook salmon.

Operational difficulties in isolated locations caused many problems, although considerable success was obtained with spring chinook salmon in some instances. The most successful channel is that on the upper Pitt River, Fraser River system, constructed by the International Pacific Salmon Fisheries Comm. in 1963. Sockeye salmon fry production provides for a substantial share of the Pitt River salmon and the channel is still operational. The Oregon Game Commission built three channels in 1965, but lack of coho salmon and steelhead trout returns caused discontinuation of the structures. The Washington Department of Fisheries built a channel at its Satsop Springs salmon hatchery in 1969. It was operational for some years, but apparently funding restricted its use.

The author designed and operated a small experimental "miniaturized incubation channel" in the small hatchery on Auke Creek in 1969-1970. Despite severe freezing problems with waterflow, indications of a successful design were apparent. A transfer of duties eliminated further development of design. Otherwise no known attempts of incubation channel construction can be cited for Alaska.

Factors for consideration during site selections and evaluations include 1) flow requirements are low, below 5 cfs if necessary, 2) egg seeding densities can exceed 2,000 eggs/ft^3, 3) a loading of 6,000,000 eggs/cfs. or more, dependent upon water quality, 4) land area requirement is much less than that of a spawning channel, and 5)handling of gametes provide genetic control that may be desirable to the fish culturist but not the geneticist.

The dual-purpose channel concept

The dual-purpose channel concept is a new approach toward the rehabilitation of depleted natural stocks of pink and chum salmon. This salmon enhancement channel concept combines the operational features of the spawning and incubation channels into a versatile dual-purpose unit. In the rehabilitation of a stream one must take the available residual stock and initiate restoration by using the channel first as an incubation unit to obtain maximum production of emergent salmon fry. Cyclic increases in adult returns, combined with effective stock management, would permit eventual rehabilitation of the runs while permitting partial harvesting as well.

Within several generations, assuming normal fluctuations in marine survival, adult returns should 1) fulfill incubation channel requirements, 2) obtain optimal spawner escapements into the channel not used for incubation, and 3) begin rehabilitation of available stream areas outside of the channel area. Eventually the incubation channel operations can be phased out and the channel reverted to a self-sustaining spawning channel.

The following considerations are pertinent in selecting and evaluating sites for this type of channel; 1) its design is specifically for the rehabilitation of depleted pink and chum salmon stocks, 2) space and water requirements are similar to a spawning channel, 3) annual O & M costs will be dependent upon labor intensive activities, 4) has operational versatility as to type of operation desired, 5) genetic control will be dependent upon operational use, and 6) assume that it will eventually become a self-sustaining spawning channel.

Intertidal locations for salmon enhancement channels

A relatively new departure from a conventional upstream enhancement channel site selection is that of a location on the upper intertidal area of a river or stream. Such a site has a number of advantages, both environmental and cost-wise, over conventional sites. These include 1) good to excellent local availability of gravel by screening the alluvial fan of the stream's delta, 2) ease of excavation of alluvial till, 3) complete lack of ground cover removal, 4) periodic tidal submersion with a therapeutic effect on eggs to reduce fungus formation and its spread from dead eggs, as well as eliminating or reducing losses from severe freezing or flooding, 5) potential intertidal sites are quite abundant in southeast Alaska and the Prince William Sound regions, and 6) occasionally sites with stream braiding in the intertidal section will provide a side channel for conversion with minimal excavation.

Two of the Alaskan spawning channels, Indian Creek and Lovers Cove Creek, were at least partially intertidal in location. Although both were experimental channels, they were not designed to determine feasibility of intertidal locations. Their operational lives were short and thus cannot be considered as examples of feasibility or effectiveness of such sites. If the Indian Creek channel had been engineered for withstanding very severe floods, it might have proven its feasibility.

The development of this concept of an enhancement channel resulted from an investigation of an ideal site at the mouth of Favorite Creek in Favorite Bay, which is approximately five miles south of Angoon on Admiralty Island. A side channel in the intertidal area between the 14 and 18 foot tidal elevations presented an excellent location for a dual-purpose channel as the present stocks of pink and chum salmon are severely depleted. For a nominal amount of excavation, substrate replacement, and construction of a flow control headworks a fine enhancement channel could be constructed. This was, in fact, one of the recommendations made by the author in his report to the Admiralty Citizen's Council on salmon enhancement potentials in the Hood Bay-Kootznahoo Inlet in 1977.

A word of caution, if donor stocks are used for stocking this type of channel, one must be sure to use salmon genetically adapted to intertidal spawning environment.

Substrate replacement in stream channels

The conversion of an existing stream channel into a virtual spawning channel is not a new innovation. The Washington Department of Fisheries has conducted such activities upon salmon streams in the western part of the state with success. The most favorable locations for such improvements are streams with stable flows, preferably from lake outlets and groundwater fed streams. In such streams flooding, siltation, freezing, and stream erosion are greatly reduced or even eliminated. In surface run-off streams with large annual flow fluctuations degradation of installed gravel substrate will be much greater, hence duration of effectiveness greatly reduced.

Substrate replacement in Perkins Creek, Washington, resulted in improved chum salmon egg-to-fry survival of 57 percent compared to only 17 percent in an adjacent unimproved section of stream for the 1973 brood. In Exeter Springs, Nisqually River, the sand loaded substrate was replaced with graded gravel that resulted in a chum salmon egg-to-fry survival of 62.4 percent compared to a range of 21.440.7 percent prior to improvement (Gerke, 1973). Gerke also stated: "Adding spawning gravel to impoverished stream areas as a means of enhancing the fisheries resources has, to date, been a solid success. The Perkins Creek and Exeter Springs projects have demonstrated that by providing suitable spawning habitat a stock of fish can be appreciably improved upon. Furthermore, benefit-cost ratio estimates indicate that this method of resource enhancement is very profitable as the monies expended are offset, in a very short time, by the benefits derived. From both a biological and economical standpoint, creating spawning channels in natural streambeds is a feasible means of accomplishing this task."

It is recommended that substrate replacement under Alaskan conditions be most feasible only in streams with stable flows, i.e. lake outlets and groundwater fed streams. Opportunities for locating the latter type of location are most commonly found below receding glaciers, the braided river valleys of formerly glaciated valleys, and the coastal forelands that lie between Cape Spencer and the Copper River flats.

Groundwater development for salmon enhancement channels

A new approach is that of developing groundwater sources for channel use by excavating into near-surface aquifers found in specific locations. Excellent groundwater is available in the alluvial fans of receding glaciers, the floodplains of formerly glaciated, braided river valleys, and the extensive forelands of the Gulf of Alaska. An enhancement channel site with groundwater below a receding glacier has the following advantages over a conventional upstream site; 1) ready availability of groundwater with a high water table, flow dependability, lack of drought, flooding, siltation, and reduced freezing, 2) unlimited quantities of gravel in the glacial till, 3) extreme ease of excavation, 4) gentle land gradient favorable for laying out channels, and 5) a lack of heavy ground cover, particularly large conifers. A choice channel location is one that is an established side channel or a stream originating from a large groundwater upwelling on the floodplain of a formerly glaciated river valley. Two major advantages gained include 1) the use of an existing stream channel, and 2) an established groundwater supply with minimal development costs. The above types of channel sites eliminate or greatly reduce costly features of conventional channels including 1) complicated headgates or flow control structures, 2) a long water supply line, 3) extensive excavations, 4) extensive site preparations, and 5) long distance hauling of gravel substrate.

A groundwater source for an enhancement channel has one major disadvantage, which is a low dissolved oxygen content. Studies in the Port Valdez area indicated saturation rates of between 57 and 70 percent. This must be countered by reduced loading of channels.

Observations of outstanding groundwater potentials in Port Valdez resulted in the development of this concept. Two gravel pit excavations near the old town of Valdez resulted in the development of small, but very dependable stream flows. Local stocks of pink and chum salmon strayed into the outlet streams, became established and presently provide moderate to sometimes outstanding adult returns. Observations of excellent streamflows originating from groundwater upwellings within the Lowe River floodplains below Keystone Canyon east of Valdez have further substantiated the validity of this concept. Such streamflows have been gauged in excess of 40 cfs. during the fall spawning of pink salmon in Canyon Slough stream. An excellent example of groundwater development on the coastal foreland of the Gulf of Alaska is that of the extensive system of drainage ditches excavated around the Yakutat airfield during World War II. An extensive aquifer was tapped by these ditches, forming a vast network of small streams of which the shallower ones will cease flowing during periods of drought or severe freezing. These ditches presently provide spawning and rearing areas for hundreds of adult coho and and thousands of pre-smolt.

Discussion

The use of salmon enhancement channels as an approach to increase Alaskan natural production and to rehabilitate depleted runs has been overlooked in favor of artificial propagation by large state operated production hatcheries and a small number of private non-profit hatcheries. A number of factors have undoubtedly dampened interest and enthusiasm in salmon enhancement channels including 1) institutional barriers within agencies, 2) high Alaskan construction costs thus lowering benefit-cost ratios, 3) lack of success and notable failures in stateside channels, and 4) lack of familiarity among personnel engaged in salmon enhancement planning and construction.

During the rush into salmon enhancement activities in Alaska since 1970 virtually all efforts and funding were concentrated on artificial propagation. The need for rehabilitating depleted natural stocks of salmon was overlooked. Hatcheries are not the answer for natural stock rehabilitation. Under certain favorable conditions within depleted streams salmon enhancement channels can provide a means f rehabilitation. Perhaps the application of four innovations including the dual-purpose channel concept, substrate replacement, use of intertidal areas for channels, and combining groundwater with channels may place this enhancement approach in a better perspective to those involved in increasing our salmon resources.

Channel technology has been well developed, particularly by the Canadians. The technology and research conducted over many years at the Big Beef Creek research station of the Fisheries Research Institute, University of Washington must also be considered. Satsop Springs and Abernathy Creek operations must not be overlooked either. In contrast to the numerous channel failures stateside we must consider the numerous Canadian successes with very attractive benefit-cost ratios. Hence there hasn't been a lack of channel technology nor success, but certainly a lack of initiative in applying this approach to salmon enhancement in Alaska.

Alaska has a number of factors favorable for including enhancement channel technology as an approach towards increasing salmon production. Alaskan topography is unique in that it has excellent availability of intertidal channel sites and groundwater aquifers that are found in decreasing abundance with a more southerly latitude. Public land ownership is very extensive and receptive toward salmon enhancement, although wilderness and preservationist concepts will place restrictions upon projects. Industrial, municipal, and private developments are still minimal hazards compared to more southerly areas. Native land claims settlements will place large areas of land into their possession, which will reduce the number of permits required and red tape encountered that presently strangles the private operator.

The potentials for greatly expanding the use of salmon enhancement channels are outstanding in Alaska, compared to the more southerly areas, particularly stateside. Through the use of innovations, the high costs of conventional channels can be overcome and make benefit-cost ratios more attractive. However, the application of channel technology into the Alaskan scene will be dependent upon the initiative and willingness of the enhancement personnel to overcome the institutional barriers that may be preventing them from involving themselves in this type of approach.

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