Annotated Bibliography
Cowichan River System

Literature Related to Factors Affecting the Production of Cowichan River
Chinook, Coho, and Chum Salmon

April 2002

By

Coastline Environmental Services
3453 Falcon Drive, Nanaimo BC
V9T 4G7,
Home: (250) 756-2287
Cell: (250) 729-6238
Email: cns@telus.net

For

Oceans and Community Stewardship
4166B Departure Bay Road,
Nanaimo, B.C
V9T 4B7.

and

Cowichan Tribes
5760 Allenby Road
Duncan, B.C
V9L 5J1

INTRODUCTION

Concerns have been identified regarding the Cowichan River system and possible factors affecting the production of chinook, coho and chum salmon. Despite stringent management strategies Cowichan River salmon stocks continue to remain below optimal production levels for the river system.

This annotated bibliography was created in conjunction with a compilation of the reports cited, creating a specialized literature resource. The majority of reports included have been copied from originals, bound and organized in alphabetical order by author. There are two complete sets available; one set will be kept at oceans and community stewardship office in Nanaimo and the other at DFO district office in Duncan. Each report has been annotated in this bibliography including; full citation, abstract source and abstract. Abstracts were derived from a variety of sources, including, original reports, an annotated bibliography created by Kristen Daniels, and myself.

These resources were created to aid in a preliminary assessment into why Cowichan River salmon populations have failed to recover despite management efforts. The hope was that available literature would provide clues as to possible limiting factors for influencing recovery of chinook, chum and coho populations in the Cowichan River system.

The literature included was gathered from various libraries, biologists, scientists and government organizations. Undoubtedly, there is more information available however, literature included in this bibliography is sufficient to allow for a thorough preliminary assessment of the Cowichan River system salmon populations.

ACKNOWLEDGEMENTS

I am indebted to many organizations and individuals for assistance in the preparation of this annotated bibliography. I am especially appreciative to the Department of Fisheries and Oceans. In particular, George--- and Gordon Miller who graciously accepted many requests for literature while aiding me in locating information and reports in the far corners of the library. In addition, Dr. Dick Nagtegaal supplied valuable knowledge and resources for the compilation of this bibliography. Also, Joyce Deproy of the Ministry of Lands, Parks and Air Pollution, was integral in making Ministry resources accessible. Further, I am particularly grateful to David Burt and Cheri Ayers for providing technical guidance and support that made for the timely completion of this document. Lastly, an extended gratitude to Kristen Daniels, whose past work provided valuable information and summaries on various characteristics of the Cowichan River system.

CITATION:

Argue, A.W., B. Hillaby, and C.D. Shepard. 1986. Distribution, timing, change in size, and stomach contents of juvenile chinook and coho salmon caught in the Cowichan estuary and bay, 1973, 1975, 1976. Can. Tech. Rep. Fish. Aquat. Sci. 1431: 151 p + fig and tab.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1973, 1975 and 1976, field studies were conducted to determine the distribution, abundance, duration of residence, growth and feeding habits of juvenile chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon on the Cowichan Estuary and in Cowichan Bay. Chinook and coho were captured with pole seine, tow net, beach seine and purse seine in 1973, with beach seine and purse seine in 1975, and with purse seine in 1976. Surveys took place from the last two weeks in March to the last two weeks in October; different time periods were covered each year. In 1975 and 1976, a number of stations outside Cowichan Bay were fished by purse seine. Surveys in 1975 and 1976 coincided with releases of large numbers of coded-wire tagged and adipose clipped chinook juveniles (June – July) and coho smolts (April – June) from several sites on the Cowichan and Koksilah Rivers (coho) and on the estuary (chinook).

Juvenile chinook and coho fry were captured on the estuary between early April and late June. Chinook then moved into deeper water at the head of Cowichan Bay, just adjacent to the estuary, and to intertidal beaches around the perimeter of the bay. Coho smolts did not appear to be abundant in the catches of the different nets on the estuary, or in beach seine catches at intertidal stations around the perimeter of the bay, but were abundant at deeper water stations fished by purse seine at the head of the bay and around the edges of the bay. Neither species was abundant at stations in water exceeding 45m in the middle of Cowichan Bay. Large numbers of both species were captured at nearshore stations outside Cowichan Bay.

In 1976, many chinook and coho stayed resident in Cowichan Bay until October. The percentage of marks in the catch inside Cowichan Bay did not change appreciably during this time; few non-Cowichan marks were recovered. Thus, it was concluded that there was little immigration of other stocks into the bay. There was evidence that later migrants from freshwater tended to disperse less from Cowichan Bay than early migrants. There was also evidence that as chinook and coho grew they moved from the estuary to nearshore waters as of Cowichan Bay and then to nearshore waters outside the bay.

Both chinook and coho in 1976 grew at a rate of approximately one millimetre (fork length) per day between July and September. Growth rate appeared to slow in late September.
Juvenile Pacific herring (*Clupea harengus pallasi*) were present in large numbers in the purse seine catch, and were by far the dominant diet item (by weight) of chinook and coho caught between July and October at stations in Cowichan Bay. Decapod larvae, mostly zoea of pocellanid crabs, were numerically the most common diet item. Estuarine benthic organisms

were the dominant diet items of chinook and coho caught on the estuary flat in march, April and May.

CITATION:

Argue, A.W., L.M. Patterson, and R.W. Armstrong.1979. Trapping and coded-wire tagging of wild coho and chinook juveniles from the Cowichan-Koksilah River system, 1976. Fish. Mar. Serv. Tech. Rep. 850: vi + 117 pp.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*) and steelhead trout (*Salmo gairdneri*) smolts from the Cowichan - Koksilah River system were enumerated and coded-wire tagged between April 6 and July 14, 1976. A total of 72,152 coho smolts, 16,673 chinook smolts and 488 steelhead smolts were adipose fin-clipped and released with coded-wire-tags. The total numbers of juveniles caught, their age and size, their utilization of specific habitats and their migration patterns during freshwater residence are described in this report. Numbers of coho and chinook smolt migrants are compared for recent and past years.

CITATION:

Armstrong, R.W. and A.W. Argue. 1975. Trapping and coded-wire tagging of wild coho, and chinook juveniles from the Cowichan River system. Fisheries and Environment Canada, Technical Report Series PAC/T-77-14: 58 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Between April 7 and July 2, 1975, coho salmon (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) smolts from the Cowichan River system were captured and tagged with binary coded-wire-tags. This was a pilot study to assess logistics and field methods of tagging sufficient numbers of juveniles from a wild stock, at a reasonable cost, for assessment of ocean migration patterns and fishery contributions.

The total number of coho smolts tagged over a two month period was 26, 135; made up of 18,928 captured using plywood fence traps on outlet streams from Rotary park pools near Duncan; 4,110 captured using fence traps on Pastuch Creek, a small tributary of the Robertson River which enter Cowichan Lake; and 3,097 captured using minnow traps on an isolated side channel of the main Cowichan River. A total of 18, 332 90-day chinook smolts were captured with beach seine gear and tagged over a nine-day period (June 23 to July 2) on the north side of the Cowichan Estuary. All tagging equipment performed without any important mechanical problems.

This study demonstrated that tagging of wild coho and chinook juveniles, particularly coho, is highly feasible under field condition (cost exclusive of capital items less than $20,000). Further work is required on delayed tagging mortality of juvenile coho and chinook in fresh and estuarine waters.

CITATION

Bams, R. A. 1993. Coho salmon smolt and adult production from Kelvin Creek (Cowichan River Watershed) B.C., during four years of colonization with hatchery and salvaged wild fry. Can. Tech. Rep. Fish. Aquat. Sci. 1933: 53 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Coho underyearlings of salvaged (wild) and , in two years only, hatchery origin were scatter planted in about 15,000 m^2 of stream habitat above a barrier falls in four successive years. Finclipped subgroups identified location of release or fry source. Mean annual survival to the 1^+ smolt stage ranged from 2.9 to 26.2% (mean 13.0%) in the wild fish, and from 2.0 to 10.4% (mean 6.2%) in the hatchery stock. Only the hatchery groups displayed smolting and migration as 0^+ smolts, which, when included, increased their survival to 4.4. to 18.4% (mean 11.4%). In two study years, significant losses occurred from the rearing area during the winter. However, these fish survived in and returned as adults to the stream below the barrier falls. Weight gain to smolt varied from 6 to 9 times release weight, was negatively size dependent and greater in the hatchery stock. Survival to catch was over 9% for the first three years, with zero returns for the 0^+ smolts. Survivals to the stream were low, but similar, in wild and hatchery fish. An adaptive approach to future coho colonization projects is proposed and some guidelines are discussed. This approach ("adjust as you go") follows the recognition of production limiting events associated with stressed ecosystems. It de-emphasizes determination of unreliable production potential, but increases monitoring to advance understanding of general and site-specific production processes and to maximize production.

CITATION:
Bams, R. A. and D. G. Crabtree. 1991. Coho salmon smolt and adult production from Grant Lake (Cowichan River, Vancouver Island) following two years of colonization with hatchery-reared and salvaged fry. Can. Tech. Rep. Fish. Aquat. Sci. 1842: 31 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
Coho salmon underyearlings of wild and hatchery origin were transplanted in 1985 and '86 into a 52-ha lake containing native trout. Initial coho densities were 1020 and 1650 fish/ha. Overall survivals to smolt were 18.9 and 17.6%, with sub-group survivals ranging from 13% for the smallest fish at time of planting (2.25g average weight) to 19% for the largest (5.5 and 7.3g). Annual mean smolt weights were 38.6 and 16.3g. CE-tagged fish of the second year contributed to the Canadian and American fisheries at 5.24% compared with 4.73% for 5 Gulf of Georgia hatcheries and 1.44% for 4 colonization projects of the same year. Several aspects of semi-natural production techniques utilizing lake habitats and relating to fish size and lake productivity are discussed.

CITATION:

Beamish, R.J., B.E. Riddell, C.E.M. Neville, B.L. Thomson, and Z. Zhang. 1995. Declines in chinook salmon catches in the Strait of Georgia in relation to shifts in the marine environment. Fisheries Oceanography. 4(3): 243-256 + figures and tables.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Chinook (*Oncorhynchus tshawytscha*) catches in the Strait of Georgia increased in the 1970's and reached maximum levels from 1976 to 1978. Catches then declined until they stabilized through regulation at levels approximately one–quarter of the 1976 to 1978 levels. The timing of the decline in catch was synchronous with an increase in the mean temperature of the Strait of Georgia, a decline in annual Fraser River flows, and an abrupt decrease in the marine survival of hatchery-reared chinook released into the Strait of Georgia. Surprisingly, the number of young chinook salmon (smolts) more than doubled over the period of declining catches compared with the number produced during the period of high catches. The increase in smolt abundance was a consequence of the production from hatcheries that was approximately equal to wild production.

We conclude that there was a change in the carrying capacity for chinook salmon in the Strait of Georgia in the late 1970's that contributed to the declines in abundance and that rebuilding stocks to the high abundance of the late 1970's is unlikely until the carrying capacity for chinook salmon changes either naturally or through manipulation. Although we did not separate density-dependent and density-independent effects on marine survival, the current total number of chinook smolts produced appears larger than required for the current marine carrying capacity.

CITATION:

Bell, L.M. and R.J. Kallman. 1976. The Cowichan-Chemainus River estuaries status of environmental knowledge to1975. Report of the Estuary Working Group, Department of the Environment, Regional Board, Pacific Region. Special Estuary Series No.4: 328 p. + appendices, figures, and tables.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

This is the fourth volume in the Special Estuary Series that covers so-called critical estuaries of British Columbia. Existing and proposed developments in the Cowichan and Chemainus estuaries have prompted investigations into the natural renewable resources and their environment and into the existing and potential impacts of such developments on these resources. This report is a compilation of existing environmental knowledge on the: geology; soils; climatology; hydrology; oceanography; flora; invertebrates; fish; wildlife; land and water use; and effects of development, for the estuaries.

CITATION:

Bigg, M.A., G.M Ellis, P. Cottrell, and L. Milette. 1990. Predation by harbour seals and sea lions on adult salmon in Comox Harbour and Cowichan Bay, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 1769: 31p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

The movements, feeding behaviour and predation rate on prespawning salmon by harbour seals (*Phoca vitulina*) at Comox Harbour and Cowichan Bay and by sea lions (*Zalophus californianus*, *Eumetopias jubatus*) at Cowichan Bay were examined during 1989- 90. Tidal variation largely governs the daily movement of harbour seals over the estuaries. Sea lions tended to remain in slightly deeper water than harbour seals and their movements were affected less by tides. Peak harbour seal abundances of 750 and 175 were recorded in Comox Harbour and Cowichan Bay respectively. A maximum of 30 sea lions were counted at Cowichan Bay. The seasonal movement of these pinnipeds into the estuaries coincided with the migration of prespawning salmon into nearby rivers. Harbour seals and sea lions fed on salmon mainly along the outer edge of the estuaries, although harbour seals also commonly fed in the lower reaches of the Puntledge River, which drains into Comox Harbour. Two to four harbour seals usually preyed together upon a single salmon. A combination of cooperation and opportunism seems involved in group predation. Sea lions tended to feed individually. Based on the number of salmon seen eaten hr^{-1} in 1989, an estimated 46% of the fall run of chinook, 4% of pinks, 8% coho and 7% chum salmon were taken by harbour seals at Comox Harbour. In Cowichan Bay an estimated 1% of coho and 1% of chum were eaten by harbour seals and 3% of coho and 3% of chum were eaten by sea lions during 1989. The fall run of chinook salmon at Comox Harbour were particularly vulnerable to predation by harbour seals due to the low number of fish and their availability for predation in both the Comox Harbour estuary and the slow moving Puntledge River.

CITATION:

Burns, T. Resident trout and salmon fisheries in the upper Cowichan system: Present status and opportunities for enhancement. Fisheries Branch, Ministry of Environment and Parks, Nanaimo, B.C.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

The introduction of brown trout to the upper Cowichan River occurred from 1932 to 1935. Oliver (Hatchery) and Beadnell Creeks were the next spawning runs established. Small numbers of brown trout occurred in Stanley, Tiny and Fairservice Creeks, and in the side channels Art Watsons Creek, Joginder Inlet and Outer, Double D Inner and Outer, and three near the Sawdust Pile Pool. The brown trout tend to rear in small stable tributaries and side channels for at least one year before entering the mainstem of the Cowichan. The brown trout are unusual for they tend to spend the summer in the warm waters of the Cowichan mainstem instead of retreating to the cooler depths of Cowichan Lake like cutthroat trout and rainbow trout.

The rainbow trout of the upper Cowichan system are either lake migrants and river residents. The lake migrants migrate to the Cowichan River until the lake level drops and warms usually in late May. They spawn in the late winter and early spring in areas like Hatter's Pool, Road Pool and Holmes Pool. The river resident rainbow trout are very low in numbers with a yield of 4,990 fish in the upper Cowichan River.

The cutthroat trout of the upper Cowichan consist of two groups the resident and season migrants from the lake. The lake migrants do not appear to spawn in the mainstem of the river like rainbow trout. The cutthroat trout tend to spawn in Hatchery, Beadnell, Stanley and Tiny Creeks and the side channel Joginders. The primary reason for the cutthroat migration was probably for the extra food supply including salmon eggs (fall) and fry (spring). Furthermore, many have noticed a decline in the cutthroat population over the past few years.

Enhancement opportunities within the upper Cowichan River are numerous. For brown trout, Burns suggested stocking tributaries such as Beaver, Upper Hatchery, Beadnell, Upper Stanley, Green Timers, Josiah, Watercress, West and East Skutz Creeks. Stocking densities should be 1 fry/m^2 for stream reaches with <2% gradient and 0.5 fry/m^2 for areas with a gradient between 2-5%. Burns went on to summarize some of the qualities of the tributaries considered for brown trout stocking. Coho competition appears to be a major factor limiting brown trout production at Hatchery Creek. Thus, some think that elimination of coho from the creek may be a worthwhile project. Also there is the assumption that brown trout suffer the same competitive disadvantage as cutthroat trout when they share habitat with coho. Enhancement for river resident rainbow trout could be adding fly only catch and release regulations from June 1 to November 1. The same regulations should apply for the cutthroat trout populations in upper Cowichan.

Good fishing in early and late winter, spring and fall occur in Cowichan Lake. The high flushing rate and thin, low nutrient soils on the mountain slops surrounding the lake do not allow for high

productivity in the lake. Resident sport fish include kokanee, rainbow trout, and cutthroat trout. According to a Creel Survey rainbow trout were the most abundant with an average size of 35 cm. These rainbow trout tended to feed exclusively on insects. The lake cutthroat trout spawn in Robertson River, Pastuch Creek, Ashburnham Creek, Sutton, Creek, Millar Creek, Misery Creek, Dusty, Creek, Nixon Creek, Lakehead Creek, Lakehead North (Hall Creek), Shaw Creek, Utility Creek, and Miracle Creek. In addition, the lake cutthroat trout spawn on the beaches of Cowichan Lake. These shore dwellers tend to be only in the littoral zone (< 10 m deep) and mature at 45 cm yet can reach 70 cm and 4.5 kg. Once the cutthroat are 40 cm they tend to eat small fish including kokanee, sculpins, sticklebacks and coho fry. Finally, kokanee are seldom caught in the sport fishery at Cowichan Lake. It is thought that there are 3.4 - 5.2 million kokanee in the lake. The kokanee are very efficient consumers of zooplankton which is an important food source for young trout. Also, the kokanee are not available during the warm months (mid-May to early Nov.) because they prefer water temperatures of 10EC which is at depths between 17 and 20 m below the water surface.

Overall enhancement opportunities for the resident sport fish of Cowichan Lake are limited. One suggestion was in introduce Gerrard rainbow trout to the lake at a capacity if 1400 fish. Also it was suggested that more be learnt about the status of lake cutthroats in Cowichan Lake.

Burns also examined small lake fisheries within the Cowichan Watershed. Lakes that were mentioned included Mayo Pond, Mesachie Lake, Whissken (Kissenger) Lake, and Gillespie Lake. First, Mayo Pond has an area of 3.5 hectares and was extremely productive producing 20 lb. rainbow trout and cutthroat trout per acre. Fishing in the pond is excellent in the early spring and late fall. Second, Mesachie Lake supported a self-sustaining population of rainbow trout, cutthroat trout, and kokanee, with coho also being present. Excellent fishing opportunities occur during the cooler months of the year. A possible enhancement project for Mesachie Lake could be building a small boat ramp with access through the Camp Imadene property to encourage more angling. Rainbow trout and cutthroat trout are found in Whisken Lake where they spawn in a 100 m section of the outlet stream. This outlet only contains three patches of shallow, low quality spawning gravel yet can produce > 500 fry/year. The Lakes fry capacity for rearing is around 10,000 fish. Also, the fishing pressure is light within the lake. Adding 300 m^2 of quality (3 - 6 cm) gravel to the outlet could improve the fry recruitment of Whisken Lake. Finally, Gillespie Lake, which is a tributary to the east fork of Shaw Creek, supports a self-sustaining population of rainbow trout. These rainbow trout were introduced in 1934 and between 1962-1971. Since only a few m2 of low quality gravel is available for spawning an enhancement opportunity for the lake would be to add high quality gravel to the system.

CITATION:

Burns, T., R.A. Bams, T. Morris, T. Fields, and B.D. Tutty. 1987. Cowichan watershed fry salvage and coho colonization operations (1986): A review of preliminary results. Can. Manuscr. Rep. Fish. Aquat. Sci 1949. 68 p + app + fig + tab.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Extensive fish habitats frequently de-water during the dry summer months in the Cowichan watershed, Vancouver Island, British Columbia. During the past half-century salmonid fry have been salvaged from these habitats and redistributed into anadromous zones of the watershed by Department of Fisheries and Oceans, personnel, contractors, and volunteers without the benefit of an evaluation of this fish management strategy. In 1984, a strategic inventory system identified extensive fish habitats above barriers, which were subsequently verified as potentially viable, low gradient coho habitat in the dry summer of 1985. Based on this knowledge, a management team was assembled to plan, conduct, and evaluate the performance and benefits of fry salvage operations in 1986. A total of 174,291 salmonid fry were salvaged (162,219 coho) and 121,306 of these coho were subsequently colonized at specified densities into designated above barrier habitats of which three were selected and trapped the following spring to determine over-wintering and eventually ocean survival. Preliminary estimated fry to smolt survival at these three study sites was 6.5% at Bings Creek, 16.4% at Kelvin Creek, and 18.9% at Grant Lake. An economic evaluation of the 1986 fry salvage program indicates that, to break even, at least 100,000 coho must be salvaged and colonized, at the specified densities, into designated habitats, assuming a minimum 1.7% fry to smolt survival rate and at 1986 programs costs ($22,034 with volunteers). If the highest estimate of 350,000 salvaged coho were obtained at 1986 costs, then a benefit of $50,000 to $115,000 would result with the assumptions of 1.7% and 3.3% fry to adult survival rate, respectively, and a harvest rate of 75%. All economic benefits were derived from the Salmonid Enhancement Program Evaluation model. Economic and operational recommendations to streamline Cowichan fry salvage and transport activities are identified to increase economic benefits and reduce costs in future programs.

CITATION:

Burns, T., E.A. Harding, and B.D. Tutty. Cowichan river assessment (1987): The influence of river discharge on sidechannel fish habitats. Can. Manuscr. Rep. Fish. Aquat. Sci. 1999: 24 p. + appendices, figures, and tables.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

The Cowichan-Koksilah Water Management Plan – Final Report (MOE&P, 1986) recommended that flow releases from the Cowichan Lake weir be studied and alternative operational strategies be examined to optimize storage release flows to the Cowichan River for the most beneficial use of all species of salmonids while meeting the existing water licence requirements. On February 12, 1987, the Regional Water Manager (B. Hollingshead) invited the Department of Fisheries and Oceans and Provincial Fisheries Branch to undertake joint flow regime studies during that year. The Provincial Fisheries Branch carried out selected studies on the Cowichan mainstem while the Department of Fisheries and Oceans responsibility was to determine the influence of river discharge on sidechannel fish habitats of which this study reports.

The present rule curve for the Cowichan lake weir is operated to provide a minimum river flow of 7.08 m^3/s and 9.91 m^3/s. (350 cfs) after September 15 from a storage supply of approximately 61 million m^3/s. (49, 700 acre/ft). The duration of flow release begins when weir control of the lake is accomplished (spring) through to fall when the storage is exhausted and lake inflow equals outflow, or fall rains recharge the watershed.

The report identifies 142 sidechannels and classifies them into four categories defined as flood channels, active channels, back channels and relic channels. Field assessments during 1987 at flows of 20 m^3/s., and 4.48 m^3/ s. were conducted to ascertain the amount of wetted sidechannel fisheries habitat that was lost as discharge to the Cowichan River was reduced.

The loss of 17,897 m^2 of active sidechannel habitat of the sidechannels selected for analysis is considered significant when flows were reduced from 7.08 m^3/s. to 4.48 m^3/s. and represented an average loss of 12 – 17% of the total wetted area of this sidechannel type in the upper, middle and lower Cowichan River sidechannel zones. The flood, back and relic sidechannel categories did not appear to sustain significant losses.

The report recommends against reduction of flow below 7.08 m^3/s. and concludes optimum wetted area in sidechannels cannot be satisfied from the existing lake storage capacity. The report also recommends individual enhancement strategies be developed for each sidechannel as part of a comprehensive multi-species salmonid production plan for this watershed.

CITATION:

Burns, T. and B.D. Tutty. 1986. Coho Colonization Potential of the Cowichan-Koksilah Watershed: A habitat evaluation. Can. Manuscr. Rep. Fish. Aquat. Sci. 1865: 68 p + app + fig + tab.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Reaches of the Cowichan-Koksilah system situated above barriers were assessed for their suitability as coho rearing habitat in the arid late summer of 1985. Discharge and temperature were recorded, along with structural characteristics of specified stream sections. An estimate of 6, 383, 900 m^2 of viable habitat was identified with a potential smolt yield of approximately 500,000 or 2.5 million based on two different production models. Dollar value at harvest is annually estimated near $1 million and $5 million (1984) respectively, depending on the production model employed. More conservative or liberal production assumptions can be applied to the habitat data contained in the report. Development of cost models and possible strategies would be part of a Cowichan-Koksilah watershed production plan that would embrace a balanced multi-stock rebuilding/ enhancement effort in cooperation with the Provincial Fisheries Branch.

CITATION:

Burt, D.W. and J.C. Wightman. 1997. The fish resources of the Cowichan River and their economic value. Ministry of Environment, Lands and Parks, Nanaimo, B.C. 38 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

As part of an ongoing study to assess the productivity of chinook salmon (*Oncorhynchus tshawytscha*) in the Cowichan River, the Department of Fisheries and Oceans, Pacific Biological Station, began monitoring the downstream migration of chinook juveniles in 1991. The interaction between hatchery and naturally spawned chinook juveniles was also monitored. Various techniques and equipment (minnow traps, purse seines, beach seines, incline-plane traps, and auger trap) were used on the Cowichan River in 1991 and 1992 to collect information on growth, abundance and migration timing of juvenile chinook salmon. An estimate of juvenile chinook abundance was not calculated for 1991 since we were investigating various means to collect migrant juveniles. In 1992, the production of naturally spawned chinook juveniles was estimated to be 810,240 and hatchery releases of chinook juveniles totalled 1.9 million fish. Peak migration for naturally spawned juveniles occurred from mid-March to mid-April. Hatchery chinook tended to move downstream in a large pulse and most fish appear to be in the estuary within a few days of release.

CITATION:

Candy, J.R., D.A. Nagtegaal, and B. Riddell. 1996. A Preliminary report on juvenile chinook production in the Cowichan River during 1993 and 1994. Can. Manuscr. Rep. Fish. Aquat. Sci 2354: 80 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

As part of an ongoing study to assess the productivity of chinook salmon (*Oncorhynchus tshawytscha*) in the Cowichan River, the Department of Fisheries and Oceans, Pacific Biological Station, began monitoring the downstream migration of chinook juveniles in 1991. Inclined – plane traps and auger traps were used in 1993 and 1994 to collect information on growth, abundance and migration timing. For both years, trap catch was expanded using two methods to give estimates of hatchery and naturally spawned chinook migrants. The cross-sectional area method estimated 60-61% and the trap-efficiency method estimated 23-26% of known numbers of hatchery fish released above the trapping site. The production of naturally spawned chinook juveniles was estimated at 350,000-430,000 in 1993 and 130,000-170,000 in 1994. The Cowichan hatchery released approximately 2.9 million juvenile chinook each year. Hatchery migrants tend to move downstream in a large pulse and most of the hatchery fish appeared in the estuary within a week after release.

CITATION:
Candy, J. R., D. A. Nagtegaal and B. Riddell. 1995. A Preliminary report on juvenile chinook production in the Cowichan River during 1991 and 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2329: 64 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
As part of an ongoing study to assess the productivity of chinook salmon (*Oncorhynchus tshawytscha*) in the Cowichan River, the Department of Fisheries and Oceans, Pacific Biological Station, began monitoring the downstream migration of chinook juveniles in 1991. The interaction between hatchery and naturally spawned chinook juveniles was also monitored. Various techniques and equipment (minnow traps, purse seines, beach seines, incline-plane traps, and auger trap) were used on the Cowichan River in 1991 and 1992 to collect information on growth, abundance and migration timing of juvenile chinook salmon. An estimate of juvenile chinook abundance was not calculated for 1991 since were investigating various means to collect migrant juveniles. In 1992, the production of naturally spawned chinook juveniles was estimated to be 810,240 and hatchery releases of chinook juveniles totalled 1.9 million fish. Peak migration for naturally spawned juveniles occurred from mid-March to mid-April. Hatchery chinook tended to move downstream in a large pulse and most fish appear to be in the estuary within a few days of release.

CITATION:

Carl, G.C. 1953. Limnobiology of Cowichan Lake B.C. J. Fish. Res. Bd. Can. 9(9): 417-449.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

Cowichan Lake is 34 kilometres long, up to 4 kilometres wide and up to 150 metres deep, with an area of 62 square kilometres. Its average depth is 51 metres. Its shores are of precipitous rock for over half their length, the remainder being boulders or gravel, with a very little marsh.

Summer surface temperatures are usually close to 20° C., while the winter minimum in 1938 was 5.0° C. Oxygen is generally abundant in the lake, the lowest value observed being 3.4 cc. per litre, just before the fall overturn (November 24, 1939). The reaction of the water is alkaline (pH 7.0 – 7.8), and its becarbonate content was 18 – 22 mg. per litre (as $CaCO_2$).

Lists are presented of organisms collected in the lake. The plankton is reasonably rich in variety but was poor in quality, in 1940 at least. Bottom organisms also are not abundant. Two species of lampreys and three fishes were found in the lake, plus a number of Salmonidae whose occurrence is described elsewhere

CITATION:
Carl, G.C. Report of limnological survey: Cowichan Lake District June, July and August, 1935. Pacific Biological Station, Nanaimo, B.C. 15 p. + app. + tab. + fig.

ABSTRACT SOURCE:
Abstract provided by Kristen Daniels

ABSTRACT:
This paper concentrated on certain lakes within the Cowichan watershed including Cowichan Lake, Mesachie Lake, Bear Lake, Quamichan Lake, and Somenos Lake. Primarily most of the limnological studies occurred at Cowichan Lake during June to August 1935.

In Cowichan Lake the dissolved oxygen levels never fell below 60%. On June 21 a thermocline formed at depths between 15 to 20 m. Surface water temperatures ranged from 14 to 20EC to 5 to 7EC near the lake bottom. The lake pH at the surface ranged from 7.2 to 7.6 and at the lake bottom it was 6.8. In addition, the lake waters were low in alkalinity.

Using an Ekman dredge to obtain benthic samples the bottom fauna was identified. The location of prevalence and densities varied throughout the sampling period in Cowichan Lake. Chironomid larvae and oligochaete numbers decreased in the deep waters of the lake toward the end of the summer season. The Nostoc sp. were plentiful in the early summer. The fresh water clam (Pisidium sp.) was found both in the shallow and deep waters of Cowichan Lake. Whereas the amphipod, Hyalella azteca, was common only in the shallow waters of the lake. And at moderate depths in the lake the gastropods Planorbis sp. and Valvata sp. were common.

Six sets of plankton samples were also taken during the survey at Cowichan Lake. Some common geneses identified were Diaptomus, Cyclops, Daphnia, Bosmina, Polyphemus and Scapholeberis. In the deep waters of the lake Dinobryon and Asterionella was identified. Polyarthra and Nothalca plankton were invented to inhabit the surface waters of Cowichan Lake. Although the number of each genus remained relatively constant throughout the season, by the end of August Diaptomus and Cyclops species had increased in the water column.
Cowichan Lake does not have a plentiful supply of aquatic plants due to the rocky or gravely shores that provide little anchorage possibilities. Most of the aquatic plants were found in small bays and along shallow shores where accumulated snags allowed a muddy bottom to exist. In addition to the aquatic plants collected Carl identified the organisms associated with each plant.

A plankton sampling was completed on the Cowichan River. It was noted that the plankton undergoes nocturnal pulses when moving within the river.

CITATION:

Carl, G.C. 1937. Report on the fish ladder and the natural fishways at Skutz Falls, Cowichan River. 1937. Pacific Biological Station, Nanaimo, B.C. 3 p. + fig.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

Although the fish ladder was constructed to allow easy passage up the Cowichan River to spawning channels this did not occur. The primary reason for this was that due to the fish ladder's position the water at the ladder entrance enters the river at right angles to the swift current making it excessively difficult to ascend the river. During heavy water flows the fish could not ascend the fish ladder either.

Thus two side channels over rocks were selected for improvement in hopes that the fish could use these as optional ways to ascend the Cowichan River. The larger stream flowed via an unobstructed channel through two large rock pools then entered the Cowichan River as a sheet of water over rocks. The small stream was shorter and lacked pools and only carried water during floods. Upon the improvement of these streams four routes were available to the ascending fish. These included via the falls (passable at high water), via the fish ladder (passable at low water), via a minor fishway passable at high water, and via a major fishway passable at all times.

It was noted that improvements needed to be done to the fish ladder to improve the chances of the fish ascending the river to the spawning grounds above the falls. The improvement suggested included; 1) timbers be fitted to the slotted gate-way in the dam above fish ladder, 2) a fish guardian be made responsible for regulating water flow through the gateway by insertion or removal of timbers, and 3) timbers be inserted in the uppermost step of the ladder to reduce flow of water over the ladder and deflect more water over the adjacent fishways.

CITATION:
Clough, D.R. 1985. The Cowichan River creel survey, 1985. Ministry of Environment, Land and Parks, Nanaimo, B.C. 17 p.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
Dramatic declines in catch success of brown trout (*Salmo trutta*) and other native fish species of the Cowichan River were evident in the 1970's. These declines were attributed to improved access to the river for anglers and a growing urban population in close proximity to the Cowichan. Consequently, restrictions were soon implemented in 1980; harvest and possession reductions, seasonal openings and size restrictions.

The success of these measures and regulations are examined in conjunction with the status of the brown trout fishery on the Cowichan River. Defined objectives are outlined to determine angling effort of brown trout and other native species, record physical characteristics (ie. Age, fork length) and the implementation of an angler questionnaire.

CITATION:
Cowichan Estuary Presentation Society. 1981. Brief to the commission on Pacific fisheries policy. Submission to the commission on pacific fisheries policy (Canada). (Various Paging).

ABSTRACT SOURCE:
Abstract from Department of Fisheries and Oceans (WAVES)

ABSTRACT:
Believes that fishing restrictions and closures by federal fisheries are made based on very limited research. Instead, the lack of enforcement has created this situation. Recommends 1) Establish estuary protection reserves or zones to secure this renewable resource. 2) Enforce the fisheries act. 3) Protect the wild stock by insuring adequate runs and habitat 4) Prohibit the use of toxic chemicals and disallow dredging.

CITATION:
Cowichan River Recreation Management Steering Committee. 1992. Cowichan River recreation management plan.

ABSTRACT SOURCE:
Abstract from reference (Introduction)

ABSTRACT:

The Cowichan River Recreation Study Area (Figure 1) extends approximately 20 kilometres from the Village of Lake Cowichan to Glenora, West of Duncan. The Cowichan River is widely recognized for its high conservation and recreation values. There are a variety of land uses, tenures and resource interests within the study area, including; private residences, Indian Reserves, Regional District parks, designated and undesignated Crown Land, and privately owned forested land. Presently a large portion of the study area is undeveloped and remains in a natural state.

The Cowichan River Recreation Study is being conducted as part of the provincial Rivers and Trails program, and the Cowichan River was also identified for the study in the parks and Wilderness for the '90's program and is an integral part of the Protected Areas Strategy. An inter-agency committee was established to develop management options for public review. Extensive consultation with the public, interest groups and the Cowichan Indian Band has taken place and the input received has been taken into consideration in the development of this management plan. This document recommends a direction for the long-term management of the study area.

The overall intent is to protect conservation and recreation values by designating a Provincial Park along the river and riparian zone of the study area. The area recommended for Provincial Park designation, which are important for recreation and conservation. Land tenures such as Regional District parks, Indian Reserves, and small lots of developed private property will not be included. Integrated resource management may take place outside of the Provincial Park.

There will be numerous benefits derived from establishing a Provincial park in the Cowichan Valley, including the protection of:

- Biodiversity in the riparian zone;
- Conservation, recreation and aesthetic values;
- Most river-based and river-side recreation opportunities;
- Riparian fish and wildlife habitat;
- Cultural and heritage values;
- And organized and controlled recreation use, minimizing issues related to trespass, safety and security.

CITATION:

Dawe, N.K. and L.E Jones. 1986. Vegetation of the Koksilah marsh, Cowichan estuary: A pre-restoration study, July 1985. Technical Report Series No. 9. Canadian Wildlife Service, Pacific and Yukon Region. B.C. 30 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

To determine the effect of returning a former agricultural field (Koksilah Marsh) and adjacent disturbed wetland (CN Marsh) on the Cowichan River estuary to intertidal habitat, baseline vegetation and soil-water salinity data were gathered in July and September 1985. Three permanent transects were established across the areas of proposed impact and from a total of 103 releves, 21 species of vascular plants were recorded. Seven additional species from the family Gramineae were also noted. Four plant communities were identified and are described along with elevation and soil water salinity data. Broad predictions of the resulting vegetation, following a return of the study area to tidal inundation, are made.

CITATION:
Department of Fisheries and Oceans Canada. SSR – Lower Strait of Georgia Chinook. Lower Strait of Georgia Chinook Salmon.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
This report is a brief but thorough descriptive analysis of the Lower Straight of Georgia (LGS) chinook salmon, which include salmon from Qualicum, Cowichan, Puntledge and Quinsam rivers. Historical background and distinguishing geographical characteristics on this particular British Columbia population of salmon is reviewed. Various other aspects regarding the LGS populations are outlined. Aspects included are; the fresh and saltwater fisheries, life history, stock distribution, exploitation, enhancement and environmental factors. The report concludes with a chronological description of stock status and a future outlook of the LGS chinook salmon stocks.

CITATION:
Department of Fisheries and Oceans Canada. Habitat Based Escapement Goals for Chinook (Oncorhynchus tshawytscha) in the Cowichan River. 5p + tab.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
This historical overview of the Cowichan River initially provides an introduction to tributaries and salmonid species of the Cowichan River. Historical events that have effected the Cowichan River are recalled and outlined. These events include first logging practises, weir installations, salmonid enhancement programs and various others. The detriments and beneficial consequences of these events are briefly summarized and are related to habitat and or salmonid enhancement.

CITATION:

Department of Fisheries and Oceans. 1950-1999. Annual report of salmon streams and spawning populations (BC 16's). Available from Brenda Wright, Fisheries and Oceans, 3225 Stephenson Point Road, Nanaimo, B.C., V9T 1K3.

ABSTRACT SOURCE:

Abstract from author

ABSTRACT:

A compilation of reports that outline salmon populations in the Cowichan River. These reports are filled out by Department of Fisheries and Ocean officers on an annual basis. Included reports, 1950 to 1999.

CITATION:

Derksen, G. 1981. The effects of a sewage lagoon effluent on the water quality of the Cowichan River during the 1980 low flow period plus an evaluation of the lagoons bacteriological reduction performance and effluent toxicity. Environmental Protection Service, Environmental Protection Branch. Pacific Region. Regional Program Report 82-5. 83 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

The water quality of the Cowichan River was monitored over the summer low flow period of 1979 and 1980. During August and September 1980, the impact of the Duncan-North Cowichan sewage discharge was monitored. The discharge dramatically increased nutrient levels in the river and stimulated a large algal bloom. Intragravel dissolved oxygen levels were significantly lower downstream of the outfall in August and September, 1980. An onsite flow-through bioassay showed the effluent to be non-toxic to resident juvenile coho salmon. The lagoon system provided adequate disinfection to reduce fecal coliform levels and no significant water quality deterioration in the river with respect to fecal coliforms was found. Nutrient control considerations are discussed.

CITATION:
Ferguson, K.D. 1978. A performance evaluation of the village of Lake Cowichan sewage treatment. Environmental Protection Service, Environmental Protection Branch. Pacific Region. Regional Program Report 78-4. 49 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
An evaluation of the Village of Lake Cowichan sewage treatment lagoon system was conducted by personnel of the Environmental Protection Branch, Environmental Protection Service (Pacific Region) from February 20 to 24, 1978. Sampling for bacteriological, chemical and toxicity analyses, as well as a dye study of the dechlorination basin were conducted.

Chemical and bacteriological analyses results indicated that the lagoon treatment system performed well, producing an effluent of typical quality for this type of system.

Results of a 48-hour total residual chlorine (TRC) survey revealed high chlorinated and dechlorinated effluent TRC concentrations. A dye test indicated that the dechlorination basin functioned as designed.

Although bioassay results indicated that a non-toxic final dechlorinated effluent was produced by the treatment system, certain chemical agents were present at concentrations reported to be toxic to fish.

CITATION:

Fielden, R.J. and L.B. Holtby. 1987. Standing crop and habitat characteristics of juvenile salmonids at sites in the Cowichan River System. Can. Man. Rep. Fish. and Aquat. Sci. No. 1950: 65 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Juvenile salmonid densities, size and habitats were investigated at 90 sites in the Cowichan River system during the late summer and early winter of 1986. The sites, averaging 32 m in length, were distributed among lake, tributary, side channel, mainstem and marsh areas. Some of the sites were in areas inaccessible to anadromous fish, but where coho fry had been previously outplanted.

The largest coho were taken from the lakes sites. Mainstem sites had the next largest fry followed by tributary and then side channel fry. Side channel habitat contained the highest arial densities of coho fry, followed by tributary, mainstem, and then, outplant habitat. Except in the Somenos system, there was a general reduction in coho densities in all areas and habitat types from late summer to early winter. Coho densities were highest in pool habitat during late summer an in slough habitat during early winter. During high-water flows in the fall, there appeared to be movement of coho fry into the Somenos system. Coho fry were not caught in many of the Somenos sites in late summer and in slough habitat during early winter. Wood debris was found to be the most important cover type for both trout and coho juveniles.

CITATION:

Griffith, R.P. 1989. Assessment of enhancement needs and opportunities for cutthroat trout and Dolly Varden char in streams tributary to Cowichan Lake, Vancouver Island. Fisheries Section, B.C. Ministry of Environment.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

During July 17 to October 4, 1989, a total of 37 primary and secondary tributaries to Cowichan Lake were investigated to estimate existing and potential production of cutthroat trout and Dolly Varden char to the lake fishery. To determine species distribution and abundance, electrofishing was conducted at a total of 75 sites. Greatest numbers of both cutthroat and Dolly Varden were found in stream systems on the south side of the lake. Major stream systems on the north side of the lake were not found to contain either Dolly Varden or cutthroat, although evidence of cutthroat x rainbow hybridization was found to varying degrees in trout fry populations throughout the drainage. The most abundant and most widely distributed species in streams was coho salmon, followed by rainbow, cutthroat, Dolly Varden, and finally, brown trout. Although production modelling indicated a general under-exploitation of habitat by trout/char juveniles in streams, high accompanying densities of coho may result in supersaturation, relative to natural carrying capacity; particularly with the low flows in those streams important to cutthroat and Dolly Varden. It would appear that high densities and wide distribution of other species (coho and rainbow), coupled with low flows, is the principal factor limiting the production of cutthroat and Dolly Varden in the tributaries to Cowichan Lake. A relative lack of deeper water may also limit parr populations during low flows, but in general, stream habitat is excellent, for fry. An estimate of standing stock in streams relative to theoretical lake production and requisite recruitment suggests that both the lake and tributaries may be functioning close to their natural capacities. Modelling of lake production suggests that the carrying capacity for large predaceous trout in Cowichan lake may be as few as 1000 fish. As in streams, a variety of species interactions are likely regulating overall and specific production in the lake. Short of increasing streamflows (unlikely), few stream enhancement opportunities were apparent. Furthermore, given the complex interactions between the various species (in both the streams and the lake), in the absence of more detailed information regarding the lake, major enhancement undertakings could be detrimental to overall production within the system. In fact, the current program of relocating surplus coho fry within and between streams within the drainage raises a variety of concerns with respect to the production of other species, notably cutthroat trout. It is recommended that this be addressed, and that the operational plan for the fishery, at this point, should be to concentrate on broadening the understanding of the system to enable a higher level of management resolution, perhaps ultimately to include appropriate (yet to be identified) enhancement activities. Special regulations are suggested as an immediate means to restore greater numbers of large fish in the cutthroat population. Given the particularly narrow distribution and low abundance of Dolly Varden in the drainage, as well as a lack of angler interest in this species, it is recommended that management of this species be limited to stock maintenance.

CITATION:

Harris, D.C. 2001. Fish, law and colonialism. Toronto: University of Toronto Press. 2001. 3-13 p. and 127-185 p.

ABSTRACT SOURCE:

Abstract from reference (Introduction)

ABSTRACT:

Chapter 3 is the story of the late-nineteenth and early-twentieth century struggle to allocate, or re-allocate fish in the Cowichan River. More generally, it illustrates how the forces of colonialism and resistance unfolded on one particular river that was increasingly surrounded by a settler society. By 1894 the key elements of the Dominion's fisheries laws were in place in British Columbia, but the struggle over fish had just been engaged. The disputes over conflicting uses of the Cowichan River emerged as a struggle over appropriate fishing technology, and they became most visible in the local courts. In this forum the weirs were challenged and defended, vilified and supported, condemned and justified. Reports of the trials, combined with the records of the departments of Fisheries and Indian Affairs, provide many details of the state's attempt to impose its law and of Cowichan resistance. These documents also illustrate how state law, constructed and imposed from a distance, was modified both by Cowichan resistance and by the presence of local settlers who were committed to the British Crown and its law, but also neighbours of the Cowichan. All involved, whether Cowichan, missionary, state official, settler, lumber-mill owner, angler, invoked law to support their claims, and the language of rights, customs, and privileges pervaded the conflict that enveloped the weirs.

CITATION:
Hay, S.E. and G.H. Scholten. 1984. Habitat conservation fund Cowichan River habitat improvement project, B.C. Fish and Wildlife Branch.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
Continued declines of brown trout populations and other resident species in the Cowichan River stimulated the utilization of $47,500 in funds from the habitat conservation fund for habitat improvement projects. Stream specific habitat improvement objectives for 5 streams (Bear Creek, Dale Creek, Holt Creek, Skutz Creeks and Oliver Creek) are outlined. Details regarding progress and success of the project work performed is documented with photos, descriptive text and tabular models. Public reaction, Budget details and future remedies are also briefly outlined.

CITATION:

Healey, M.C., R.V. Schmidt, F.P. Jordan, and R.M. Hungar. Young salmon in the Nanaimo area 1975: 1. Distribution and abundance. Fisheries Research Board of Can. Man. Rep. Series No. 1369: 161p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

The run of chum fry in the Nanaimo River in 1975, although larger than expected, was not unusual in its duration or timing by comparison with other areas on the British Columbia coast. Chum fry from Hook Nose Creek on the central British Columbia coast migrated somewhat earlier and at lower water temperatures than the Nanaimo fry. Chum fry migrations in the Cowichan and Big Qualicum Rivers, however, were fully comparable in timing and duration to the Nanaimo.

CITATION:
Hillaby, B. 1991. Benthic invertebrates, metal concentrations, particle size, interstitial water chemistry, shear-strength and compaction of the sediments in relation to intertidal log storage on the Cowichan River estuary. Can. Data Rep. Fish. Aquat. Sci 826: 77 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
Data are presented on the benthic invertebrates, metals, particle size and interstitial water chemistry of the sediments of the Cowichan River estuary collected during 1984, 1985, and 1986. Samples were taken from a log storage area, reference area and an area where the storage of logs had been discontinued in May 1984. Data are also provided on shear strength and compaction of the sediments from all three areas.

CITATION:

Hume, M. 1992. The run of the river: Portraits of eleven British Columbia Rivers. New Star Books, Vancouver, Canada: 167-192.

ABSTRACT SOURCE:

Abstract from author

ABSTRACT:

This section of the book outlines stream flows and water usage issues that pertain to Cowichan River system. The advantages and disadvantages of a weir that was constructed by B.C Forest Products in 1956 are desribed by the author. Advantages include raising stored water levels in Cowichan Lake by reducing water flows in the spring. This allows adequate streamflows throughout the entire year. Benefiting are neighbouring pulp mill and resident fish populations that struggle for adequate water in the summer months. By permitting a rush of water from the weir, heavy rainfall can be mimicked, abundant migrating salmon would then enter the rivers. Disadvantages outlined are; interrupting the natural processes of the Cowichan River, steelhead redd destruction and pulp mill intake installations, among others. Perspectives from Cowichan Valley residents, government representatives and biologists regarding water usage and stream flow utilization are also illustrated. Holistic fisheries management strategies implemented by free-lance biologist Ted Burns are described, and results summarized

CITATION:
Idyll, C.P. 1940. (Thesis) A contribution to the study of the bottom fauna of some portions of the Cowichan River, British Columbia. University of British Columbia. 23 p. + tab. + fig.

ABSTRACT SOURCE:
Abstract provided by Kristen Daniels

ABSTRACT:
Benthic sampling was performed at ten sites around the a hatchery pool just below the lake where the river widens and at Oliver Creek. Pondweed (Potamogeton sp.) was present in the pool and Oliver Creek. The Cowichan River was poor in bottom fauna with only 74 organisms per square foot with the pools being more productive than the riffles. Pools yielded 623 organism per square yard, riffles with 887 organisms per square yard and Oliver Creek with 448 organisms per square yard. Trichoptera was the most dominant group in the river.

Next, gill nets were set over a four-year period during the summer months to determine the salmonid population in the hatchery pool. In total 101 rainbow trout, 66 cutthroats, 111 brown trout, and 6 Dolly Varden were netted. Upon observation salmonids spawn and produce young in Oliver Creek. The rainbow trout, brown trout, and cutthroats feed extensively on midges and mayflies in Oliver Creek.

An examination of the habitat around the hatchery pool and Oliver Creek resulted in vegetation being the most productive habitat type followed by mud, rubble, and gravel. Also, no close correlation between number of organisms present in the bottom fauna and the number taken as food by trouts. This could suggest that the fish are able to discriminate on which food they want.

CITATION:

Iwamoto, R.N. and E.O. Salo. 1977. Estuarine survival of juvenile salmonids, a review of the literature. The Washington State Department of Fisheries, contract number 803. Fisheries Research Institute, College of Fisheries, University of Washington Seattle Washington 98195.

ABSTRACT SOURCE:

Abstract from reference (Preface)

ABSTRACT:

We have attempted to summarize the available literature on factors associated with estuarine residence of chum, chinook, and coho juveniles. A separate report has been prepared for each of the primary species. Within each report, we have summarized data on downstream migration, food types and availability, predation, competition, water quality requirements. Information on morbidity has also been included. We have also attempted to define major areas where future research might be addressed.

CITATION:

Lambertsen, G. K. 1987. Cowichan Estuary environmental management plan. B.C. Ministry of Environment, Lands and Parks, Planning and Assessment Branch. (Various Paging).

ABSTRACT SOURCE:

Abstract from reference (Forward)

ABSTRACT:

Coastal British Columbia is rich in environmental resources. The pressures on use of these resources are correspondingly intense. Those responsible for managing coastal resources must balance the needs of an expanding population, of industry, commerce and transportation, the demand for high quality tourism and recreation, and the maintenance of aesthetic and ecological values.

Such complex challenges call for cooperative solutions, involving the participation of the entire spectrum of government, corporate and local public interests. This approach is exemplified in the Cowichan Estuary Environmental Management Plan.

In 1981, The Ministry of Environment began a program to coordinate the consultation and actions necessary to implement a balanced plan for the estuary. In September 1986, using the powers conferred by the Environment Management Act, the Minister of Environment and Parks enacted an Order implementing the first environmental management plan of its kind for the Cowichan estuary.

The Cowichan Estuary Environmental Management Plan, described in this report, provides guidance and a focal point for pursuing the opportunities offered by the estuary, and for sustaining its environmental quality for the benefit of future generations.

CITATION:

Lill, A.F., D.E. Marshall, and R.S. Hooton. 1975. Conservation of fish and wildlife of the Cowichan-Koksilah flood plain. Environment Canada, Fisheries and Marine Service Operations Branch, Vancouver, B.C. 84 p.

ABSTRACT SOURCE:

Abstract from author

ABSTRACT:

Within this report background information on fish and wildlife resources and recreational assets of the Cowichan-Koksilah river systems is described, with greater emphasis on flood plains. Recommendations for enhancement opportunities are outlined. Various in-depth issues relating to flood control are discussed. Possible remedial measures are illustrated for the protection of the Cowichan-Koksilah flood plain resources.

CITATION:

Lister, D.B., L.M. Thorson and I. Wallace. 1981. Chinook and coho salmon escapements and coded-wire tag returns to the Cowichan-Koksilah River system, 1976-1979. Can. Manuscr. Rep. Fish. Aquat. Sci 1608: xiii + 78 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Chinook and coho salmon escapements were studied during 1976 to 1979 to estimate adult returns and incidence of marked fish for coho (1973 and 1974 brood yrs.) and chinook (1974 and 1975 brood yrs.) coded wire tagged as wild juveniles. Escapements were estimated by 4 methods (1) tagging and recovery of tags by purse seine in the estuary; (2) tagging in the estuary with recovery of tags on the spawning grounds. (3) tower counts of adult migrants and (4) swim survey counts of spawners. The results obtained by each method are compared and discussed. Salmon migration timing, spawning distribution and timing, age and size composition are described. Ocean survival of marked chinook from tagging to adult return was significantly lower than unmarked chinook, 0.3% versus 1.6% (1974 brood) and 0.4% versus 5.5% (1975 brood). Marked coho smolts survived to adult return at rates of 1.7% (1973 brood) and 3.6% (1974 brood), compared to 4.4% for unmarked 1974 brood coho. Post-release loss of coded-wire tags was calculated at 9-13% among coho and 10% among chinook. A majority of coded-wire tagged adult coho salmon returned to spawn in locations that differed from the smolt tagging sites. It was postulated that adult coho return to spawn in the area from which they emerged as fry rather than the area utilized for summer rearing or over-wintering.

CITATION:

Lister, D.B., C.E. Walker, and M.A. Giles. 1968. Studies of chinook salmon populations of the Cowichan River, Vancouver Island, B.C. 13 p. + app.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Chinook (*Oncorhynchus tshawytscha*) and coho (*O. Kisutch*) salmon escapements were studied during 1976 to 1979 to estimate adult returns and incidence of marked fish for coho (1973 and 1974 brood years) and chinook (1974 and 1975 brood years) coded-wire tagged as wild juveniles. Escapements were estimated by 4 methods: (1) tagging and recovery of tags by purse seine in the estuary; (2) tagging in the estuary with recovery of tags on the spawning grounds; (3) tower counts of adult migrants; and (4) swim survey counts of spawners. The results obtained by each method are compared and discussed. Salmon migration timing, spawning distribution and timing, age and size composition are described. Ocean survival of marked chinook from tagging to adult return was significantly lower than unmarked chinook, 0.3% versus 1.6% (1974 brood) and 0.4% versus 5.5% (1975 brood). Marked coho smolts survived to adult return at rates of 1.7% (1973 brood) and 3.6% (1974 brood), compared to 4.4% for unmarked 1974 brood coho. Post-release loss of coded-wire tags was calculated at 9-13% among coho and 10% among chinook. A majority of coded-wire tagged adult coho salmon returned to spawn in locations that differed from the smolt tagging sites. It was postulated that adult coho return to spawn in the area from which they emerged as fry rather than the area utilized for summer rearing or over-wintering.

CITATION:
McKean, C.J.P. 1989. Cowichan – Koksilah Rivers water quality assessment and objectives, technical appendix. Ministry of Environment, BC. Resource Quality Section Water Management Branch. 89p.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
This report assesses various water quality characteristics of the Cowichan and Koksilah river systems. Characteristics in this assessment include; hydrology, water usage, waste discharge, bioassays and various others. Water quality monitoring protocols for the Cowichan and Koksilah rivers are described for factors such as fecal contamination, dissolved oxygen, metals, suspended residues and others. Water quality objectives for these rivers are set for the protection of human consumption, industrial/ agricultural usage, recreation and aquatic life.

CITATION:
Ministry of Environment. 1981. Cowichan-Koksilah Rivers water quality assessment and objectives. British Columbia Water Management Branch. 21p.

ABSTRACT SOURCE:
Abstract from reference (Introduction)

ABSTRACT:
This study assesses the water quality of the Cowichan and Koksilah rivers which are located on south-eastern Vancouver Island (Figure 1). Three permitted discharges to the Cowichan River, a small abandoned base metal mine, public wharfs near the outlet of the lake, and an operational sawmill upstream from the Cowichan River are potential sources of contaminants to the Cowichan River. Nonpoint nutrient and bacteriological loading from farms, and runoff from gravel washing operations near Duncan are the potential sources off pollution in the Koksilah watershed.

This report discusses the water quality of the two rivers, interprets the impact of the nonpoint and point discharges, and develops water quality objectives to protect the major uses of the rivers.

A detailed Technical Appendix was prepared by the author, and forms the basis for the conclusions presented.

CITATION:
Ministry of Environment, Lands and Parks. 1994. Cowichan Estuary environmental management plan. 46 p + fig.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
The Cowichan Estuary environmental management plan is an updated summary and implementation of recommendations of the Cowichan Estuary Task Force. This plan is a management and planning tool for land and resource usage of the Cowichan Estuary. Addressed within are; priorities, concerns and other relevant issues pertaining to various organizations and interested parties. The objectives established in the plan are to set guidelines for land and resource management, and to develop an in-depth protocol for reviewing proposals regarding resource or land use within a proposed area.

CITATION:
Mottley, C.M. 1936. Fishing regulations proposed for the Cowichan River area during the four-year period of investigation by the biological board of Canada. Pacific Biological Station. B.C. 3p.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
The Biological Board of Canada proposed a four-year detailed investigation of the Cowichan river watershed and its fish producing capacity. During this proposed duration a strict set of regulations is suggested to be implemented and enforced until an efficiency assessment of various fish cultural methods can be completed. The proposed fishing regulations and reasons for implementation are outlined and defined.

CITATION:

Mottley, C.M. and G.C. Carl. 1940. Cowichan River investigation. Fisheries Research Board of Canada. Nanaimo, B.C. 34p.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

For the purposes of the authors study they divided the Cowichan River system into four sections. They included: 1) Cowichan Bay, 2) Quamichan and Somenos Lakes and their tributaries, 3) The mainstem of Cowichan River and tributaries up to Cowichan Lake, 4) Cowichan Lake and its tributaries including Beaver, Mesachie and Bear Lakes.

For the Quamichan and Somenos Lakes, both are shallow and are filling in rapidly. Although Somenos Lake is fed by small streams throughout the year during the summer Quamichan Lake has no direct flow into it. This, in turn, led to an increase in water temperature and the frequency of large populations of algae blooms. The algal blooms allow for high dissolved oxygen levels at the water surface, but at the lake bottom oxygen is lacking due to the decomposition of the algae. The surface of water of Quamichan Lake was even supersaturated with oxygen due to the photosynthetic activity of the algae and floating plant life. Moreover, Somenos Lake is a few feet above sea level and Quamichan Lake is 100 feet above sea level.

Within the Cowichan River very few aquatic plants were identified. However, in the lakes in the system the following species were identified: Nuphar polysepala - common waterlily, Scirpus robusta – reeds, Potamogeton pusillis – waterweed, Ledum groenlandicum - Labrador Tea.

Reeds were prevalent around Quamichan Lake with water lilies and waterweed in restricted areas. In Somenos Lake water lilies and water weed was also present in addition to abundant populations of Labrador Tea.

Cutthroat trout, steelhead, Atlantic salmon, brown trout, Dolly Varden, lake trout, kokanee, spring salmon, coho, chinook, chum, pink salmon, catfish, sticklebacks and sculpins were identified in the Cowichan Watershed. The Atlantic salmon, brown trout, lake trout, and catfish (Ameirus nebulosis) are introduced species. The catfish is only found within Somenos Lake.

The bottom fauna of Cowichan Lake and River were typical of those found in previous studies. Quamichan Lake benthic fauna included amphipods, insects, and gastropods. Various tables provide the identification of these benthic fauna. These benthic fauna were found in Somenos also; but Anondontidae, fresh water mussels, were also identified in Somenos Lake. Plankton tows were also performed for Quamichan, Somenos, Cowichan, Mesachie, and Beaver Lakes.

The authors concluded their study by suggesting that Chara beds be used to support large populations of food organisms for fish, introduce dace to increase food supply for large fish, construct pools and cover, eliminate Native Indian weirs, and use counting fences to determine fish populations within the watershed

CITATION:

Mottley, C.M. and G.C. Carl. 1934. Cowichan River investigation. Fisheries Research Board of Canada. Nanaimo, B.C. 22p.

ABSTRACT SOURCE:

Abstract from reference (Introduction)

ABSTRACT:

As a result of an appeal from the Cowichan Fish and Game Association and the Duncan Board of Trade a start was made during the past summer on a biological survey of the Cowichan river system. The work this year has been mainly of a preliminary nature.

The people of the Cowichan district are chiefly interested in the production of game fish comprising four native and two introduced species, namely rainbow (including steelhead) and cut-throat trout, coho and spring salmon, Atlantic salmon and brown trout. The people believe that these species of fish are extremely valuable as a tourist-attraction and as an inducement for wealthy anglers, retired from business, to settle in British Columbia. The residents of the district have expressed a feeling, which seems to be well-substantiated, that the number of native game fish is getting less every year. Although certain varieties appear to be more numerous at times, as in the case of the good run of steelhead last spring, nevertheless, there is, apparently, a gradually declining fishery.

To prove the existence of a downward trend by statistical methods is impossible in this instance, because the necessary data are not available for any particular district on the east coast of Vancouver island. The salmon roam so far afield, as tagging operations have shown, that the catch statistics are inextricably mingled. In the case of the trout and freshwater fisheries there has never been an adequate statistical indicator of the conditions. Consequently to look to the records, as has been done for sockeye salmon and halibut, in order to construct a clear-cut picture of the history of the situation is out of the question. The only source is to accept the statements of men who have fished in the district for the past twenty years or more and to acknowledge for the time being at least that the total number of fish is becoming less.

If this conclusion is acknowledged then it becomes evident that the present methods of conservation are proving inadequate and that ways and means of increasing prediction of game fish must be devised. Before going into this phase of the situation, however, the results of the routine, preliminary investigations including the physiographical data, the study of physical and chemical summer conditions and the qualitative survey of the food supplies carried out this year should be presented in order to serve as a background. Thus, after an analysis of the existing facilities and possibilities for increasing production has been made, a concrete program of management for the district may be attempted.

CITATION:

Nagtegaal, D.A. and E.W. Carter. 1998. Adult chinook escapement assessment conducted on the Cowichan River during 1996. Can. Manuscr. Rep. Fish. Aquat. Sci. 2449: 51 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1996, the Stock Assessment Division, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners and total return, ii) estimation of Native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) recovery data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 14,701 in 1996. The number of natural spawners was estimated to be 12,217.

CITATION:

Nagtegaal, D.A. and E.W. Carter. 1998. Adult chinook escapement assessment conducted on the Cowichan River during 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2466: 53 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1997, the Stock Assessment Division, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners and total return, ii) estimation of Native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) recovery data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 8,132 in 1997. The number of natural spawners was estimated to be 7,435. Carcass mark-recapture escapement estimate was determined to be 5,547. (95% CL; 5,366 – 5,728).

CITATION:

Nagtegaal, D.A. and E.W. Carter. 1999. Adult chinook escapement assessment conducted on the Cowichan River during 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2501: 51 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1998, the Stock Assessment Division, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners and total return, ii) estimation of Native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) recovery data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 7, 062 in 1998. The number of natural spawners was estimated to be 4, 328. Carcass mark-recapture escapement estimate was determined to be 2, 087 (95% CL; 1, 956 - 2, 218).

CITATION:

Nagtegaal, D.A. and E.W. Carter. 2000. Adult chinook escapement assessment conducted on the Cowichan River during 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2544: 59 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1999, the Stock Assessment Division, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners and total return, ii) estimation of Native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) recovery data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 6,392 in 2000. The number of natural spawners was estimated to be 4,500. Carcass mark-recapture escapement estimate of upper river spawners was determined to be 3,440 (95% CL; 2,908 – 3,972).

CITATION:

Nagtegaal, D.A., E.W. Carter and B. Riddell. 1996. A Preliminary report on juvenile chinook production in the Cowichan River, 1995. Can. Manuscr. Rep. Fish. Aquat. Sci 2360: 43 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1995, the Department of Fisheries and Oceans, Pacific Biological Station, conducted a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. This study has been conducted since 1991 and the key components of this ongoing project i) enumeration of juvenile outmigrants, ii) monitoring growth of hatchery and naturally-reared fry; iii) monitoring hatchery releases and interaction between hatchery and naturally-reared fry in the river. Rotary screw traps were used to estimate naturally reared fry production. Bismarck Brown dyed hatchery juveniles were released above the trap catches to estimate total production. Estimated production of naturally reared juvenile chinook for 1994 brood year was 169,828. Total hatchery releases of chinook fry and smolts were approximately 1.6 million. The interaction between hatchery and naturally reared juveniles was believed to be minimal since most of the hatchery fish moved out of the river in just a few days after release.

CITATION:

Nagtegaal, D.A., G.W.F. Graf, and E.W. Carter. 1997. A Preliminary report on juvenile chinook production in the Cowichan River, 1996. Can. Manuscr. Rep. Fish. Aquat. Sci 2415: 58 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1996, the Department of Fisheries and Oceans, Pacific Biological Station, undertook a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. This research, ongoing since 1991, is primarily concerned with the enumeration and outmigration timing of juvenile chinook salmon along with monitoring of the growth of and interaction between hatchery produced and natural reared fry. The estimated production of natural reared chinook from the 1995 broodstock was 3,092,626 (95% confidence limit: 1,906,674 - 5,326,827) with two outmigration peaks: the first larger peak from March 20-28, 1996 and then again on April 9th to the 16th. Trapping results indicated the majority of hatchery fish migrate out of the river within one week after release. Due to the relatively short period of residency in the river by hatchery produced juveniles, the behavioural interaction between hatchery produced and naturally reared juveniles in the river is believed to be minimal.

CITATION:

Nagtegaal, D.A., C.J. Hillier, and E.W. Carter. 1999. Juvenile chinook production in the Cowichan River, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2471: 32 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1991, Fisheries and Oceans Canada, Pacific Biological Station began a study of juvenile chinook salmon productivity in the Cowichan River. The 1998 study is concerned primarily with the enumeration and out-migration timing of naturally reared chinook juveniles. The estimated production of naturally reared chinook juveniles from the 1997 brood year was 1,638,198 (95% Confidence limit 1,376,097 - 1,900,324). There were three distinct peaks in the out-migration of naturally reared chinook. The first occurred March 15 - 17, the second and largest occurred March 19 - 21 and the final peak occurred March 23 - 28. The release of chinook from the Cowichan River hatchery totalled 262,675. Of these, 160,924 hatchery-reared chinook were released above the trapping site. Trapping results maintain that most hatchery-reared chinook migrate to the Cowichan estuary within one week of release. Interaction between naturally reared and hatchery-reared chinook juveniles is therefore believed to be limited.

CITATION:

Nagtegaal, D.A, and E.W. Carter. 2000. A Preliminary report on juvenile chinook production in the Cowichan River, 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2504: 38 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1991, Fisheries and Oceans Canada (DFO), Pacific Biological Station began a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. The 1999 study is concerned primary with the enumeration and out-migration timing of naturally reared chinook juveniles. The estimated production of naturally reared chinook juveniles from the 1998 brood year was 173,225 (95% CL: 85,159 – 193,718. The hatchery-reared chinook were released above the trapping site. Egg to fry survival for naturally reared chinook was estimated to be 2.2% (95% CL: 1.08% - 2.47%). Trapping results maintain that most hatchery-reared chinook migrate to the Cowichan estuary within one week of release. Interaction between naturally reared and hatchery-reared chinook juveniles is therefore believed to be limited.

CITATION:

Nagtegaal, D.A., P.J. Starr and B. Riddell. 1994. A Preliminary report on the chinook productivity study conducted on the Cowichan River, 1988 and 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2233: 53p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1988, the Biological Sciences Branch, Pacific Biological Station, initiated a study of chinook productivity in the Cowichan River. Major components of this study include: i) enumeration of spawners; ii) estimation of Native food fish catch; iii) hatchery broodstock collection; iv) biological sampling and coded-wire tag (CWT) data. Total returns of adult chinook to the Cowichan River were estimated to be approximately 6,071 in 1988 and 5,000 in 1989. These were considered to be minimum estimates since in both 1988 and 1989 the enumeration fence was washed out due to high water levels prior to the end of the run. Low water flow conditions in the Fall of 1989 added to the uncertainty of this estimate. Fishery officers estimated adult chinook returns in 1988 to be 5,500 and in 1989 to be 5,000. In addition, a water management plan was initiated by the Department of Fisheries and Oceans, Fisheries Branch, in conjunction with the B.C. Ministry of Environment and Parks and the B.C. Forest Products Ltd., Pulp and Paper Division in Crofton.

CITATION:

Nagtegaal, D.A., J. Candy, and B. Riddell. 1994. A Preliminary report on the chinook productivity study conducted on the Cowichan River during 1990 and 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2265: 71p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1990 and 1991, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this study include: i) enumeration of spawners, ii) estimation of native food fish catch, iii) recording hatchery broodstock removal iv) biological sampling and coded-wire tag (CWT) data collection. In 1991, a mark-recapture study was also conducted to augment the fence count. Total returns of adult chinook to the Cowichan River were estimated to be 5, 094 in 1990 and 5,065 in 1991. These were considered to be minimum estimates since both years the enumeration fence was washed out due to high water levels prior to the end of the run. Fishery Officers estimated adult chinook returns in 1990 to be 5,300 and in 1991 to be 10, 000. In addition, a water management plan was executed by the Department of Fisheries and Oceans, Fisheries Branch, in conjunction with the Ministry of Environment and Parks and Fletcher Challenge Canada, Ltd., Pulp and Paper Division in Crofton.

CITATION:

Nagtegaal, D.A., J. Candy, and B. Riddell. 1994. A Preliminary report on the chinook productivity study conducted on the Cowichan River during 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2268: 73p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1992, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners, ii) estimation of native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) data collection. A mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 8,678 in 1992. The total return was determined to be the sum of the fence count, the native food fish catch, and the numbers of broodstock removed below the fence. The number of natural spawners was estimated as 6,676. These were considered minimum estimates since the enumeration fence was washed out due to high water levels prior to the end of the run. Fishery Officers estimated the adult chinook return to be 7,500. In addition, a water management plan is described which was intended to aid upstream movement of chinook.

CITATION:

Nagtegaal, D.A., J. Candy, and B. Riddell. 1995. A Preliminary report on the chinook productivity study conducted on the Cowichan River during 1993. Can. Manuscr. Rep. Fish. Aquat. Sci. 2315: 84p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1993, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners, ii) estimation of native food fish catch, iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag (CWT) data collection. Both live and carcass mark-recapture studies were conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 7,312 in 1993. It was estimated that less than half the spawners made it to the traditional spawning grounds above Skutz Falls. This was probably due to unusually low water levels during the fall. The number of natural spawners was estimated to be 5,047. Fishery Officers estimated the adult chinook escapement to be 5,200. In addition, a water management plan is described which was intended to aid upstream movement of chinook.

CITATION:

Nagtegaal, D.A., E.W. Carter, and B. Riddell. 1995. A Preliminary report on the adult chinook productivity study conducted on the Cowichan River during 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2331: 62p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In 1994, the Biological Sciences Branch, Pacific Biological Station, conducted a study of chinook salmon productivity in the Cowichan River. Major components of this ongoing study include: i) enumeration of spawners, ii) estimation of native food fish catch; iii) recording hatchery broodstock removals, iv) biological sampling and coded-wire tag data collection. A carcass mark-recapture study was conducted to augment the fence count. Total return of adult chinook to the Cowichan River was estimated to be 6,628 in 1994. The number of natural spawners was estimated to be 4,936. Cowichan Tribes Aboriginal Fisheries Management estimated the adult chinook escapement to be 5, 500. In addition, a water management plan is described which was intended to aid upstream movement of chinook.

CITATION:

Nagtegaal, D.A. and B. Riddell. 1998. Stock status of Cowichan River chinook salmon (Oncorhynchus tshawytscha). **(Draft)** DFO Stock Assessment Division, Science Branch. 34 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Considerable interest has been focussed toward the chinook stocks in the southern portion of the Strait of Georgia due to the perceived decline in the these stocks and their importance to local fisheries. In 1985, a chinook rebuilding plan was initiated through the Pacific Salmon Treaty between the United States and Canada to stop the decline in escapements to naturally spawning chinook stocks and attain escapement goals in selected indicator stocks (Cowichan, Nanaimo, Squamish) by 1998. This report compiles the information available on the status of the Cowichan chinook stock, including escapement data, habitat assessment, biological data, juvenile production, ocean catch distribution, enhancement history, trends in survival and exploitation rates.

Chinook escapement to the Cowichan River had declined during the mid 1980's but have generally been increasing since 1990. Natural spawners to the system are primarily comprised of 3 and 4 year old fish. Hatchery chinook production began in 1979 and a significant expansion of the facility in 1992 increased production form less than 500,000 chinook juveniles to more than 2.5 million. Enhanced contribution to the stock, measured in terms of coded-wire tag expansion information, indicated that this contribution has increased to approximately 40% of the total return in 1997. Several factors were discussed including ocean fishery dynamics, in-river water flow, distribution of chum salmon spawning, native food fishery and hatchery broodstock removals, and seal predation. Exploitation rates have declined for the 1991 and 1992 brood years (the most recent complete reduction in sport fishing effort in Georgia Strait.

The decline in escapement has been stopped and for 1995 and 1996 chinook returns to the Cowichan River have been above the original escapement goal of 12,500. It is necessary to continue monitoring this system to further evaluate the biological basis for this escapement goal. It is recommended that the Cowichan system remain a key escapement indicator stock. It is also recommended that the impact of enhancement on the natural chinook population be assessed and a review of enhancement procedures and outcomes be initiated. It would be desirable to further assess the impact of chum spawning on the reproductive success of chinook, and continue to monitor the impact of seal predation in the estuary.

CITATION:

Neave, F. 1941. Cowichan River investigation. Pacific Biological Station, Nanaimo, B.C. 18 p.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

The purpose of this Cowichan River study was to investigate the factors limiting fish yield and to determine a means whereby the various fisheries could be maintained in a healthy condition. Coho, cutthroat trout, rainbow trout, Kamloops trout, steelhead, brown trout, speckled char, Dolly Varden, and lake trout life histories were included within the paper.

Coho

Cowichan River coho appear in Cowichan Bay beginning in the second week of September. They will migrate up the river in one mass movement and they can reach Skutz Falls in two days. During November and December the coho will spawn in all accessible tributaries and the mainstem of the river. Then in March and April the fry will emerge. If the fry are in small stream they tend to migrate to the river immediately. Finally, fry undergo immense losses due to predators like cutthroats.

Sea-running Steelhead

The winter run steelhead begin their spawning migration in October and continue the migration through out the winter. From January to late March spawning occurs in the Cowichan River and Robertson River. Some spawning does occur in small tributaries. During the steelhead's early life they may make local migrations from the river to small tributaries or to Cowichan Lake. The steelhead begin the downstream migration (April to May) to the sea as yearlings at approximately 5 inches long. In comparison the spring run steelhead begin their spawning migration in late March to mid May. And spawning of the spring run steelhead will occur during April and May.

Rainbow Trout

Rainbow trout are numerous in the upper part of Cowichan River and in the Cowichan Lake. The rainbow trout can be found year round within the river. During September and October the rainbow trout migrate from the lake to the upper portion of the Cowichan River where they remain over the winter. At this time they will spawn. Then in May they will migrate back into the lake. Rainbow trout will first spawn when they are four years of age.

Kamloops Trout

Approximately 1,500,000 Kamloops trout were introduced to the Cowichan River between 1922 to 1934. And then between 1938 to 1940 approximately 74,000 marked fingerlings were released into the Cowichan River and Cowichan Lake. No studies were performed to examine the survival of the Kamloops trout within the Cowichan watershed.

Cutthroats

Cutthroats are the most widely distributed fish in the Cowichan watershed. They are found in the deeper portions of the lower stretches of the Cowichan River and in small tributaries. The cutthroats spawn through out the winter and early spring in small and moderate size tributaries. The cutthroat young will remain in the spawning stream for 1 to 2 years. When the cutthroats migrate downstream in the spring it is at the same time the coho fry begin their downstream migration. During the past few years Neave noticed that the numbers of cutthroats was decreasing due to the seasonal drying of smaller streams.

Brown Trout

Brown trout were introduced to the Cowichan watershed between 1932 to 1935. They have successfully established themselves above Skutz Falls. They also concentrate themselves in the a hatchery pool below the falls in the summer when rainbow trout and cutthroat are scarce. An interesting point is that the brown trout compete with coho for spawning ground and food.

Speckled Char

The speckled char was introduced during 1911 to 1931. They were only found in the upper reaches of Oliver Creek, a tributary to the Cowichan River.

Dolly Varden

Dolly Varden were abundant in Cowichan lake particularly in the western portions of the lake near logging settlements and mouths of streams. Dolly Varden are also found in the Cowichan River during the winter and spring and they ascend various tributaries for spawning and feeding purposes. Finally, salmon eggs have been found in winter caught fish.

Lake Trout

During 1912 to 1916 approximately 147,500 lake trout were introduced into Cowichan Lake. However there are no records to indicate their survival at the time of Neave's paper.

Physical Conditions of Cowichan River

Runoff is heavy during the winter months and becomes very light during the later part of the summer only to increase again during the October rains. In addition the water temperature fluctuates from 6EC in February to 21EC in the summer. During the period of low water many of the tributaries dry up and the volume of the river decreases. During the winter floods the lower end of tributaries and spawning grounds are torn up. The gravel is often carried downstream and is deposited into drifts several feet high. Moreover, the increases in flows often means an increase in siltation of the spawning beds. They are on the Cowichan River that is most affected by the winter floods is between Sahtlam and Duncan to the tide water. During the summer of low flows fish are often trapped in pools and become susceptible to predation.

The large changes in flow in the Cowichan River has probably contributed to the lowering of the foodstuff production. The scouring action of the floods kill, displaces and buries bottom dwelling animals. Yet the shifting of the gravel to expose soil can promote plant growth. It was suggested that the introduction of crustaceans Pontoporeia and Mysis in deeper waters of Cowichan Lake and burrowing may-fly Hexagenia and Ephemera in shallow bays and the hatchery pool. In conclusion, the survival of coho from naturally spawned eggs to the time of commencement of the downstream migration varied from 12 to 40%.

CITATION:

Neave, F. 1949. Game fish populations of the Cowichan River. Fisheries Research Board of Canada, bulletin No. 84. 34 P.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Assesses fish production and exploitation on the Cowichan River on Vancouver Island, British Columbia to determine the type of management policy to improve game fishing. Status of native salmon and trout are given, together with the results of attempts to establish exotic fish in this river system. Identifies factors in growth of fish and suggests remedial measures.

CITATION:

Obee, B. 1978. Cowichan Estuary… will it be studied until death. BC Outdoors. March 1978. 56 – 61p.

ABSTRACT SOURCE:

Abstract from author

ABSTRACT:

The industrial and environmental benefits of the rich Cowichan Estuary are examined by industrialists and environmentalists a like. One party states that the economic potential through development of the Cowichan Estuary far exceeds the benefits of estuarine preservation as another points out the many benefits of environmental preservation. Each argument is presented to the general public in hope of a resolution, resulting is an approved order-in-council. The intention of the newly passed order is to allow industrial development while recognizing the sensitive fisheries, wildlife, recreational and aesthetic value of the Cowichan Estuary. The Order states that industrial and urban development would not be approved until detailed environmental impact assessments were completed and passed by the Minister of Environment. This order was still viewed as a defeat by conservationists and local residents. Various community groups and residents of the Cowichan Valley continually voice their concerns regarding commercial and wild fisheries, wildlife, recreational areas and the aesthetic value of the Cowichan Estuary. With this order, other estuarine ecosystems are also potentially threatened.

CITATION:

O'Donnell, B. 1988. Indian and non-native use of the Cowichan and Koksilah rivers: an historical perspective. Department of Fisheries and Oceans. Policy and Program Planning Branch. Native Affairs Division. Issue 8: 84p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

This is one of a series of reports on the historical uses of waterways in New Brunswick and British Columbia. This report outlines how Indian and non-native populations have used the Cowichan and Koksilah rivers, with emphasis on navigability, tidal influence, riparian interests, settlement patterns, commercial use and fishing rights.

CITATION:

Perrin, C.J., N.T. Johnston, and S.C. Samis. 1988. Effects of treated sewage effluent on periphyton and zoobenthos in the Cowichan River, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci.1591: 64 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Inorganic nutrient concentrations, periphyton accrual and zoobenthos biomass were measured at one upstream and three downstream sites in the Cowichan River to determine effects of effluent discharge from the upgraded Duncan-North Cowichan sewage treatment plant. Samples were taken during summer months in 1979 and before and after discharge began in August 1980.

Concentrations of total dissolved phosphorus (TDP) and ammonia (NH_3 + NH_4-N) and biomass of algal periphyton on artificial substrata increased by an order of magnitude after discharge began. NO_3 + NO_2-N levels did not change likely due to the reduced nature of the sewage effluent.

Taxonomic composition of the zoobenthos was greater between years than among sites within years. The relative abundance of taxa suggests that the three sites downstream of the discharge in 1980 differed from the spatial and temporal control sites. The abundance of cladocerans and oligochaetes generally increased at the sites subject to the sewage effluent discharge. Tardigrade abundance increased with the increasing concentration of algal biomass and macronutrients, and with decreasing intragravel dissolved oxygen concentrations. The abundance of Diptera, Ephemeroptera, Plecoptera, and Trichoptera were not influences by the discharge.

The availability of fish food organisms is unlikely to have been greatly altered by the sewage effluent; neither oligochaetes nor benthic cladocerans are commonly important components of the diets of stream dwelling salmonids. The development of algal mats may have reduced availability of chironomids to juvenile salmon.

CITATION:

Prentice, A.C. 1989. Vegetation change one to three years following dyke breaching at the Blackley farm enhancement area, Cowichan River estuary. B.C. Ministry of Environment, Fish and Wildlife Branch. Pp.59

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Vegetation and salinity changes one, two and three years following dyke breaching were examined at the Blackley farm enhancement area. Vegetation changes included the disappearance of upland species and the increase of species important form a fish and waterfowl perspective e.g. *Carex*, *Scirpus* and *Triglochin*. Two desirable species – *Ruppia* and *Eleocharis* were new to the study area one year after dyke breaching. The newly created channels and areas that became devoid of vegetation due to heavy machinery gaining access to the dykes bo5th supported new communities containing desirable species such as *Ruppia* and *Scirpus*.

Those changes were most likely related to the increased tidal flooding of the area since the salinity and pH did not show much change following dyke breaching.

CITATION:

Prentice, A.C and W.S. Boyd. 1988. Intertidal and adjacent upland habitat in estuaries located on the east coast of Vancouver Island – A pilot assessment of their historical changes. Tech. Rep. Series No. 38. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia: 75p.

ABSTRACT SOURCE:

Reference from reference

ABSTRACT:

This pilot study investigated historical change to estuaries on the east coast of Vancouver Island. Within the estuary intertidal boundary, the most serious habitat loss was a 32% decrease in marsh habitat, which occurred at the turn of the 20th century when early settlers dyked upper marshes for agricultural purposes. During the last 40 to 50 years, loss of marsh habitat has slowed and has been offset by dyke breaching and vegetation transplanting. Intertidal substrate and subtidal water habitats have experienced relatively high losses in recent years, however those losses represent only 2% of their original areas. The major threats to estuarine intertidal habitats were log areas adjacent to estuaries, forest, meadow, and agricultural land have been increasingly replaced by log handling industries, logged areas, and residential development. Aerial photographs were useful in determining habitat change even though some problems with time period coverage and scale were experienced.

CITATION:

Pritchard, A. L. 1945. Observations of the upstream migration of coho salmon spawning runs in the Cowichan River. Fish. Res. Bd. Can. Pacific Progress Report: 14-16 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

For a number of years it has been the practice to tag a proportion of the cohoes from the Cowichan river spawning run as it passed over Skutz falls about eight miles below the lake. The fish are dipped at random each day throughout the migration, tagged and released to proceed on their way. Later in the season, most of the creeks in the system are examined in order to obtain counts of the tagged and untagged salmon. From these counts and the number tagged originally, the approximate escapement above the falls is calculated. In addition, all fish entering Oliver and Beadnell creeks, two streams about one mile below the lake, are trapped and examined. There is thus afforded an excellent opportunity to observe the behaviour in many areas, and from the findings to outline a picture for the season.

CITATION:

Riddell, B.E. 1993. Salmonid enhancement: lessons from the past and a role in the future. In Mills, D., Salmon in the Sea and New Enhancement Strategies. 338-355 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

This chapter discusses a debate developing about the value of intensive artificial culture techniques in managing salmonid production. The debate is basically whether such techniques provide sustainable increases in total production or may actually contribute to reduced production and persistence of natural populations. Concerns have recently been directed at large scale hatchery projects, including ocean ranching, mariculture, supplementation, colonization and stock transfers, and can be grouped into three sources of impact: genetic, ecological and fishery management. Regrettably, the debate has tended to be more rhetorical than empirical owing to a paucity of critical evaluations. Studies have demonstrated, however, that impacts attributable to each source can occur but that the degree of impact will vary with the scale of the project, its integration with management objectives, and the status of the natural populations.

Intensive culture projects intended to augment natural production cannot be developed or evaluated independently of natural populations, or be perceived simply as technological fixes to harvest or habitat issues. During future resource management planning, decision-makers must be aware of and consider the risk of these impacts. I suggest, however, that increased awareness of the need to conserve biological diversity (within and between species) and productive fish habitat will probably direct future enhancement towards smaller scale and/or semi-natural projects. Such a change will also necessitate change in evaluation standards with increased emphasis on conservation, ecological stability and broader social benefits.

CITATION:

Riddell, B., D.A. Nagtegaal, and D. Chen. 2000. A biologically based escapement goal for Cowichan River fall chinook salmon (*Oncorhynchus tshawytscha*). Fisheries and Oceans Canada Stock Assessment Division Science Branch. Nanaimo, BC. 23 p.

ABSTRACT SOURCE:

Abstract from reference (Discussion)

ABSTRACT:

This assessment provides our first evaluation of a biologically-based escapement goal for a naturally-spawning chinook population in the lower Strait of Georgia. It must be noted, however, that this stock is not solely a natural population as it is supplemented with production from the Cowichan CEDP hatchery. Production from this facility has contributed to increased numbers of chinook spawning naturally and enabled the annual tagging of chinook for assessment, but it also complicates interpretation and application of this assessment. For example, this assessment indicates that productivity of the naturally-spawning population decreased for recent years of larger spawning population sizes. For those years, we also noted that the proportion of hatchery fish in the natural spawning population had increased substantially and that the marine survival for hatchery fished (produced in the same brood years) had decreased substantially. Consequently, we are left with the uncertainty that our results may be consistent a density-dependent production function, or confounded with trends in marine survival and/or increasing interactions between hatchery-produced and naturally-produced chinook in the spawning population.

Two independent sources of information also suggest that our estimate of S_{MSY} may under estimate the potential production from this stock. A recent (and preliminary) assessment of spawning habitat indicates that, in the upper river alone, there is approximately 140,000 square metres of available spawning area (D. Nagtegaal, pers. Comm). The quality of this area has not been fully assessed, but conservative application of area per redd and/or suitability of habitats would still indicate that the numbers of females supported could be 50-100% greater than our estimate of 7400 chinook (4000+ females). The second source is the assessment of downstream juvenile migrations conducted in the Cowichan River (Nagtegaal et al. 1997a). The most recent assessments for brood years 1995 and 1997, years of large escapements, resulted in the largest egg/fry survivals (13%, range 1.5 to 13% range) measured since 1990. Both years involved numbers of females exceeding our estimated goal.

Given the above comments and the limitations of our current data (limited numbers of years, most escapements between 4,000 – 6,000 spawners), these authors suggest than an appropriate use of this assessment would be to define this escapement goal as a Target Reference Point, and that a management plan be established that continues probing production from escapements exceeding this point.

One serious cautionary note is appropriate for this stock. At the present poor marine survival rates (i.e., less than 1% survival to Age 2 recruitment), Cowichan fall chinook salmon will not be able to sustain recent spawning population sizes. Present population sizes are not an immediate

conservation concern, but recall that a significant portion of the return is from hatchery production. If poor survivals persist, the number of naturally-spawning fish in this population will continue to decline. Presently, the rate of decline has been minimized by the reductions in ocean fishery exploitation rates. The escapement trend and fishery exploitation on this population must be closely monitored in the next few years to minimize risks of a more serious conservation issue developing.

It is also noteworthy that this assessment culminates 12 years of intensive stock monitoring programs with cumulative costs exceeding one million dollars. Implementation of the Department's Wild Salmon Policy will necessitate investigations of other populations in this detail. The message is simple, stock assessments of natural populations is inherently complicated and expensive, and will require a serious long-term commitment in this Region.

CITATION:
Salasan Associates. 1995. Marine protected areas forum report of discussions. Marine Protected Areas Forum (1995: Cowichan Bay, B.C.) 20 p.

ABSTRACT SOURCE:
Abstract from reference (thematic summary)

ABSTRACT:
This summary provides a brief thematic overview of the discussions during the Marine Protected Areas Forum held in Cowichan Bay December 8-10, 1995. Points made here are intended to convey the "sense of the meeting" but are not the results of voting or consensus direction. Ideas and suggestions made during the forum are recorded in the further detail in the main body of the report, which accompanies this thematic summary. The statements in both this summary and the main body of the report do not represent "consensus" nor are they necessarily a commitment by either the Federal or Provincial governments to a specific action or set of actions.

CITATION:

Sheng, M. D., M. Foy and A. Y. Fedorenko. 1990 coho salmon enhancement in British Columbia using ground-fed sidechannels. Can. MS. Rep. Fish. Aquat. Sci. 2071: 81 p.

ABSTRACT SOURCE:

Abstract From reference

ABSTRACT:

Improved groundwater-fed side channels, which were originally built for increasing chum salmon (*Onchorynchus keta*) production in British Columbia, show promise as a viable enhancement technique for coho salmon (*O.kisutch*). Preliminary results indicate that these channels can produce up to 3 coho smolts/m^2. Indirect evidence suggests that additional coho adults are produced from presmolt channel outmigrants that rear and over winter beyond the confines of the channel. It is postulated that these outmigrants provide stability to the overall smolt and adult production in the parent river system.

Coho smolt abundance in groundwater –fed channels was found to be closely related to the availability of cover. Placing rip-rap armouring on channel banks, the crevices of which can provide sanctuary for up to 10 presmolts per linear meter, can increase smolt productivity over ten fold, as was demonstrated at Worth Creek Channel. At Deadman Channel, colonies of water cress (*Nasturtium officiale*) provided both escape cover and abundant food supply, and were associated with high densities of coho juveniles.

Other topics included in this paper are volitional spawner recruitment to a newly developed channel from the parent river system, surplus coho fry outmigrations, and seasonal patterns in distribution, diet and growth of juvenile coho.

CITATION:

Shirvell, C. S. 1994. Effects of changes in streamflow on the microhabitat use and movements of sympatric juvenile coho salmon (*Oncorhynchus kisutch*) and chinook salmon (O. tshawytscha) in a natural stream. Can. J. Fish. Aquat. Sci. 51: 1644-1652 p.

ABSTRACT SOURCE:

Abstract From reference

ABSTRACT:

The microhabitats at positions selected by juvenile coho (*Onchorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) following a change in streamflow differed from microhabitats occupied at normal streamflows. At drought streamflow (37% mean seasonal streamflow (MSF)), juvenile coho salmon selected slower, darker, and higher sites above the streambed ($P < 0.05$) than sites selected at normal (75% MSF) or flood (159% MSF) flows. Juvenile chinook salmon microhabitat use changed similarly with changes in streamflow, but the differences were not significant, Up to one fifth of the fish chose positions with faster water velocities than those available either 30cm above or 30 cm lateral to them. These fish chose positions inconsistent with the hypothesis of optimal position selection based on maximizing net energy gain. On average, fish moved 6.8 m following a change in streamflow. Juvenile coho salmon generally moved upstream in response to decreasing streamflows and downstream in responses to increasing streamflows. Juvenile chinook salmon tended to move offshore and downstream in response to all streamflow changes. These results show that juvenile coho and chinook salmon will move to find suitable microhabitat following a change in streamflow and that the microhabitats are not the same at all streamflows

CITATION:
Sibert, J., T.J. Brown, B.A. Kask, and J.D. Fulton. 1976. Observations on the lower trophic levels of the Cowichan estuary, Vancouver Island, B.C. Fisheries Research Board of Canada. Manuscript Report Series No. 1394: 25 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
On July 14-16, 1975, a brief intense multidisciplinary study of the lower trophic levels in the Cowichan estuary was undertaken. This work was initiated for several purposes: (1) to provide management with the basic data on the distribution of planktonic and intertidal benthic resources; (2) to compare with a similar but larger study on the Nanaimo estuary; (3) to evaluate the feasibility of undertaking such studies in the future. This report is a preliminary analysis of the data.

CITATION:
Simeon, J. (Editor). 1974. Natural history of the Cowichan Valley. The Cowichan Valley Natural History Society. 47 p.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
This book is a compilation of natural history characteristics of the Cowichan Valley. Each section is written by a different author and provides a species list and descriptive analysis. Sections included are; geology, mammals, birds, insects, flora, marine life and a sketch map of the Cowichan Valley.

CITATION:
Simpson, K.S. 1991. Preparatory stream reconnaissance, smolt trapping and habitat utilization surveys for a coho salmon research program in northern British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2116: 28 p.

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
This is an account of preliminary work by the Coho Program of the Biological Sciences Branch to obtain more information on the coho salmon populations of northern British Columbia. The objectives were: 1) find a suitable population to study intensively for several years; 2) as part of the first objective, obtain additional data on the size and age of coho smolts in the region, their run timing and a rough measure of their abundance; and 3) compare the relationships between habitat type, juvenile size and density in this region to those found in a south coast population assemblage (the Cowichan River system).

CITATION:

Sparrow, R.A.H. 1968. The freshwater and early life ecology of chinook salmon from the Cowichan River, with particular emphasis on the differences in the life history between early and later migrant fish. (Rough Draft). Fisheries Research Board of Canada. 17 p + tab + fig.

ABSTRACT SOURCE:

Abstract from author

ABSTRACT:

This study examines chinook salmon (*Oncorhynchus tshawytscha*) from the Cowichan river system. Freshwater, early sea life ecology and differences in life history characteristics between early and late migrant fish was emphasized within this report. Information regarding distribution and timing of chinook salmon that spawn in the Cowichan River provided by Neave (1943, 1949) is included within this report.

CITATION:
Taylor, G.D. 1963. Preliminary inventory of the Cowichan River 1962, 1963. 21 p.

ABSTRACT SOURCE:
Abstract from author

ABSTRACT:
This in-depth inventory compilation of the Cowichan River of 1962 and 1963 provides valuable detailed summaries and tabulations of biological, physical and other aspects of the river. The content of this inventory includes; Hydrography, physiography, fishing potential, sport fish utilization, recreational area, aesthetic value and various other characteristics of the Cowichan River. Observations, problems and recommendations are also outlined by the author.

CITATION:
Tutty, B.D. 1984. The Koksilah River: Low streamflows and salmon production. Fisheries and Marine Service M.S. Report 1822. pp

ABSTRACT SOURCE:
Abstract from reference

ABSTRACT:
Critically low summer streamflows occur annually in areas of prime fish habitats in the Koksilah River watershed. This occurrence, typical of most east coast Vancouver Island streams coupled with elevated water temperatures and demand for water for irrigation, domestic and industrial purposes, threatens the long-term production of coho salmon.

A major fishway was constructed in 1980 at Marble Falls in an attempt to provide salmon access to some upper reaches of the watershed. The Water management Branch of the provincial Ministry of the Environment has deferred issuance of water licenses since November 5, 1980, pending a review of fisheries concerns. This report contains a summary of the documented fisheries of the Koksilah watershed. The Department of Fisheries and Oceans recommends that a cooperative interagency water management plan be developed to balance the current and future demand for water with the available options for supply.

Specific recommendations are as follows:
An objective of 15 cfs as a minimum summer streamflow to maintain the fisheries resource in the mainstem Koksilah River (measured below Kelvin Creek confluence).
All water licenses for consumptive use from the Koksilah River and especially the Kelvin/ Glenora systems should be reviewed. Delinquent or inactive licenses should be revoked and licensed amounts recorded and verified as to actual consumption.
A review of headwater storage potential for summer release should be undertaken as part of an overall water management plan.

CITATION:

Tutty, B.D. 1988. Fish habitat inventory and information program: Stream summary catalogue Subdistrict #18 Duncan. South Coast Division, Fisheries Branch, Department of Fisheries and Oceans.

ABSTRACT SOURCE:

Abstract provided by Kristen Daniels

ABSTRACT:

The mainstem of the Cowichan River is 47 km long and has a low gradient of 0.3%. Tributaries to the Cowichan River include Koksilah River, Quamichan Creek, Somenos Creek, Holt Creek, Skultz Creek, Bear Creek, Fairservice Creek, Stanley Creek, Beadnell Creek, Hatchery Creek, Beaver Creek, Mesachie Creek, Robertson Creek, Ashburnham Creek, Sutton Creek, Meade Creek, Utility Creek, Coonskil Creek, Youbou Creek, Cottonwood Creek, Croft Creek, Wardroper Creek, McKay Creek, Nixon Creek, Shaw Creek, and Little Shaw Creek. The primary obstruction is the falls located 29 km upstream of the Cowichan River. The fishway alleviates the difficult ascend area. All the side channels are dry during low runoff periods and water management is important to limit fry strandings. Coho, which spawn from October to February in the Cowichan River, are the largest coho stock of Vancouver Island. Priest's pond at the north fork at the mouth of the Cowichan River is excellent coho rearing habitat. Spawning and rearing is concentrated in the mainstem of Cowichan River above Skutz Falls and tributaries to Cowichan Lake; however, they are accessible to spawn and rear in all accessible waters. The chum salmon of Cowichan River spawn from November to January primarily between the White bridge and the estuary. Late chum spawn in side channels at Marie canyon, bible camp before or at the confluence of Holt Creek. The Cowichan River chinook migrate upstream from July to September and then spawn from October to November. From Skutz Falls to Cowichan Lake 50% of the area was prime habitat for spawning where 33% of the area consisted of holding pools. The small spring run mature in the deep pools of the upper river and in Cowichan Lake until the fall. Finally, there is a large winter steelhead run on the Cowichan River and they spawn throughout the mainstem. For the period of 1976 to 1985 the mean escapement were 28,270 coho, 81,550 chum, and 5,650 chinook. The maximum escapements for the same periods was as follows 75,000 coho, 150,000 chum, and 9,000 chinook.

Over-spawning occurs in downtown Duncan side channels and sloughs of the Cowichan River. Thus increasing the spawning grounds can be done by improving the side channels, a potential coho spawning site. The best rearing potential for juvenile chinook appears in the flood plain due to the low gradient and the meandering of the river.

CITATION:

Vander Haegen, G., and D. Doty. 1995. Homing of coho and fall chinook salmon in Washington. Washington Department of Fish and Wildlife Hatcheries Program Assessment and Development Division. 31 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

A well-known characteristic of pacific salmon is their remarkable ability to home to their natal river for spawning. The vast majority of salmon home accurately, but spawning outside the river of origin is also a natural part of their life history. We examined and recoveries of coded-wire tags to determine the patterns of homing among wild and hatchery-reared coho (*Oncorhynchus kisutch*) and fall chinook (*O. tshawytscha*) salmon in Washington. We also assessed whether the method of releasing hatchery fish affected homing.

Most fish reared in Washington Department of Fish and Wildlife hatcheries spend all or the majority of their freshwater life in a single hatchery and are released on-station from that hatchery. Less than 1% of coho released by this method were recovered at locations other than the release site. This is comparable to the homing behaviour of wild coho. An alternate method of releasing hatchery fish is to transport them from the rearing hatchery for release off-station. From 1.6% to 55% of coho released off-station were recovered at locations other than the release site.

The homing patterns of fall chinook varied widely between regions of Washington and between hatchery release methods. For on-station releases, the percent recovered at locations other than the release site was lowest for fall chinook originating at Puget Sound hatcheries (1.1%) and highest for those originating at hatcheries in the Columbia River and its tributaries (23.9%). Our results suggest that releasing fish on-station at the hatchery where they were reared can reduce the number of fish that are recovered at locations other than the release site.

CITATION:

Wightman, J.C., and R.A. Ptolemy. 1989. Evaluation of available trout habitat in the upper Cowichan River in response to flows (1987). Ministry of Environment Recreational Fisheries Program, Canada. 81 p.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

In order to optimize water releases from storage on Cowichan Lake, the upper Cowichan River was systematically investigated from June to August 1987, to determine the variability in trout habitat in response to known flows. Field measurements of depth, velocity, wetted width and substrates were taken at 11 cross-sectional transects in representative habitats over an 8 km reach. Fish habitat was expressed in terms of weighted usable width for each transect by marrying depth, velocity and width data with suitability curves for a given trout species and age (or size).

Results indicated that at the highest flow (18.1 m^3/s or 40% of MAD) usable habitat for rainbow (steelhead) trout fry and par was reduced by 67% and 54% respectively, compared to the lowest flow observed (5.1 m^3/s or 11% MAD). Similarly, for catchable size brown trout (> 20cm), usable habitat was reduced by an average of 43% at the highest flow. However, in terms of stream width, the highest flow produced significantly greater wetted cross-sections, particularly in established riffle sites.

A review of other instream flow methods, supported by generic concerns for seasonal temperature loading, waste assimilation and recreational use, suggested the current maintenance flow of 7.08 m^3/s (16% MAD) generally satisfies trout rearing and angling requirements. Recommendations warranting further study included an evaluation of additional lake storage potential and improved streamflow forecasting techniques for the Cowichan watershed. A continued holistic approach to Cowichan River fisheries-flow management problems was also endorsed.

CITATION:

Zhang, Z., R.J. Beamish, and B.E. Riddell. 1995. Differences in otolith microstructure between hatchery-reared and wild chinook salmon (*Oncorhynchus tshawytscha*), 1994. Can. J. Fish. Aquat. Sci. 52: 344-352.

ABSTRACT SOURCE:

Abstract from reference

ABSTRACT:

Otolith microstructure exhibited some characteristic differences between hatchery-reared and wild chinook salmon (*Oncorhynchus tshawytscha*) from the Cowichan River. Daily growth increments that formed in the otoliths of the hatchery-reared chinook salmon after exogenous feeding were more regular in width and contrast than those in the otoliths of wild chinook salmon. In addition, otoliths from hatchery-reared individuals frequently produced a check when the fish were released from the hatchery. Eighty-nine percent of a sample of 67 chinook smolts that had been coded-wire tagged in hatcheries and later captured in the Strait of Georgia were correctly identified as originating from hatcheries based on otolith microstructure. These tagged fish originated from at least 17 different hatcheries, indicating that the method could be used to identify chinook salmon originating from other hatcheries.