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Capilano Hatchery:
A Record of Strategy

Second Draft

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ABSTRACT

This report represents the first in a series of reports dealing with salmon enhancement facilities in B.C. and the Yukon. The purpose of these reports is to examine specific facilities and the manner in which they fit into the regional fisheries framework.

In this first report, Capilano Hatchery is examined. Items to be discussed include objectives for development of Burrard Inlet and Indian Arm, the davelopment and history of the Capilano Hatchery, Capilano fish production, management of that production and options for the future of the river system.

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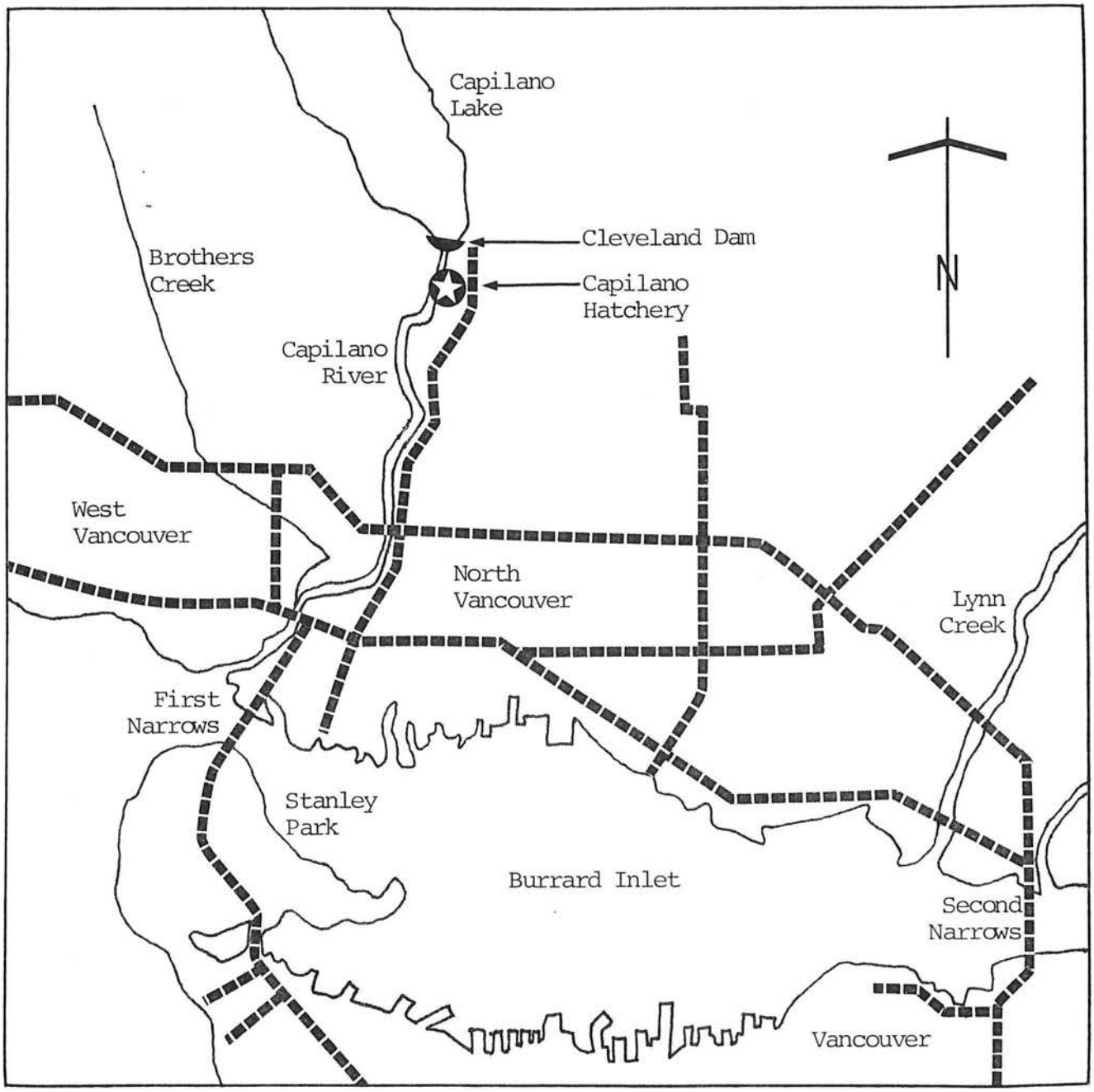
I. INTRODUCTION

The Capilano River system is located on the north shore of Burrard Inlet, between North and West Vancouver. Historically, this river has supported pink, chum, coho, cutthroat and steelhead populations. In 1951, the Cleveland Dam was constructed at the outlet of Capilano Lake, several kilometres from the mouth of the river. This project eliminated access to the prime spawning areas for Capilano coho and steelhead. Early attempts to provide enhancement facilities to compensate for lost production were unsuccessful but the Greater Vancouver Water District did agree to transport coho and steelhead past the dam. This operation was only partially successful as fry suffered high mortalities when they passed over the dam on their seaward migration.

In 1969, the idea of a hatchery on the Capilano River was revived. In this proposal, a Capilano hatchery would serve as a pilot facility to test enhancement technology in B.C. It would produce coho and chinook (using Big Qualicum chinook as a brood stock). Steelhead were also added to the plans shortly after the original proposal. The hatchery has been releasing fish since 1971 and is now operating at full capacity.

Figure 1. Capilano Hatchery.



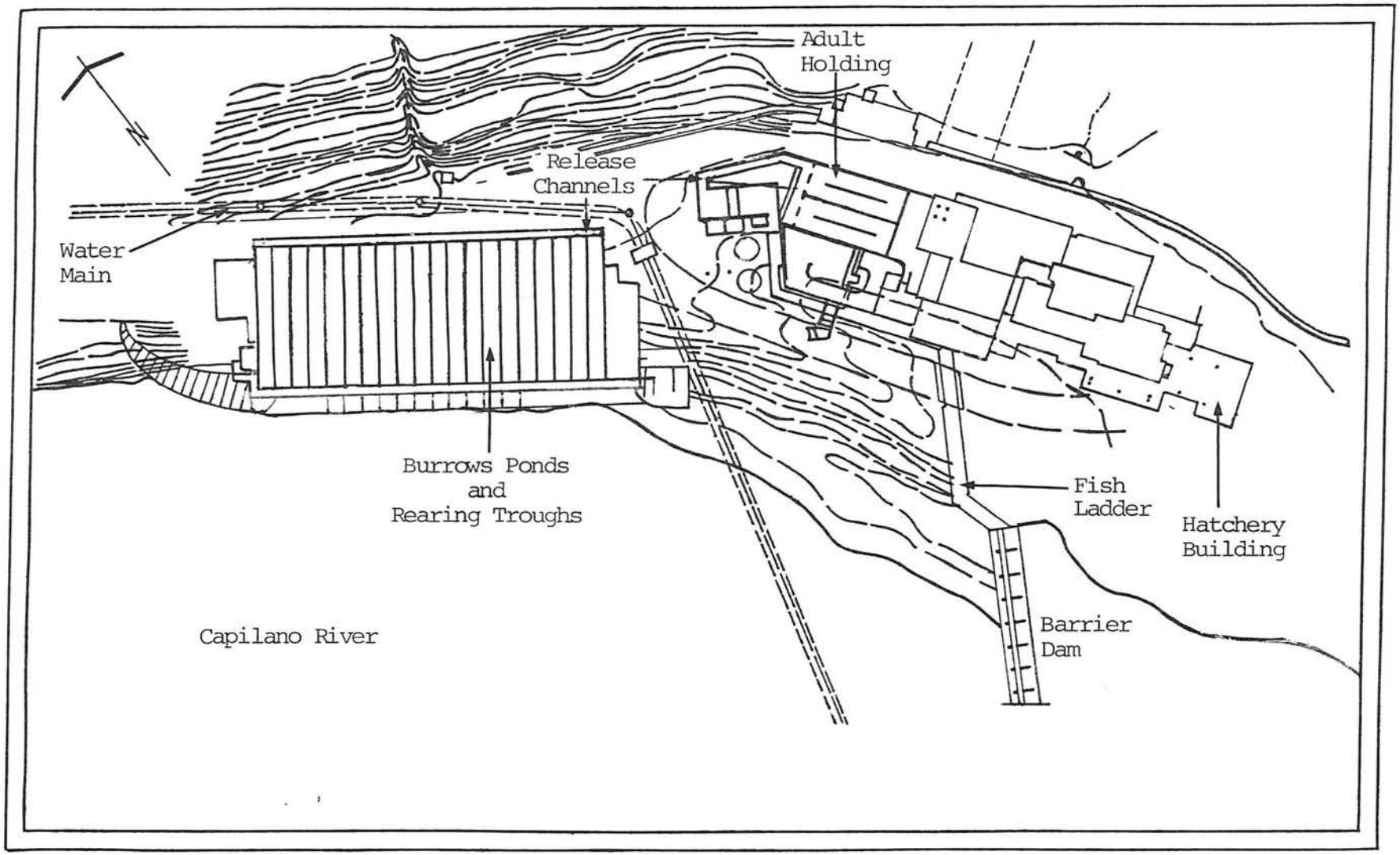


Figure 2. Layout of the Capilano Hatchery.

II. NATURAL STOCKS

1. Stock Assumptions

Before the Cleveland dam was constructed, annual escapements to Capilano averaged seven thousand coho, seventeen hundred steelhead, three thousand chum and one thousand pinks (Larkin and Hourston, 1951). The dam had devastating effects on salmonid populations, however, and in the period between construction of the dam and construction of the hatchery, escapements dropped to about seventeen hundred coho, one hundred steelhead, forty chum and forty pink (1963 to 1967 average). Currently, escapements are running at twenty seven thousand four hundred coho, one hundred steelhead, two hundred fifty chum, two hundred thirty pinks and twenty one hundred chinook (1977 to 1981 average). About ten percent of the coho returns to the Capilano are wild fish (Sandercock, pers. comm.).

The historical distribution of spawning (pre-dam) is shown in Figure 3. Paish (1973) reported that:

> "Pink and chum salmon had traditionally spawned in the lower 1 1/2 miles of the Capilano and in Brothers Creek. Steelhead and coho salmon primarily utilized tributary streams in the headwater areas above the present reservoir, and the lower end of the river and Brothers Creek to a lesser degree."

The Cleveland dam removed prime steelhead and coho spawning areas (except via the high mortality trap and truck operations). This may account for their decline during the 1960's. The reduction of chum and pink runs is more difficult to understand and problems with flooding and channel grading are not sufficient to explain the decline (Murray, 1978).

Migrant timings in the Capilano are presented in Tables 1 and 2 taken from Hourston, 1951.

Table 1: Period of Upstream Migration of Adult Salmon and Steelhead Trout in Capilano River

Species	Start	Peak	End
Pink Salmon	Aug. 1	Sept. 12	Sept. 30
Chum Salmon	Sept. 30	Oct. 20	Nov. 30
Coho Salmon	June 25	Oct. 7	Nov. 30
Steelhead trout			
Summer Run	May 1	June 20	Aug. 1
Winter Run	Nov. 15	Dec. 30	Feb. 28

Table 2: Period of Downstream Migration of Young Salmon and Steelhead Trout in Capilano River

Species	Start	Peak	End
Pink Salmon	March 31	April 30	June 15
Chum Salmon	March 31	May 15	June 15
Coho Salmon	March 31	May 15	June 21
Steelhead trout	March 15		Aug. 15

Hatchery releases are similar in timing to wild smolt migration and these indicate that smolt timings have not altered appreciably due to the hatchery or the dam (Appendix D). Migrant studies indicate that coho life history strategies have been altered by the reservoir, so that the small sized early timing portion of the run has been emphasized. The reservoir is claimed to induce extended upriver rearing and early returns from the ocean (Hourston and Vernon, 1957). These changes are reflected in the age compositions for Capilano stocks, which are based on analysis of 1958, 1971 and 1972 returns (Pope, 1973). The standard age compositions (biostandards) used in economic analyses are provided for comparison.

Figure 3. Historical Spawning Distribution in the Capilano Watershed.

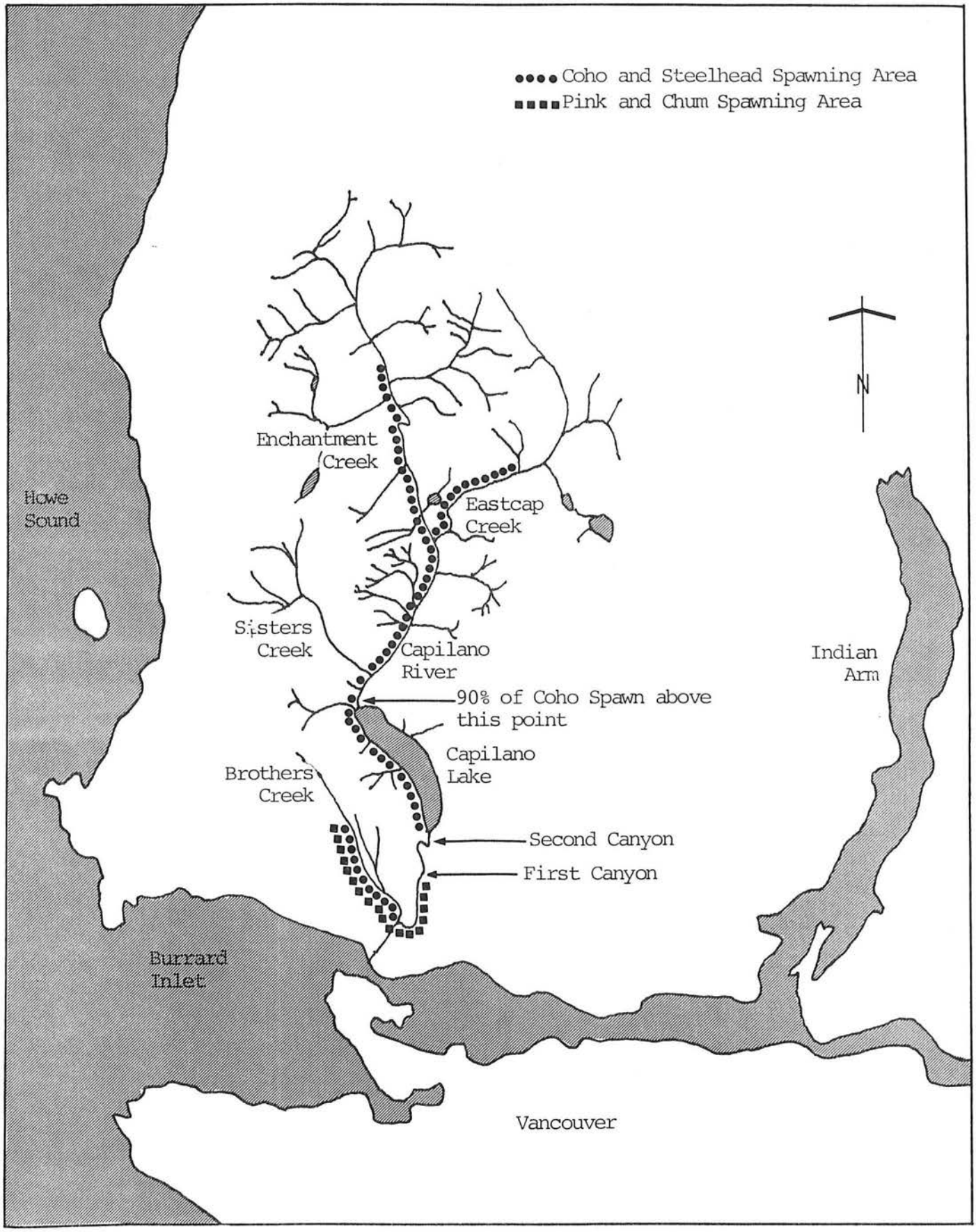


Figure 4. Approximate Arrival time of Salmon stocks in the Capilano River.

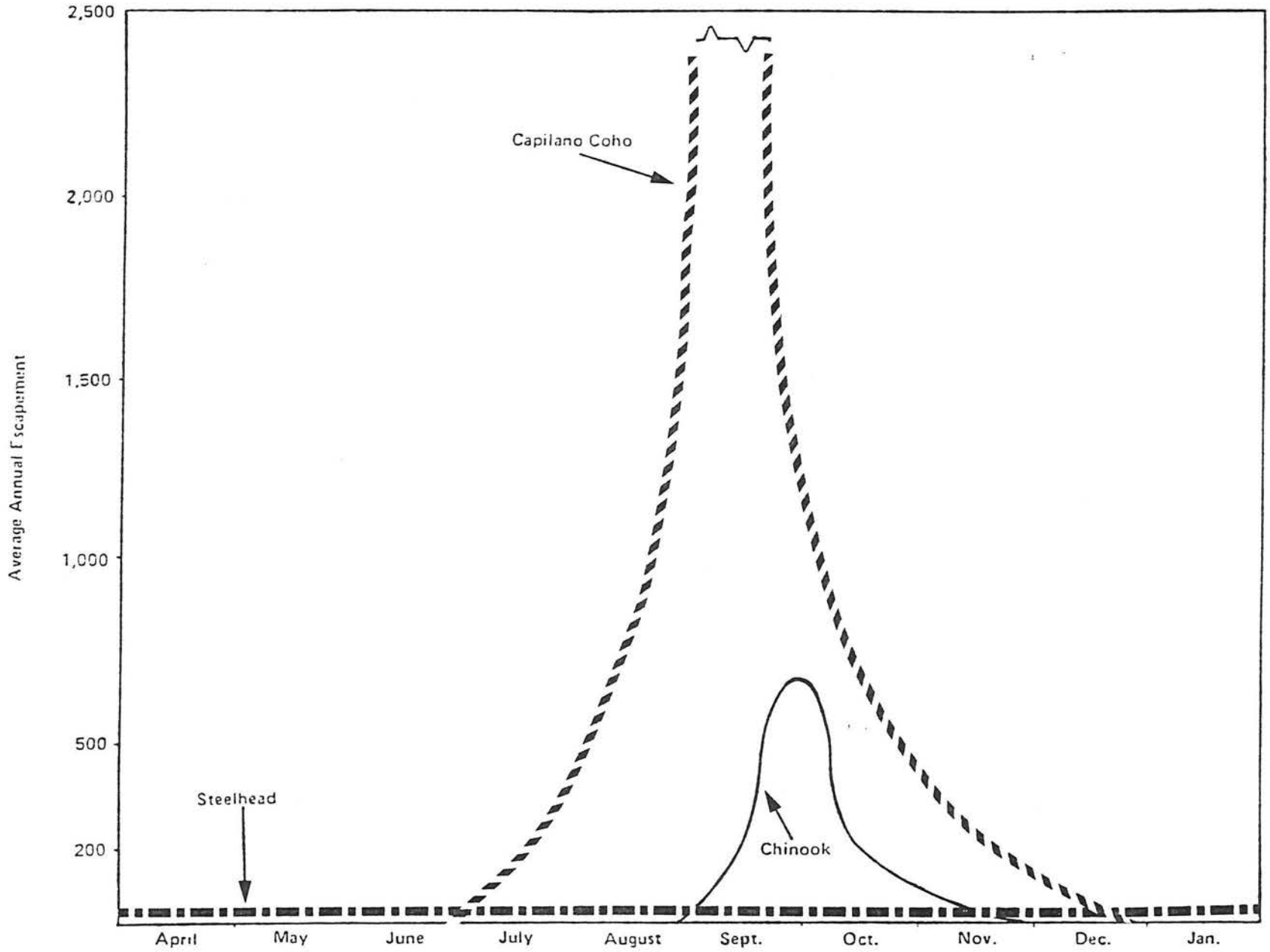


Table 3: Age Composition of Capilano Returns

Chinook	2_1	3_1	4_1	5
1971	93.5%	6.5%	-	
1972	-	87.8%	12.2%	
BioStandard	49%	32%	18%	1%
Coho	2_2	3_2	3_3	4_3
1971	1.3%	79.6%	-	19.1%
1972	2.3%	83.6%	0.3%	13.6%
1958	2%	94%	-	4%
BioStandard	2%	98%		

Length-weight relationships for hatchery coho and chinook are presented in Figures 5 and 6. Steelhead lengths and weights are presented in Table 4.

Table 4: Capilano Steelhead Length-Weight Data

Year	Age	Weight (kg)			Length (mm)		
		# of Fish	Mean	Deviation	# of Fish	Mean	Deviation
1971	-	2	4.2	0.1	2	708	3
1972	-	11	2.8	1.2	11	656	134
1975	-	3	3.9	0.6	3	709	24
	5	3	2.9	0.6	3	646	32
1976	-	3	3.5	0.5	3	675	36
	5	2	4.4	1.1	2	700	50
	6	1	5.8	-	1	838	-

All length-weight data is from Murray, 1978. Sex ratios for chinook as reported by Murray are shown in Table 5. These figures exclude jack returns.

Table 5: Capilano Chinook Sex Ratios

Year	Males		Females	
	Number	%	Number	%
1974	77	92%	7	8%
1975	135	73%	50	27%
1976	179	63%	106	37%
1977	46	25%	135	75%

No data for coho are given, but fishery officers report a 50-50 sex ratio for natural fish. Survival rates for wild fish are taken from the SEP Phase II biostandards (Lill et al., 1982a) and are presented in Table 6.

Table 6: Natural Survival Rates

Species	Egg-Adult Survival
Pink	0.30%
Chum	0.13%
Coho	0.18%
Chinook	0.20%
Steelhead	0.10%

Information on migration routes for natural Capilano stocks are unknown. At the time of construction it was felt that the majority remained in Georgia Strait but little else was known (Chappell, 1969).

Fin marking done at Capilano hatchery in the early days of its operation indicated that eighty five percent of coho production remained in Georgia Strait (Sandercock, pers. comm.). There are now indications of variable migration of Capilano coho along three different routes. In one case, they move north from Capilano and remain primarily in Georgia Strait. In the second case they move south from Capilano and remain in Juan de Fuca Strait, the Fraser River plume and southern Georgia Strait. In the final case, they move south from Capilano, exit Georgia Strait through Juan de Fuca and then move south along the Washington coast before returning. These migration routes, if they occur, may be controlled by differences in the Fraser River freshet or by interaction with releases from Puget Sound hatcheries (Pitre, pers. comm.).

2. System Capacities for Natural Production

Little is known about the capacity of the Capilano to support salmonid stocks. One estimate of the number of coho adults required to fully utilize the

river and hatchery is 8,000 (Fraser, 1979). Since the current requirements of the hatchery are 1,000 fish for brood stock, this would result in an optimum escapement to the river of about 7,000 fish. In 1971, Hollett estimated the capacity of the Capilano to produce coho from the area below the dam. He arrived at a range of 725 to 1,450 adult coho to fully utilize the natural spawning areas. The capacity of the river to support other species is undocumented.

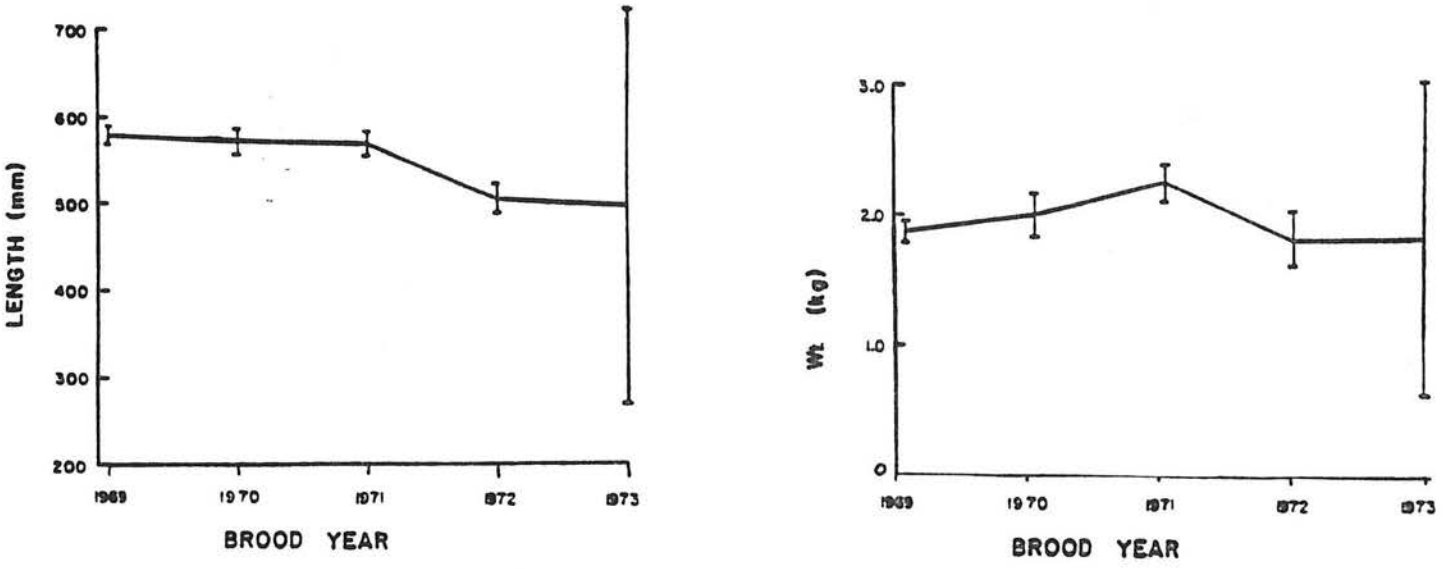


Figure 5. Mean Weights and Lengths of Three Year Old Coho Returning to Capilano Hatchery.

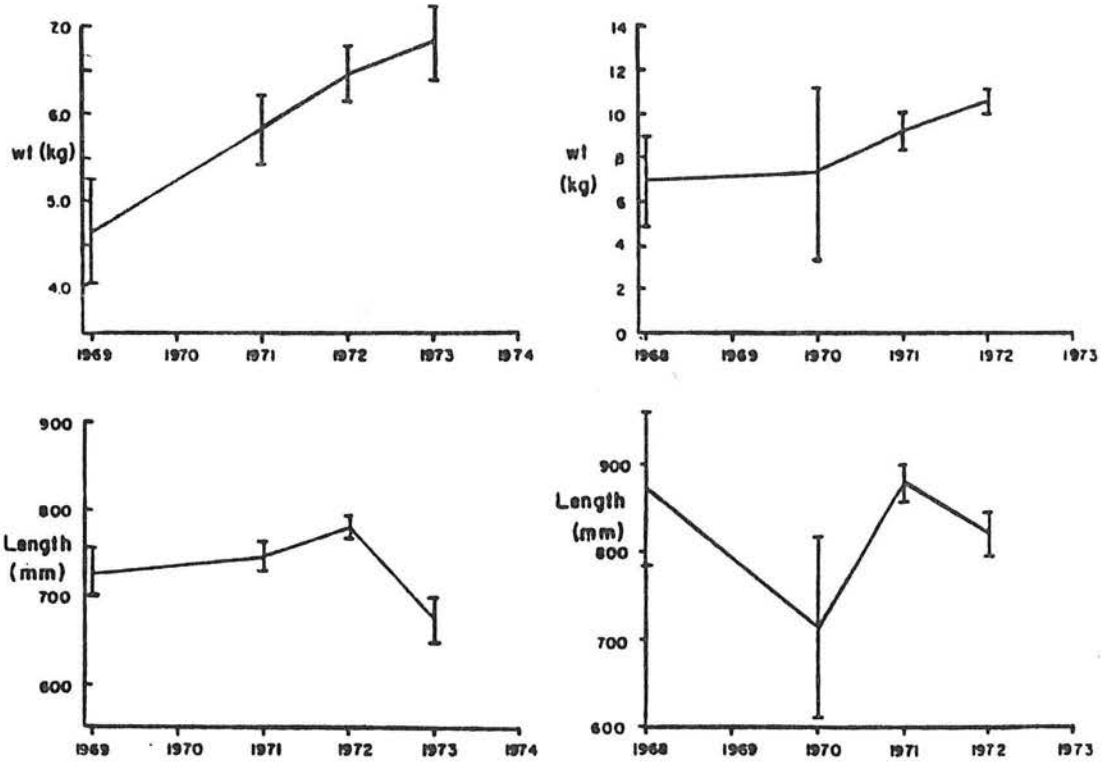


Figure 6. Mean Lengths and Weights of Chinook Returns to the Capilano Hatchery.

III. OBJECTIVES FOR BURRARD INLET

In 1969 the Department of Fisheries developed a proposal for increased production of Georgia Strait chinook and coho. This proposed program included five hatcheries to be constructed in areas around Georgia Strait. Locations for these hatcheries were undetermined but proposals were developed for a number of sites. The aim of these hatcheries was to mitigate the increasing pressure on salmon from commercial and recreational fisheries, particularly in the Gulf of Georgia (Davis, 1970). Capilano Hatchery itself was intended to increase the commercial and sports catch of coho and chinook in Georgia Strait by at least twenty-five percent (Murray, 1978).

When Capilano was being planned, overall management objectives for Burrard Inlet were unstated, and objectives for the Gulf of Georgia were sketchy. In 1969, the Department planned to phase out the Georgia Strait commercial troll fishery although no time frame was given (Hourston, 1969b). Restrictions to the troll fishery were the only immediate management changes planned for Georgia Strait.

IV. HISTORICAL FISHERIES MANAGEMENT

1. Commercial Fisheries

Capilano hatchery was intended to produce chinook and coho for the fisheries targetting on the pool of stocks in Georgia Strait. It was expected that commercial catch of Capilano coho and chinook would occur primarily in the Georgia Strait troll fishery. Capilano was expected to increase catches in this fishery by twenty five percent (Murray, 1978).

Enhanced production was intended to compensate for declining B.C. salmon stocks, felt at that time to be a result of coastwide industrial encroachment on salmon habitat (Burridge, 1975). It was hoped to prevent a drop in commercial catch due to increasing fishing pressure on declining stocks of chinook, coho and steelhead (Davis, 1970).

At the time of its development, Capilano hatchery was not intended to support a terminal commercial fishery. On several occasions since that time, a Burrard Inlet gillnet fishery targetting on Capilano stocks has been suggested (Argue and Anderson, 1976; Harrison, 1979; Fraser, 1979). This gillnet fishery was intended to operate in an area inside a line from Point Atkinson to Dundarave (Fraser, 1979). Opposition from the Harbours Board and sport fishermen resulted in the eventual dismissal of the idea (Pitre, pers. comm.).

2. Sport Fisheries

At the time of construction of Capilano, cutbacks in the Gulf troll fishery were expected, so the long term emphasis for Capilano would be production of fish for the Georgia Strait sport fishery (Hourston, 1969b). In addition, it was hoped that a local sport fishery could be developed (Burridge, 1975).

The local sport fishery had been closed for conservation purposes during the sixties due to declining Capilano escapements. As with the commercial fishery, Capilano was expected to increase Georgia Strait sport fish catches by twenty five percent (Murray, 1978).

3. Native Food Fisheries

Native catch of Capilano fish had declined in the 1960's and Capilano was intended to stimulate native food fishing (Burridge 1975). This fishing has traditionally occured in the Capilano estuary, on reserve land.

V. ENHANCEMENT

1. PROJECT DEVELOPMENT

A. Reasons for Enhancing

In the early fifties, the iminent construction of the Cleveland dam led to a report outlining the likely effects of the dam on the natural runs in Capilano (Larkin and Hourston, 1951). This report suggested the construction of a hatchery to partially offset losses of natural fish. A supplemental to this report (Anonymous, 1951) indicated that a hatchery would serve as an adjunct to natural production of coho and steelhead above the dam and could not feasibly be extended to accommodate the entire run. The hatchery would compensate for loss of stream habitat and act as a safeguard against possible losses of downstream migrants. Following construction of the dam, studies were undertaken to investigate mortality of juveniles passing over the dam. These studies suggested that coho suffered mortalities of 66% due to the dam while steelhead mortalities were 75% (Vernon and Hourston, 1957). The Greater Vancouver Water District felt its requirement for mitigation was sufficiently met by trap and truck operations around the dam and hatchery development on the Capilano was shelved.

In the late sixties, American hatcheries were successfully producing salmon and there was a desire to attempt hatchery production in Canada (Burridge, 1975). It was felt that hatcheries for chinook or coho could increase troll catch and sport catch for resident and non-resident sport fishermen. In addition, hatcheries would increase salmon stocks available to native food fishermen (Burridge, 1975). Hatcheries were also viewed as a means to compensate for habitat lost to industrial development, and mitigate the resulting depletion of salmon runs which was occurring simultaneously with increasing fishing pressure (Davis, 1970). To develop this technology, a pilot programme was developed, and Capilano was suggested as the site for the first hatchery (Davis, 1969).

B. Site Selection

The first stimulus for selection of Capilano to test hatchery technologies came from the Pacific Salmon Society (Chappell, 1969). Their letter to the minister resulted in his interest in Capilano and ultimately led to the construction of the Capilano hatchery. The minister urged that Capilano development be kept to a small scale (Davis, 1969).

Departmental staff proposed drilling for groundwater on a number of rivers, including Capilano (Brown, 1969). Surveys suggested that location of a Capilano hatchery below the damsite would require pumping of groundwater from a well which was separate from the hatchery site. Arrangements with the Greater Vancouver Water District could provide a free supply of high quality water from the reservoir. In addition, land for a hatchery would be provided for free by the Vancouver Parks Board. A barrier dam, fishway and collecting pools were in place for the ongoing trap and truck operations and these could be used for a hatchery (Anonymous, 1970).

A number of other reasons were put forward for selection of Capilano as the first hatchery site. Runs were depleted by urbanization before construction of the dam (Paish, 1973). The dam resulted in further depletion of Capilano salmon runs, with coho dropping from about 5,000 fish to about 2,100 spawners annually (Sandercock, pers. comm.). The proximity of Capilano was seen as a chance for public relations, for a tourist attraction and for informing the public about salmon (Chappell, 1969). Although stocks were depleted, returns were sufficient to ensure availability of brood stock (Chappell, 1969). Accessibility of the site and the presence of the barrier dam would allow better assessment of the success or failure of the project (McNally, pers. comm.). Capilano fish were believed to remain primarily in the Gulf of Georgia and would thus contribute to the area where the greatest increase in fishing pressure was occurring (Chappell, 1969). A local sport fishery was also hoped for as a result of Capilano development (Anonymous, 1970). The combination of these factors led to the selection of Capilano as the first site for the new hatchery programme.

C. Desired Species and Methods of Enhancement

Capilano was designed to test hatchery technology so the method of enhancement was pre-determined for this project. The lack of a warm groundwater supply has necessitated ongoing heating of reservoir water to allow rearing to occur (Hourston, 1969a).

Coho and steelhead were proposed for inclusion in the hatchery since its inception (Larkin and Hourston, 1951). Coho was the main production species. Steelhead were included to offset the incidental commercial catch of Capilano stocks and to provide increased sport catch (Burridge, 1975).

Chinook production from Capilano was in addition to the original proposal. Chinook were added to help increase chinook stocks on the West Coast to historic levels (Burridge, 1975). In addition, department staff wanted to test hatchery techniques and transplant technologies (Anonymous, 1969). Chinook production would also increase the benefit cost ratio of the hatchery and more fully utilize the capabilities of the river and the hatchery (Stone, pers. comm.). Big Qualicum chinook were chosen as a donor stock because the run was healthy and brood stock collection was easy and convenient.

Additional species which have been reared at Capilano have been on a small scale basis (pink, chum, and cutthroat) and were tests of hatchery technology through use of vacant rearing and incubation space (Stone, pers. comm.).

D. Project Review and Modification

Informal staff reviews of the Capilano project resulted in addition of chinook production to increase the benefit-cost ratio (Hourston, 1969b). During the design and construction period for Capilano, attempts to improve the aesthetics of the hatchery, to expand public displays and to perfect the pollution abatement systems, resulted in major changes to the design of the facility (Parish, 1971). These modifications resulted in large cost increases

and changed the construction cost for the hatchery from $950,000 to $3,000,000 (Anonymous, 1971).

E. Project History

1951 - Larkin - Hourston Report on effects of a proposed dam on the Capilano River. First suggestion of hatchery construction.

1951 - Contract to build dam awarded in May
- Fisheries advised Greater Vancouver Water District that cost and maintenance of fish protection is the responsibility of the G.V.W.D.

1952 - Capilano River diverted through diversion tunnels
- Coho salmon blocked at North Portal.

1953 - Trap-trucking facility approved by Fisheries and operational by July 1954.

1955 - July - first free spill from dam

1955-57 - Studies on the effects of the Cleveland dam on downstream migrant Coho and Steelhead.

1957 - Fisheries meet with G.V.W.D. to ask for hatchery to compensate for spillway losses. G.V.W.D. would not accept the results of the studies and refused to build a hatchery.

1969 - Minister of Fisheries decides to build a hatchery on the Capilano River.

1969-71 - Big Qualicum chinook transplanted to Capilano River and marked before release.

1970 - Hatchery design.

1971 - Hatchery construction
- First hatchery egg take.

1972 - Hatchery construction continues
- G.V.W.D. suggests ending fish transport but later agrees to truck 1972 stock pending a meeting to clarify maintenance and operation responsibilities.

1973 - First returns of hatchery fish (jack coho)
- Fisheries and Water District meet and agree to divide costs such that:
  - Fisheries will pay for potable water and sewerage treatment
  - G.V.W.D. will maintain barrier dam and trucking facility.

1974 - Capilano troughs first used.

1975 - Chlorine kill at hatchery attributed to faulty design or operation of Water District chlorination plant. Modifications to hatchery water supply suggested.

1976 - Transport of fish above dam discontinued by G.V.W.D.

1982 - SEP Phase II opportunities committee recommends expansion of Capilano hatchery.

2. FISH PRODUCTION

A summary of production is provided in Table 7.

Table 7: Production Targets for Capilano Hatchery

	Planned Capacity	Current Production[1]	Actual Capacity
Coho		(1980 brood)	
Eggs	1,300,000	800,000	900,000
Fry out	0	77,000	200,000
Smolts out	1,000,000	623,000	600,000
Adult returns	56,000		90,000
catch	51,000		
esc.	4,000		
Chinook		(1981 brood)	
Eggs	400,000	1,400,000	1,800,000
Fry out	-	-	-
Smolts out	325,000	996,000	1.5-2 million
Adult returns	2,950	29,900	26,000
catch	2,360	26,600	
esc.	590	3,300	
Summer Steelhead		(1980 brood)	
Eggs		24,000	
Fry out		6,000	20,000
Smolts out	65,000[2]	24,000[2](1+)	10,000(2+)
Adults returns			
catch			
esc.	3,200[2]		
Winter Steelhead			
Eggs		24,000	
Fry out		8,000	20,000
Smolts out		-	10,000(2+)
Adult returns			
catch			
esc.			
Chum		(1980 brood)	
Eggs	0	5,400	200,000
Fry out	0	5,000	180,000
Adult returns	0		3,600
catch	0		
esc.	0		
Cutthroat			
Eggs	0	2-3,000	
Fry out	0		
Adult production	0		

[1] Actual production for all brood years up to release is documented in Appendix A.

[2] Combined winter and summer stocks.

A. Coho

Coho production goals for Capilano have decreased from 1 million ot 1/2 million smolts out (20 g). This change is due to lowered rearing densities and high survival.

Capilano coho are overescaping, so production of coho is not limited due to their use for other enhancement and research projects; however, eggs and fry from Capilano coho supply many of the North Vancouver and Howe Sound public involvement projects.

In the future, development of other large scale hatcheries in Burrard Inlet and Indian Arm could require limitations on Capilano production to avoid problems associated with harvesting surpluses.

Experiments involving Capilano coho include time and size at release studies and rearing density experiments. Hormones have been used to control maturation and spawning in adults.

1978 brood coho juveniles were used in a sterilization experiment. This experiment tested whether excess coho could be prevented from returning to the hatchery and kept in the marine fishery. In 1982, experiments to produce all male or all female broods were conducted. These experiments were intended to test these techniques and their feasibility for use in increasing stock numbers. A study is presently being conducted to determine whether the timing of upstream migration can be controlled. A comprehensive list of experiments for all species at Capilano hatchery is provided in Appendices B and C.

Approximately 25% of coho smolt releases are marked with coded wire tags to evaluate production. In 1983, 20,000 fry transplanted above the dam were tagged. Production from the upper watershed is assessed with a downstream tagging program during the smolt migration period. Spillway mortality is now estimated to be about 50% (Vernon and Houston,1957).

Capilano coho have contracted a number of diseases including bacterial gill disease, bacterial kidney disease, coldwater disease, furunculosis and chloromyxum.

Bacterial kidney disease is a recurring problem at Capilano. While major mortalities may not be suffered in the hatchery, the resulting adult returns are lower. 1972 brood coho had the lowest survival rate of all years as a result of the disease (Sandercock, pers. comm.).

Capilano releases are presented in Appendices A and D. Most coho are released from the hatchery but when fry are released above the dam, the staff trucks them above the reservoir to various sites around Enchantment Creek.

Smolt release strategies were developed by K. Sandercock and E. Stone about 1971. They looked at factors such as reduced salinities and increasing temperature, photoperiod and food. In 1977, studies showed that the original release dates were close to optimal. There have been no changes in strategy for coho.

Until 1976, adult coho were transported above Cleveland dam to allow additional natural spawning. The adult trucking operation ceased in 1976 to be replaced by an expanded coho and steelhead fry trucking operation. Fry transplants utilize natural rearing area above the dam and are insurance against disasters such as the 1975 chlorine kill. Data for the operation appears in Appendix E.

Perhaps the greatest success at Capilano has been the realization of much high coho survival rates than anticipated. The biostandards expected in 1971 for coho are compared with actual survival data in Table 8.

Table 8: Survival of Capilano Coho

	Smolt-to-Adult Survival	Exploitation Rate
Coho - Expected (1971)	6.8%	75%
Coho - Actual (1971-76)	15%	55%

The observed survival rates and the estimated exploitation rates for all hatchery production are given in Table 9. This includes the biostandards presently being used to calculate adult production at Capilano.

Table 9: Survival Rates for Capilano Production

	Coho[1]	Chinook[1]	Steelhead[2]
Observed			
smolt-to-adult	.15	.03	.003
exploitation	.50	.89	<.10
Biostandards			
egg-to-fry	.90	.90	
fry-to-smolt	.75	.80	
smolt-to-adult	.15	.03	.03
unfed fry-to-adult	.016		
fed fry-to-adult	.02		.003

[1] based on 1971-76 broods
[2] based on 1972-76 broods

B. Chinook

The addition of 20 Capilano troughs in 1974 doubled production capacity and, keeping coho production constant, chinook production goals increased from 325,000 to 1 million smolts released at 10 g. This change will eventually double chinook capacity and production of chinook smolts is now targetted at 2 million (10 g). In the meantime, coho production goals have decreased from 1 million to 1/2 million smolts out (20 g).

Chinook production from Capilano is not limited by other enhancement facilities in the area. Transplants of chinook to the Indian River are carried

out on an annual basis but do not limit Capilano chinook production since significant shortfalls can be compensated by transfer of additional eggs from Big Qualicum. The same is true for the False Creek project which supplies net-pen reared Capilano chinook for the annual children's fishery.

As with coho production, Capilano chinook have been involved in a number of experiments. These include heritability of timing studies and the original transplant of chinook from Big Qualicum. About 25% of chinook production is coded wire tagged for evaluation purposes.

Other experiments have looked at improving the survival of Capilano chinook by releasing larger smolts. In 1982, supersmolts of 1980 brood were released at 41 g. Hormone and temperature experiments were performed on 1977 brood chinook.

Capilano chinook have been relatively disease free. The only diagnosed infection of capilano chinook, however, was Saprolegnia fungus in the 1975 brood.

Releases of Capilano chinook occur in early June to the river at the hatchery site. Smolts average five to ten grams at the time of release.

C. Steelhead

Steelhead production has remained fairly constant but rather than aim for 60,000 summer and winter yearlings, the hatchery is releasing 40,000 as under yearlings and 20,000 (10,000 summer and 10,000 winter) as two year smolts.

Summer and winter steelhead are now reared separately but until 1976 the two were spawned and reared together. For 1976 and 1977 broods, they were spawned and reared separately. Space contraints and lack of provincial funds for marking led to the practice of separate spawning but combined rearing for 1978-1980 broods. When a decline in the summer stock was apparent, the steelhead were again reared separately and tagged before release to allow analysis of interception in the fishery (Stone, pers. comm.).

Since 1981 steelhead have been reared for longer periods. Steelhead were not growing to an appropriate release size in one year. The extremely low temperatures of the Capilano water supply are thought to be the reason (McKinnon, pers. comm.). Presently, about one-third of steelhead production will be reared for two years (80-100 g.) before release.

Furunculosis was the only serious disease problem experienced with Capilano steelhead. The 1974 brood fry were destroyed to prevent spread of the disease.

About 10,000 summer steelhead, smolts and 10,000 winter steelhead smolts (80-100 gm.) are released from Capilano at the hatchery site. In addition, about 40,000 fed fry steelhead are released above Cleveland dam at a size of two grams.

VI. CURRENT MANAGEMENT

1. Changes in Fishing Patterns and Strategies

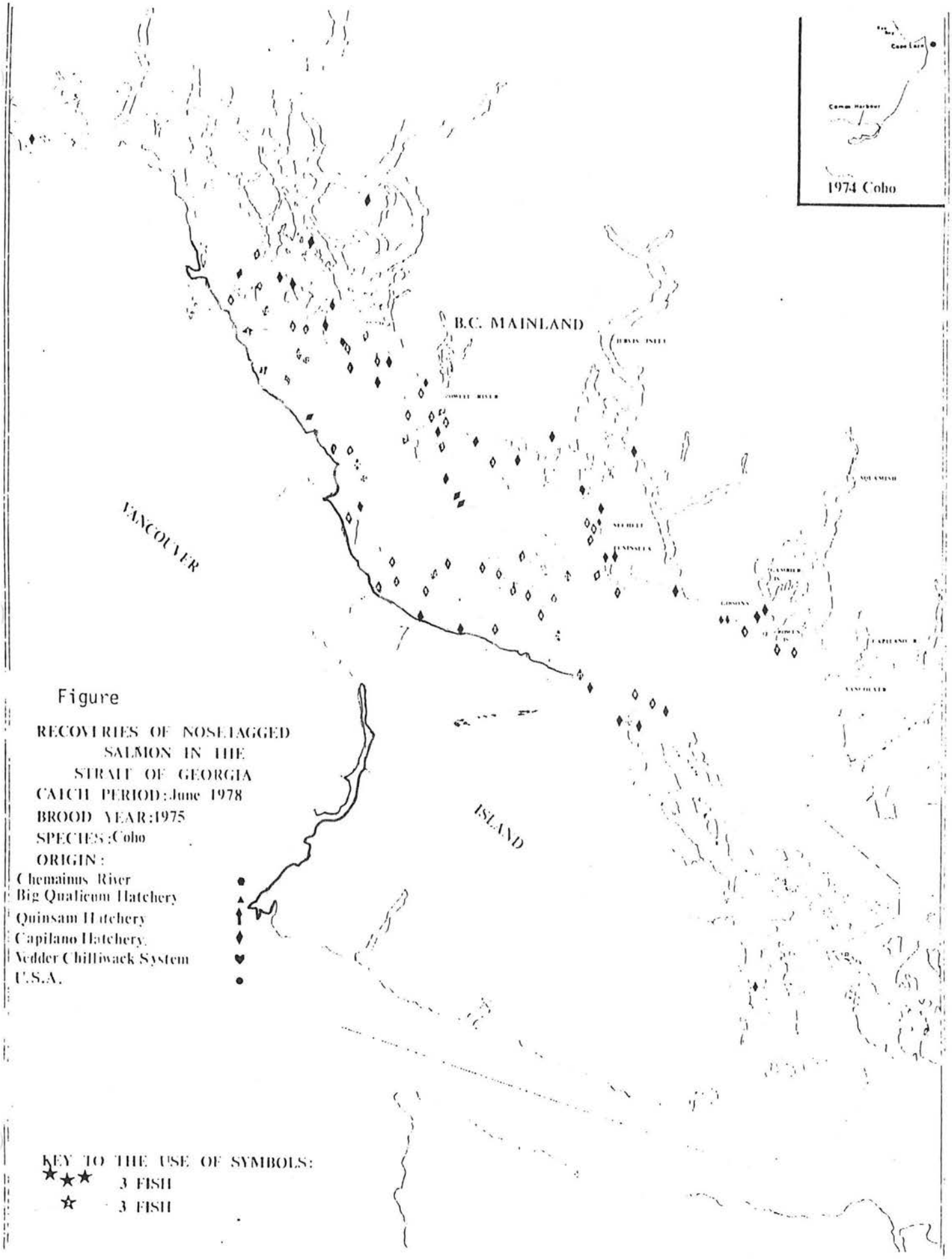
A fishing strategy was never developed for Capilano. Capilano fish were intended to supplement Georgia Strait sport and troll catches, and to stimulate local sport and native food fisheries. At the time of Capilano construction, the future Georgia Strait troll fishery was expected to be much smaller. It was hoped that increased restrictions on the troll fishery would ease the pressure on dwindling chinook stocks (Hourston, 1969b). This reduction in the Gulf troll fishery has not occurred.

The two area troll fishery, introduced in the last two years, is meant to reduce fishing pressure and aid wild stocks. This two area split is designed to prevent fishermen from creaming off large catches of fish when the troll fisheries open (Pitre, pers. comm.).

Predictions of revival of local sport and native food fisheries have proven to be accurate. Before Capilano hatchery, closure of the local sport fishery had become necessary to preserve the runs. Since Capilano, the river mouth sport fishery, inriver steelhead and coho sport fishery and the native food fishery have boomed. These fisheries can be directly attributed to successful production from Capilano hatchery.

2. Observed Catches and Returns

Using coded wire tag analysis, departmental staff have calculated Capilano production from 1971 to 1976. Production from these five brood years is presented in Table 10 (Birch, pers. comm.).



Figure

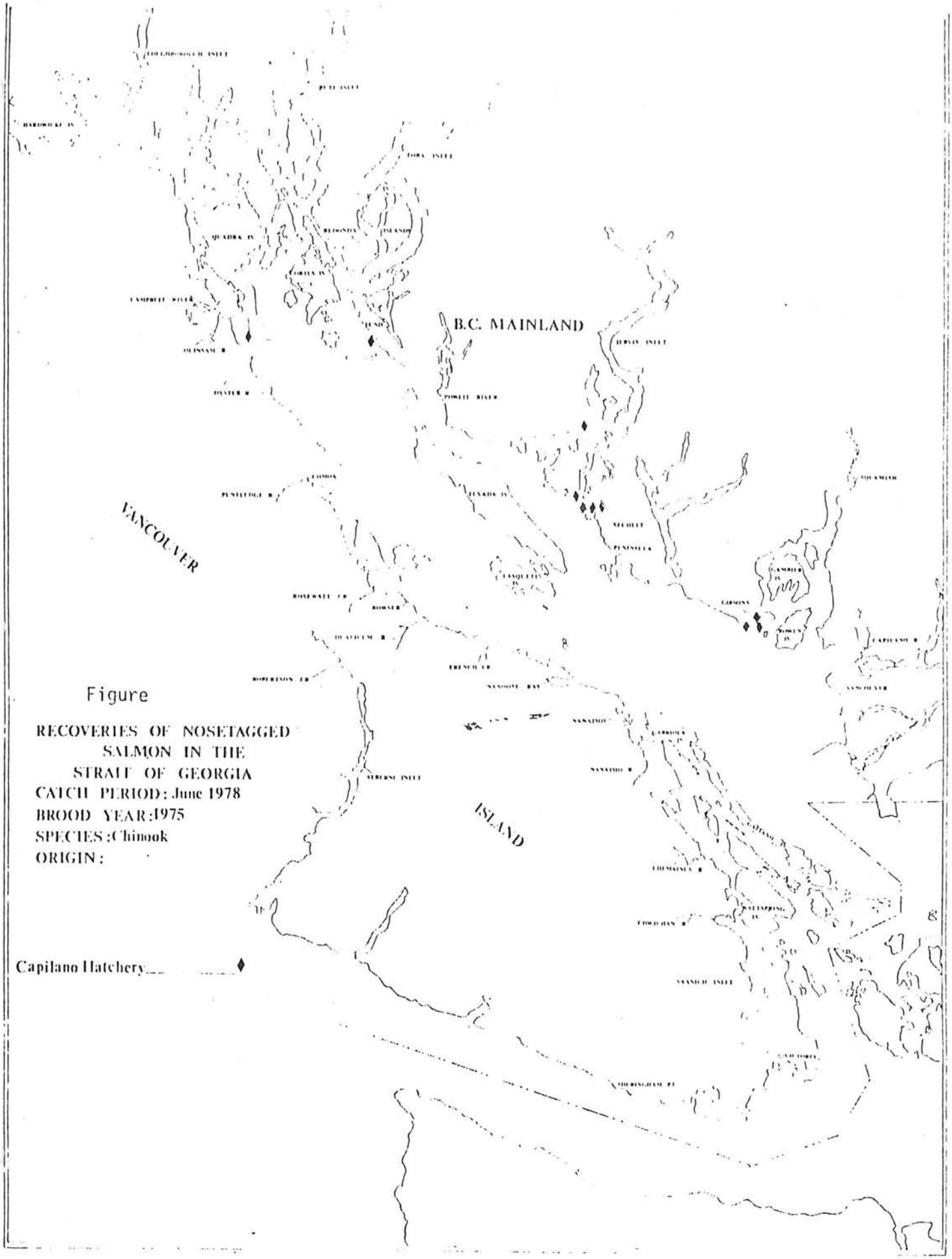
RECOVERIES OF NOSETAGGED SALMON IN THE STRAIT OF GEORGIA
CATCH PERIOD: June 1978
BROOD YEAR: 1975
SPECIES: Coho
ORIGIN:

- Chemainus River ●
- Big Qualicum Hatchery ▲
- Quinsam Hatchery ⬆
- Capilano Hatchery ♦
- Vedder Chilliwack System ♥
- U.S.A. ●

KEY TO THE USE OF SYMBOLS:

★★★ 3 FISH

☆ 3 FISH



Figure

RECOVERIES OF NOSETAGGED SALMON IN THE STRAIT OF GEORGIA
CATCH PERIOD: June 1978
BROOD YEAR: 1975
SPECIES: Chinook
ORIGIN:

Capilano Hatchery ♦

Table 10: Capilano Production for 1971 to 1976 Broods

Species	Coho	Chinook
Canadian Catch	150,798	57,458
American Catch	21,915	1,278
Escapement	142,600	9,438
Total Production	315,313	68,714
Exploitation Rate	54.8%	86.2%

A detailed analysis of Capilano coho returns is currently being carried out. Analysis of the 1975 brood coho is presented in Table 11 (Forster, pers. comm.).

Table 11: Catch Distribution of 1975 Brood Capilano Coho

	Number	%	
West Vancouver Island Troll	1,340	5.6	
West Vancouver Island Net		5	Trace Outside Canadian catch = 1.592 (6.6%)
West Vancouver Island Sport	1	Trace	
Central Coast Troll	198	0.8	
Central Coast Net	47	0.2	
Central Coast Sport	1	Trace	
Washington and Oregon Troll	453	1.9	
Washington Net	1,325	5.5	American catch = 2,074 (8.6%)
Washington Sport	296	1.2	
Juan de Fuca Net	286	1.2	
Johnstone Strait Net	896	3.7	Georgia Strait and Accessory Areas catch = 9,505 (37.7%)
Georgia Strait Troll	3,775	15.7	
Georgia Strait Net	157	0.7	
Georgia Strait Sport	3,532	14.7	
Escapement	10,802	48.0	
TOTAL	24,005	----	

Due to the small number of tag releases, similar analyses are not available for the other species produced by the Capilano hatchery.

Returns to the facility are presented in Table 12. These are summarized beginning with 1974 when adult returns to the hatchery began. Information for

the years 1974 to 1976 were taken from Murray (1978), while the information from 1977 to 1982 was obtained from the SEP Annual Reports.

Table 12: Returns to Capilano Hatchery

Year	Chinook	Coho	Steelhead	Cutthroat
1974	753	40,103	32	
1975	767	6,611	35	
1976	1,103	25,255	26	
1977	1,225	19,913	52	
1978	2,836	25,717	59	
1979	2,280	41,272	35	
1980	1,851	23,931	10	
1981	1,200	23,000	18	12
1982	1,284	28,900	113	7

3. Data Needs for Fisheries Management

To improve the management of Capilano stocks, a number of gaps in our knowledge of these stocks must be filled. Information on the heritability of timing is required to allow a more successful terminal sport fishery. Studies ongoing at Capilano should address this need (McKinnon, pers. comm.).

Fish quality studies in Burrard Inlet are required if enhancement of net species (chum and pink) is to be emphasized at Capilano and surrounding river systems. If quality studies show favourable results, a Burrard Inlet net fishery could be reconsidered to harvest excess production of net species.

The effects of sterilization on migration and fishery susceptibility for coho must be addressed. If sterilization is to be a production program, its management impacts, including the impact on Georgia Strait carrying capacity, must be examined in the immediate future.

VII. FUTURE PLANS

A major change for Capilano hatchery is now in the experimental stage. This involves the sterilization or feminization of fish. Feminization is being tested but is unlikely to play a continuing role for Capilano stocks. Sterilization is being considered as a standard operational procedure for Capilano coho (Perry, pers. comm.). The current production of 600,000 coho smolts could be increased to the orginal target of 1,000,000 coho smolts. The majority of these fish (600,000) would be sterilized and remain in the ocean. The remainder (400,000) would serve as brood stock for the hatchery, the river and other user groups (Sandercock, pers. comm.).

A second possible change is modification of the timing of Capilano coho. These fish enter the river over a period of six months. Low flows during mid summer are currently hampering upriver migration so returns to the hatchery exhibit two distinct peaks. Studies on the heritability of migration timing are examining this phenomenon. Middle timing salmon could be decreased to avoid producing fish that are highly susceptible to the poaching which occurs at low flows.

Other suggestions include the introduction of new stocks (Pitre, pers. comm.). Introduction of a late timing coho stock could provide fish which spend more time in saltwater and would be more susceptible to the fishery. If timing changes are seen as desirable, selection for late timing native coho could have the same effect. Introduction of an early timing chinook stock such as Puntledge summer chinooks could increase the season for local sport fishing.

Chinook brood stock collection may be modified in the future. Currently, brood stock is limited to hatchery returns. In the future, chinooks may be captured off the river mouth. This will allow access to the fish before they are subjected to a major portion of the sport, native and poaching fishing pressure.

Potential production modifications include increased pink, chum and cutthroat production. Cutthroat trout have been reared in small numbers at Capilano. In the future, greater numbers of Cutthroat may be produced to provide additional sport opportunities. (Sandercock, pers. comm.). Pink and chum production have also been tested at Capilano. Production of these species at Capilano would be limited by rearing space. There is potential for rearing chum in saltwater, and this may be attempted (McNally, pers. comm.).

Physical modifications to Capilano hatchery centre on the water supply and rearing space. The most likely change at Capilano is the full use of the pollution abatement system for expanded rearing of juvenile salmonids. The underground infiltration galleries were designed to prevent hatchery wastes from entering the river, but two of the galleries have already been modified for rearing of salmonids. There is also room for a few additional rearing troughs on the site, but additional rearing expansion is limited by the lack of surrounding flat land.

Other modifications involve the water supply. The fish kill in 1975 was attributed to faulty design or operation of the Greater Vancouver water chlorination plant (Murray, 1978). To prevent a recurrence the main water supply for Capilano must be modified. This could involve new alarm systems to detect backups of chlorinated city water into the hatchery. Alternatively, a separate water supply could be developed, with a pipeline running from an inoperative gate under the Cleveland dam spillway (LeBlanc, 1976). This pipeline would remove the danger of chlorine contamination and would increase available water from 410 l/sec to 708 l/sec.

Expansion of Capilano as outlined for Phase II (Lill et al, 1982b) would include modification of the water supply and expansion of incubation and rearing capacity to allow production of 50,000 adult coho, 50,000 adult chinook and 1,000 adult steelhead. Other options for expansion of Capilano revolve around the use of the hatchery as a central facility to service expanded production for Seymour and Indian Rivers (McIntyre, 1983).

Future changes to fisheries operating on Capilano stocks will emphasize a shift of fishing from Georgia Strait to more terminal areas. Severe depletions of wild coho and chinook stocks require tighter control of sport and troll fisheries in Georgia Strait. Modifications to these fisheries will likely occur once a Canada/U.S. salmon treaty has been signed (Pitre, pers. comm.). These changes could include limits on total sport catch accompanied by further restrictions on Georgia Strait troll catch. None of these changes will occur without extensive consultation with the parties involved.

Opportunities for a terminal gillnet or troll fishery are limited. Opening a commercial fishery was suggested in 1976 and in 1979 (Argue and Anderson, 1976; Harrison, 1979). In neither case was the recommendation implemented. Ministry of Transport officials are concerned with maintaining clear shipping lanes. Problems could also arise with navigation through the sport fleet. The simplest option for terminally harvesting excess fish is to increase harvest pressure by sport and native fishermen. If native fishermen are given quotas for commercial sales of salmon as recommended by Pearse (Pearse, 1982), then excesses could be harvested in the river.

Appendix A

BROOD SUMMARIES FOR CAPILANO HATCHERY

Year	Species	Origin River System	Eggs Taken	Eggs Kept	Fry Ponded	Fry Kept	Fry Released	Smolt Released
72	ST	Capilano	77,013	77,013	57,062	57,062		41,656
73	ST	Capilano	82,806	82,806	73,502	73,502		64,551
74	ST	Capilano	73,600	73,600	73,903	73,903		0[3]
75	ST	Capilano	32,470	32,470	23,774	23,774		30,945
76	ST	Capilano	27,781	27,781	14,728	14,108		12,459
77	ST	Cap Winter[1]	12,232	12,232	10,974	10,954		9,391
78	ST	Cap Summer	81,091	81,091	71,351	68,611	28,241	18,680[7]
78	ST	Cap Winter	18,098	18,098	17,675	17,465		15,343[7]
79	ST	Cap Winter	21,080	21,080	14,604	14,604		
79	ST	Cap Summer	56,850	56,580	47,833	47,833	34,730[2]	28,222[7]
80	ST	Capilano Summer	24,081	24,081	19,764	19,764	5,897[2]	
80	ST	Capilano Winter	24,495	24,495	21,093	20,793	8,366[2]	24,307[7]
71	CO	Capilano	443,200	443,200	368,673	368,673		284,607
72	CO	Capilano	423,589	423,589	409,864	399,854		255,090
73	CO	Capilano	562,181	562,181	491,951	491,951		384,807
74	CO	Capilano	1,686,430	1,498,109	1,384,767	1,309,767		0[4]
75	CO	Capilano	36,198	36,198	33,186	33,186		34,083
75	CO	B.Q.R.	1,035,902	555,905	543,347	543,347		495,911
76	CO	Capilano	1,552,745	858,401	708,619	690,436	82,000	681,622
77	CO	Capilano	1,106,530	1,106,530	948,597	948,151	379,724	524,680
78	CO	Capilano	1,515,720	1,260,542	1,073,322	915,802	429,057	483,527
79	CO	Capilano	1,291,375[5]	881,548	710,410	574,570		565,493
80	CO	Capilano	1,505,140	864,212	748,025	704,757	77,385[6]	622,839

[1] no summer steelhead in 1977
[2] trucked over dam
[3] destroyed by furunculosis
[4] chlorine kill
[5] 263,405 unfed fry were planted above dam
[6] 76,353 transferred above dam
[7] combined summer and winter stocks

(Appendix A - Continued)

BROOD SUMMARIES FOR CAPILANO HATCHERY

Year	Species	Origin River System	Eggs Taken	Eggs Kept	Fry Ponded	Fry Kept	Fry Released	Smolt Released
69	CN	B.Q.R.	-	-	-	-		111,200
71	CN	B.Q.R.	528,000	528,000	358,199	358,199		338,150
71	CN	Harrison R.	248,145	248,145	160,987	0[3]		
72	CN	B.Q.R.	390,749	390,749	354,411	354,411		298,967
73	CN	Capilano	319,979[1]	319,979	304,524	304,524		298,452
74	CN	Capilano	10,899	10,899	12,027	12,027		0[2]
74	CN	B.Q.R.	35,112	35,112	34,727	34,727		0[2]
75	CN	Capilano	36,156	36,156	47,780	47,780		47,908
75	CN	B.Q.R.	459,747	459,747	434,117	431,117		435,412
76	CN	Cap Early	822,831	822,831	775,420	775,420		769,270
76	CN	Cap Late	459,515	459,515	408,650	408,650		415,032
77	CN	Cap Early	956,605	936,477	818,272	817,550	269,148	610,612
77	CN	Cap Late	546,701	542,563	464,568	459,417		477,809
78	CN	Capilano	353,593	353,593	277,170	267,050		279,870
78	CN	Squamish	129,718	129,718	73,520	0[4]		
78	CN	B.Q.R.	201,196	201,196	197,983	197,953		190,763
79	CN	Capilano Early	1,590,253	1,314,071	1,000,266	996,281		952,088
79	CN	Capilano Late	756,221	732,158	499,675	464,454		403,346
80	CN	Capilano Early	1,225,886	1,225,886	1,041,348	1,040,461		926,816
80	CN	Capilano Late	1,119,485	831,369	713,727	479,769		400,148
81	CN	Capilano	1,386,770	1,386,770	1,202,925	1,165,209		995,659
80	CM		5,393	5,393	5,131	5,131	5,009	

[1] 190,237 from B.Q. females
[2] chlorine kill
[3] transferred to Harrison River
[4] transferred to Squamish

Appendix B

MAJOR EXPERIMENTS ASSOCIATED WITH
CAPILANO HATCHERY

Species	Brood/Return	Type and/or Comments
Coho	1972	Transplant to Indian Arm.
	1973	Testosterone and survival.
	1974	Transplant to Indian Arm.
	1975	Testosterone study.
	1977	Feeding.
	1978	Hormones.
	1979-80	Time and Size of release.
	1981	Predation.
	1981	Water hardening.
Chinook	1976-82	Separation of early and late.
	1977	Hormone and temperature.
	1979-80	Density.
	1980	Transplant to Indian Arm.
	1980	Photo period effects.
	1980	Supersmolts.
Steelhead	1978-80	Separation of summer and winter.

Appendix C

MISCELLANEOUS RESEARCH EXPERIMENTS PERFORMED USING CAPILANO STOCKS, HATCHERY OR RIVER

Species	Brood/Return	Type and/or Comments
Chinook	1971	Effects of kraft pulp mill effluents.
	1977	Anabolic steroids in combination with variation in temperature.
	/1978	Hormone and salinity studies on maturation in adults.
Coho	1976	Coho transplant to Scotland.
	1975	Avoidance behaviors experiments with pulp mill affluent.
		Transfer frequencies of coho from B.Q. and Capilano reported January 1979.
	1980	Egg bank project by W.D.F.
	/1982	Fish quality study by Bilinski.
	1976	Sex reversal by West Van Lab.
	/1976	Regulation of spawning via steroid hormones to reduce prespawning mortality. West Van Lab.

Proposed Studies

1. Transplant of coho fry to Yukon Territory pothole lakes.

Appendix D

A REVIEW OF PAST RELEASES FROM THE CAPILANO HATCHERY

Species	Brood Year	Time of Release	Size (#/lb)	Size (g)	Site
Coho	1971	June 4/73	23.6	19.2	lower Cap.R.
	1972	June 26/74	25.3	17.9	lower Cap.R.
		Aug. 23/74	10.5	43.2	Indian Arm
	1973	June 23/75	14.8-35.4	12.8-30.6	lower Cap.R.
	1975	June 6/77	23.2	19.6	lower Cap.R.
		May 30/77	20.4	22.2	lower Cap.R.
	1976	June 4/78	24.5	18.5	lower Cap.R.
	1977	June 6/79	25.0-31.0	14.6-18.1	lower Cap.R.
	1978	June 6/80	30.0-36.0	12.6-15.0	lower Cap.R.
	1979	June 6/81	30.7	14.8	lower Cap.R.
		Apr. 20/81	39.0	11.6	lower Cap.R.
		May 7-July 13/81	13.0-30.0	15.0-35.0	lower Cap.R.
	1980	May 7-July 9/82	21.0-32.0	14.0-21.0	lower Cap.R.
		June 15/81	163.0	2.8	lower Cap.R.
		June 30/81	163.0	2.8	above dam
	Average size after 14 month rearing			1.7 ± 2 g	
Chinook	1971	July 19/72	89.0	5.1	lower Cap.R.
		July 31/72	95.0	4.8	Harrison R.
	1972	June 11/73	85.0	5.3	lower Cap.R.
	1973	June 11/74	90.5	5.0	lower Cap.R.
	1975	June 17/76	77.0-86.0	5.3-5.9	lower Cap.R.
	1976	June 6/77	72.0	6.3	lower Cap.R.
		June 21/77	147.0	3.1	lower Cap.R.

(Appendix D - Continued)

A REVIEW OF PAST RELEASES FROM THE CAPILANO HATCHERY

Species	Brood Year	Time of Release	Size (#/lb)	Size (g)	Site
(cont'd)	1977	June 4/78	56.0-67.0	6.8-8.1	lower Cap.R.
		June 20/78	89.0	5.1	lower Cap.R.
	1978	May 11/79	85.0	5.3	lower Cap.R.
		June 7/79	78.0	5.8	lower Cap.R.
	1979	June 5/80	65.0-81.0	5.6-7.0	lower Cap.R.
		June 13/80	100.0	4.5	lower Cap.R.
	1980	May 21-22/81	69.0-77.0	5.9-6.6	lower Cap.R.
		June 18/81	47.0	9.7	lower Cap.R.
		Apr. 14/82	11.0	41.2	lower Cap.R.
		Apr. 15/81	299.0	1.5	Indian Arm
	1981	May 14/82	131.0	3.4	lower Cap.R.
		May 28/82	116.0	3.9	lower Cap.R.
		June 11/82	86.0	5.3	lower Cap.R.
	Average size at June release			5.6 ± 1.8 g	
Chum	1980	June 18/81	N/A	-	lower Cap.R.
Steelhead	1972	June 4/73	20.8	21.8	lower Cap.R.
	1973	June 12/74	16.0	28.0	lower Cap.R.
		May 20/75	20.0	22.7	lower Cap.R.
	1975	June 3/76	29.7	15.3	lower Cap.R.
	1976	May 19/77	21.0	21.6	lower Cap.R.
	1977	May 23/78	24.8	18.3	lower Cap.R.

(Appendix D - Continued)

A REVIEW OF PAST RELEASES FROM THE CAPILANO HATCHERY

Species	Brood Year	Time of Release	Size (#/lb)	Size (g)	Site
Steelhead (cont'd)	1978	June 7/79	20.5	22.1	lower Cap.R.
		Oct. 18/78	-	-	over dam
	1979	Jan. 31/80	-	-	over dam
		Mar. 15/80	24.6	18.4	over dam
		May 7/80	24.1	18.8	lower Cap.R.
	1980	Nov. 30/80	18.0	25.2	over dam
		Dec. 12/80	25.9	17.5	over dam
		May 5/81	11.3	40.1	lower Cap.R.

Average release size 1972-79 20.8 ± 3.6 g

Pre-hatchery Releases

Chinook	1968	August/69	-	-	BQ transplants
	1969	July /70	-	-	BQ transplants
	1970	Aug. 10-17/71	90.0	5.0	BQ transplants

Appendix E

NUMBER OF ADULTS TRUCKED OVER DAM

Year	No. of Steelhead	No. of Salmon[1]
1954	47	2,984
1955	93	5,097 (4 sockeye)
1956	78	~ 1,900
	(7 steelhead transferred to Cultus Lake)	
1957	25	5,087 (3 sockeye; 1 chum)
	(47 steelhead transferred to Cultus Lake; 25 coho transferred to F.R.B.C.)	
1958	95	3,884
1959	214	2,785
1960	161	3,663
1961	39	2,119
1963	96	2,103
1964	125	2,623
1965	49	617
1966	80	2,086

(Appendix E - Continued)

NUMBER OF ADULTS TRUCKED OVER DAM

Year	No. of Steelhead	No. of Salmon[1]
1967	127	1,203
1978	87	1,470
1969	64	1,316
1970	75	2,613
1971	56	3,053
1972	4	540

(1973-1976 data is not available)

[1] The salmon transported were usually all coho but figure includes some sockeye and chum adults that were transported above dam.

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