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FISHERIES MANAGEMENT  
STRATEGY FOR THE PALLANT  
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A FISHERIES MANAGEMENT STRATEGY  
FOR THE  
PALLANT CREEK WATERSHED, QUEEN CHARLOTTE ISLANDS

by

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## ABSTRACT

deLeeuw, A.D. A fisheries management strategy for the Pallant Creek watershed, Queen Charlotte Islands.

As a consequence of past and proposed steelhead and coho enhancement efforts in an anadromously isolated lake (Mosquito Lake) within the Pallant Creek drainage on the Queen Charlotte Islands, two conflicts have been identified. Hybridization between the resident cutthroat and residualized hatchery steelhead resulting in the genetic deterioration of both stocks is a distinct possibility. The influx of hatchery-produced coho fry into lake tributary nursery streams presently utilized by juvenile cutthroat trout is also considered to impact negatively on the lake's cutthroat population.

Key words: Pallant Creek, Mosquito Lake, management objectives, strategies, steelhead, cutthroat, Dolly Varden, coho.

## INTRODUCTION

The Pallant Creek system of the Queen Charlotte Islands presently supports an active sport fishery for steelhead and cutthroat trout, Dolly Varden char and coho salmon. Located on the east coast of Moresby Island, it is one of only three readily accessible steelhead streams in the area. Perhaps the most unique feature of the drainage however, is the substantial resident cutthroat trout population in Mosquito Lake (1 of 2 accessible lakes), with angled fish of over 1.5 kg (3.5 lbs.) not uncommon. A 3 m falls limits migration of all anadromous salmonids to the lower reaches of Pallant Creek downstream of the lake. Mosquito Lake fish therefore are wholly resident, and constitute a distinct population.

In 1978, a federal hatchery was constructed on lower Pallant Creek primarily to enhance existing chum and, to a lesser degree, coho salmon stocks. In order to curtail high costs of artificially rearing fry to smolt size, and to make use of natural nursery capabilities of the system, hatchery raised coho fry have been released throughout the watershed by the Department of Fisheries and Oceans. In an effort to enhance steelhead runs, fry of this species have also been released in the upper watershed by the Fish and Wildlife Branch. Once increased adult coho and steelhead populations have been established, the Pallant Creek barrier could be removed (blasted), allowing for unrestrained dispersal and ultimate natural continuation of these runs in previously inaccessible areas.

The purpose of the present paper is to outline provincial fisheries management objectives and strategies for the Pallant Creek/Mosquito Lake system in light of existing and future enhancement efforts.

## THE STUDY AREA

Pallant Creek drains an area of 8,495 hectares on northern Moresby Island (Fig. 1). Discharge ranges from 0.223 m<sup>3</sup>/s to 126 with an average annual flow of 15.2 m<sup>3</sup>/s (Environment Canada, 1982). Temperatures in the mainstem range from 0.5° to 19.0° C. Total dissolved solids (T.D.S.) measured in July were 27.95 p.p.m. For additional information on the Pallant system, note: Caw, 1978; Marshall, et.al., 1978; and Shepherd, 1978, 1982.

Four species of Pacific salmon are represented: sockeye (Oncorhynchus nerka), coho (O. kisutch), chum (O. keta) and pink salmon (O. gorbuscha). All are distributed in the lower 3.5 km downstream of the barrier, while kokanee or land-locked sockeye are found in Mosquito Lake. Average escapements over the 10 years preceeding 1977 were: sockeye - 50-90 (frequent observations of zero fish); coho - 3,900 (range 0-8,000); chum - 12,965 (range 150-35,000); pink - 44,470 (range 400-130,000) (Marshall et.al., 1978). Rainbow or steelhead trout (Salmo gairdnerii) and cutthroat trout (S. clarkii) are also represented, along with Dolly Varden char (Salvelinus malma), prickly sculpin (Cottus asper), three spine stickleback (Gasterosteus aculeatus), and lamprey (Lampetra sp.).

Rainbow trout (steelhead) occur only downstream of the Pallant Creek barrier. Almost no cutthroats are found below the falls, however an abundant population is found in Mosquito Lake and its tributaries. Dolly Varden char are distributed upstream (residents) and in good numbers downstream (anadromous) of the falls.

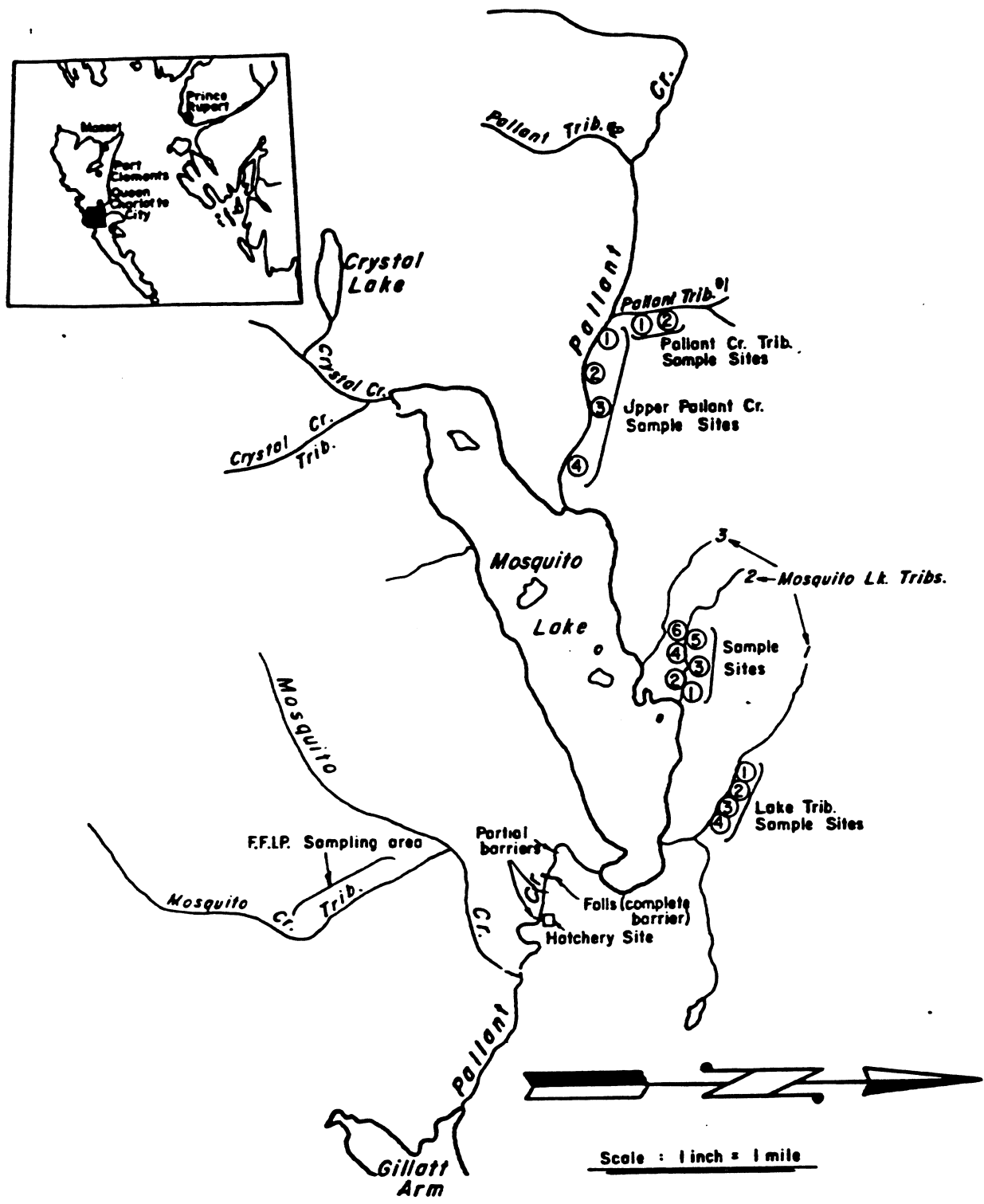


Fig. 1 PALLANT CREEK AND MOSQUITO LAKE SYSTEM

## METHODS

Stream and lake habitats were quantified from field measurements (July and January) and 1:50,000 topographical maps (for methods see deLeeuw, 1981). Fish were sampled by electrofishing, gillnets, fry traps and angling. More detailed information on and interpretation of fish and fish habitats sampled will be made available in a forthcoming report (deLeeuw, in prep.).

Average annual theoretical steelhead smolt yield was calculated by the following formulae (Slaney, 1980):

$S = H(N/.02)(T/9)$  where:

$N = .0049x + .0037$  where  $x = \text{TDS}$

$T = \text{ave. ann. stream temp. } ^\circ\text{C.}$

$H = .4(\text{Pr} + \text{Pg} + \text{Pp})$  where:

$\text{Pr} = (0.0029b + 0.0031c - 0.004) (\text{Ar}/\text{As}) = \text{Parr in riffles}$

$\text{Pg} = (0.107) (\text{Ag}/\text{As}) = \text{Parr in glides}$

$\text{Pp} = (0.064) (\text{Ap}/\text{As}) = \text{Parr in pools}$

$b = \% \text{ of wetted area of riffles comprised of protruding boulders greater than 30 cm diam.}$   
 $c = \% \text{ of wetted area of riffles comprised of over-stream cover, cutbanks, roots, debris, vegetation, etc.}$

$\text{Ag} = \text{area glide}$

$\text{Ap} = \text{area pool}$

$\text{As} = \text{area stream}$

$\text{Ar} = \text{area riffles}$

Following Marshall and Britton (1980), average annual coho smolt yield was calculated by  $S = 3.1 (A^{.7899})$ , where  $A = \text{stream area (m}^2\text{)}$ .

Extrapolations from electrofishing results were used to compute rough estimates of fish abundance.

## RESULTS AND DISCUSSION

### HABITAT

Downstream of the falls, 10,560 m of stream length are available to anadromous fish for spawning and rearing, with a total area during low summer flows of 76,183 m<sup>2</sup> (Table 1). This habitat is more or less evenly distributed between the mainstem Pallant (53.4%) and Mosquito Creek (46.6%). Upstream of the falls are located 12,710 m of stream length, or 53,475 m<sup>2</sup> of fluvial habitat. In total then, the Pallant Creek drainage contains 129, 640 m<sup>2</sup> of stream space. An additional 635 hectares of lake surface area (Mosquito Lake) and 16,670 m of lake shoreline are also available (Table 1).

### STEELHEAD RUN SIZE AND SPORT FISHERY

Steelhead enter Pallant Creek from September through May, with slight peaks in run size occurring in December and April. A "Schnabel and Schumacher" multiple catch and recapture population estimate (Ricker, 1975) during the 1980-81 winter season gave varying results of 364, 263 and 328, with an average of 318 steelhead. The estimated harvest on the Pallant during this time was 59 (Table 2), bringing the total run size to 377 steelhead. Recaptures were few, and over-estimation is likely.

Steelhead angler effort increased dramatically on the Pallant from 1966 to the present (Table 2). Prior to 1975, the average annual number of days fished was 29, while from 1975 to 1983 it rose to an average of 224 with a high of 382. The success rate, or catch/day was

Table 1. Summary of salmonid habitat in the Pallant Creek watershed.

Habitat	Length (m)	Pool (m <sup>2</sup> )	Glide (m <sup>2</sup> )	Riffle (m <sup>2</sup> )	% Log	Cover Boulder	Total Area m <sup>2</sup>
Pallant Creek (to falls)	3,456	1,517	9,680	29,487	40	40	40,684
Mosquito Creek	4,600	14,754		8,245	5	25	22,999
Mosquito Creek (tributary)	2,500	8,019		4,481	5	25	12,500
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Total Anadromous	10,565	24,290	9,680	42,213			76,183
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Pallant Creek (falls to lake)	818	354	2,263	6,893	20	30	9,510
Upper Pallant	6,400	17,279	11,199	3,200	5	5	31,678
Upper Pallant (tributary #1)	800	264	386	255			875
Upper Pallant (tributary #2)	700	231	338	198			765
Crystal Creek	800	2,566		1,434	5	25	4,000
Crystal Creek (tributary)	800	2,566		1,434	5	25	4,000
Mosquito Lake tributaries							
Tributary #1	1,200	393	579	339			1,314
Tributary #2	800	264	386	225			875
Tributary #3	400	132	193	113			438
Total Non-Anadromous	12,710	24,052	15,344	14,061			53,457
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Total Stream	23,272	49,392	25,024	56,274			129,640
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Mosquito Lake	16,670 (perimeter)						635 ha.

Table 2. Pallant Creek steelhead harvest analysis, 1970-71 to 1982-83.

Season	Days Fished	No. of Anglers	Kept	Released	Kept/Day	Catch/Day	Charlottes' Catch/Day
70-71	8	4	8	20	1.00	3.50	.36
71-72	10	3	21	25	2.00	4.60	.52
72-73	89	12	45	86	.50	1.47	.31
73-74	26	3	26	34	1.00	2.22	.33
74-75	10	3	7	0	.67	.67	.27
75-76	73	30	23	40	.32	.86	.47
76-77	107	46	47	20	.45	.65	.37
77-78	74	30	48	92	.64	1.86	.48
78-79	177	42	35	26	.21	.38	.41
79-80	236	50	36	86	.16	.53	.48
80-81	382	53	59	709	.16	1.96	.79
81-82	227	66	47	190	.22	1.05	.93
82-83	293	50	17	511	.10	1.92	1.23
Average) Last 10) Years)	150	37	34	170	.39	1.21	.58

consistently better for this stream (average over past 10 years, 1.2), than it was for the entire Queen Charlotte Islands as a whole (0.5).

#### STEELHEAD PRODUCTION POTENTIAL

Applying Slaney's model to the habitat, a theoretical yield of 267 adult steelhead was calculated for the area below, and a possible 131 for the area upstream of the falls (Table 3). This could be accomplished by ensuring adequate natural escapements downstream of the falls and releases of hatchery-reared fry throughout the upper watershed. In the upper Pallant, upstream of Mosquito Lake, an output of 630 smolts (79 adults) could be obtained by stocking 8,000 fry (fry to smolt survival = 8%). A total of 14,000 fry could be planted in all upstream tributaries to realize the full potential of 1,113 smolts (Table 3). Steelhead fry releases to date are summarized in Appendix 3.

In addition to enhancement of steelhead through fry plants, habitat improvement opportunities exist on the mainstem Pallant downstream of the falls. Further investigations are necessary to clearly identify these options.

#### DOLLY VARDEN CHAR ESTIMATED POPULATION SIZE AND FISHERY

Based on juvenile densities sampled throughout the watershed, a rough population estimate was calculated for Dolly Varden. Below the falls, the anadromous adult char run was estimated to range from about 500 to 2,000 fish, while in the lake the resident char population was

Table 3. Theoretical<sup>1</sup> Adult Steelhead Production in Pallant Creek Watershed.

Stream	Total Area	% G	% P	% R	Cover <sub>c</sub> (Log)	% Riffles <sub>b</sub> (Boulders)	Ns	X	T	P <sub>Ri</sub>	P <sub>G</sub>	P <sub>P</sub>	H <sub>s</sub>	Total Smolts	Adults <sup>2</sup>
							$\frac{.02}{9}$								
Pallant Cr. (to falls)	40,684	24	4	72	30	40	.6372	.148	.026	.003	.071			1,840	202
Mosquito Cr.	22,999	0	64	36	5	25	.588	.030		.041	.0284			384	42
Mosquito Cr. Tr.	12,500	0	64	36	5	25	.588	.030		.041	.0284			209	23
														2,433	267
Total Anadromous															
Pallant Cr. (falls to lake)	9,510	24	4	72	20	35	.6372	.15	.026	.003	.0576			349	38
Upper Pallant	31,678	55	35	10	5	5	.588	.002	.059	.023	.034			630	79
Upper Pallant, Trib 1	Primarily cutthroat habitat														
Upper Pallant, Trib 2	Primarily cutthroat habitat														
Crystal Creek	4,000	0	64	36	5	25	.588	.030		.041	.0284			67	7
Crystal Creek Trib	4,000	0	64	36	5	25	.588	.030		.041	.0284			67	7
Mosquito Lk Trib 1	Primarily Cutthroat habitat														
Mosquito Lk Trib 2	Primarily Cutthroat habitat														
Mosquito Lk Trib 3	Primarily cutthroat habitat														
														1,113	131
Total Non-Anadromous															
															398
Grand Total															

<sup>1</sup> Slaney Model (see methods).

<sup>2</sup> Adults from smolts  $S(.1) (1.1)$ ; where 1.1 repeat spawner rate of 10%.

estimated to be considerably smaller, ranging from about 250 to 350 fish (Table 4). Repeat spawner rate is not known, but assumed to be about 26% (Armstrong, 1974).

The small sport fishery for anadromous char occurs during early summer. Very few resident Dolly Varden are angled in the lake, possibly because this fishery targets primarily on cutthroats. In lakes, the latter are generally found on the surface, whereas Dolly Varden char frequent deeper areas, thus evading the cutthroat angler (Andrusak and Northcote, 1970).

#### CUTTHROAT TROUT ESTIMATED POPULATION SIZE AND FISHERY

Since very few anadromous cutthroats occur in Pallant Creek below the falls (none sampled), this discussion will be limited to Mosquito Lake. The resident cutthroat trout population in Mosquito Lake was roughly estimated to range from about 1,400 to 3,000 adult fish (Table 5). This calculation is perhaps an underestimate (assuming the survival values to be within acceptable range), since the prespawning age group ("smolts") were not included. These are also present in the lake, and available to the fishery.

Juvenile cutthroat densities in the small tributaries of the north shore of Mosquito Lake were greater than twice those encountered in upper Pallant Creek, a larger stream. In the former, average fry and parr densities were 2.09 and  $.36/m^2$ , respectively, while in the latter, densities were  $.92$  and  $.15/m^2$  for fry and parr, respectively (Appendix 2). Recognition of the importance of these small tributaries and the maintenance of their high juvenile trout densities is paramount to

Table 4. Theoretical adult Dolly Varden char production in Pallant Creek, based on sampled juvenile densities.

Stream	Area	0+/m <sup>2</sup>	Parr/m <sup>2</sup>	Total 0+	Total Parr	Adults from 0+ fry <sup>1</sup>	Adults from Parr <sup>1</sup>
Pallant Creek	40,684	.52	.23	21,156	9,357	279	1,029
Mosquito Creek	22,999	.52	.23	11,959	5,290	158	582
Mosquito Creek Trib	12,500	.52	.23	5,850	2,875	77	316
Total Anadromous	76,183	.52	.23	38,965	17,522	514	1,929
Pallant Creek (Falls to Lake)	9,510	.48	.04	4,565	380	60	42
Upper Pallant	31,678	.48		15,205	1,267	201	139
Upper Pallant Tributary 1	875	.48	.04	420	35	6	4
Upper Pallant Tributary 2	767	.48	.04	368	31	5	3
Crystal Creek	4,000	.48	.04	1,920	160	25	18
Crystal Creek Trib	4,000	.48	.04	1,920	160	25	18
Mosquito Lake Tributary 1	1,314	.48	.04	631	63	8	6
Mosquito Lake Tributary 2	875	.48	.04	420	35	6	4
Mosquito Lake Tributary 3	438	.48	.04	210	18	3	2
Total Resident	53,475	.48	.04	25,659	2,138	339	235

<sup>1</sup>Survival rates: 0<sup>+</sup> to Parr = .12; Parr to Smolt = .44; Smolt to Adult = .25 (Slaney, 1979)

Table 5. Theoretical adult cutthroat trout production in Mosquito Lake, based on sampled juvenile densities.

Stream	Area m <sup>2</sup>	O+/m <sup>2</sup>	Par/m <sup>2</sup>	Total O <sup>+</sup>	Total Parr	Adults from O <sup>+</sup>	Adults from Parr <sup>1</sup>
Pallant Creek							
Mosquito Creek							
Mosquito Creek Tributary							
Total Anadromous						100 est.	100 est.
Pallant Creek (falls to Upper Pallant)	9,510	.92	.15	8,749	1,427	306	143
Upper Pallant, Trib 1	31,678	.92	.15	29,143	4,752	1,020	475
Upper Pallant, Trib 2	875	.92	.15	805	131	28	13
Upper Pallant, Trib 2	767	.92	.15	706	115	25	12
Crystal Creek	4,000	.92	.15	3,680	600	129	60
Crystal Creek Tributary	4,000	.92	.15	3,680	600	129	60
Mosquito Lake Tributary <sup>1</sup>	1,314	.92	.15	1,209	197	42	20
Mosquito Lake Tributary <sup>2</sup>	875	.92	.15	805	131	28	13
Mosquito Lake Tributary <sup>3</sup>	438	.92	.15	403	66	14	7
Total Resident	53,475	.92	.15	49,180	8,019	1,721	802
Total lake population:	<u>1st spawners</u>	<u>2nd spawners<sup>2</sup></u>	<u>3rd spawners<sup>2</sup></u>	<u>Total</u>			
From O <sup>+</sup>	1,721	861	430	3,012			
From Parr	802	401	200	1,403			

<sup>1</sup>Survival rates: O<sup>+</sup> to smolt .14; Parr to smolt - .40; smolt to adult .25 (Wood, 1978); Slaney (1979).

<sup>2</sup>First return to 2nd return, 50%; (Johnston, 1978) (adapted from anadromous cutthroat). 2nd return to 3rd return, 50%.

sustaining Mosquito Lake resident cutthroat populations.

Of the three readily accessible large lakes on the Queen Charlotte Islands, Mosquito Lake is best known for its excellent cutthroat fishery, both in terms of angler success and size of fish. Over the past 9 years, angler success during an annual fishing derby ranged from .64 to 1.91 fish per day (Table 6). The largest derby-caught cutthroat weighed in at 2.75 kg.

Table 6. Mosquito Lake trout harvest analysis (Sandspit Rod and Gun Club Trout Derby Days).

Year	Date	Largest Fish (kg.)	Total Catch	Total Entries (Angler Days)	Catch/ Angler Day
1974	June 30	.94 (2 lbs. 1 oz.)	--	--	--
1975	July 20	.99 (2 lbs. 3 oz.)	32	50	.64
1976	June 20	1.47 (3 lbs. 4 oz.)	49	59	.83
1977	June 19	1.13 (2 lbs. 8 oz.)	100	85	1.76
1978	June	1.05 (2 lbs. 5 oz.)	--	--	--
1979	June 24	1.28 (2 lbs.13 oz.)	17	74	.23
1980	June 22	1.05 (2 lbs. 5 oz.)	30	30	1.00
1981	May 31	1.50 (3 lbs. 5 oz.)	54	94	.57
1982	--	1.70 (3 lbs.12 oz.)	--	56	--
1983	May 29	2.75 (6 lbs. 1 oz.)	84	44	1.91

## COHO SALMON, EXISTING AND POTENTIAL POPULATION SIZE

Natural adult coho production below the falls was calculated at either 1,000 (933) or 4,100 (4,133) fish, depending on which estimation method was used (Table 7). These results are within the expected range, since Pallant Creek coho escapements have averaged 3,900 during the 10 years preceeding 1977 (Marshall, et.al., 1978). The formula ( $S=3.1 A^{.7899}$ ) provided by Marshall and Britton (1980) is likely more applicable for calculating adult numbers than is extrapolating from sampled fry densities, since results of this model for the Pallant (4,100) most closely approximate average observed escapements (3,900).

Coho production from the area above the falls would theoretically increase the total coho run by about 3,500 fish. The combined total estimate of 7,600 (4,100 + 3,500) closely approximates adult coho escapements in 2 other nearby lake-headed systems: Copper and Mathers Creeks. Both Skidegate Lake (Copper Creek) and Mathers Lake (Mathers Creek) are accessible to coho. Escapements from 1967 to 1977 in Copper Creek (drainage area 16,524 hectares) and Mathers Creek (drainage area 8,158 hectares) have averaged 10,000 and 7,063 coho respectively.

Coho fry plants in the upper Pallant system to date are summarized in Appendix 3.

## MANAGEMENT OBJECTIVES

All freshwater fishes and anadromous trout in B.C. are managed by the Ministry of the Environment (Fisheries Branch) of the provincial government. The goal of fisheries management in B.C. is to produce

Table 7. Theoretical adult coho production in Pallant Creek, based on sampled fry densities (Appendix 1) and Marshall and Britton (1980).

Stream	Total Area (m <sup>2</sup> )	Total Fry <sup>1</sup>	Total Smolt (8% of Fry)	Adults (15% of smolts)	Total Smolt <sup>3</sup>	Adult <sup>4</sup>
Pallant Cr.	40,684	41,498	3,320	498	13,563	2,035
Mosquito Cr.	22,999	23,459	1,877	282	8,643	1,297
Mosquito Tr.	12,500	12,750	1,020	153	5,340	801
Total Anadromous	76,183	77,707	6,217	933	27,546	4,133
Pallant Cr. (falls to lake)	9,510	9,700	776	116	4,303	645
Upper pallant	31,678	32,312	2,585	388	11,130	1,670
Upper pallant Trib 1	875	893	71	11	654	98
Upper pallant Trib 2	767	782	63	10	589	88
Crystal Cr.	4,000	4,080	326	49	2,171	326
Crystal Cr. Trib	4,000	4,080	326	49	2,171	326
Mosquito Lake Trib 1						
Mosquito Lake Trib 2	1,314	1,340	107	16	901	135
Mosquito Lake Trib 3	875	893	71	11	654	98
	438	447	38	5	378	57
Mosquito Lake Shore Length	16,670 m	9,169 <sup>2</sup>	734	110		
Total NonAnadromous		63,696	5,096	765	22,951	3,443

<sup>1</sup>Average coho fry density in Mosquito Creek 1.02/m<sup>2</sup> (Appendix 1).

<sup>2</sup>Fry density per meter of lake shore - .55/m (from Mason, 1974).

<sup>3</sup>Marshall and Britton, 1980.

<sup>4</sup>Marshall and Britton, 1980.

maximum economic, cultural, recreational and scientific benefits for present and future generations of British Columbians by:

- a) maintaining all native and desirable introduced species of fish at optimum levels of distribution, abundance and health, and protecting, or enhancing essential freshwater habitat; and
- b) providing an equitable distribution of opportunities for a wide variety of socially acceptable uses of fish by all segments of society.

Angling is an important activity on the Charlottes, with up to 45% of the eligible population (i.e., between the ages of 15-64) annually purchasing non-tidal angling licenses (Table 8). Fresh water angler use in general, but of the Pallant and Mosquito systems in particular, is expected to increase substantially over the next decade or two. Therefore, management objective for Pallant creek are as follows:

1. Maintain optimum population size, diversity and genetic integrity of steelhead, cutthroat trout and Dolly Varden char of Pallant Creek and Mosquito Lake;
2. Allow a sports harvest of the above species consistent with providing adequate escapements to optimally repopulate the system.

#### MANAGEMENT STRATEGIES

##### Steelhead:

A maximum of 54 steelhead can be harvested from Pallant Creek (i.e. 20% of 267 = 54). Should this figure be exceeded on a regular basis as indicated through steelhead harvest Questionnaire returns, regulations

Table 8. Population of the Queen Charlotte Islands, historic and future (Statistics Canada 1981) and angling licences sold (Fish & Wildlife, 1961-82)

Year	Total Population	Population Between age 16 and 64	No. Sold	Resident Angling License % of Eligible Population (16-64)
ACTUAL				
1961	3,014			
1966	3,739			
1971	4,352	2,630		
1976	5,509	3,545	1,182	34%
1981	5,621	3,790	1,657	45%
1984	5,713	3,872	1,529	39.5% <sup>1</sup>
ESTIMATED				
1985	5,780	3,919	1,548	39.5%
1986	5,872	3,982	1,573	39.5%
1987	5,991	4,069	1,607	39.5%
1988	6,133	4,170	1,647	39.5%
1989	6,295	4,287	1,693	39.5%
1990	6,473	4,412	1,743	39.5%
1991	6,660	4,544	1,795	39.5%
1996	7,681	5,262	2,078	39.5%
2001	8,778	6,169	2,437	39.5%
2006	9,880	6,995	2,763	39.5%

<sup>1</sup>39.5% is average for 1976 and 1981; then applied to years 1984 to 2006.

designed to reduce steelhead harvest (kill) will be applied. These will include reductions in bag limits with the ultimate being catch and release only, during parts of, or for the entire season. A substantial and continued reduction in the angler success rate will also necessitate implementation of the above.

The earliest steelhead enter the Pallant with chum salmon during September and October. Incidental catch of steelhead in the commercial net fishery in Cumshewa Inlet is therefore a distinct possibility. Regulations aimed at reducing the sport harvest of early returning steelhead can also be implemented should the incidental catch of these fish prove substantial.

Spawning of resident cutthroat and anadromous steelhead overlap temporally. On the Pallant, they are segregated geographically by the falls. Steelhead and cutthroat can successfully hybridize (given the opportunity) since sterility barriers do not exist between western *Salmo* species (Behnke, 1979). Removal of the falls would therefore effectively break down the existing segregation between the two species. Steelhead juveniles furthermore will often residualize in large lakes, becoming sexually mature at a much reduced size without a marine migration phase. In view of the above two points (genetic segregation and smolt residualism) it is suggested that the Pallant Creek falls remain intact, and that stocking of steelhead fry above the falls into the upper mainstem Pallant and Mosquito Lake tributaries be discontinued. Considering the better than average steelhead fishery of Pallant Creek, enhancement of

this species is not a requirement at this time. Should this become a priority in the future, enhancement will be confined to the lower reaches.

Cutthroat:

The impact of angling on Mosquito Lake cutthroats is considered minimal. Success rates (catch/day) have been variable; i.e., a steady declining trend in either total catch or catch/day is not apparent (Table 6). The existing regulation of five fish/day of any size, adequately protects Mosquito Lake cutthroats at this time. More stringent regulations may be implemented, should this situation change.

As discussed previously, genetic integrity of resident cutthroats can be sustained by leaving the physical barrier (falls) in place, and discontinuing the stocking of steelhead fry in lake tributaries.

In addition to anglers' catches and steelhead-cutthroat hybridization, releasing coho fry in non-anadromous nursery areas often results in considerable reductions of resident cutthroat populations. Juvenile cutthroat trout were found throughout Mosquito Lake tributaries, although the highest cutthroat densities were encountered in several small streams flowing into the north shore where coho fry releases occurred only once. On the other hand, in the upper Pallant where coho had been stocked for three consecutive years, the lowest juvenile cutthroat densities were observed. Whether high juvenile cutthroat use is attributable to a lack of coho fry presence in these small streams (only one year of coho fry releases), or to some habitat specific criterion is not clear.

As a result of these and additional findings (Glova, 1978; Glova and Mason, 1977a, 1977b; Tripp and McCart, 1983), it is suggested these small lake tributaries be allocated for the exclusive use of resident Mosquito Lake cutthroat. Falls removal would negate this latter option.

Juvenile coho densities sampled in Mosquito Creek were highly variable, but averaged 1.02 fry/nt<sup>2</sup> (Appendix 1). Assuming these results reflect natural juvenile coho populations, it is recommended fry be released at this density in the mainstem and upper Pallant Creek (i.e., above falls, and tributary to lake).

The interactions between juvenile resident cutthroat and naturally occurring or stocked coho fry in lakes vis-a-vis competition for food and space are not known. The average density of coho fry observed in Great Central Lake on Vancouver Island was .55 fry per linear meter of lake shoreline (Mason, 1974). This lake contains both coho and cutthroats. In view of the above discussion, the following coho fry stocking strategy for Mosquito Lake is suggested:

<u>Stocking Location</u>	<u>Habitat Dimension</u>	<u>Density</u>	<u>Number of Fry</u>
Pallant mainstem (from falls to lake)	9,510 m <sup>2</sup>	1.02/m <sup>2</sup>	9,700
Upper Pallant	31,678 m <sup>2</sup>	1.02/m <sup>2</sup>	32,312
Lake shore	16,670 m	.55/m	9,169
Total			51,181

Transporting mature Pallant Creek coho into Mosquito Lake on an annual basis for the purpose of naturally colonizing tributary streams should not be considered.

### Dolly Varden Char:

The Pallant Creek and Mosquito Lake char populations are considered healthy, and no additional regulations in the fishery are required.

### CONCLUSIONS

As a consequence of provincial and federal salmonid enhancement activities on the Pallant Creek – Mosquito Lake system, two conflicts have been identified. These include:

1. The possibility of cutthroat-rainbow (steelhead) hybridization; and
2. The reduction of the resident cutthroat population and its associated sport fishery incurred through the introduction of coho fry to cutthroat nursery areas.

In order to maintain genetic isolation between resident and anadromous trout stocks, and to minimize impacts on the resident cutthroat population, it is recommended that:

1. The Pallant Creek falls remain a complete barrier to anadromous salmonids.
2. All steelhead enhancement efforts be limited to areas downstream of the falls.
3. The distribution of coho fry above the falls be limited to the upper Pallant (average maximum density of 1.02 fry/rn<sup>2</sup>, or a total of 32,312 fry), the Pallant mainstem upstream of falls (1.02 fry/m<sup>2</sup> total of 9,700 fry), and the lake shoreline (.55 fry/linear meter, total of 9,169 fry), for a maximum total coho fry population of about 50,000.
4. Other than the upper Pallant, all other Mosquito Lake tributaries are to be retained for the production of resident trout and char stocks.

## SUMMARY

1. The Mosquito Lake-Pallant Creek system supports sport fisheries for lake-resident cutthroat trout, plus steelhead, Dolly Varden char and coho salmon. It also supports considerable numbers of commercially valuable chum and pink salmon.

2. A federal hatchery was constructed on Pallant Creek in 1978 primarily to enhance chum, and to a lesser extent coho salmon. Enhancement of the latter was seen as a stock maintenance exercise, since increased incidental harvest of unenhanced coho during the commercial net fishery for enhanced chums was considered possible.

3. Downstream of the falls on Pallant Creek, 76,183 in<sup>2</sup> of stream habitat is available for spawning and rearing salmonids. Upstream of this barrier are located an additional 53,475 in<sup>2</sup> of stream space plus the 635 hectare Mosquito Lake.

4. Average steelhead run size is estimated to be 267 fish, allowing for an annual maximum harvest of 20%, or 54 fish. This figure was exceeded during the 1980-81 season, when 59 fish were taken. The average kill of steelhead in general, however, has been well below the 20% level. Upstream tributary utilization (ie, blasting falls or fry stocking) would increase the run by 131 fish. Enhancement and/or increased regulation are not required at this time.

5. An estimated adult anadromous Dolly Varden char run of from 500 to 2,000 utilizes the lower Pallant, while the resident Mosquito Lake population is estimated to range from 250 to 350 fish. Enhancement is not a requirement, and existing regulations adequately protect the Pallant Creek-Mosquito Lake char population.

6. The resident Mosquito Lake cutthroat trout population is estimated to range from about 1,400 to 3,000 fish. This estimate excludes the prespawning age group, which is also available to the fishery. Juvenile cutthroat were found in high densities in several small, north shore tributaries to Mosquito Lake. Upper Pallant Creek, a larger tributary, contained low juvenile cutthroat densities. Relative to the fishery, existing regulations adequately protect the Mosquito Lake cutthroats. Enhancement is not required.

7. Coho escapements to Pallant Creek have averaged 3,900 during the ten years preceeding 1977. Based on sampled fry densities and a smolt estimation model, adult run size was estimated to range from 933 to 4,133 coho salmon below the falls. An increase in coho abundance of 83% is predicted, should all Mosquito Lake tributaries be utilized to their optimum coho production potential.

8. In order to reduce impacts of coho enhancement on cutthroats, and to maintain genetic isolation between resident and anadromous trout and char stocks, it is recommended that the Pallant Creek falls remain intact, steelhead enhancement upstream of these falls cease, and that Mosquito Lake coho enhancement be limited to the distribution of 50,000 fry into specific tributary and lake shore areas.

## ACKNOWLEDGEMENTS

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## APPENDICES

- I. Mosquito Creek, fish sampled by F.F.I.P.
- II. Mosquito Lake tributaries, fish sampled, July 1983.
- III. Pallant Creek steelhead and coho fry releases.
- IV. Provincial fisheries regulations pertaining to Pallant creek from 1975-76 to 1984-85.

Appendix I. Mosquito Creek, fish sampled by F.F.I.P.

Date	Area m <sup>2</sup>	Coho				Dolly Varden char				Rainbow trout			
		O <sup>+</sup> N	N/m <sup>2</sup>	1 <sup>+</sup> N	N/m <sup>2</sup>	0 <sup>+</sup> N	N/m <sup>2</sup>	1 <sup>+</sup> N	N/m <sup>2</sup>	0 <sup>+</sup> N	N/m <sup>2</sup>	Parr N	N/m <sup>2</sup>
July 22/82	48	54	1.13	20	.42	27	.56	15	.31				
July 22/82	55	79	1.44	1	.02	9	.16	0	0				
July 22/82	60	70	1.17	11	.18	14	.23	14	.23				
July 22/82	95	13	.13	2	.02	7	.07	15	.16				
July 22/82	55	39	.71	4	.07	3	.05	10	.18				
July 22/82	28	19	.68	6	.21	15	.54	11	.39				
Total ( $\bar{x}$ )	341	274	(.80)	44	(.13)	75	(.22)	65	(.19)				
Sept 27/82	40	73	1.83	15	.38	71	1.78	34	.85			1	.03
Sept 27/82	30	6	.20	0	0	33	1.01	2	.06				
Sept 27/82	16	13	.80	0	0	16	1.00	3	.19				
Sept 27/82	48	101	2.10	5	.10	49	1.02	4	.08				
Total ( $\bar{x}$ )	134	193	(1.44)	20	(.15)	169	(.88)	43	(.32)				
Total ( $\bar{x}$ )	475	467	(1.02)	64	(.13)	244	(.52)	107	(.23)				

Appendix II. Mosquito Lake tributaries, fish sampled, July 1983.

Site	Area m <sup>2</sup>	Coho		Dolly Varden				Cutthroat			SteeTheed			
		N	0+ N/m <sup>2</sup>	N	0+ N/m <sup>2</sup>	N	0+ N/m <sup>2</sup>	N	0+ N/m <sup>2</sup>	Parr N	N	0+ N/m <sup>2</sup>	Parr N	N/m <sup>2</sup>
Lake Trib #1 Site #1	21.3	106	4.98	0	0	0	0	52	2.44	7	.33	None	Stocked	
Lake Trib #1 Site #2	19.4	10	.52	0	0	0	0	57	2.94	3	.15		"	
Lake Trib #1 Site #3	21.0	8	.38	0	0	0	0	53	2.52	7	.33		"	
Lake Trib #1 Site #4	7.5	40	5.33	0	0	0	0	1	.13	2	.27		"	
Total	69.2	164	2.37	0	0	0	0	163	2.36	19	.27		"	
Lake Trib #2 Site #1	15.5	2	.13	9	.58	1	.06	36	2.32	5	.32		"	
Lake Trib #2 Site #2	5.0	3	.6	3	.60	9	1.80	9	1.80	2	.40		"	
Lake Trib #2 Site #3	9.75	6	.62	1	.10	2	.21	24	2.46	4	.40		"	
Lake Trib #2 Site #4	10.25	30	2.93	0	0	3	.29	16	1.56	8	.78		"	
Lake Trib #2 Site #5	10.00	22	2.20	1	.01	3	.30	18	1.80	4	.40		"	
Lake Trib #2 Site #6	10.75	14	1.30	0	0	0	0	24	2.23	3	.28		"	
Total	51.25	77	1.26	14	.23	9	.15	127	2.70	26	.42		"	
Upper Pallant Trib #1	7.2	0	0	13	1.81	0	0	8	1.11	4	.56		"	
Upper Pallant Trib #2	5.5	0	0	2	.36	0	0	1	.18	2	.36		"	
Total	12.7	0	0	15	1.18	0	0	9	.71	6	.47		"	
Total Small Tribe	143.2	241	1.68	29	.20	0	.06	299	2.09	51	.36		"	
Upper Pallant Site #1	75.0	88	1.17	1	.01	6	.08	8	.11	10	.13	144	1.92	0 0
Upper Pallant Site #2	18.0	22	1.22	1	.06	0	0	14	.78	0	0	6	.33	0 0
Upper Pallant Site #3	76.0	37	.49	160	2.11	0	0	34	.45	0	0	54	.71	1 .01
Upper Pallant Site #4	84.5	140	1.66	0	0	0	0	11	.13	0	0	5	.06	0 .01
Total	253.5	287	1.13	162	.64	6	.02	67	.26	10	.04	209	.82	1 .004
Grand Total	396.7	528	1.33	191	.48	15	.04	366	.92	61	.15	N/A	N/A	N/A N/A

Appendix III. Pallant Creek steelhead and coho fry releases.

Nov 18/83 Brood Year	Major Group	# Eggs Taken	# Fry Ponded	Date Released	Steelhead Release Site	Release Size(grn)	Tag Code or Mark	# Ad+Cwt or Marked	# Incompl. Marks	# Released	Comments
1982		10,410	6,001	82/07/22-23	Up. Pall.	1.6	R. Max	4,174		5,128	
1983		24,303	19,456	82/07/14	Up. Pall.	1.5	None	0		7,200	
				82/07/14	Pallant	1.5	None	0		<u>8,258</u>	
										15,458	

Nov 17/83					Coho						
Brood year	Major Group	# Eggs Taken	# Fry Ponded	Date Released	Release Site	Release Size(grn)	Tag Code or Mark	# Ad+Cwt or Marked	# Incompl. Marks	# Released	Comments
1978	Hart	23,643	19,000	79/07/04	Hart Cr.	2.6					
1979	Pallant	9,581	9,168	80/05/28	Pallant	1.7	None	0		18,817	
1980	Pallant	91,067	81,501	81/06/23	Pallant	5.2	None	0		9,120	
				81/06/29	Up. Pall.	4.6	022220	39,643	1,200	40,483	1
							022221	31,587	800	<u>32,387</u>	2
										72,870	
1981	Pallant	223,901	199,732	82/06/24-26	Mosq. Lk.	4.9	022402	31,282	557	68,023	
				82/06/22-24	Mosq. Cr.	2.9	None	0		32,699	
				82/06/25-27	Pallant	3.5	None	0		45,574	3
				82/06/21-26	Up. Pall.	3.2	None	0		<u>46,574</u>	
										192,857	
1982	Pallant	459,817	486,044	83/06/1-22	Up. Pall.	4.5	022535	47,951	3,776	59,727	
				83/05/26 -	Up. Pall.	2.9	None	0		124,384	
				83/06/10					4,588	98,751	
				83/05/30 -	Pallant	4.0	022449	48,143			
				83/06/21					307	26,968	
				83/06/21-22	Mosq. Lk.	5.2	022403	15,475		<u>138,143</u>	
				83/06/2-10	Mosq. Lk.	3.1	None	0		447,973	

Comments:

1. Fry released in Pallant mainstem above falls.
2. Includes 1025 fry also marked with a RV clip.
3. 15,571 fry released in Pallant mainstem above falls.

Appendix IV. Provincial Fisheries regulations pertaining to  
Pallant Creek from 1975-76 to 1984-85.

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1974-75 40 steelhead/year; trout over 50 cm. - 2/day, 6  
possession; total trout and char 8/day, possession 16.

1975-76 Same as above.

1976-77 40 steelhead/year; trout over 50 cm. - 2/day, 4  
possession; total trout and char 8/day, possession 16;  
minimum size 20 an., streams only.

1977-78 20 steelhead/year, no more than 10 steelhead from any  
specific stream; total trout over 50 cm. - 2/day,  
possession 4; total all trout and char, 8/day, 16  
possession; minimum size 20 cm., streams only.

1978-79 Same as above.

1979-80 Same as Above.

1980-81 Same as above.

1981-82 10 steelhead/year, no more than 5 from any Queen  
Charlotte stream; trout and char over 50 cm. 2/day,  
possession of 4; aggregate all trout and char 5/day,  
possession of 10; minimum size, 25 c., streams only; (1)  
angling closure below signs located 100 m. above Pallant  
Creek fence, Aug. 1 to Oct. 31; (2) single hook.

1982-83 Same as above.

1983-84 Same as above, steelhead, 1/day, possession 2; single  
hook, all Queen Charlotte Island streams Aug. 15 - Nov.  
15; (single hook restriction specific to Pallant  
removed.)

1984-85 Same as above; single hook all Queen Charlotte Island  
streams.