Paul Stan

Biological Reconnaissance of Mathers and Pallant Creeks to December, 1977

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Paul Starr

FISHERIES AND MARINE SERVICE

MANUSCRIPT REPORT NO. 1450

July, 1978

BIOLOGICAL RECONNAISSANCE OF MATHERS AND PALLANT CREEKS TO DECEMBER, 1977

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ABSTRACT

Together with relevant background data, the results of Salmon Enhancement Program studies of the water quality and chum spawning populations of Pallant and Mathers Creeks from August to December, 1977, are presented. A wide range of water quality parameters were sampled for, and most were within an acceptable range for fish culture facilities. Suspended solids loadings indicated potential problems for Mathers Creek. Substrate inventories were made of most of both systems, and predicted potentials were verified by subsequent spawner distribution in Pallant Creek. Timings, distributions, and abundances of chum spawners were estimated using temporary counting fences and aerial and walking surveys. Spawner characteristics, as determined by live and dead sampling of 469 chums at Pallant and 37 chums at Mathers, consisted of the following (Pallant value, followed by Mathers value): sex ratios of 49 percent and 35 percent males; ages of 2 to 5 years, with 64 percent and 82 percent 4's and 35 percent and 12 percent 3's; average hypural lengths of 570 and 603 mm for males and 561 and 578 mm for females; average fecundities of 2732 and 2919 eggs; and egg retentions of 2.3 percent and 1.5 percent. The combined regression equation of fork length (FL) to hypural length (HL) was HL = 0.89 FL - 56, and of fecundity (F) to hypural length was F = 10.97 HL - 3422. A program outline for 1978 is included.

RÉSUMÉ

Nous présentons les résultats des études de la qualité de l'eau et des populations de géniteurs de saumon kéta dans les ruisseaux Pallant et Mathers, réalisés de août à décembre 1977 dans le cadre du programme de mise en valeur du saumon, en même temps que les données de base pertinentes. De nombreux paramètres de la qualité de l'eau ont été analysés et se sont avérés, pour la plupart, propices aux installations de pisciculture. Les matierès en suspension du ruisseau Mathers risquent de poser un problème. Des inventaires des substrats ont été faits sur la plus grande partie des deux ruisseaux et les possibilités prévisibles ont été vérifiées par une analyse ultérieure de la répartition des reproducteurs dans le ruisseau Pallant. Le moment du frai et la répartition et l'abondance des kétas reproducteurs ont été évalués à l'aide de barrières de comptage temporaires et d'inventaires aériens ou sur place. Les paramètres déterminés respectivement sur 469 et 37 fraiyeur vivants du morts des ruisseaux Pallant et Mathers se présentaient comme suit (valeurs du ruisseau Pallant suivies des valeurs du ruisseau Mathers): 49 et 35% de mâles; chez les saumons de 2 à 5 ans, 64 et 82% ont 4 ans et 35 et 12% ont 3 ans; longeurs aux hypuraux de 570 et 603 mm chez les mâles, et 561 et 578 mm chez les femelles; fécondité moyenne de 2732 et de 2919 oeufs; rétention des oeufs de 2,3 et de 1,5%. L'équation combinée de régression de la longueur aux hypuraux (LH) en fonction de celle à la fourche (LF) est: LH = 0,89 LF - 56, et celle de la fécondité (F) en fonction de LH est: F = 10,97 LH - 3422. Un résumé du programme de 1978 est inclus.

INTRODUCTION

This report provides preliminary analyses of the first calendar year's biological reconnaissance data collected on two chum salmon spawning creeks of the Queen Charlotte Islands (Fig. 1). Within the Salmonid Enhancement Program, the northern coast of British Columbia was given development priority on the basis of sociological considerations. Pallant and Mathers Creeks were selected for investigation by the Enhancement Services Branch upon the recommendation of management staff, who had identified these two creeks as most amenable to enhancement of chum salmon. The following considerations resulted in their selection:

(1) A sub-goal of the Salmon Enhancement Program is to expand the fishing season in time. Historically, the chum fishery in the Queen Charlotte Islands has been relatively late for the north coast (Fig. 2), and thus increased effort there would aid in extending the season.

(2) Fisheries Statistical Area 1 was eliminated, due to poor accessibility and low natural utilization of the area by chum salmon (1970-75 chum stocks averaged 70,500 in Area 1, 156,800 in Area 2W, and 474,300 in Area 2E). The only portion of Area 2W which was accessible and had an existing chum fishery was Skidegate Channel. Unfortunately, the chum spawning in Skidegate was scattered in several small streams; the most likely candidate, Tarundl Creek, was found to have unacceptable low flows and freezing problems. In Area 2E, only Cumshewa Inlet offered both access and an existing local fishery.

(3) To manage enhanced stocks effectively, it is important that the fishery occurs in a well-defined geographic location, with no significant mixing of unenhanced stocks, and that interception of the enhanced stock is minimal in other fisheries. Chum salmon, which are taken mainly in inside passages and inlets near their spawning stream (Aro and Shepard, 1967), are in general very suitable in this respect. Although information is limited regarding the migration routes of Queen Charlotte chum salmon, Cumshewa Inlet chums appear to approach either from the west through Skidegate Channel, or from the south through Selwyn Inlet and Louise Narrows (Fig. 1), and thus experience little interception, except for a net fishery in Selwyn Inlet (F. Dickson, pers. comm.).

(4) It is also imperative that the area considered for enhancement is not presently at its biological optimum. Of the three major

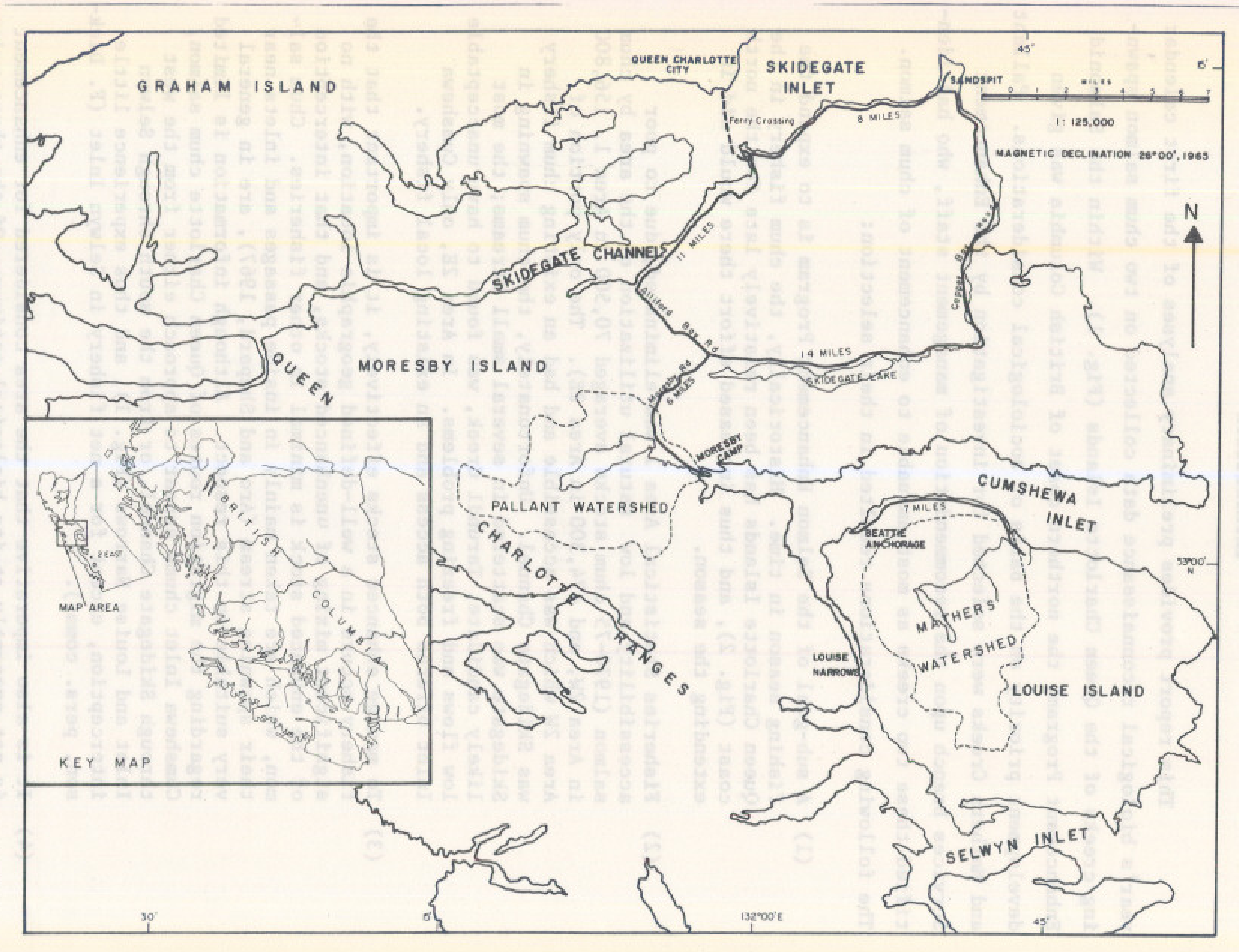

Figure 1: Geographic location of Pallant and Mathers Creeks.

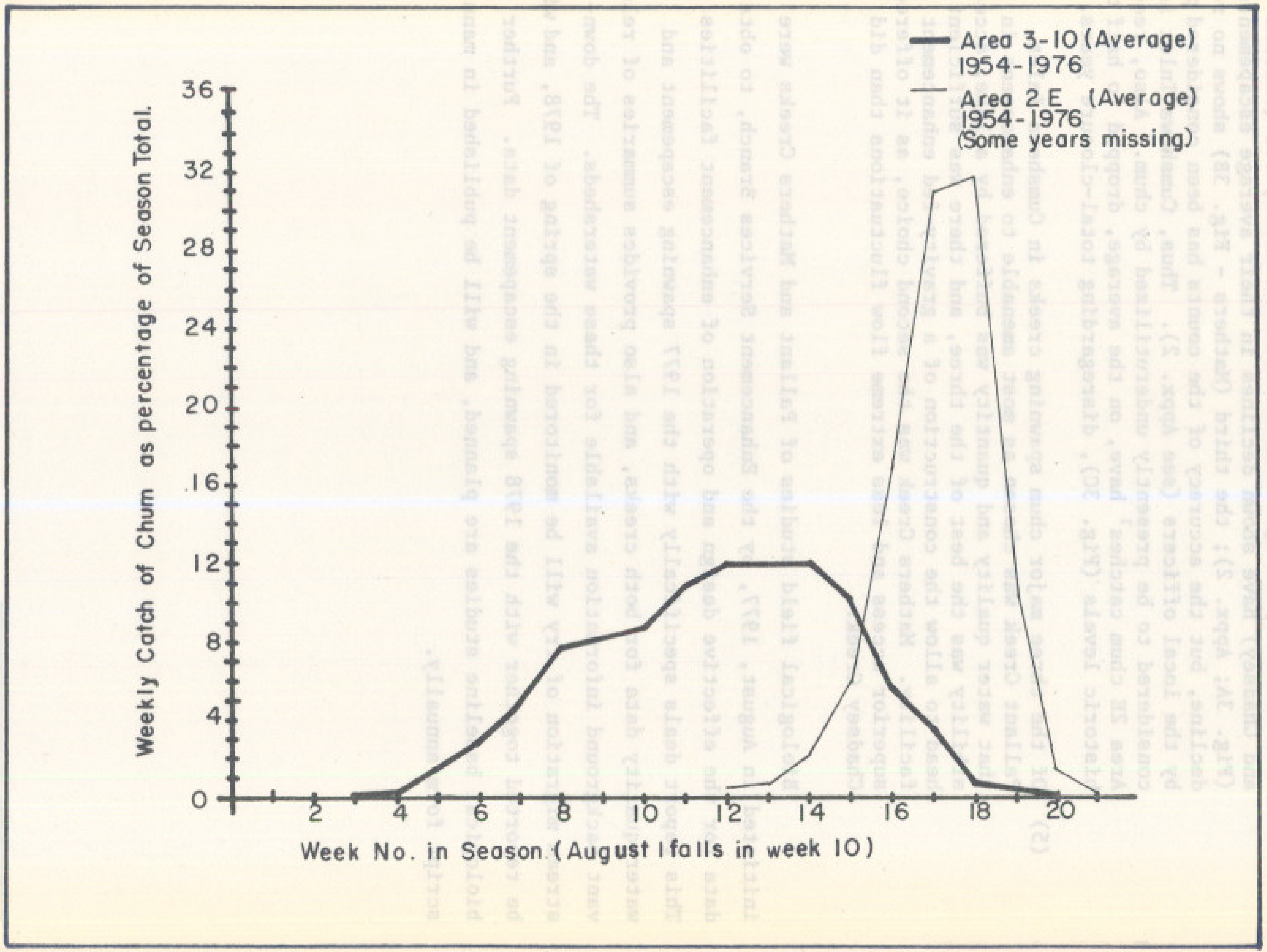

Figure 2: Timing of total catches of chum salmon by Fisheries Statistical Area.

chum salmon spawning creeks in Cumshewa Inlet, two (Pallant and Chadsey) have shown declines in their average escapements (Fig. 3A; Appx. 2); the third (Mathers - Fig. 3B) shows no real decline, but the accuracy of the counts has been considered poor by the local officers (see Appx. 2). Thus, Cumshewa Inlet is considered to be presently underutilized by chum. Also, recent Area 2E chum catches[1] have, on the average, dropped to half their historic levels (Fig. 3C), disregarding total-closure years.

(5) Of the three major chum spawning creeks in Cumshewa Inlet, Pallant Creek was chosen as most amenable to enhancement in that water quality and quantity was buffered by a lake, accessibility was the best of the three, and there was sufficient head to allow the construction of a gravity-fed enhancement facility. Mathers Creek was the second choice, as it offered superior access and less extreme flow fluctuations than did Chadsey Creek.

Biological field studies of Pallant and Mathers Creeks were initiated in August, 1977, by the Enhancement Services Branch, to obtain data for the effective design and operation of enhancement facilities. This report deals specifically with the 1977 spawning escapement and water quality data for both creeks, and also provides summaries of relevant background information available for these watersheds. The downstream migration of fry will be monitored in the spring of 1978, and will be reported together with the 1978 spawning escapement data. Further biological baseline studies are planned, and will be published in manuscript form annually.

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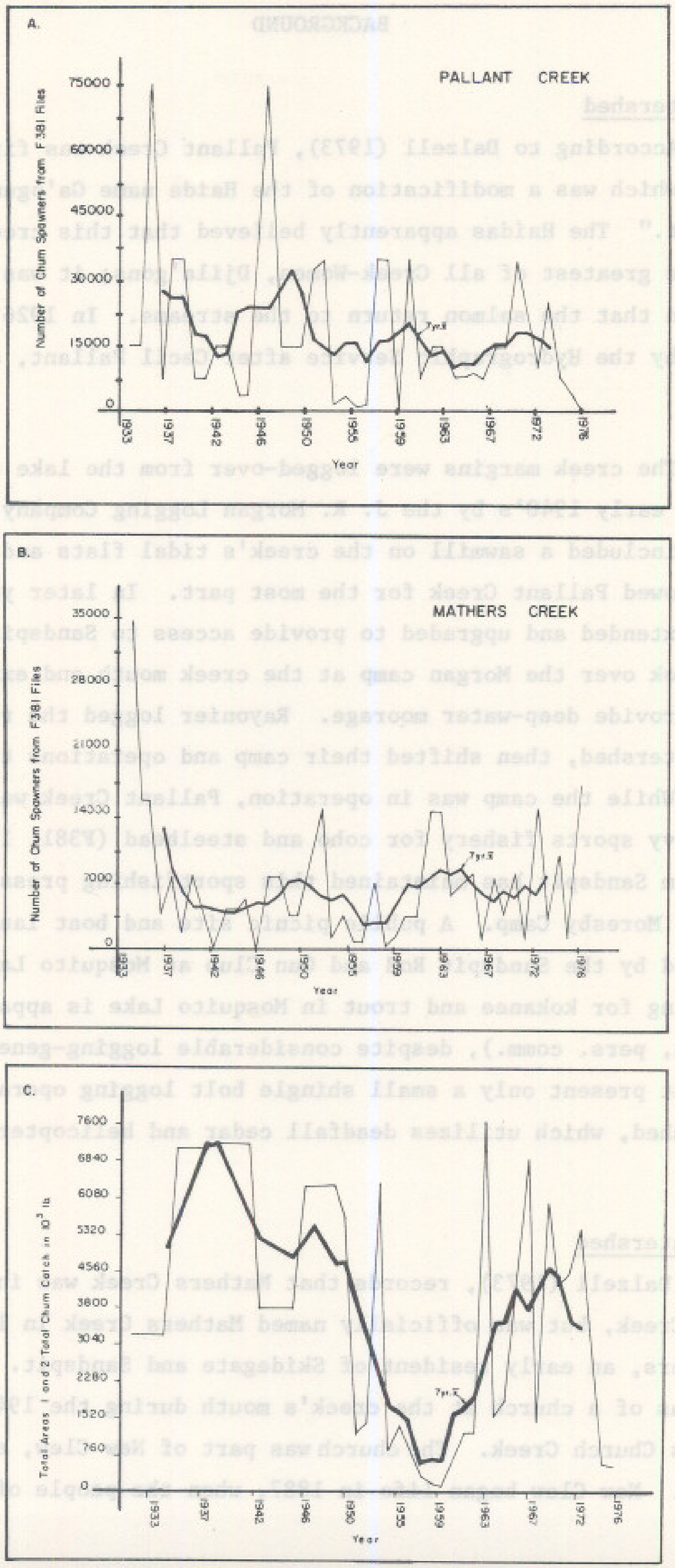
[1]Separate records of Cumshewa Inlet catches not available.



A.

Escapements to Pallant Creek.

B.

Escapements to Mathers Creek.

C.

Total Area 1 and 2 catches.

Figure 3: Trends in chum salmon catches and escapements.

BACKGROUND

HISTORY

Pallant Watershed

According to Dalzell (1973), Pallant Creek was first called Kallahin, which was a modification of the Haida name Ga'oguns, "of the great inlet." The Haidas apparently believed that this creek was the home of the greatest of all Creek-Women, Djila'gons; it was to see the Creek-Women that the salmon return to the streams. In 1926, the creek was named by the Hydrographic Service after Cecil Pallant, a Sandspit pioneer.

The creek margins were logged-over from the lake to the inlet during the early 1940's by the J. R. Morgan Logging Company. The Morgan operation included a sawmill on the creek's tidal flats and a plank road which followed Pallant Creek for the most part. In later years, this road was extended and upgraded to provide access to Sandspit. The Rayonier Company took over the Morgan camp at the creek mouth and expanded it to the north to provide deep-water moorage. Rayonier logged the remainder of the Pallant watershed, then shifted their camp and operations to Sewell Inlet in 1970. While the camp was in operation, Pallant Creek was subject to a fairly heavy sports fishery for coho and steelhead (F381, 1969). Improved access from Sandspit has maintained this sportfishing pressure despite closure of Moresby Camp. A public picnic site and boat launching ramp was constructed by the Sandspit Rod and Gun Club at Mosquito Lake in 1976. Sportfishing for kokanee and trout in Mosquito Lake is apparently popular (G. Buxton, pers. comm.), despite considerable logging-generated debris. There is at present only a small shingle bolt logging operation active in the watershed, which utilizes deadfall cedar and helicopter transport of the bolts.

Mathers Watershed

Dalzell (1973), records that Mathers Creek was initially known as Falls Creek, but was officially named Mathers Creek in 1926, after John Mathers, an early resident of Skidegate and Sandspit. Loggers found the remains of a church at the creek's mouth during the 1940's, and still know it as Church Creek. The church was part of New Clew, a small native community. New Clew began life in 1887, when the people of Tanu Village relocated there. Captain William Oliver, a future partner of John Mathers, assisted the community in constructing the church, a store, and a small oilery. The village was abandoned in 1897, when all outlying native villagers moved to Skidegate. The only obvious remains of New Clew are the graveyard (Fig. 4), as a logging camp was built over the village site. The Mathers watershed was logged-over in the 1940-1950 period by the Kelly and Powell River Logging Companies. Although F381 reports (Appendix 1) mention stream clearing operations in the late 1940's, old logging debris is still highly evident in the main water courses, particularly in Mathers Lake (Fig. 5). The remains of the 'fore-and-aft' logging mainline (Fig. 6), the equipment used (Figs. 7,8), and the camp itself (Fig. 9) are of interest. The ruins of the camp are extensive, and cover most of the flat near-shore area from Mathers Creek north to Kitson Point. Logging of the northwest margins of the tributary entering Mathers Creek just below the lake is planned by MacMillan Bloedel in the near future, which could increase downstream suspended solids loadings over present levels. Fishery officers (F381) report a small but active sportfishery on this creek, initially made up of anglers from Moresby Camp. The establishment of a logging camp on Louise Island at Beatty Anchorage in recent years, together with the construction of a logging main across Mathers Creek in 1976, should increase sportfishing pressure. In addition, a small (1-2 permits per year) native food fishery for sockeye, spring, and steelhead occurs above the logging bridge from April to July; permits occasionally are issued during the fall in good coho years (J. Broome, pers. comm.). Participants generally live onboard their fishboats, which they anchor at the mouth of Mathers Creek.

CLIMATE

Chapman et al., (1956) classify the Cumshewa Inlet area as Inner West Coast. This marine, humid climate is characterized by high precipitation and a small, annual range in temperature, compared to other climatic regions (Table 1). It is differentiated from the Outer West Coast in that the Inner West Coast region is sheltered from Pacific disturbances to a degree, resulting in relatively less precipitation and cloudiness and

Figure 4: Some of the several tombstones still standing in the New Clew graveyard site at the mouth of Mathers Creek.

Figure 5: Logging debris accumulation at Mathers Lake outlet (photo by K. Cormack).

Figure 6: Remains of the 'fore-and-aft' main logging road from the mouth of Mathers Creek to Mathers Lake.

Figure 7: One of the many British Leyland or White logging trucks left at the Mathers logging camp site on Cumshewa Inlet. Note solid rubber tires.

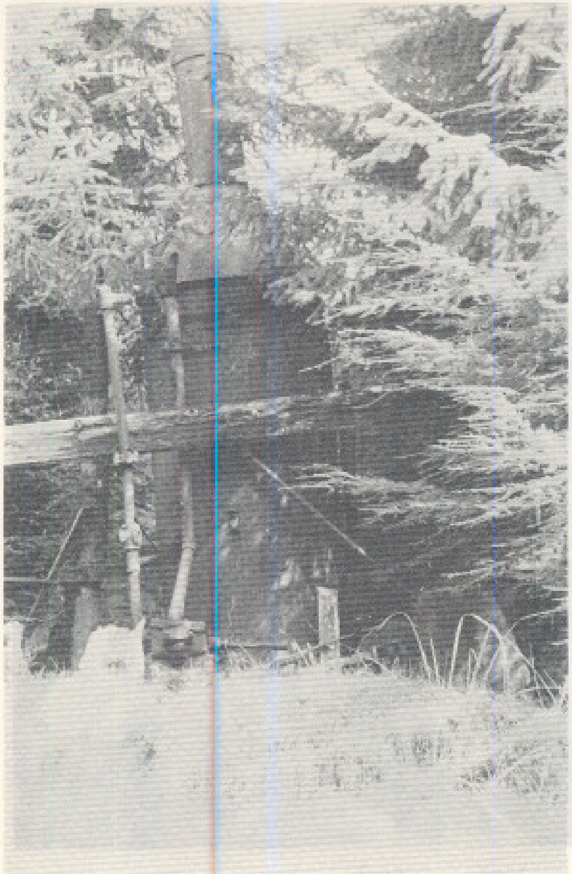


Figure 8: Stream donkey abandoned at Mathers logging camp site.

Figure 9: Ruins of logging camp building at Mathers Creek.

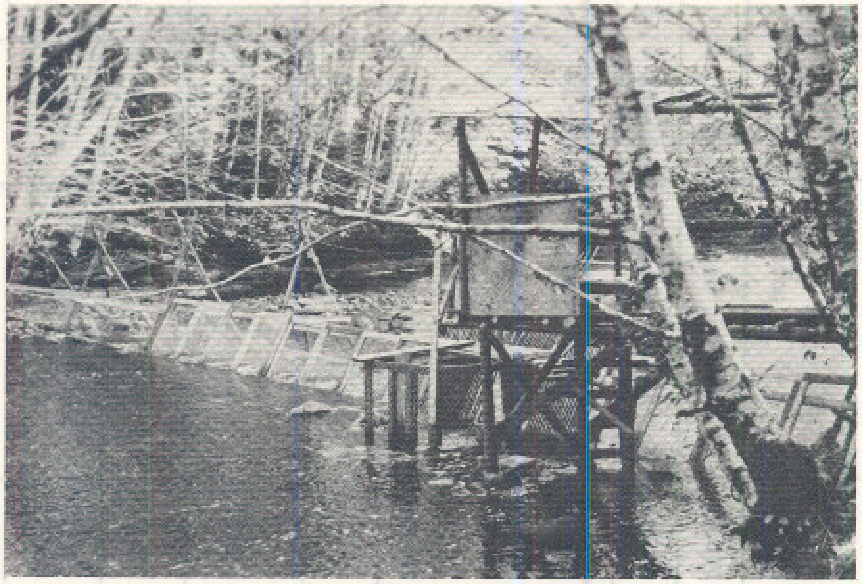


Figure 10: Mathers counting fence (Pallant fence of similar design). Pier to right allowed observation of fish, and provided sheltered work area for tagging.

TABLE 1: Generalised Characters of B. C. Climatic Regions (from Chapman *et al.*, 1956).

REGION	TEMPERATURE (^{o}F)							
	Mean Monthly		Mean Daily		Number of Months		Annual Range	Average number of Days Frost Free
	Jan.	July	Min: Jan.	Max: July	Above $50^{o}F$.	Below $32^{o}F$.		
I COAST								
A. WEST COAST								
1. Outer Coastal	35-40	56	30-35	60-65	4-5	nil	17-20	200-250
2. Inner Coastal	35-38	60-65	30-32	70-75	5-6	nil	20-27	200-250
3. Head of Fiord	20-25	58-62	20-25	70-75	4-5	3-4	35-40	130-150
B. SOUTHWEST COAST	35-40	60-65	30-35	70-75	5-7	nil	20-30	200-275
II INTERIOR								
A. SOUTHWEST INTERIOR								
1. Valleys	15-25	65-73	10-20	80-90	5-7	3-4	40-50	100-175
2. Plateaus	10-20	55-60	0-10	70-75	3-4	4-5	40-50	50-120
B. SOUTHEAST INTERIOR								
1. Valleys	{12-15 20-25	60-68	{0-5 15-20	80-85	5	3-5	40-50	90-150
2. Mountains	10-15	55-60	5-10	60-70	2-3	5-6	35-40	50-100
C. CENTRAL INTERIOR	10-15	55-60	5-10	70-75	3-4	4-5	40-50	50-100
D. NORTHERN INTERIOR	- 5 to 10	55-60	-10 to 5	65-70	3	5-6	50-65	50-100
III NORTHEAST	-10 to 5	60-65	-20 to 5	70-75	3-4	5-6	55-70	50-125

TABLE 1: (cont'd.)

REGION	PRECIPITATION (In.) Mean Annual	Season and Month of: Max:	Season and Month of: Min:	% of Total Precipitation Which Falls as Snow
I COAST				
A. WEST COAST				
1. Outer Coastal	50-150	SOUTH Winter 30-40 Dec.	Summer 10-15 Aug.	Less than
2. Inner Coastal	35-50			5-10
3. Head of Fiord	50-100	NORTH Autumn 35-40 Oct.-Nov.		10-15
B. SOUTHWEST COAST	25-50	Winter 40-45 Dec.	Summer 5-10 July-Aug.	5-10
II INTERIOR				
A. SOUTHWEST INTERIOR				
1. Valleys	7-10 12-20	SOUTH Winter 30-40 Dec.	Spring 15-25 Mar.-April	20-30
2. Plateaus		NORTH Summer 30-35 June		30-50
B. SOUTHEAST INTERIOR				
1. Valleys	15-20 25-30	Winter 30-40 Dec.-Jan.	Variable Spring-Summer	30-40
2. Mountains		Winter 35-40 Jan.	Inadequate Data	50-70
C. CENTRAL INTERIOR	15-20	Summer 24-35 Variable	Spring 15-20 April	25-30
D. NORTHERN INTERIOR	10-20	Variable	Spring 10-15 April	30-50
III NORTHEAST	15-20	Summer 35-40 July	Spring 15-20 April	35-45

TABLE 2: Thirty-year means of temperature and precipitation for Sandspit Airport (from Atmos. Env. Serv., 197?).

LATITUDE 53 15 N LONGITUDE 131 49 W ELEVATION 25 FT ASL

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.
Mean Daily Temperature (DEG F)	35.5	38.2	39.0	42.6	47.9	53.1	57.1	58.3	55.1	48.0	41.7	37.9	46.2
Mean Daily Maximum Temperature	39.8	42.7	44.0	48.1	53.4	58.1	62.0	63.5	60.3	53.1	46.3	42.1	51.1
Mean Daily Minimum Temperature	31.1	33.6	33.9	37.1	42.4	48.0	52.2	53.2	49.8	42.8	37.1	33.6	41.2
Extreme Maximum Temperature	54	54	57	66	71	77	79	80	72	66	60	56	80
No. of Years of Record	23	23	23	22	22	22	22	23	23	24	24	24	
Extreme Minimum Temperature	7	10	10	27	30	36	42	42	31	28	20	9	7
No. of Years of Record	23	23	23	22	22	22	22	23	23	24	24	24	
No. of Days with Frost	17	11	12	4	*	0	0	0	*	1	6	12	63
Mean Rainfall (Inches)	4.93	3.81	3.60	3.12	1.79	1.86	1.90	1.89	3.40	7.27	6.99	5.99	46.55
Mean Snowfall	11.9	5.6	4.1	0.6	0.1	0.0	0.0	0.0	0.0	T	2.9	5.7	30.9
Mean Total Precipitation	6.12	4.37	4.01	3.18	1.80	1.86	1.90	1.89	3.40	7.27	7.28	6.56	49.64
Greatest Rainfall in 24 hrs.	2.25	1.38	1.33	3.13	1.90	1.08	0.87	1.52	1.91	1.94	1.69	2.19	3.13
No. of Years of Record	23	23	23	22	22	22	22	23	23	24	23	24	
Greatest Snowfall in 24 hrs.	14.0	10.0	7.7	2.0	0.6	0.0	0.0	0.0	0.0	0.1	9.0	9.2	14.0
No. of Years of Record	23	23	23	22	22	22	22	23	24	24	23	24	
Greatest Precipitation in 24 hrs.	2.25	1.38	1.87	3.13	1.90	1.08	0.87	1.52	1.91	1.94	1.69	2.19	3.13
No. of Years of Record	23	23	23	22	22	22	22	23	23	24	23	24	
No. of Days with Measurable Rain	16	16	17	17	14	13	12	13	16	23	21	21	199
No. of Days with Measurable Snow	6	4	3	1	*	0	0	0	0	*	2	4	20
No. of Days with M. Precipitation	20	18	18	17	14	13	12	13	16	23	22	23	209

slightly higher temperatures. There is only one active weather station in the Queen Charlotte Islands for which long-term values of monthly air temperature and precipitation can be presented (Table 2). Although this weather station is in the inner west coast region at Sandspit Airport and is less than 20 air miles from either Mathers or Pallant Creek, the weather has been noted to be considerably localized. For example, 6 mm of precipitation was recorded at Sandspit Airport between September 22 and 24, 1977, yet the water level of Pallant Creek rose 165 mm between September 23 and 24. There also was less precipitation at Mathers Creek than at Pallant Creek in the August to November period of 1977 (P. Slobodzian, pers. comm.). As the Pallant watershed is more closely associated with the Queen Charlotte mountain range (see geological and topographical sections), higher precipitation is expected; Chapman et al. (1956) predict 100-150 cm of precipitation per year for most of Louise Island, 150-250 cm for the head of Cumshewa Inlet, and 250-380 cm for the upper portions of the Pallant watershed. Because of these variations, arrangements are being made to install a Class II weather station (rain can and max-min thermometer) at the Pallant hatchery site.

GEOLOGY

The Mathers watershed straddles two physiographic subdivisions of the Insular Mountains (Sutherland Brown, 1968). That portion of the Mathers watershed below the lake is assigned to the Skidegate Plateau subdivision. The Skidegate Plateau is well-dissected, consisting of continuous flat-topped ridges and broad valleys that have been scoured by glaciers. The majority of the lower portion of the Mathers valley is composed of marine sediments, glacial tills, and recent alluvium; the valley sides are largely folded sedimentary rock in nature, being made up of limestones, argillites, sandstones, siltstones, shales, and conglomerates. Just below Mathers Lake, the Rennell Sound-Louscoone Inlet fault zone crosses Louise Island in a NW-SE direction. The geological formations change markedly across this major fault zone, and thus the upper end of the Mathers watershed is considered part of the Queen Charlotte Ranges physiographic unit. The upper Mathers watershed consists of folded rock of marine sedimentary origin that has been almost entirely overlaid by a plutonic intrusion of quartz mozonite, probably in connection with fault action.

The Pallant watershed is entirely contained within the Queen Charlotte Ranges physiographic unit. In contrast to the upper regions of the Mathers watershed, no plutons were intruded, and the Pallant watershed bedrock is of marine sedimentary origin (argillite, shale, and sandstone). Similar to Mathers, the Pallant valley floor is made up of marine, glacial and river outwash deposits.

The above geological summary has been condensed from Sutherland Brown (1968), and the reader is referred to that publication for further details.

Forest-generated topsoils are generally of the strongly leached podzol types, associated with dense forest cover and high precipitation (Chapman et al., 1956). Gleysols and regosols are associated with the creekbeds (W. Bourgeois, pers. comm.)

TOPOGRAPHY

Pallant Watershed

Pallant Creek (mouth 53°4'30"N; 132°01'00"W) drains an area approximately 80 km² to the immediate east of the Queen Charlotte Range (Fig. 11). The watershed rises from sea level at Cumshewa Inlet to over 1140 m at Mount Moresby on the southern edge of the watershed. Other peaks of note are Mosquito Mountain (over 990 m) to the west of Mount Moresby, and Koohoo Hill (321 m), on the eastern boundary of the watershed. Mosquito Lake is the major waterbody in the system, and has the following morphometric parameters:

Parameter	Value
Altitude of Lake	50 m (approx.)
Maximum Length (ℓ)	6.17 km
Maximum Width (W)	1.67 km
Area (A)	6.35 km² (excluding major islands)[1]
Mean Width (A/ℓ)	1.03 km
Shoreline (L)	16.67 km;20.67 (including 4 major islands)[2]
Shoreline Development ($L/2\sqrt{\pi A}$)	2.31

[1]But including six minor islets and five rocks awash.
[2]But excluding " " " " " " " .

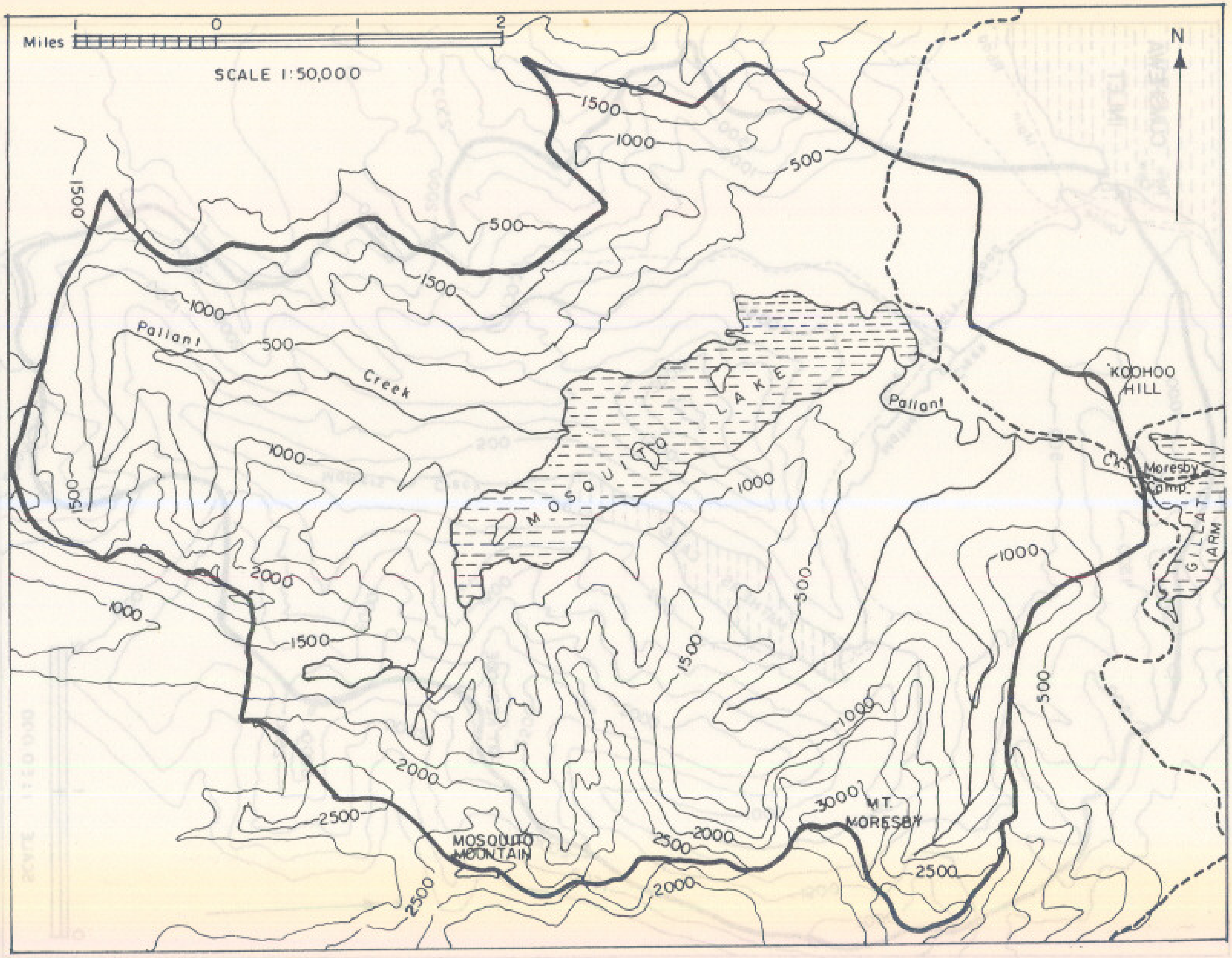


Figure 11: Topographical map of Pallant watershed.

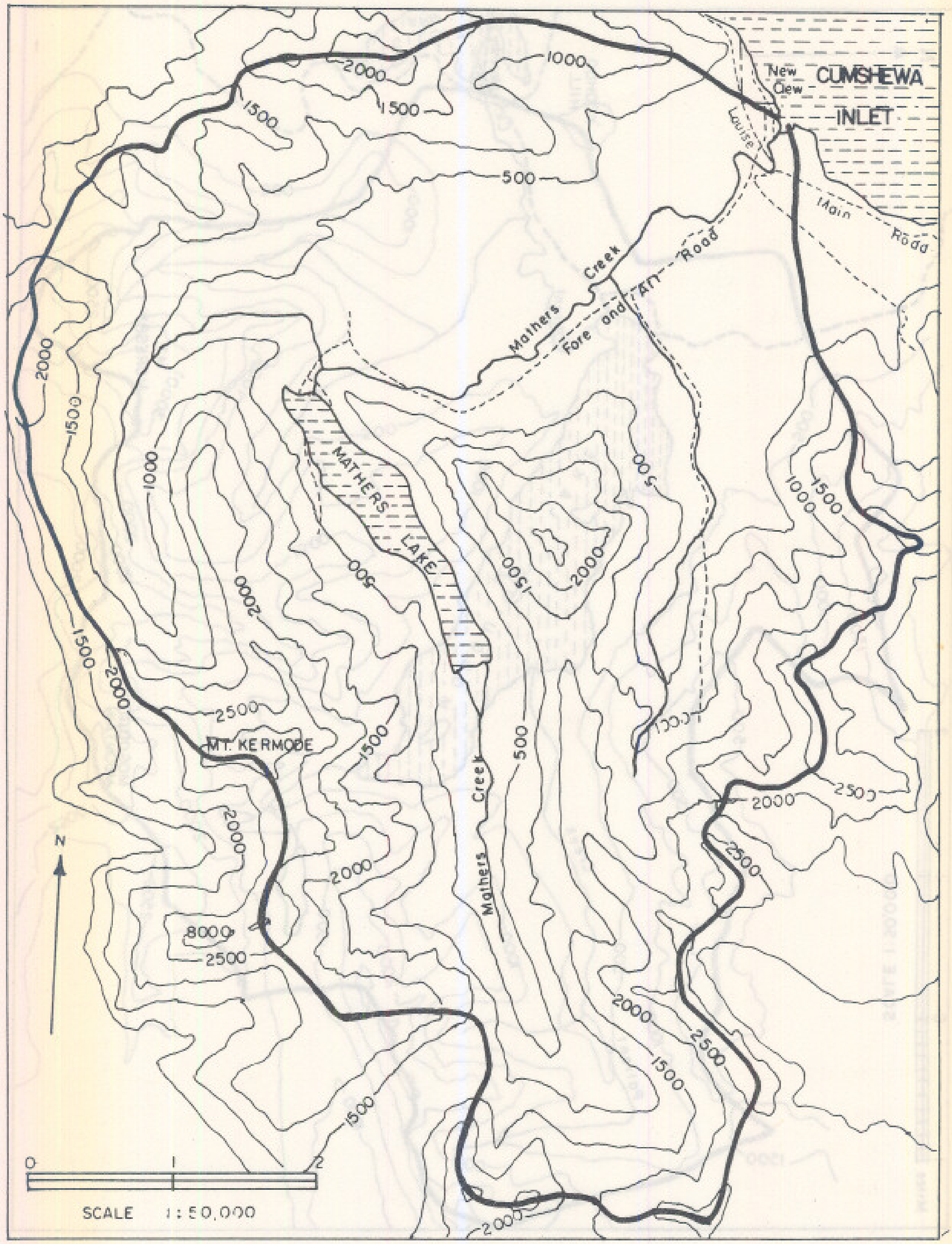


Figure 12: Topographical map of Mathers watershed (scale in miles).

Lake bathymetry will be examined in January, 1977. This narrow, irregularly-shaped lake has its major axis aligned WSW - ENE, and is fed by two main tributaries. The Pallant Creek tributary rises from the NW, flows over 7 km through a broad, flat valley, and enters Mosquito Lake midway down its length on the NW side. The other tributary enters the head of Mosquito Lake and rises much faster; within 2 km of Mosquito Lake, this tributary has subdivided into four feeder streams, the most northerly one of which has a small (0.21 km^2) lake (altitude 350 m approx.) at its top. Pallant Creek drains ESE for 5 km, through a small estuary (0.2 km^2), and into the head of Cumshewa Inlet. There is only one major tributary below Mosquito Lake, and it enters Pallant Creek 3 km below the lake from the south. This tributary forks 2 km above its confluence with Pallant Creek; both forks run for another 3 - 4 km, rising steeply at their heads.

Mathers Watershed

The Mathers watershed (Fig. 12) is similar in size to Pallant, and comprises approximately 90 km^2 of the northern quarter of Louise Island, on the southern side of Cumshewa Inlet. Elevations span sea level at Cumshewa Inlet (mouth at 53°2'30"N; 131°47'00"W) up to 1,065 m on Mount Kermode at the SW edge of the watershed. Mathers Lake heads the system, and has the following morphometric parameters:

Parameter	Value
Altitude of Lake	33 m
Maximum Length (ℓ)	4.00 km
Maximum Width (W)	0.67 km
Area (A)	1.87 km^2
Mean Width (A/ℓ)	0.62
Shoreline (L)	8.67 km
Shoreline Development ($L/2\sqrt{\pi A}$)	1.79

In comparison to Mosquito Lake, Mathers Lake is of similar shape and elevation, but is smaller, its shorelines are more regular, and its orientation is SE-NW. The one major lake tributary flows south for 3.5 km and enters the head of the lake. Mathers Lake drains NE for 9 km, and enters Cumshewa Inlet through a very small (0.05 km^2) estuary area. Two tributaries enter Mathers Creek below the lake, one 5 km long which joins Mathers Creek 0.5 km below the lake, and one 6.5 km long which joins Mathers Creek 5.5 km below the lake.

HYDROLOGY

The Water Survey of Canada has monitored flows near the mouth of Pallant Creek since 1968. Examination of their records (Fig. 13, Appendix 4) shows the stream to be subject to rapid increases in flow. Flows have varied from less than 600 ℓ/sec in late August (and occasionally in mid-winter), to 100,000 ℓ/sec in late December; freshets of 40,000 ℓ/sec are common from mid-September to the end of January. The average annual mean discharge for the 1968-1976 period was 8,650 ℓ/sec (range 7,550-9,250 ℓ/sec). The gauge site is within the area of tidal influence, and daily variations in flow can be masked by tidal flux. Despite adjustment of the data by Water Survey personnnel (R. Layne, pers. comm.), D. Toews (pers. comm.) has found the runoff data to result in a suspiciously high calculated precipitation yield, when compared to other Queen Charlotte watersheds. Observers (F381 and 30-2-P6 files) have noted rapid response in water level to rain, and heavy silt loads in the lower reaches during freshets. It is considered that the bulk of the flow fluctuations and silt loadings can be attributed to the southern tributary that enters below the lake (see stream survey results, p.44). Casual observations and water quality data (p.27) from Pallant Creek above its confluence with this tributary indicate that Mosquito Lake moderates flows and silt loadings considerably.

The Pallant Creek hydrograph for 1977 is shown in Fig. 13. At present, only daily staff gauge readings during the chum salmon spawning period are available for Mathers Creek (Fig. 15); Enhancement Services Branch engineers installed a water level recorder in Mathers Creek on November 18, 1977, and data will be forthcoming. In general, it would appear that Mathers is subject to even higher fluctuations in flow than is Pallant (Fig. 15).

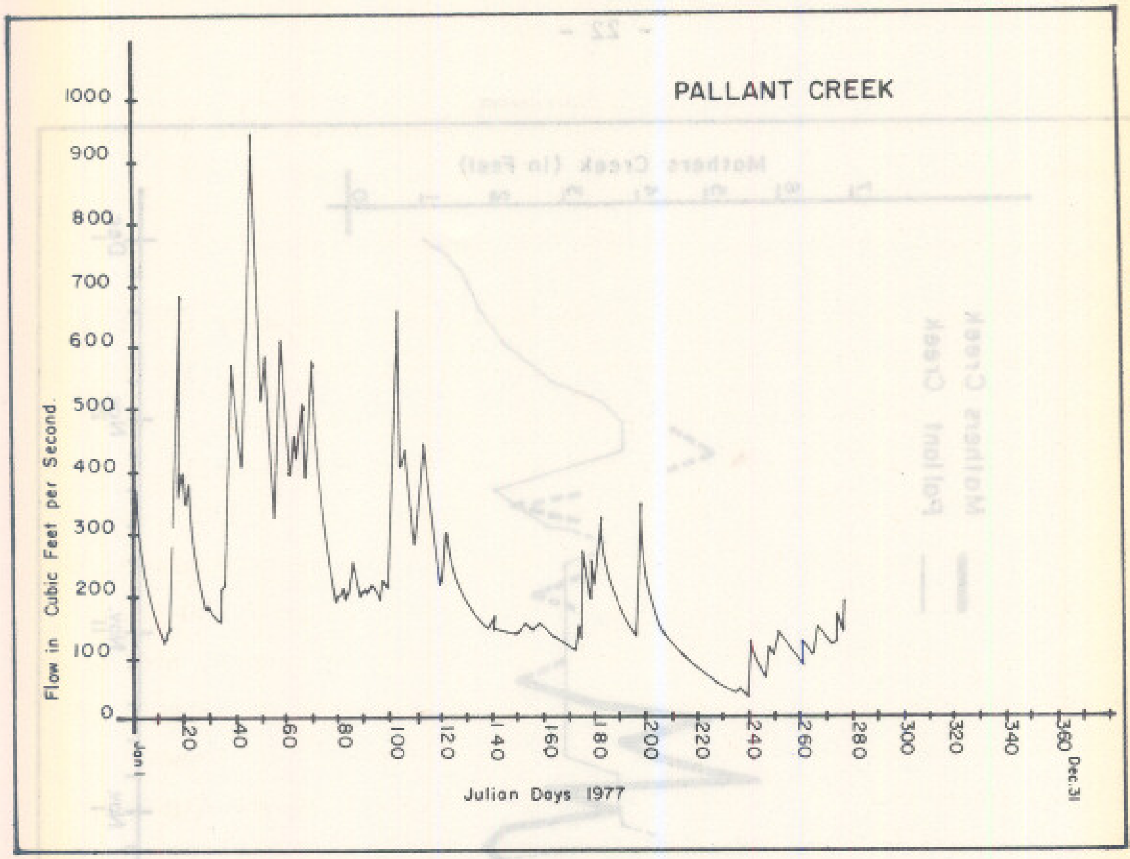


Figure 13:

Pallant Creek hydrograph for 1977 (data courtesy of Water Survey of Canada).

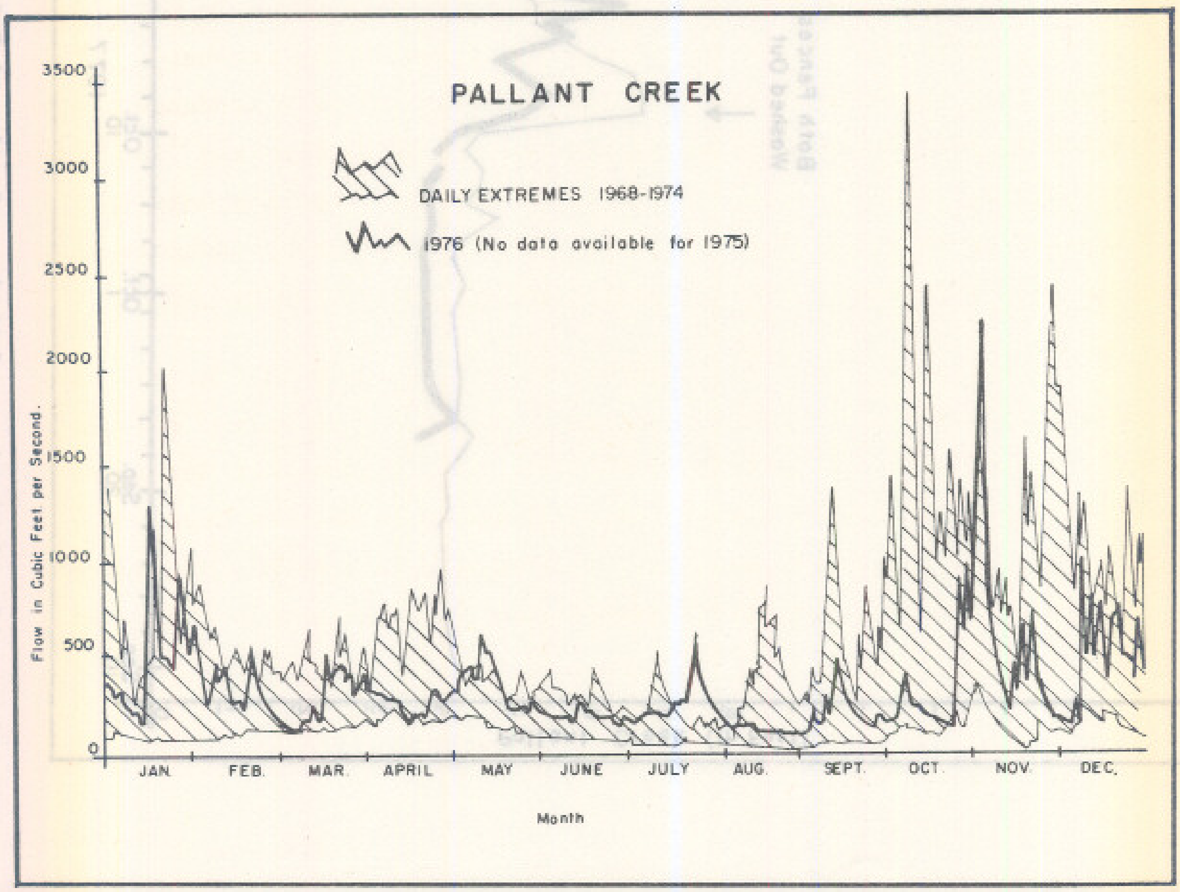


Figure 14: Range in Pallant Creek discharges for 1968-74, and 1976 hydrograph.

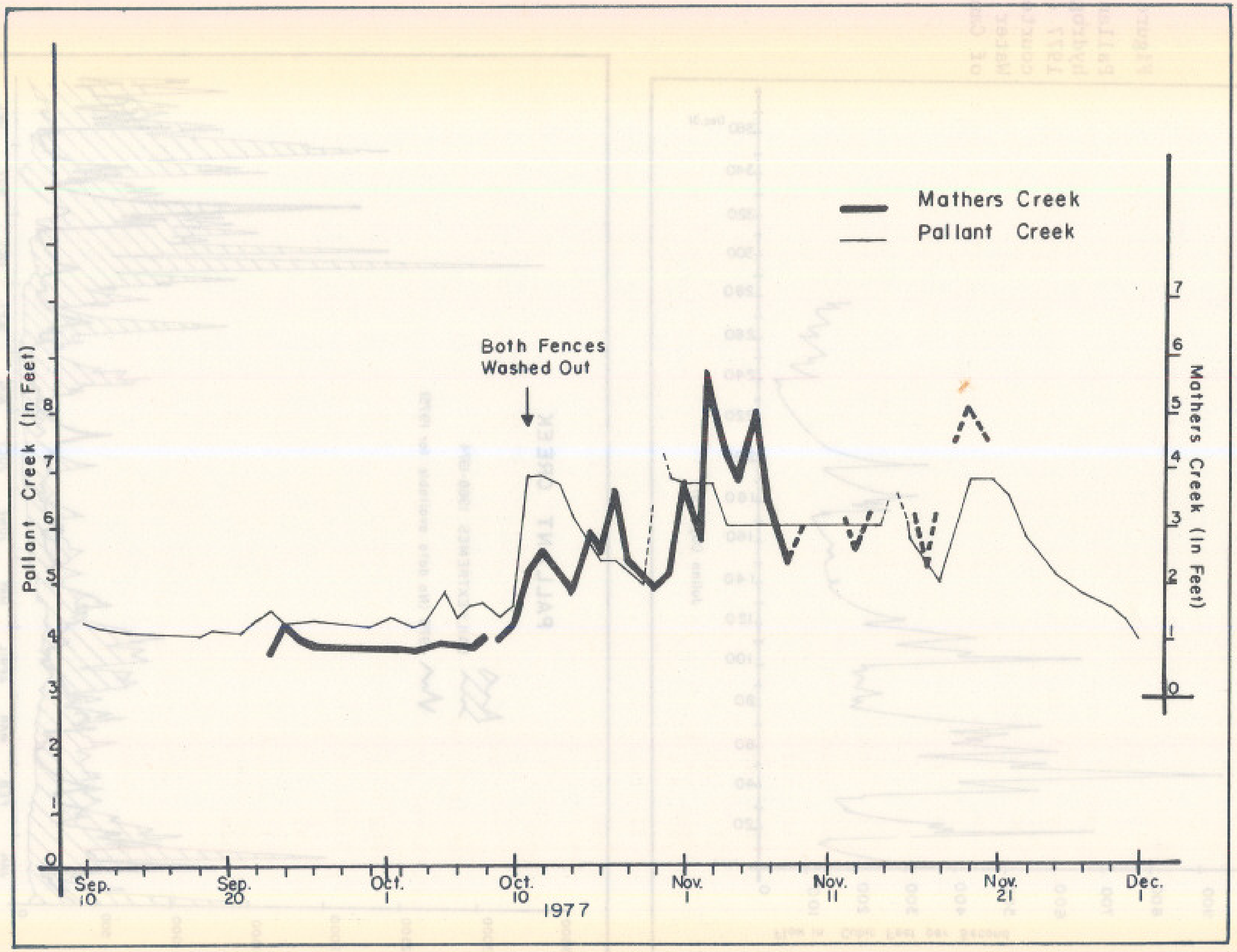


Figure 15: Comparison of Mathers Creek and Pallant Creek daily staff gauge readings during the fall of 1977.

BIOTA

Flora

All of the Queen Charlotte Islands are considered to belong to the Coastal Western Hemlock Zone (Bell, 1971). As both watersheds were heavily logged in the 1940's, their forest covers are still in transition, and the streamside vegetation is mostly red alder with some spruce, hemlock and cedar. Calder and Taylor (1968) provide more detailed information on local vegetation. Aquatic vegetation noted during substrate surveys in 1977 include: filamentous algae in sidepools of both creeks; lily pads in Mathers Creek near the lake; and typical associations of eelgrass, filamentous algae, and marsh grasses in both estuaries. Mosquito Lake has been more intensively surveyed for aquatic plants by Calder and Taylor (1968), and their species list is duplicated in Table 3. Calder and Taylor found Mosquito Lake to be one of three lakes in the Queen Charlottes that have abundances of aquatic plants as high as mainland lakes; they consider the flow fluctuations experienced in most Queen Charlotte systems to be too extreme to support aquatic plants in any number.

Fauna

Black bear, river otters, pine martens, racoons, and deer are common land animals in both watersheds. Seals have been sighted off the mouths of both creeks, and usually four were observed in a pool above the logging bridge in Mathers Creek on high tides during the 1977 chum run (P. Slobodzian, pers. comm.). Ravens, seagulls, and bald eagles were the main avian predators/scavengers noted during the 1977 studies. Foster (1965) reviews in detail the endemic fauna found on the Queen Charlotte Islands.

Sportfish other than salmon that are present in both systems include rainbow/steelhead and cutthroat trout, and dolly varden char (Gunville, 1977 MS; G. A. Buxton and P. Slobodzian, pers. comm.). Kokanee also are reported to have been caught in Mosquito Lake (D. Klimek, pers. comm.). Stickleback were noted at the mouth of Mathers Lake (P. Slobodzian, per. comm.). The Stream Inventory Section of the B.C. Fish and Wildlife Branch has sampled for fish in the Pallant watershed, and the information will be available in a forthcoming report (G. Caw, pers. comm.).

TABLE 3: Occurrence of aquatic plants in five lakes on the Queen Charlotte Islands (from Calder and Taylor, 1968).

Aquatic Species	Lakes				
	Skidegate	Mosquito	Yakoun	Upper Victoria	Pure
Equisetum fluviatile......................	x		x		
Equisetum palustre......................	x				
Isoetes echinospora ssp. muricata.........	x	x	x	x	x
Sparganium minimum......................			x		
Sparganium simplex......................	x		x		
Potamogeton berchtoldii ssp. berchtoldii..	x	x			
Potamogeton epihydrus ssp. nuttallii......		x	x		
Potamogeton gramineus...................	x	x			
Potamogeton natans......................	x	x	x	x	
Potamogeton nodosus.....................	x		x	x	
Potamogeton richardsonii................		x	x		
Potamogeton robbinsii...................	x				
Elodea canadensis.......................	x	x			
Glyceria occidentalis...................			x		
Eleocharis acicularis...................	x				
Eleocharis obtusa.......................	x				
Scirpus lacustris ssp. glaucus...........			x		
Juncus oreganus.........................	x		x	x	x
Nuphar luteum ssp. polysepalum...........	x	x	x	x	x
Ranunculus aquatilis....................	x	x	x		
Subularia aquatica ssp. americana........	x	x			
Callitriche heterophylla ssp. bolanderi...			x	x	
Myriophyllum spicatum...................		x			
Lilaeopsis occidentalis.................	x	x	x		x
Utricularia intermedia..................			x		
Utricularia vulgaris....................	x				
Lobelia dortmanna.......................	x	x	x		
Totals..............................	19	13	17	6	4

METHODS AND MATERIALS

WATER QUALITY SAMPLING

A Hach DR-EL kit was used once on-site to sample a wide range of water quality parameters. Monthly sample series were taken at the intake site at Pallant Creek, and upstream of the counting fence site at Mathers Creek, beginning August, 1977. Intermittent sampling was done in 1976 by G. A. Buxton. Each series of five one-liter samples were depth-integrated by hand, as near to the center of the creek as possible. Additional suspended solids samples were taken at times of high or turbid water. Preservation and storage of the samples were as follows:

#	Sample Type	Analyses Requested	Preservation and Storage
1.	Nutrients	NO_2, NO_3, TPO_4, SiO_2, SO_4	Keep cool (4°C) or freeze.
2.	Suspended Solids	FR/NFR	" " " " "
3.	" "	Particle Size	" " " "
4.	Cations	Ca, Cr, Cu, Fe K, Na, Mg	Add 5 ml of conc. HNO_3 to sample; keep cool or freeze.
5.	Algae	Genera, Abundances, Sizes	Add 25 ml of std. Lugol's sol'n first, then add sample; keep dark and add Lugol as needed to maintain amber-orange colour.

Polyethylene sample bottles were leached in water from the sample sites for at least 24 hr prior to taking the sample. Samples were transported to Vancouver as soon as possible. Sample bottles #1, #2, and #4 were sent to the Cypress Creek lab in North Vancouver for analysis by standard methods (see Environment Canada, 1976). Sample #3 was sent to CanTest Ltd., Vancouver, for more detailed analysis of the particle sizes of the suspended solids (see Appendix 2 for details of methods). Algae samples (#5 above) are still being held while contract arrangements for their analysis are being made.

Staff gauges were installed near the fence sites, and were routinely read daily (more often, if large fluctuations in water level occurred). Thirty-day recording thermographs were installed at the lower end of the Pallant hatchery site, and upstream from the Mathers counting fence.

COUNTING FENCE OPERATION

Counting fences and cabins for the crews were constructed at both sites in early September, 1977. Fences consisted of weighted tripod pole supports, 5 x 10 cm stringers, and 120 x 120 cm panels of 5 x 5 cm wire fence mesh sand-bagged in place (Fig. 10). Broomsticks were used in a short section of each fence, to allow access to a combination trap and counting board. Artificial lighting was provided with small generators and floodlights. While the fences were in operation, the trap would be checked and opened for 15 - 30 min, or until migration through the fence slowed, at approximately 2 hr intervals throughout the day. Spot checks were made occasionally at night, if the number of fish holding below the fence or water and debris levels warranted it. Passing fish were identified as to species (coho separated by size into adults and jacks), and tallied by time and date. Some of the chums were trapped during passage and sampled in one of two ways:

1) <u>Live Sampling</u>. Trapped chum were checked as to sex, age (2 scales per fish, using standard techniques--Appendix 3), nose-fork length, tagged with Petersen discs, and released. No anaesthetic was used.

2) <u>Fecundity Sampling</u>. During live sampling, female chum were selected on the basis of nose-fork length and sacrificed. These fish were measured as in the live sampling; postorbital-hypural lengths were also taken, and all eggs were removed and counted immediately.

Dead chums that floated up against the fences and had not been previously sampled, were sampled in a similar manner to dead pitch samples (see below).

STREAM SURVEYS

Biophysical

Both mainstems were surveyed during low flows for biophysical characteristics considered important to chum spawning. Reaches of 300 paces (240 - 300 m, depending on individual) were visually evaluated for streambed composition in percent of clay, silt, sand (to 5 mm), gravel (5 - 75 mm), cobble (75 - 150 mm), boulder (over 150 mm), and bedrock; gradient and flow characteristics; presence of aquatic plants, juvenile and adult fish and predators; and number and location of log jams, cut-banks, tributaries, side channels, and landmarks. Mathers Creek was walked from Mathers Lake to tidal influence. The major tributary on the south bank below Mathers Lake was inspected on foot for approximately 3 km above the confluence. Pallant Creek was walked from the hatchery site to tidal influence, as well as the lower 2 km of the major tributary below Mosquito Lake. The remainder of both watersheds was inspected from a helicopter on October 3, 1977.

Salmon Distribution and Behaviour

Once chums began passing the fences, weekly foot inspections of Pallant Creek from the hatchery site to the estuary, and Mathers Creek from the main southern tributary to the estuary were made. During these inspections, the species, numbers, and behaviour of tagged and untagged salmon were mapped.

Dead Pitches

In conjunction with the above salmon surveys, all dead chum not previously measured were sampled as to sex, age (two scales per fish), nose-fork and hypural lengths, and egg retention (if female). Measured fish were marked by tail removal to prevent re-measurement on successive inspections.

RESULTS AND DISCUSSION

WATER QUALITY

The results of Mathers and Pallant sampling have been compiled to date in Tables 4 and 5. Comparison of these data with recommended

TABLE 4: Water quality parameters as determined on-site, October 18-19, 1977, with a Hach DR-EL analysis kit. Those values underlined exceed recommended limits (see Table 6).

Parameter	Pallant (Oct. 19)		Mathers (Oct. 18)
Alkalinity-phenolphthalein	0	ppm	0
-total	15		–
Chloride	<5		<5
Chlorine	0		0
Chromium (hexavalent)	0.02		0.02
Copper	0.2		0.05
Hardness-calcium	15		15
-total	20		20
Iron	0		0
Manganese	0		0
Nitrate	14		9.95
Nitrite	0		0.05
pH	7.3		6.9
Total Phosphate	0.05		0.05
Silica	3.5		4.0
Sulphate	0		5.0
Turbidity	0		0

TABLE 5: Water quality parameters as determined by Cypress Creek Laboratory, North Vancouver. Those values underlined exceed recommended limits. (see Table 9).

	Suspended Solids				Nutrients					Anion	Cations												
Date	FR	NFR	TURB.	COND.	NO_2	NO_3	TPO_4	SiO_2	So_4	Cl.	Ca	K	Na	Cu	Fe	Cr	Hg	Mg	Mn	Pb	Zn	pH	Alk.
MATHERS CREEK																							
Oct. 4/76	40	11	2.0	50.0	.006	.120	.042	4.8	3.0	3.8	4.6	0.38	3.0	-	.50	-	<.02	.81	.05	<.02	.01	7.1	15.0
Nov. 25/76	28	< 5	1.3	39.0	-	-	-	1.6	3.0	3.9	3.3	0.18	2.5	-	-	-	-	.57	-	-	-	7.0	10.0
Feb. 24/77	34	<10	<0.5	44.0	-	-	-	1.4	3.5	4.3	3.7	0.18	2.8	-	-	-	-	.64	-	-	-	6.9	11.8
Apr. 7/77	34	< 5	<0.5	42.0	<.001	.047	-	1.6	2.0	4.7	3.6	0.16	2.7	-	-	-	-	.69	-	-	-	7.0	36.0
Jun. 16/77	35	< 4	0.6	47.0	-	-	-	1.8	3.0	4.2	4.4	0.10	2.4	-	-	-	-	.83	-	-	-	7.1	14.0
Sept.20/77	47	< 5	-	-	<.005	.080	<.010	1.9	3.5	-	4.4	0.24	2.8	<.01	.33	<.02	-	.87	-	-	<.01	-	-
Sept.24/77	40	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct. 5/77	43	< 5	-	-	<.005	.059	<.010	2.2	3.6	-	4.3	0.25	2.7	<.01	.38	<.02	-	.90	-	-	.05	-	-
Oct. 10/77	46	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 9/77	37	< 5	-	-	<.005	.087	<.010	1.7	2.7	-	5.7	0.29	2.9	<.01	.19	<.02	-	.74	-	-	-	-	-
PALLANT CREEK																							
Oct. 4/76	42	<10	1.0	50.2	<.005	.067	≤010	3.4	3.0	3.8	5.3	0.19	2.5	-	<.14	-	<.20	.89	<.03	<.02	<.01	7.5	17.0
Nov. 25/76	38	< 5	1.3	48.0	-	-	-	1.5	2.9	3.9	5.8	0.15	2.4	-	-	-	-	.79	-	-	-	7.4	15.0
Feb. 24/77	35	<10	<0.5	51.0	-	-	-	1.4	3.5	3.7	6.8	0.12	2.4	-	-	-	-	.83	-	-	-	7.2	15.5
Apr. 7/77	36	< 5	<0.5	51.0	<.005	.046	-	1.4	3.0	4.1	5.6	0.11	2.4	-	-	-	-	.93	-	-	-	7.3	16.0
Jun. 16/77	35	< 4	<0.5	50.0	-	-	-	1.4	3.0	4.0	3.8	0.17	2.7	-	-	-	-	.72	-	-	-	7.4	16.0
Sept.20/77	38	< 5	-	-	<.005	.013	<.010	1.1	2.5	-	5.2	0.13	2.0	<.01	.08	<.02	-	.99	-	-	<.01	-	-
Oct. 5/77	36	< 5	-	-	<.005	.029	<.010	1.3	3.2	-	4.9	0.14	2.1	<.01	.07	<.02	-	.99	-	-	.02	-	-
Nov. 9/77	40	< 5			<.005	.063	<.010	1.6	4.4	-	6.5	0.21	2.4	<.01	.11	<.02	-	.93	-	-	-	-	-
Dec. 28/77	42	< 5			<.005	.068	<.010	0.5	3.2	-	6.4	0.21	2.6	<.02	.08	<.02	<.1	1.00	.012	<.10	<.02	-	-

TABLE 6: Water quality limits for aquatic life: a summary of past findings (sources are 1-Env. Can., 1976; 2-FWPCA, 1968; 3-Robbins, 1976).

PARAMETER	TOXIC LEVEL(S)	RECOMMENDED LIMIT OR RANGE	SOURCE
Alkalinity, Total	Not lethal up to pH 9.0	20 to 100+ ppm 10-400 ppm for fish culture	1, 2, 3
Ammonia (NH_3)	-	0.5 ppm max. for fish culture	3
Calcium (Ca)	-	4-150 ppm for fish culture	3
Carbon Dioxide (CO_2)	25+ ppm detrimental	below 25 ppm; 0-10 ppm for fish culture	2, 3
Chloride (Cl-)	400 ppm harmful to trout	below 170 ppm	1
Chlorine (Cl)	0.03-3 ppm kills fish	-	1
Chromium, Hexavalent (Cr)	0.02-0.7 threshold effects on Plankton	0.02 maximum	2
Copper (Cu)	1.25 ppm @ 18-20°C (Sunfish TLm) 0.06 ppm @ 15-18°C (Stickleback 96h. kill) 0.30 ppm ± 15-18°C (Stickleback 24h. kill)	1/30 of TLm; 0-0.1 ppm for fish culture	1, 2, 3
Fluoride (Fl)	-	1.5 maximum ppm	2
Hardness (Total as Ca CO_3)	-	10-400 ppm for fish culture	3
Iron, Total (Fe)	1-2 ppm trout kill @ pH 5.0-6.7	1/100 TLm; 0-0.5 ppm for fish culture	1, 2, 3
Lead (Pb)	0.34-0.4 ppm Coho 48-24H TLm 0.1-0.2 ppm Stickleback kill	1/100 TLm	1, 2
Magnesium (Mg)	300 ppm stickleback kill	1/100 TLm; 5-10 ppm for culture	1, 2, 3

TABLE 6: (cont'd.)

PARAMETER	TOXIC LEVEL(S)	RECOMMENDED LIMIT OR RANGE	SOURCE
Manganese (Mn)	Generally harmless below 40 ppm	1/100 TLm	1, 2
Nitrate/Nitrite (NO_3, NO_2)	50 ppm 14-day minnow lethal 50 ppm damage to humans	below 4.2 ppm (normal 10:1 N:P) 0.1 ppm NO_2, 3.0 ppm NO_3 max. for fish culture	1, 2, 3
Oxygen (O_2)	Not below 7 ppm for salmonid incubation Not below 6 ppm for salmonid growth	at/near saturation (never below 4 ppm)	2, 3
pH	Toxic below 6.0, above 9.0	Normally 6.5-8.5 6.5-8.0 for fish culture	2, 3
Phosphate, Total (TPO_4)	0.01-0.05 ppm allows plankton blooms	0.1 ppm max. for rivers (normally below 0.05)	2
Potassium (K)	50 ppm Stickleback kill	1/100 TLm	1, 2
Residue:			
Filtrable (FR)	Generally above 2,000 ppm	normally 70-400 ppm	1
Nonfiltrable (NFR)	1,000 ppm considered high. Fish production drops above 80 ppm	25-80 ppm for good fish production	1, 2
Silica (SiO_2)	Diatom growth inhibited below 0.5 ppm	Normally less than 10 to 60 ppm	1
Sodium (Na)	Not lethal in most compounds below 2 ppm	1/100 TLm: 1-5 ppm for fish culture	1, 2, 3
Sulphate (SO_4)	100 ppm lowest lethal (120-day minnow) 5000-7000 ppm 1-6 day trout kills	-	1
Zinc (Zn)	0.01-4.0 ppm kills salmonids	1/100 TLm; 0-0.5 ppm for fish culture	1, 2, 3

limits (Table 6) show that most parameters fall within acceptable limits for fish culture. Most of the values obtained which exceeded limits, were determinations made by Hach kit, which are considered relatively imprecise at low concentrations (T. Cleugh, pers. comm.). Nevertheless, chromium, copper, and nitrate levels were found to be high. More accurate analyses done by the Cypress Creek Laboratory did not confirm these results, and only one determination, for total iron, came close to exceeding the established criteria.

Suspended solids and algae were subjected to more intensive examination, in view of the problems experienced at the Atnarko hatchery which initially used unfiltered river water (R. Hilland, pers. comm.). At Atnarko, detritus apparently settled out in the eyeing trays and served as a substrate for *Ulothrix* sp. algae. Blue-green epiphytic algae, such as *Cnamaesipnon* sp. and *Oscillatoria* sp., then were able to establish on dead *Ulothrix* and thus were able to spread throughout the trays and bond the eggs into solid mats. Also, diatoms (*Cocconeis, Frustulid,* and *Navicula* spp.) formed gelatinous colonies in the trays, which further reduced water flow. A 10μ filtration system was installed, which eliminated most of the fouling problems; however, *Ulothrix* sp. colonization still occurs, probably because of breakup of the *Ulothrix* sp. chains when the filter is back-flushed. Further filtration to the 5μ level would be beneficial at Atnarko, but expensive; this would require the installation of a filtration gallery in the river or the digging of wells (D. McNeil, pers. comm.).

The composition of suspended solids have been analyzed in a similar manner for all three systems (Table 7). In general, the suspended solids for Mathers Creek and Atnarko River appear to be similar, both in particle size distributions and in loading rates. Pallant Creek, however, is quite different in particle size distribution. On the average, almost one-half of the particles at Pallant were smaller than 5μ, whereas over one-half of the particles at Mathers and Atnarko were 14μ and larger. Also, the size distribution of particles above 14μ is skewed at Pallant; the most abundant particle size class there was 40 - 60μ, versus 14 - 20μ at Mathers and Atnarko. These results indicate that only fairly gross

TABLE 7: Composition of suspended solids (S.S.) as determined by CanTest Ltd., Vancouver.

Date of Sample	Total Mg/ℓ S.S.	Size Distribution As % of Total mg/ℓ 0.45μ	5μ	14μ	Volatiles as % of mg/ℓ Retained Each Filter 0.45μ	5μ	14μ	Total No. Particles on 14μ Filter[a]	Size Distribution As % of Total No. 14-20	20-40	40-60	60-80	80+	
								MATHERS CREEK						
Apr. 10/77	1.8	33	22	45	-	-	50	20,000	60	5	20	10	5	
June 21/77	1.4	57	14	29	50	-	-	10,000	10	40	10	30	10	
Sept. 19/77	7.4	16	22	62	17	44	52	20,000	30	30	20	5	15	
Sept. 20/77	13.0	18	15	66	63	50	38	25,000	40	20	20	12	8	
Sept. 24/77	8.8	2	5	93	-	25	3	23,000	43	13	22	9	13	
Sept. 24/77	5.0	4	8	88	-	50	23	17,000	29	18	29	6	18	
Oct. 5/77	1.4	14	43	43	-	67	50	8,000	25	12	13	37	13	
Oct. 10/77	54.2	1	1	98	-	50	33	(particles too abundant to enumerate)						
Nov. 9/77	3.6	22	33	45	25	17	50	16,000	32	25	31	6	6	
								PALLANT CREEK						
Apr. 10/77	2.0	40	40	20	-	38	50	23,000	66	4	22	4	4	
June 21/77	1.2	66	17	17	50	-	-	7,000	14	14	29	14	29	
Sept. 20/77	8.0	33	32	35	62	23	36	18,000	44	17	11	22	6	
Oct. 5/77	0.6	34	33	33	-	-	-	6,000	16	17	33	17	17	
Nov. 9/77	6.8	3	29	68	-	50	52	20,000	45	20	15	5	15	
Dec. 28/77	1.0	20	20	60	-	-	50	6,000	19	17	17	32	17	
								ATNARKO RIVER (data courtesy of R. Hilland)						
May 18/74	13.6	28	12	60	NO ANALYSIS			11,625	72	14	9	4	1	(avg. of 5 samples)
Aug. 6/74	0.5	16	8	76	"	"		14,070	64	16	10	9	1	(" " 3 ")
Oct. 29/74	15.9	5	57	38	"	"		167,760	48	17	10	10	14	(" " 4 ")
Feb. 24/75	5.6	5	2	93	"	"		237,100	35	19	9	12	24	(" " 1 ")
	AVERAGE	14	20	66					55	17	10	9	10	

[a]per 250 ml of water sample.

(40μ) filtration would be necessary at Pallant, but that a facility located below the south tributary on Mathers Creek could have siltation problems similar to Atnarko. These conclusions could be greatly modified upon examination of the algal samples, as roughly one-half of all particle size classes were composed of volatile (i.e., organic) materials. Final filtration requirements should be set so as to minimize entrainment of potential nuisance species of algae.

The available water temperature data for both creeks (Fig. 16A,B) do not reveal any major problems for fish culture. Temperatures seldom go below $4^{o}C$ or exceed $15^{o}C$, and daily fluctuations generally are restricted to within $2^{o}C$.

Several times in the F381 reports, the water of Mathers Creek has been noted to be particularly dark; in 1977, the water of Mathers Creek developed an unusual black colour near the end of the summer low flow period, and maintained this colour through the fall freshet. The cause and significance of this colouration are unknown, although it is often associated with lake turnover or the draining of swamps (T. Cleugh, pers. comm.).

In connection with the Salmon Enhancement lake fertilization program, Stockner and Shortreed (pers. comm.) surveyed both Mosquito and Mathers Lakes during the summer of 1978. Their data on physical and chemical parameters, and plankton species and abundance, when available, will provide additional information relevant to downstream water quality considerations.

Although Water Survey's discharge data are not yet available for October through December of 1977, fall flows appeared to stay low for an abnormally lengthy period (G. Buxton, pers. comm.).

BIOPHYSICAL SURVEYS

<u>Lower Mainstems</u>

The biophysical surveys of the lower reaches of both watersheds were used to evaluate spawning potentials (Tables 8, 9; Fig. 17, 18), which are summarized below:

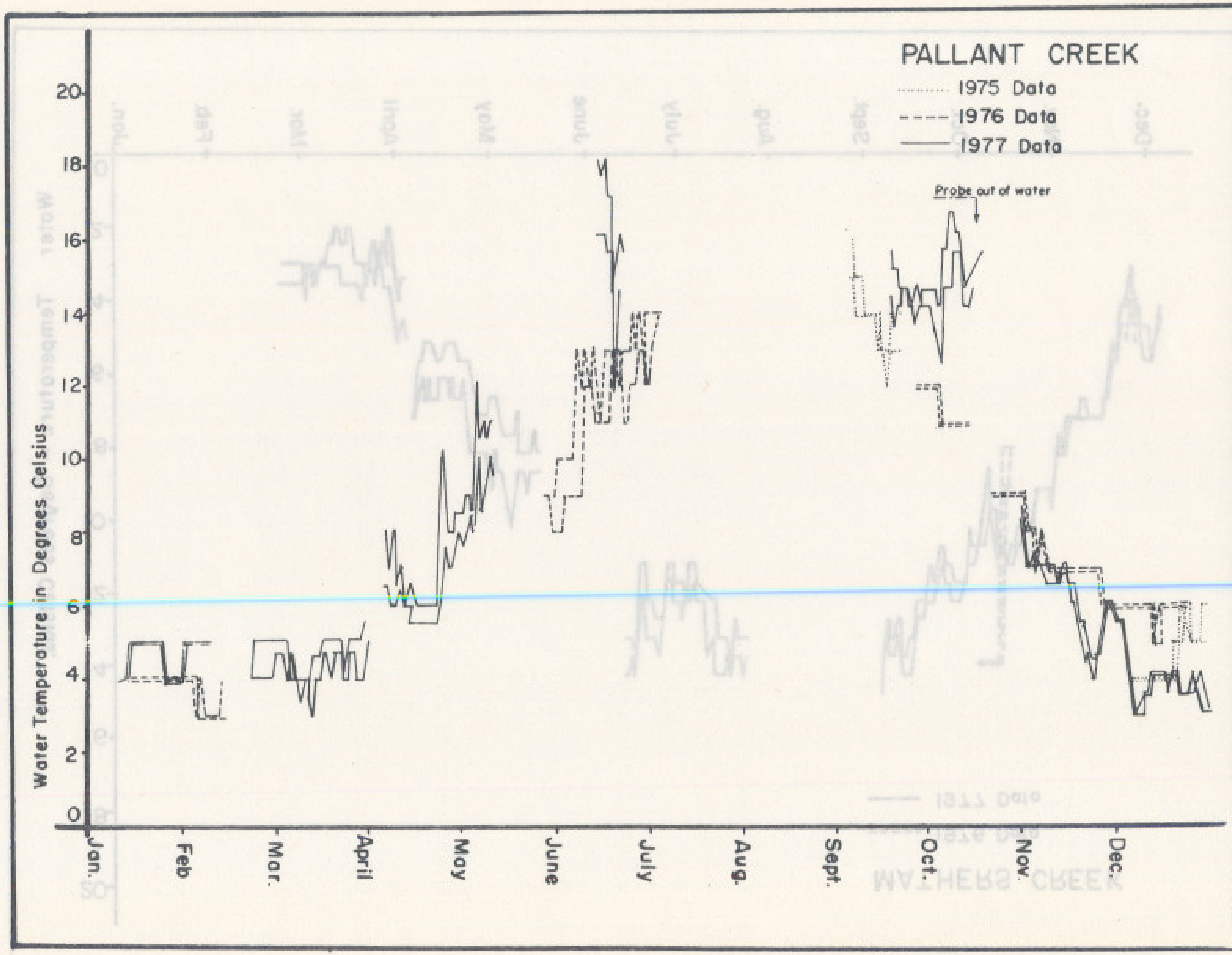


Figure 16A: Maximum and minimum daily water temperatures for Pallant Creek.

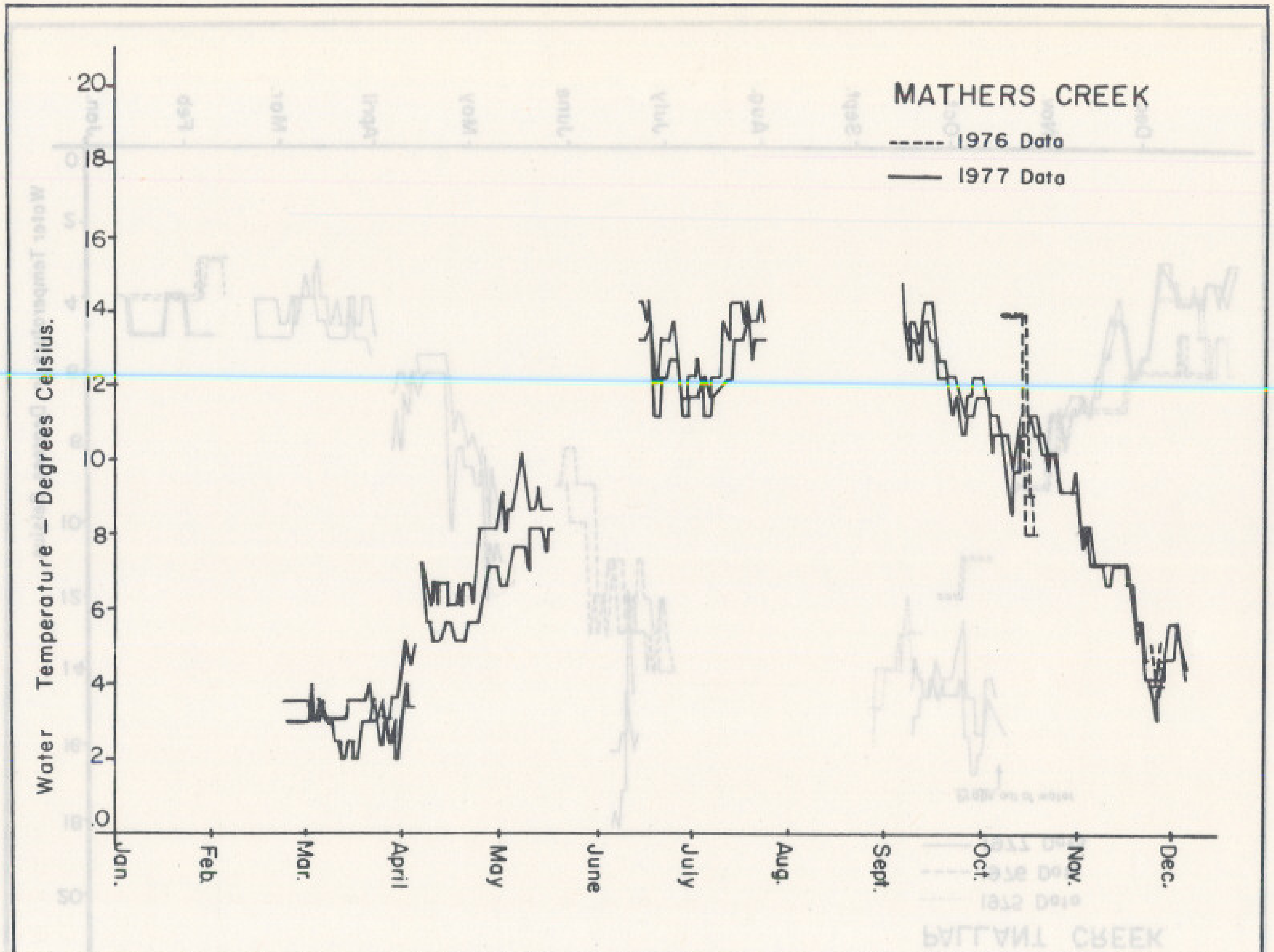


Figure 16B: Maximum and minimum daily water temperatures for Mathers Creek.

TABLE 8: Summary of biophysical inventory data for Pallant Creek (refer to Fig. 17 for location of sections).

Section	Substrate Comp'n*						Comments
	BR	BO	CO	GR	SA	SI	
(Mainstem)							
0-1	30	30	20	20	–	–	Gravel conc. in lower end
1-2	20	10	10	60	–	–	" " " " "
2-5	10	10	10	70	–	LT.	Oxbow cut forming
3-4	30	30	30	10	–	–	Gravel conc. in upper end
4-5	10	40	40	10	–	–	Gravel pocket at lower end only
5-6	–	30	30	30	10	–	
6-7	–	–	20	80	–	–	
7-8	80	10	10	–	–	–	
8-9	–	–	40	60	–	–	
9-Tidal	10	10	10	60	10		
(Tributary)							
Confl.-A	–	20	–	70	–	10	
A-B	–	–	50	30	20	–	Gravel in dewatered dunes
B-C	–	10	60	10	10	20	Clay outcrops
C-D	–	10	60	10	10	20	" "
D-E	–	–	10	70	20	–	" "
E-F	–	–	10	60	10	20	" "

*BR = Bedrock
BO = Boulders (over 15 cm diameter)
CO = Cobbles (8 - 15 cm diameter)
GR = Gravel (1 - 8 cm diameter)
SA = Sand
SI = Silt

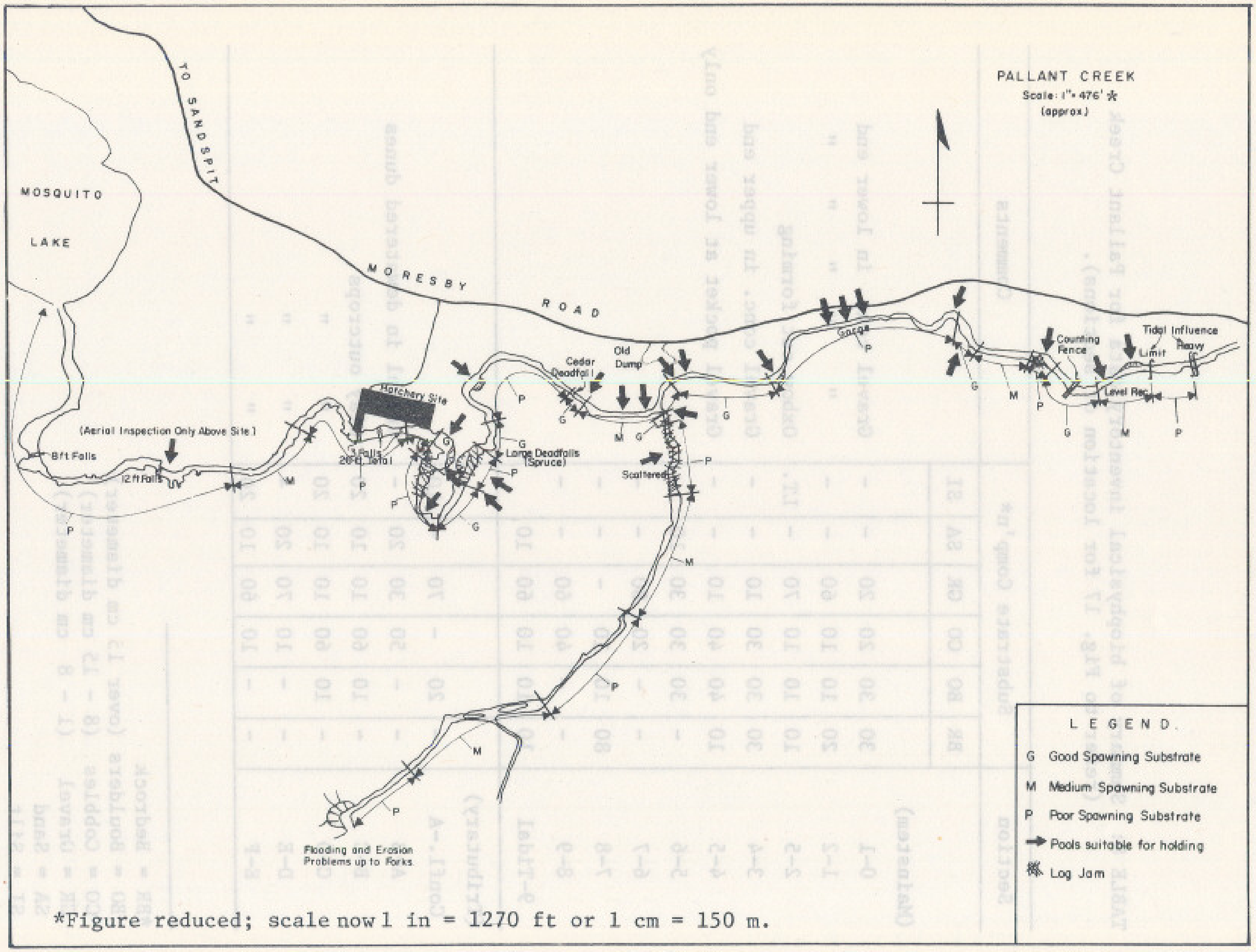


*Figure reduced; scale now 1 in = 1270 ft or 1 cm = 150 m.

Figure 17: Predicted spawning capability of stream substrate in the lower reaches of Pallant Creek (see also Table 8).

TABLE 9: Summary of biophysical inventory data for Mathers Creeks (refer to Fig. 18 for location of sections).

Section	Substrate Comp'n*						Comments
	BA	BO	CO	GR	SA	SI	
0-1	–	70		10	–	20	Pool
1-2	–	30		–	–	70	"
2-3	–	50		10	–	40	"
3-4	–	–		80	10	10	
4-5	–	5		90	5	–	
5-6	–	–		90	10	–	Slow flow
6-7	–	–		60	30	10	Log jams. Swampy
7-8	–	–		20	70	10	Log jams. Pools
8-9	–	–		10	80	10	" " "
9-10	–	–		50	40	10	" " "
10-11	–	–		80	10	10	Some deep pools
11-12	–	–		60	30	10	
12-13	–	–		80	20	–	Some large pools
13-14	–	–		50	30	20	Slow flow
14-15	–	–	–	90	10	–	Light silt cover
15-16	–	–	–	80	20	–	Light silt cover. Scouring @ high flow
16-17	–	–	–	80	20	–	" " " " " " "
17-18	–	–	–	50	40	10	
18-19		20	20	20	20	20	Continuous pool
19-20		50	10	–	10	30	Largely riffles
20-21	–	10	10	70	10	–	Continuous pool
21-22	–	20	50	10	20	–	Mainly pool
22-23	–	40	40	–	10	10	" " , heavy silt cover
23-24	–	20	30	15	20	15	" "
24-25	–	30	20	20	20	10	Log jams throughout
25-26	–	30	20	20	20	10	" " "
26-27	–	20	20	30	20	10	Lower 1/2 pool
27-28	–	10	40	20	20	10	

*See Table 8 footnote.

Figure 18: Predicted spawning capability of stream substrate in the lower reaches of Mathers Creek (see also Table 9).

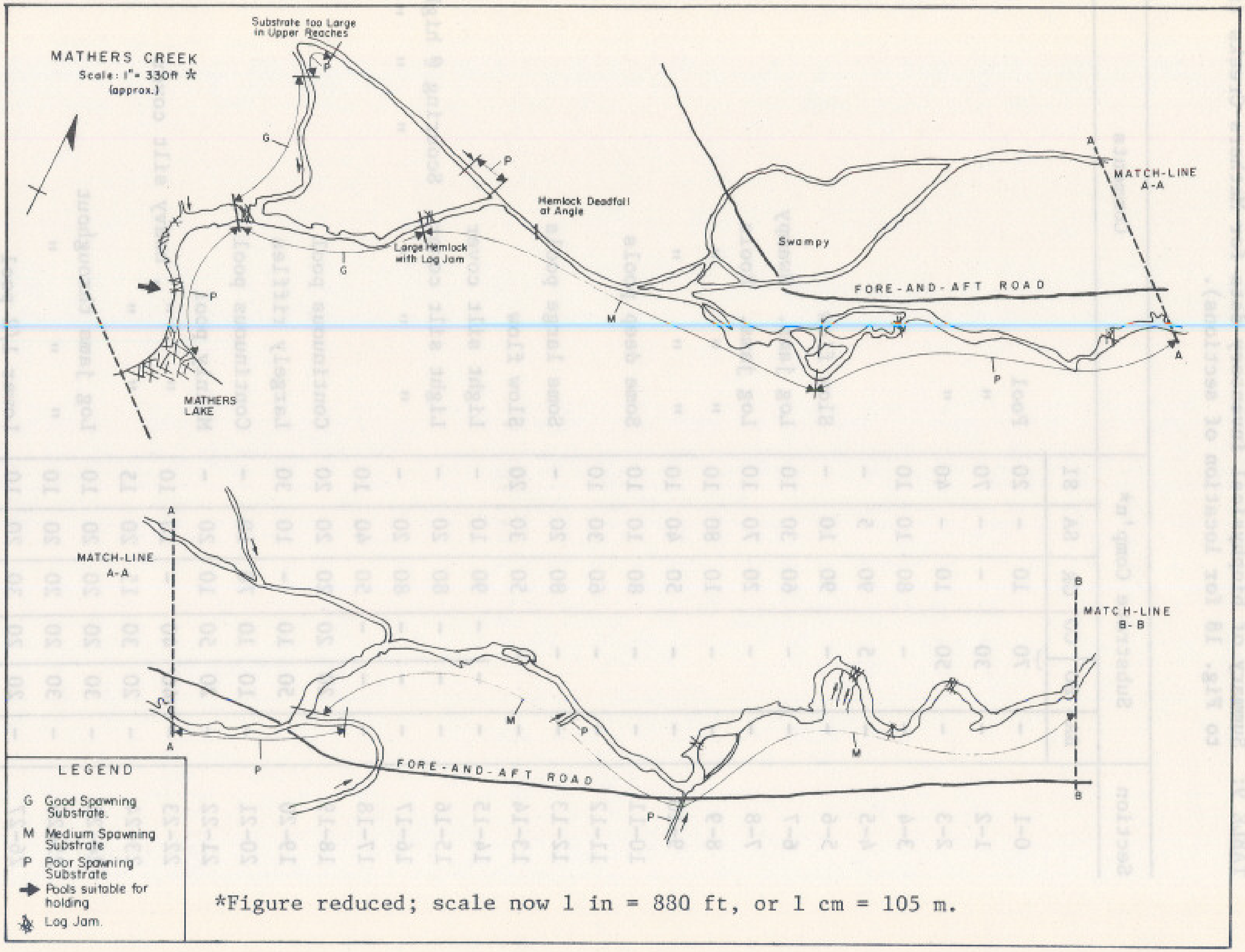
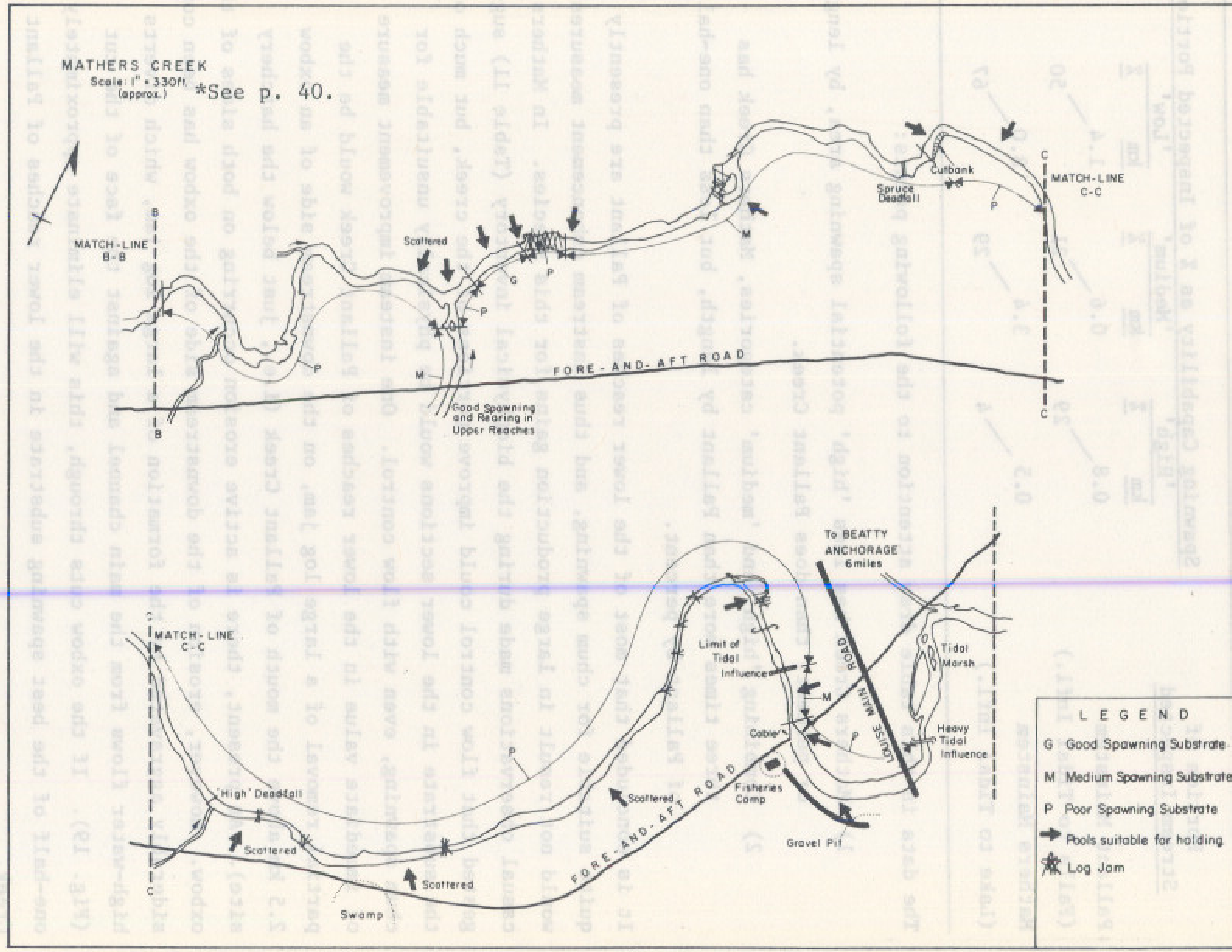


*Figure reduced; scale now 1 in = 880 ft, or 1 cm = 105 m.



(Figure 18: Cont'd.)

Portion of Stream Inspected	Spawning Capability as % of Inspected Portion					
	'High'		'Medium'		'Low'	
	km	%	km	%	km	%
Pallant Mainstem (Falls to Tidal Infl.)	0.8	29	0.6	21	1.4	50
Mathers Mainstem (Lake to Tidal Infl.)	0.5	4	3.4	29	8.0	67

The data in this table draw attention to the following points:

1) Mathers Creek has less 'high' potential spawning area, by length or percent, than does Pallant Creek.

2) Combining 'high' and 'medium' categories, Mathers Creek has three times more than Pallant by length, but less than one-half of Pallant by percent.

It is concluded that most of the lower reaches of Pallant are presently quite suitable for chum spawning, and thus instream enhancement measures would not result in large production gains for this species. In Mathers, casual observations made during the biophysical inventory (Table 11) suggested that flow control could improve portions of the creek, but much of the substrate in the lower sections would be physically unsuitable for chum spawning, even with flow control. One insteam improvement measure of immediate value in the lower reaches of Pallant Creek would be the partial removal of a large log jam, on the downstream side of an oxbow 2.5 km above the mouth of Pallant Creek (i.e., just below the hatchery site). At present, there is active erosion occurring on both sides of the oxbow. However, erosion of the downstream side of the oxbow has been considerably aggravated by the formation of a large log jam, which diverts high-water flows from the main channel and against the face of the cut (Fig. 19). If the oxbow cuts through, this will eliminate approximately one-half of the best spawning substrate in the lower reaches of Pallant Creek.

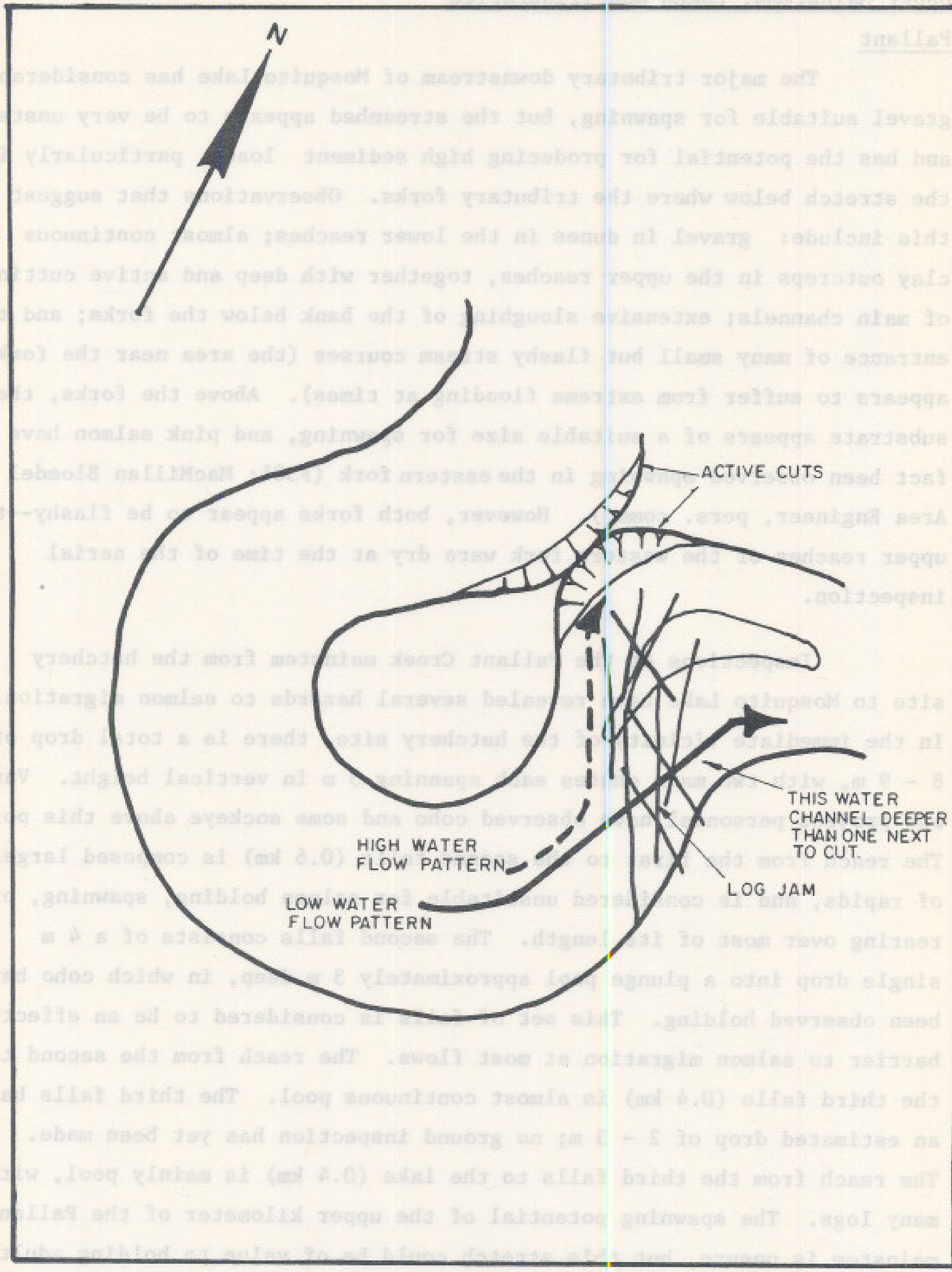


Figure 19: Sketch (not to scale) of oxbow just below hatchery site on Pallant Creek.

Upper Mainstems, Lakes and Tributaries

Pallant

The major tributary downstream of Mosquito Lake has considerable gravel suitable for spawning, but the streambed appears to be very unstable and has the potential for producing high sediment loads, particularly in the stretch below where the tributary forks. Observations that suggest this include: gravel in dunes in the lower reaches; almost continuous clay outcrops in the upper reaches, together with deep and active cutting of main channels; extensive sloughing of the bank below the forks; and the entrance of many small but flashy stream courses (the area near the forks appears to suffer from extreme flooding at times). Above the forks, the substrate appears of a suitable size for spawning, and pink salmon have in fact been observed spawning in the eastern fork (F381; MacMillan Bloedel Area Engineer, pers. comm.). However, both forks appear to be flashy--the upper reaches of the western fork were dry at the time of the aerial inspection.

Inspections of the Pallant Creek mainstem from the hatchery site to Mosquito Lake have revealed several hazards to salmon migration. In the immediate vicinity of the hatchery site, there is a total drop of 8 - 9 m, with two main chutes each spanning 3 m in vertical height. Various project personnel have observed coho and some sockeye above this point. The reach from the first to the second falls (0.6 km) is composed largely of rapids, and is considered unsuitable for salmon holding, spawning, or rearing over most of its length. The second falls consists of a 4 m single drop into a plunge pool approximately 3 m deep, in which coho have been observed holding. This set of falls is considered to be an effective barrier to salmon migration at most flows. The reach from the second to the third falls (0.4 km) is almost continuous pool. The third falls has an estimated drop of 2 - 3 m; no ground inspection has yet been made. The reach from the third falls to the lake (0.4 km) is mainly pool, with many logs. The spawning potential of the upper kilometer of the Pallant mainstem is unsure, but this stretch could be of value to holding adult and rearing juvenile salmon.

From the air, only the western end of Mosquito Lake appears to have littoral benches that could be used for spawning, if substrate composition and flow characteristics are suitable; A. Ede (memo of September 7, 1948, on file 31-2-P6) states that the bottom of Mosquito Lake is muddy in this area. Much of the littoral area is littered with floating and submerged logs. The Pallant Creek tributary of Mosquito Lake has spawning-size gravel for at least 5 km above the lake, save for a small, swampy area in mid-reach, and has no obvious obstructions to fish passage. The easterly fork of the tributary at the west end of Mosquito Lake has suitable spawning gravel throughout its length; the western fork has gravel substrate in its lower reach, but changes to boulder and bedrock after a secondary fork.

Mathers

The B. C. Fish and Wildlife Branch, Stream Inventory Section, flew Mathers Lake and its tributaries and did limited electroshocking for juvenile salmonids in 1976 (Gunville, 1977 MS). Their data confirm our 1977 biophysical observations, although their conclusions as to the utility of mainstem reaches for salmon differ markedly with ours in several instances.

The more easterly of the two major tributaries downstream of the Lake has long stretches of spawning-size gravel right to its headwaters. There are minor log jams throughout its length, which appear to have stabilized gravel movement despite the obviously flashy nature of the stream. The riffle-pool meandering nature of this tributary also give it considerable value as rearing habitat for coho.

The substrate in the upper tributary entering the Mathers mainstem is too large to be of value for spawning, beyond a short stretch just above the confluence.

Mathers Lake has no littoral areas that might support beach spawning. The shoreline is composed mostly of precipitous rock bluffs, and the few beach areas present are covered with logging debris. Most of the lake tributaries have inaccessible falls where they enter the lake, except for the tributary flowing south into the head of the lake. The gravel of this tributary is considered very good for spawning right to the headwater area. A small number of adult salmon (probably coho) were seen at the mouth of this tributary during the aerial inspection, and Gunville (1977 MS) reports coho juveniles in the stream. This tributary also has a secondary outlet to the east, but the substrate there is largely sand and fines. Gunville (1977 MS) notes that low water temperatures (4^{o}C) also may limit the potential of this tributary.

CHUM SALMON SPAWNING STUDIES

Timing

The timing of chum migration and spawning can be summarized for both creeks in 1977 as follows:

	Pallant	Mathers
Fence Installed:	Sept. 9	Sept. 9
First Chums to Pass Fence:	Sept. 11	Sept. 9
Start of Holding by Chums Below Fence:	Sept. 11	Sept. 12
Second-Highest Fence Count:	Sept. 29	Oct. 8
Peak Fence Count of Chums	Oct. 10	Oct. 10
Fence Washed Out:	Oct. 10	Oct. 10
Peak of Spawning:	Oct. 21 (approx.)	?
First Dead Seen:	Sept 21	Sept. 16
Peak No.'s of Dead - Fence:	Oct. 10	Sept. 29
- Below Fence:	Nov. 6	?
- Above Fence:	Nov. 6	?
End of Spawning:	Nov. 30 (approx.)	?

The overall timing seems similar for both creeks; however, secondary fluctuations in fence counts varied between creeks and between days (Fig. 20A,B). From the limited environmental data available, it appears that fish passage generally increased with storm events and their associated increases in flow (Tables 10, 11). Hunter (1959) found a similar situation for Hooknose

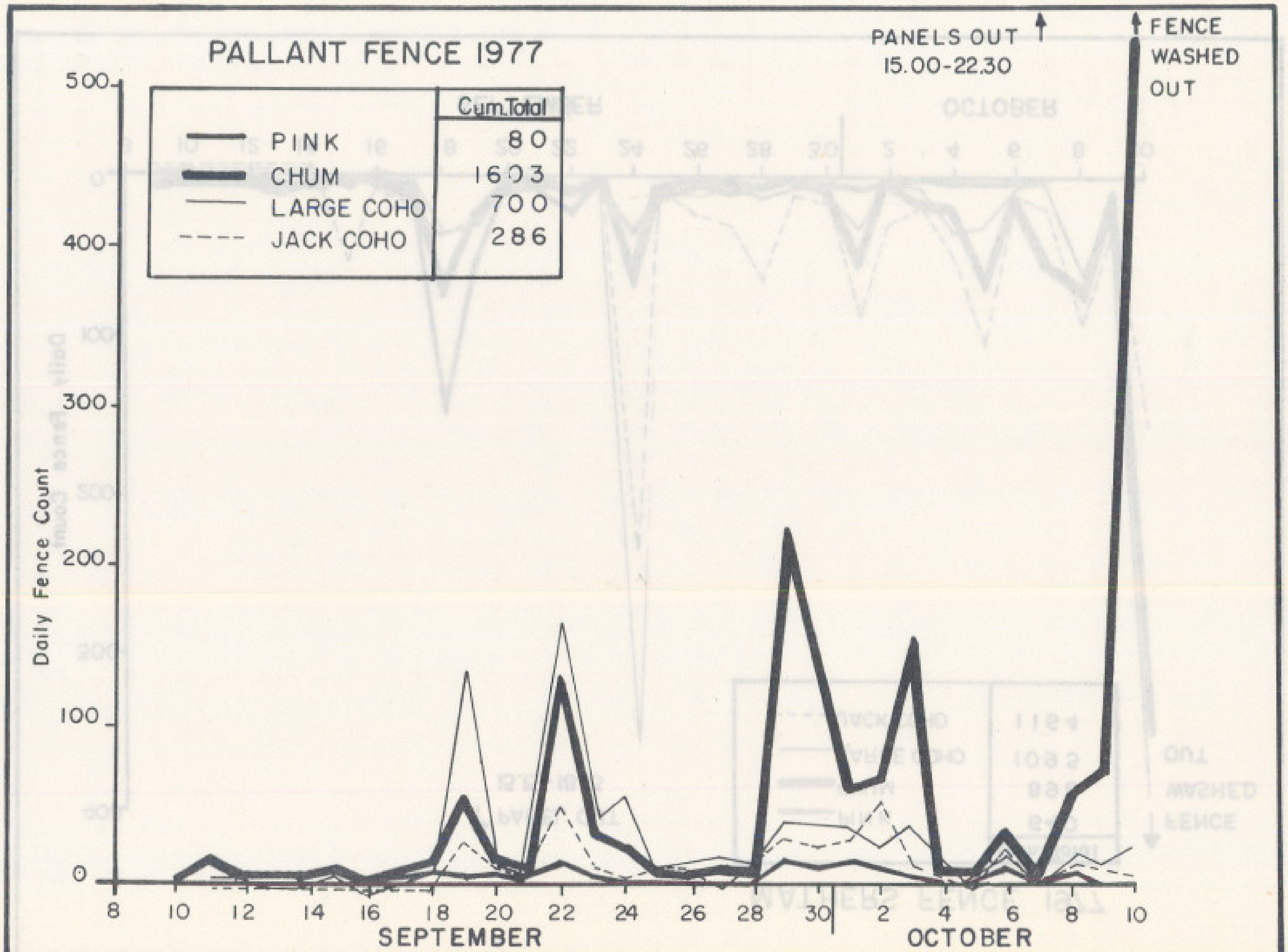


Figure 20A: Daily fence counts of adult salmon at Pallant Creek, 1977.

Figure 20B: Daily fence counts of adult salmon at Mathers Creek, 1977.

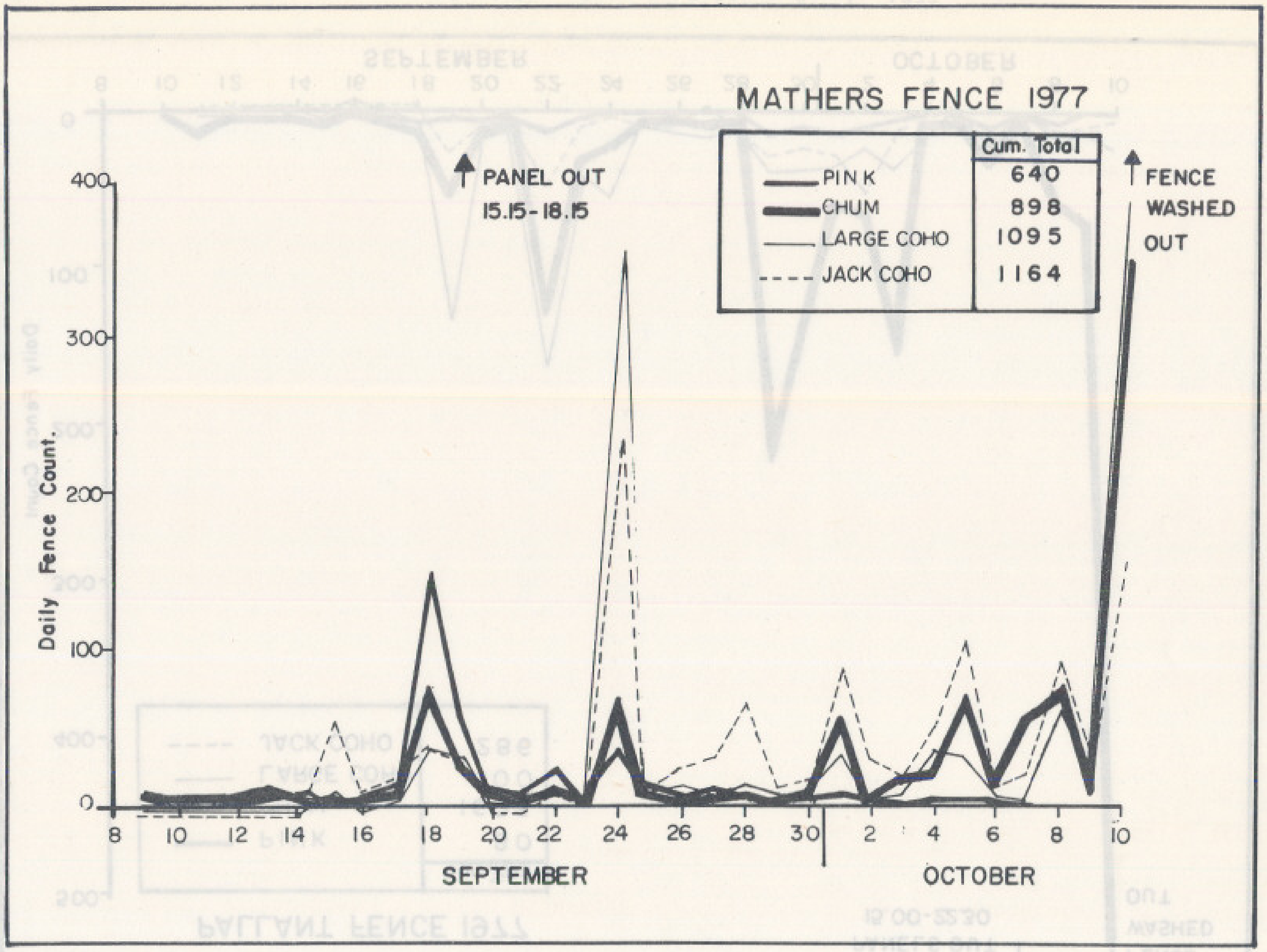


TABLE 10: Fence counts at Mathers and Pallant Creeks, 1977, in relation to some environmental variables. (High-count days are underlined.)

Date	No.'s of Chums Passed			Low-High		High-High		Sandspit Precip'n.	Mathers Gauge Ht.	Max. Dly. Ht. Δ	Pallant Gauge Ht.	Max. Dly. Ht. Δ
	Mathers	Pallant		Tide Ht.[a] (ft)	Time of Peak Tide[a]	Tide Ht.[a] (ft.)	Time of Peak Tide[a]	(2-day running x̄)[b]	(ft.)	(ft.)	(ft.)	(ft.)
Sep. 14	1	0	1	21.9	0140 h	22.2	1350 h	(14-15 0.1 mm	–	–	4.20	0.00
15	3	1	4	21.8	0215	22.5	1430	0.0	–	–	4.18	-0.02
16	0	0	0	21.3	0255	22.5	1500	0.0	–	–	4.16	-0.02
17	2	2	4	20.5	0340	22.0	1600	0.0	–	–	4.14	-0.02
18	69	9	78	19.4	0440	21.0	1635	13.3	–	–	4.12	-0.02
19	25	50	75	18.2	0540	19.9	1740	19.1	–	–	4.27	+0.15
20	0	8	0	17.3	0655	19.1	1855	5.9	–	–	4.23	-0.04
21	1	5	6	17.2	0810	19.0	2030	5.1	–	–	4.20	-0.03
22	9	122	131	17.9	0935	19.4	2130	6.8	–	–	4.40	+0.20
23	0	28	28	19.0	1040	20.1	2235	3.2	0.85	–	4.50	+0.10
24	70	20	90	20.1	1115	20.8	2335	1.6	1.40	+0.55	4.38	-0.12
25	0	4	4	–	–	20.9	1205	0.0	1.00	-0.40	4.32	-0.06
26	1	3	4	21.3	0025	21.5	1240	0.0	0.90	-0.10	4.29	-0.03
27	5	6	11	21.4	0105	21.8	1320	0.0	0.85	-0.05	4.27	-0.02
28	6	4	10	21.2	0145	21.9	1345	0.0	0.82	-0.03	4.25	-0.02
29	1	215	216	20.9	0215	21.5	1420	0.5	0.79	-0.03	4.25	0.00
30	7	128	135	20.1	0300	20.9	1455	3.5	0.79	0.00	4.26	+0.01
Oct. 1	56	56	112	19.2	0330	20.1	1530	4.2	0.87	+0.08	4.48	+0.22
2	4	63	67	18.1	0415	19.1	1610	1.2	0.85	-0.02	4.40	-0.08
3	18	146	164	17.0	0455	18.0	1650	3.6	0.79	-0.06	4.35	-0.05
4	22	6	28	16.1	0555	17.1	1730	4.3	0.81	+0.02	4.70	+0.35
5	73	2	75	15.5	0655	16.4	1850	0.7	0.97	+0.16	4.47	-0.23
6	14	31	45	15.7	0825	16.5	2010	0.0	0.84	-0.13	4.44	-0.03
7	59	8	67	16.5	0935	17.1	2120	3.5	0.97	+0.13	4.60	+0.16
8	72	56	128	17.7	1030	18.2	2220	4.2	1.10	+0.13	4.64	+0.04
9	9	69	78	19.0	1105	19.3	2315	1.2	0.98	-0.12	4.47	-0.17
10	350	549	899	20.4	1135	20.5	2345	15.8	1.39	+0.41	4.67	+0.20

[a]Prince Rupert Tide Tables.

[b]Precipitation measured @ 1000 h. on date.

TABLE 11: Selected comments from projects' daily logs on days of high (over 50 chums) fence counts for Mathers and Pallant Creeks, 1977.

Date	Stream	No.'s Passed	Comments
Sep. 18	M (=Mathers)	69	- steady rain all day (after long dry period).
19	P (=Pallant)	50	- steady rain on 18th, rising water, but bear damage and undermining problems probably allowed spawners upstream.
22	P	122	- water rising in afternoon brought fish through (Mathers level also up).
24	M	70	- Most fish through in a.m., when river high and turbid (dropped in p.m.).
29	P	215	- rain began 1700 hrs; night movement of fish (Mathers level steady and clear).
30	P	128	- pulled 5 panels @ 2400 hrs because of high water and leaves (Mathers steady).
Oct. 1	M,P	56,56	- river up overnight at both sites; level dropping through day (no ppt).
2	P	63	- fish seem attracted to lights.
3	P	146	- rain, water rising steadily; moved into cabin in p.m. (better coverage?).
5	M	73	- no ppt., water level dropping.
7			- showers and water up at both sites; panels pulled 1300-0830 hrs at Pallant.
8	M,P	72,56	- little ppt., weather variable at both sites (but levels up).
9	P	69	- Mathers lower and clearer; chums through Pallant in night.
10	M,P	350,549	- heavy rain, water up and turbid; both fences washed out in night.

Creek chums. For reasons discussed in the section on climate, the impact of a given storm can vary greatly between the two watersheds, and explains most of the between-creek variation in fence counts. Unfortunately, the fence could not be held during the crucial high-water period after October 10. Most of the chums appeared to hold off the mouths of the creeks until a freshet developed, then migrated upstream rapidly.

In comparison to past years' observations (Table 12), the start of the 1977 chum spawning run was slightly earlier than average, but the peak of spawning was delayed one to two weeks, and the end of spawning was up to five weeks later than average. This may have been an artifact caused by the more intensive survey in 1977, but the abnormally long period of low flows (see p. 34) is thought to have been largely responsible for the delay. Also, spawning was stretched out considerably by the late entry of a few fresh fish; the bulk of spawning was completed by the first week of November.

Variations in migration rate with time of day were examined (Appendix 5), and were found to fluctuate considerably both by system and by day. In general, counts were lowest during the day, and began to build in the evening (Fig. 21). At Mathers Creek, migration was steadier through the day, and counts had dropped off by midnight; at Pallant Creek, counts built sharply in the evening, and significant movement was recorded even at 0200 - 0400 hrs.

Distribution

Pallant

Chum salmon holding and spawning areas in 1977 are outlined in Fig. 22A. For the most part, chum salmon spawned in those areas of predicted high spawning potential (Fig. 17). However, because of poor accessibility, the south tributary was not checked adequately; at the time of the substrate survey, one spawned-out female chum carcass was found in the tributary 1.5 km from its confluence. Some estimate of the degree of utilization of the tributary may be possible after the redd sampling and fry enumeration studies, which are to begin in January, 1978.

TABLE 12: Timing of 1977 chum spawning in Mathers and Pallant Creeks in comparison to previous F381 observations (Appendix 1).

		Dates of Chum Spawning				
		Start		Average	End	
Yr(s)	Creek	Earliest	Average	Peak	Average	Latest
1948-76	Pallant	1st wk. Sept.	3rd wk. Sept.	2nd wk. Oct.	4th wk. Oct.	3rd wk. Nov.
1948-76	Mathers	1st wk. Sept.	3rd wk. Sept.	1st wk. Oct.	3rd wk. Oct.	3rd wk. Nov.
1977	Pallant	2nd wk. Sept.	2nd wk. Oct.	3rd wk. Oct.	1st wk. Nov.	4th wk. Nov.
	(Mathers assumed similar to Pallant in 1977)					

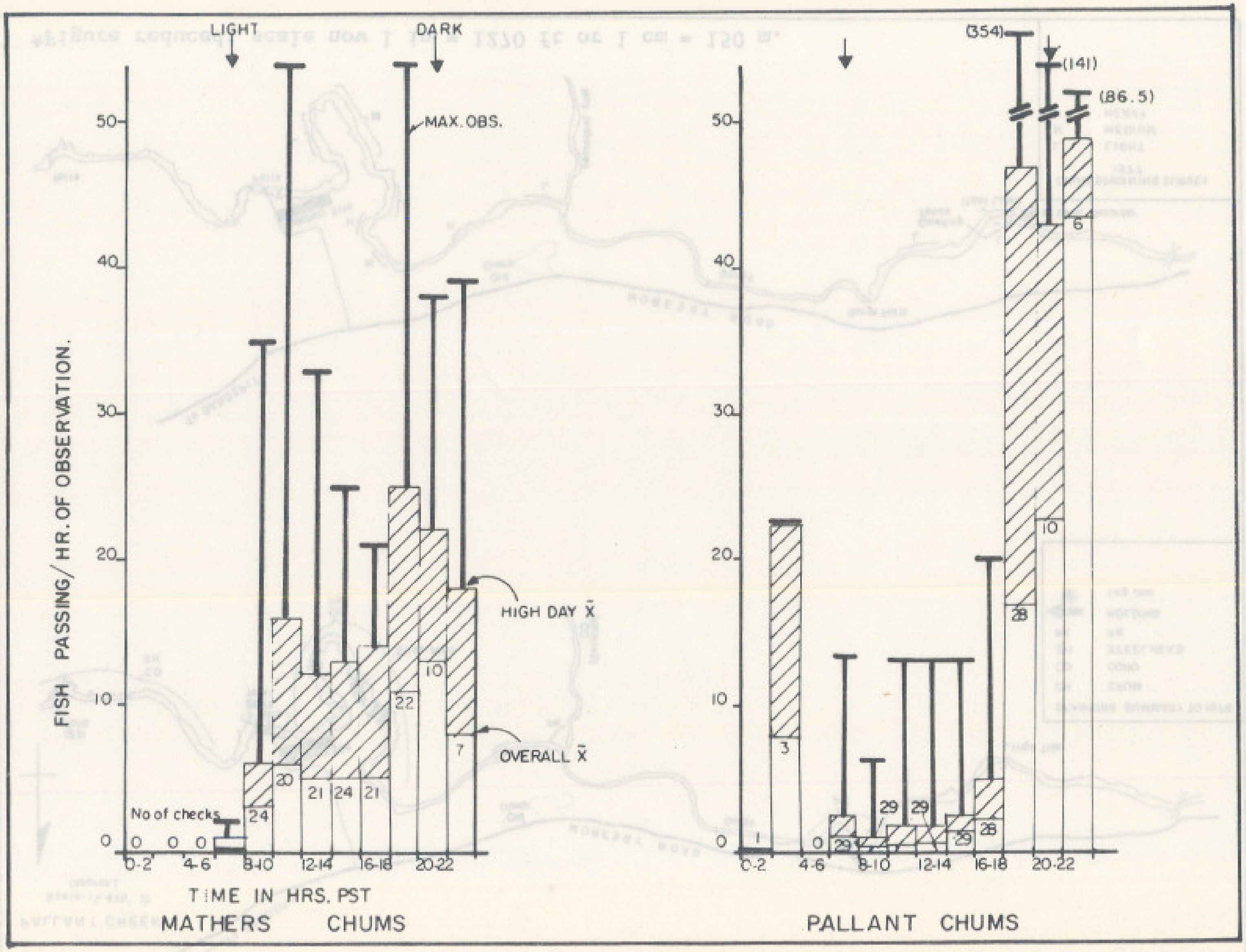


Figure 21: Diurnal variation in movement of adult chum salmon past the Mathers and Pallant counting fences, 1977.

Figure 22: Distribution and relative abundance of chum salmon in Pallant Creek; 1977, in comparison to summary up to 1976 made by G. A. Buxton.

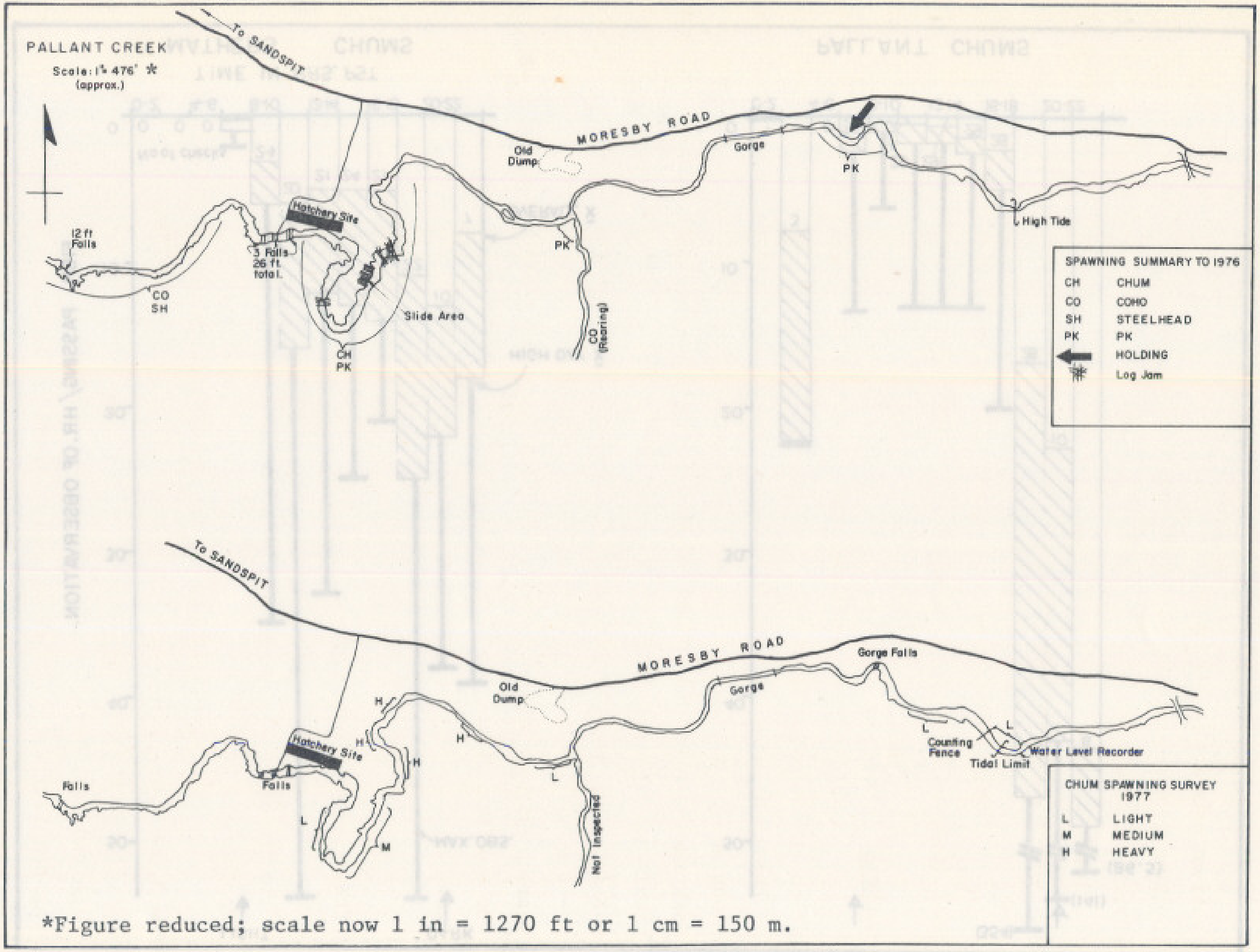


*Figure reduced; scale now 1 in = 1270 ft or 1 cm = 150 m.

The 1977 chum spawning distribution is consistent with past observations (Fig. 22B, Appendix 1); although some heavy spawning occurred farther downstream than would have been predicted either from the substrate survey or from past distributions, the run has been known to be heavier in the lower reaches in some years. Past observations also would suggest that the chum utilization of the south tributary is low.

Only three chums were tagged; of these, one was seen in the gorge pool (0.4 km above the fence), and one was observed near the oxbow.

Mathers

Holding and spawning areas for chum in 1977, in the lower 3 km of the Mathers mainstem only, are shown in Fig. 23. Lack of accessibility of the upper 6 km is a major problem in this watershed, and aerial inspections are of little value here, due to the heavy riparian vegetation and dark water. Very few chums spawned in the lower 3 km, including the one predicted high-potential area, in 1977; according to past reports (Appendix 1), chum salmon spawn in the lower mainstem tributary and in the lower 5 - 6 km of the mainstem, with the distribution contracting in low-return years. Regular inspection of the lower tributary and the upper 6 km of the mainstem will be a priority of the 1978 Mathers fall program, but spawning is predicted to be scattered in this area.

Only two of the 25 chums tagged were observed, within the week after their release, approximately 0.5 km upstream of the fence.

Abundance

Pallant

The best estimate of the total mainstem chum spawning population is 3,000 fish. The fence count reached only 1,600 before the fence washed out, forcing visual estimation of the run on the spawning grounds during high and dark water conditions. A return of 3,000 chums is poor, considering the 1973 and 1974 parent populations of 25,000 and 8,000, respectively, and the long-term (1934-1976) average return of 18,000 spawners (Appendix 1).

Figure 23: Distribution and relative abundance of chum salmon in the lower 3 km of Mathers Creek, 1977.

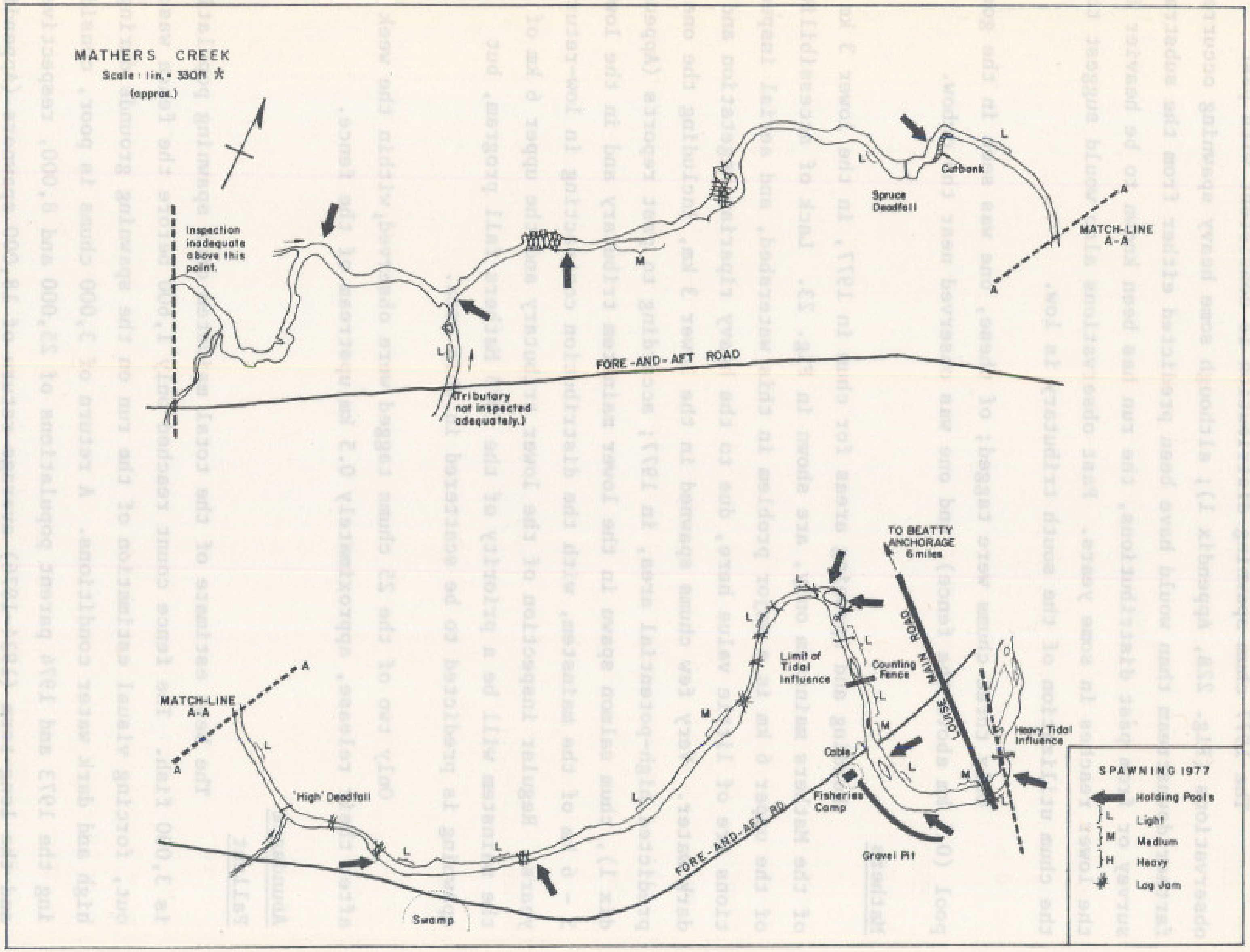


*Figure reduced; scale now 1 in = 880 ft or 1 cm = 105 m.

Mathers

No good estimate of the total chum return can be made; the fence count reached 900 before washout, subsequent observations were inadequate for even a visual estimate of the total number of spawners, and very few dead were recovered. Parent populations were 3,000 in 1973 and 10,000 in 1974, and the long-term (1934-1976) average return is 7,000. A best guess would be 2,000 - 3,000 chum spawners for Mathers in 1977.

Spawner Characteristics

Sex Ratios

Sex ratios were calculated for each sample method and location, as well as overall (Table 13). Mathers appeared to have fewer males overall than Pallant, but only the early portion of the Mathers run was sampled. Examination of the Pallant data in conjunction with the dates of sampling indicate that males were less abundant during the early portion of that run. If comparable sampling periods are selected, the Pallant and Mathers sex ratios were similar.

The overall results for Pallant are comparable to those of Hunter (1959) for Hooknose Creek, a central coastal stream. The percentage of Hooknose males varied from 45 to 50 and averaged 49 percent over 1947 to 1956. Sano (1966) states that, for Asian stocks of chum salmon, sex ratio varied with age (more males in the younger-year classes). This did not appear to be the case at Pallant or Mathers (Table 16).

Age Compositions

Overall age compositions (Table 14) show 4-year-olds to dominate the returns to both creeks. Age 3 fish are the sub-dominant group, and ages 2 and 5 also are lightly represented. Mathers Creek appears to have more 3-year-old fish than does Pallant, but this may be a result of sampling only the early portion of the run at Mathers. Breakdown of Pallant age compositions by sampling date, method, and site (Table 15) shows a trend to recovering more age 4's in dead pitches, which occurred largely after the third week of August. No consistent spatial trend could be identified from the data in Table 15.

TABLE 13: Sex ratios of chum salmon sampled at Pallant and Mathers Creeks in 1977, by sampling dates, methods and sites.

Date(s)	Method	Site	No. Males	No. Females	Total	% Males
PALLANT CREEK						
Oct. 8-9	Live Tagging	Fence	1	2	3	33
Sep.21-Oct.10	Dead Pitch	Fence	15	30	45	33
Sep.28-Nov.10	Dead Pitch	Above Fence	74	91	165	45
Oct. 2-Nov.16	Dead Pitch	Below Fence	138	118	256	54
Sep.21-Nov.16	Total for Pallant		228	241	469	49
MATHERS CREEK						
Sep.25-Oct.10	Live and Dead	Fence	13	24	37	35

TABLE 14: Age compositions (as %) of chum salmon sampled at Pallant and Mathers Creeks in 1977, by sex.

	n	Age in Years 2	3	4	5
PALLANT CREEK					
Male	208	-	34	66	<1
Female	213	1	36	63	<1
Total	421	<1	35	64	<1
MATHERS CREEK					
Male	11	-	9	82	9
Female	23	-	13	83	4
Total	34	-	12	82	6

TABLE 15: Age compositions (as %) of chum salmon sampled at Pallant and Mathers Creeks in 1977 by sampling method, date, and location

	n	Age in Years 2	3	4	5
Method					
Live Sampling	9	-	78	22	-
Dead Pitch	413	1	34	65	1
Date					
Sep. wk. 4	23	-	52	48	-
Oct. wk. 1	20	5	55	40	-
wk. 2	22	-	59	36	5
wk. 3	0	-	-	-	-
wk. 4	34	-	32	68	-
Nov. wk. 1	191	1	25	74	1
wk. 2	82	-	33	67	-
Area					
Below Fence	233	1	34	65	1
At Fence	49	-	61	37	2
Above Fence	140	-	28	72	-

TABLE 16: Hypural and fork lengths (in mm) of chum salmon sampled at Pallant and Mathers Creeks in 1977, by sex.

	n	Hypural Length Avg.	Hypural Length Range	Fork Length Avg.	Fork Length Range	HL:FL Regression
Pallant:						
Male	227	570	426-640	733	574-884	HL=.71FL+48
Female	242	561	500-621	697	590-810	HL=.72FL+58
Combined	469	565	426-640	714	574-884	HL=.71FL+53
Mathers:						
Male	13	603	543-647	744	697-795	-
Female	24	578	505-662	707	630-773	-
Combined	37	587	505-662	726	630-795	HL=.89FL-56*

*Regression calculated from total of seven fish only; HL values for remaining 30 fish predicted using this regression.

TABLE 17: Average fork lengths of chum salmon: 1977 Pallant and Mathers data in comparison to other studies.

Study	2 n	2 mm	3 n	3 mm	4 n	4 mm	5 n	5 mm
Pallant, 1977:								
Male	0	-	70	683	137	748	1	827
Female	2	690	75	694	134	730	1	770
Mathers, 1977:								
Male	0	-	1	720	9	776	1	844
Female	0	-	3	700	19	741	1	813
Scott and Crossman, 1973 (sexes combined)								
Fraser River		-		681		732		826
Johnstone Str.		-		648		724		790
Yukon River		597		648		696		-

(Age in Years: 2, 3, 4, 5)

The overall age compositions are similar to those found in studies of other chum streams, which have been reviewed by Scott and Crossman (1973) and Sano (1966):

	Age in Years 2	3	4	5	6	
Hooknose Creek	0	20	72	8	0	(%)
Nile Creek	0	24	76	0	0	(%)
Hokkaido (average)	<1	22	63	15	<1	(%)

(Generally make up over 90% of return in B. C. streams) [ages 3 and 4]

Hunter (1959) noted that the oldest fish were the first to enter Hooknose Creek; if anything, the reverse would apply to Mathers and Pallant Creeks, in that age 3 fish appear to enter before the age 4's.

All adult chum scales were examined for estuary growth checks; only 6 percent of the chums from Mathers and 8 percent of Pallant fish showed such a check, usually at the 5th or 9th circuli. The rest of the fish sampled showed circuli patterns indicative of rapid entry into the sea (Y. Yole, pers. comm). Although this should be verified by fry surveys, it seems that neither estuary is heavily utilized by rearing chums.

Lengths

Hypural and fork lengths of chum salmon have been summarized by sex and creek (Table 16). Male chums are significantly ($p<0.05$) larger than females in both systems. Mathers chum were found to be significantly larger than Pallant chums, if sexes were separated (Fig. 24); this result was surprising, in that Mathers was shown to have relatively more age 3 fish and fewer age 4 fish than Pallant. Breakdown of fork lengths by sex and age for both creeks (Table 17) showed that, by sex, Mathers chums were consistently larger than Pallant fish in every age class.

The hypural length-fork length regression equations developed for Pallant (males and females separated) and Mathers (both sexes combined)

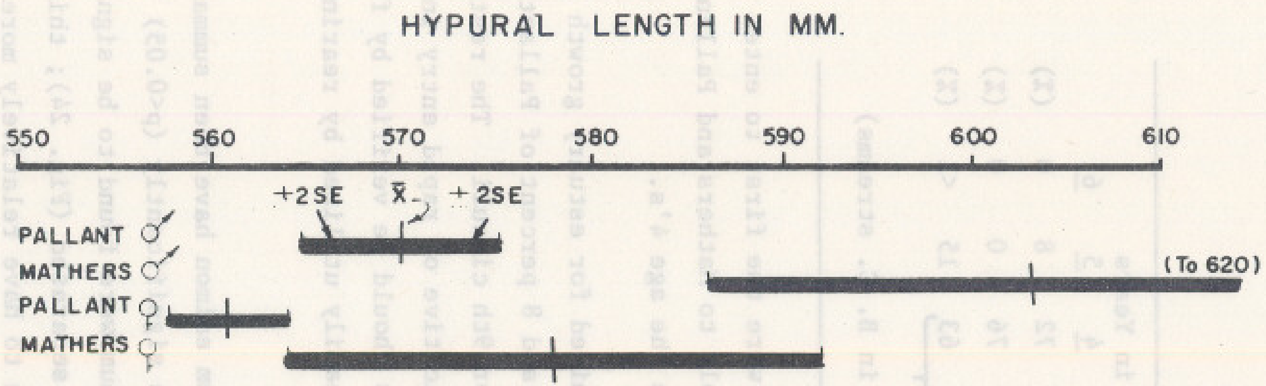


Figure 24: Comparison of hypural lengths by sex, for Pallant and Mathers chum salmon, 1977.

in Table 16 are not statistically different from one another, which suggests that changes in body length with the onset of maturity are similar for both sexes and both creeks.

Review of the lengths reported in the literature (Table 17) show Pallant chums to be average in size for the B. C. coast, but Mathers chums to be larger than usual. Sano (1966), in his summary of Asian chum stocks, reported that average fork lengths for different streams varied from 555 to 776 mm for females (overall mean 670 mm) and from 577 to 772 mm for males (overall mean 694 mm). In comparison, Mathers and Pallant chums can be considered large, but not abnormally so. Sano's review also indicates that males are generally larger than females.

Fecundities

Five female chums were sacrificed at each creek, and their eggs were counted. The average fecundity of the Pallant Creek samples was 2,501 (range 1,937 - 3,302) eggs; at Mathers, the average fecundity was 3,219 (range 2,570 - 3,697) eggs. A linear regression of female hypural length versus fecundity was done on the combined samples from both creeks; visual inspection of the point scatter for each creek indicated that the relationships were similar (Fig. 25). The resultant equation:

$$\text{No. of Eggs} = 10.97 \text{ (Hypural Length in mm)} - 3{,}422$$

was used to predict the average fecundity from the more representative average female hypural length.

Stream	Avg. HL	Predicted Avg. Fecundity
Pallant	561	2,732
Mathers	578	2,919

Mathers and Pallant fecundities were average compared to those found in other studies (Table 18).

Egg Retention

The percentages of eggs retained in female carcasses (Table 19) were calculated using the length-fecundity regression equation that had

Figure 25: Regression of female hypural length versus egg count for Mathers and Pallant chum salmon, 1977.

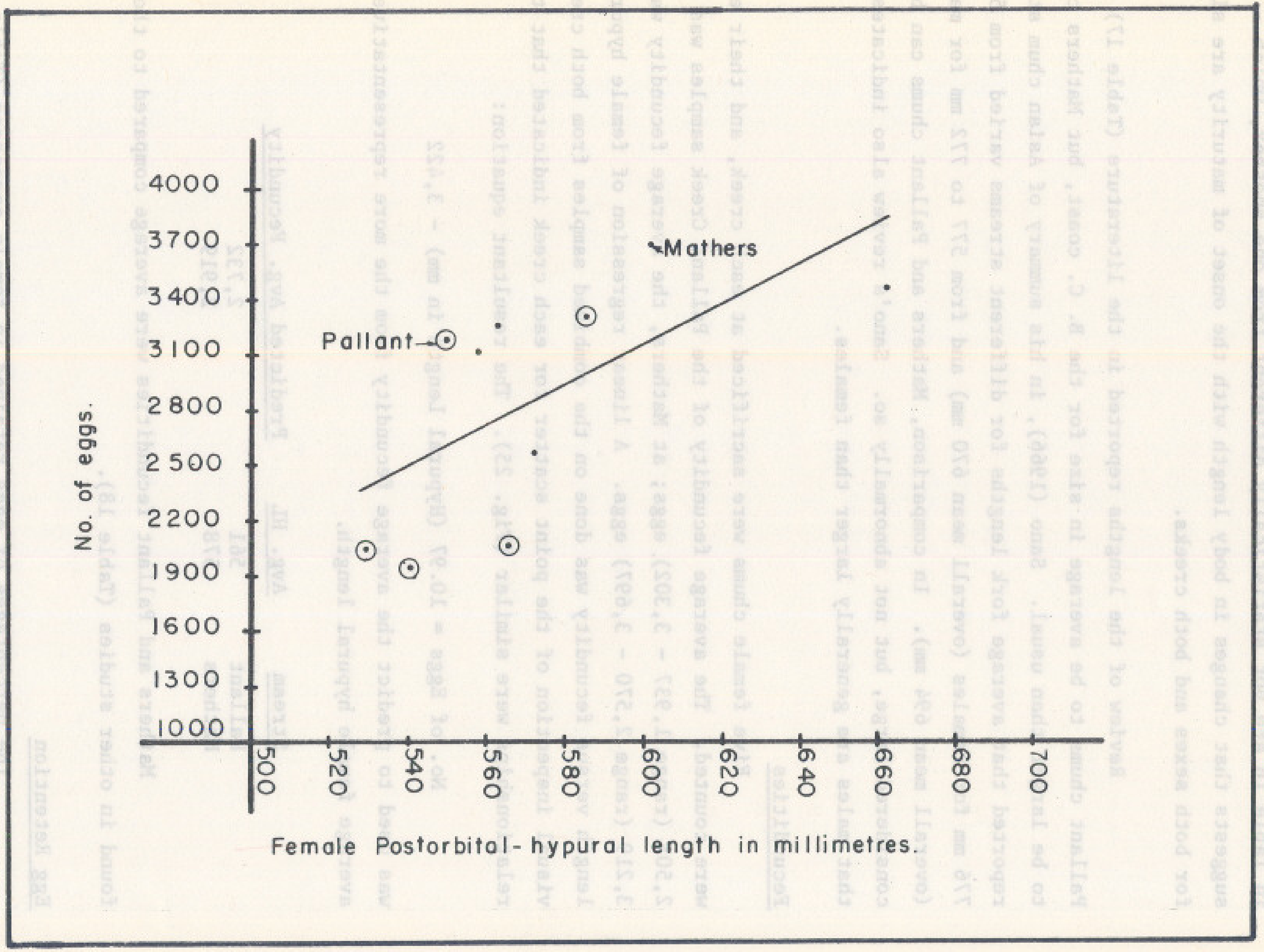


TABLE 18: Fecundities of female chum salmon sampled in 1977 at Pallant and Mathers Creeks, in comparison to other studies.

Study	n	No. of Eggs Average	No. of Eggs Range
Pallant, 1977	5	2732[a]	1937-3302
Mathers, 1977	5	2919[a]	2570-3697
Hart, 1973 (Asian stocks)	?	-	
Summer-run			2000-3000
Winter-run			3000-4300
McPhail and Lindsey, 1970 (Alaskan/Yukon stocks)	?	-	up to 4000
Neave, 1966 (B.C. stocks)	?	2400-3100	up to 4000
Sano, 1966 (Asian stocks)	?	2366-3740	909-7779

[a] Adjusted to average length.

TABLE 19: Egg retentions of female chum salmon sampled in 1977 at Pallant and Mathers Creeks.

Location	n	Avg. % Egg Retention	Range % Egg Retention	Percent of Samples Retaining:			
				0%	0-10%	10-50%	50-100%
Pallant - Above Fence	118	2.0	0.0-100.0	37	59	2	2
- Below Fence	117	2.6	0.0-100.0	48	47	3	2
- Overall	235	2.3	0.0-100.0	43	53	2	2
Mathers - Overall	6	1.5	0.0-3.3	33	67	0	0

been developed for both stocks (Table 16). The average retention of 1.5 percent at Mathers Creek was identical with the values reported by Hunter (1959) for Hooknose Creek between 1951 and 1956 (range 0.2 - 4.7 percent), and by Sano (1966) for Asian chum stocks. The percent retention was higher at Pallant, particularly below the counting fence site. The higher retention experienced at Pallant probably resulted from harassment by anglers of chums holding in pools. D. Klimek estimated a 1977 sports catch of at least 250 coho from Pallant Creek, with 75 percent of the catch taken from the pool just below the fence site. Up to six anglers were seen fishing this one pool of 10 - 15 m diameter, and snagging of chum salmon was common.

SUMMARY AND CONCLUSIONS

GENERAL

Under the auspices of the Salmon Enhancement Program, biological reconnaissance studies began in August of 1977 on two chum salmon spawning streams of the Queen Charlotte Islands, Pallant Creek and Mathers Creek. The five-year study objectives are to provide the biological data necessary for effective design and operation of enhancement facilities on these creeks. This report supplies background data on both watersheds, and presents preliminary analyses of the 1977 chum spawning studies. Those analyses are summarized below:

Water Quality

Those water quality parameters that have been measured, are at acceptable levels for hatchery operations. Particle size analyses indicate that only fairly gross filtration would be necessary at Pallant Creek, but that Mathers Creek could be subject to silting problems similar to those experienced at Atnarko. Filtration requirements may be altered once the results of algal analyses are known.

Biophysical Inventory

The Pallant survey indicated that there was a considerable amount of high-potential spawning substrate, particularly in the mainstem above the major tributary and below the first set of falls. Subsequent spawner distribution confirmed the habitat evaluation method. A similar survey on Mathers Creek revealed very little high-potential spawning substrate; spawning was therefore predicted to be more scattered than at Pallant. The first major tributaries upstream of the estuary also show some potential, but require further investigation. The major lake tributaries of both systems show considerable potential for species such as sockeye and coho. On Pallant Creek, erosion of an oxbow has been aggravated by a log jam, and threatens to markedly decrease the amount of high-potential spawning substrate available.

Spawning Escapements

Timing. In 1977, both streams appeared similar in overall timing of fence passage, allowing for inter-system variations in precipitation and resultant flows. After a major freshet washed out both fences on October 10, good numbers of spawning fish could be located in Pallant Creek only. Estimated timing for both creeks in 1977 was:

Entry	- Start:	September 10
	- Peak:	October 10
Spawning	- Start:	September 15
	- Peak:	October 21
	- End:	November 7 (few fresh chums to November 30)

Dead pitches were most productive in the first week of November on Pallant; only a few dead were recovered in Mathers Creek at any time. In comparison to previous years' observations, the runs started similarly but then were protracted, due to an abnormally lengthy low-flow period. Passage of chums past the fences appeared to build in the evenings.

Distribution. At both creeks, the bulk of the chums did not hold in freshwater, but instead moved in rapidly from Cumshewa Inlet when stream flows increased. At Pallant Creek, mainstem spawning was concentrated in six stretches, between the first tributary upstream of the estuary and downstream of the first set of falls. At Mathers Creek, spawning was scattered in the mainstem below the first tributary upstream of the estuary, and was lighter than expected from fence counts. It is thought that the majority of spawners moved well upstream of this point.

Abundance. Fence washouts on October 10 prevented accurate assessment of the numbers of spawners. Visual inspections resulted in a best estimate of 3,000 chums in the Pallant mainstem, which was poor compared to brood-year and average returns. An estimated 2,000 - 3,000 chum spawned in Mathers Creek, but the accuracy of this estimate is considered to be poor.

Spawner Characteristics

All characteristics examined, save the size of Mathers fish, were comparable with those reported in other studies.

Sex Ratios were 49 percent males at Pallant, and 35 percent males at Mathers. Separation of the Pallant data by time periods indicated that males may tend to enter earlier in the run than females; this would explain the lower male percentage at Mathers, as only the early portion of the run was sampled there.

Age composition consisted of ages 2 to 5, dominated primarily by 4's (Pallant, 64 percent; Mathers, 82 percent) and secondarily by 3's (Pallant, 35 percent; Mathers, 12 percent). Separation of Pallant data by time periods showed a trend for 4's to enter later in the season, which again may explain the higher number of 3's in the Mathers sample. Examination of adult scales also indicated that estuary rearing of the fry is minimal; less than 10 percent of the fish sampled showed probable estuary growth checks on their scales.

Lengths of males were found to be greater than females in every age class. The lengths of Mathers chums were significantly greater than those of Pallant fish, and also were larger than reported in other B. C. systems.

Fecundities averaged 2,732 eggs for the Pallant Creek samples and 2,919 for the Mathers Creek samples. Average fecundities were predicted from average female hypural lengths using the equation:

$$F = 10.97\ HL - 3{,}422$$

which was developed using the combined fecundity samples from Mathers and Pallant Creeks. Pedicted average fecundities are 2,732 eggs for Pallant and 2,919 for Mathers.

Egg Retentions were, in general, low (Pallant, 2.3 percent; Mathers, 1.5 percent). The slightly higher figure at Pallant was felt to be due to angler harassment of holding chums.

ADDITIONAL STUDIES REQUIRED

(1) A redd sampling program is planned for Pallant Creek in January, 1978, to evaluate progress of incubation, and egg density, distribution, and survival.

(2) The downstream chum fry migrations will be monitored from April to June; investigations of the rearing potential of the upper reaches of the Pallant watershed, and of estuary utilization by Pallant and Mathers chum fry, will proceed concurrently.

(3) A Class II weather station will be installed at the Pallant hatchery site in 1978, to better evaluate watershed storm events.

(4) The bathymetry of Mosquito Lake will be determined with an echo-sounder in January, 1978, and monthly surface-to-bottom temperature profiles will be taken to evaluate potential lake turnover problems.

(5) Water quality studies will continue for at least twelve consectutive months. Sampling during freshets only will continue after August, 1978.

(6) Spawning escapements will be examined in 1978 as in 1977, except that the upper reaches of Mathers Creek, and the major lower tributaries of both Pallant and Mathers Creeks, will receive more attention than in 1978. The utility of temporary counting fences on either stream is questionable, and more emphasis will be placed on foot surveys in the absence of permanent fences.

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APPENDIX 1

SUMMARIES OF SPAWNING REPORTS FOR CUMSHEWA INLET CREEKS (F381, 1934-1976)

N.O. = none observed during inspection.
U.K. = no inspection made at proper time.

SUMMARY OF F381 INFORMATION
ON NUMBERS OF CARMICHAEL CREEK SPAWNERS

Year	Sockeye	Spring	Coho	Pink	Steelhead	Chum
	NO INSPECTION PREVIOUS TO 1969					
1969						750
1970						3,000
1971						900
1972						350
1973						500
1974						400
1975			N.O.	N.O.		400
1976			N.O.	N.O.		150

SUMMARY OF F381 INFORMATION ON TIMING OF CARMICHAEL CREEK SPAWNERS

(Chum only species observed--possibly late coho in system)

Period	Start: Earliest	Start: Average	Average Peak	End: Average	End: Latest
1969-76	2nd wk. Sep.	1st wk. Oct.	2nd wk. Oct.	1st wk. Nov.	1st wk. Nov.

SUMMARY OF F381 PARTICULARS OF DISTRIBUTION OF CARMICHAEL CREEK SPAWNERS

Chum - scattered to rock gorge 1/2 mile up; some tidal spawning and in small tributary.

MISCELLANEOUS F381 OBSERVATIONS - CARMICHAEL CREEK

Year	Observations
1969	"good spawning grounds in lower reaches."
1971	"Rock gorge 1/2 mile up, patrolman believes passable, however no fish above."
1974	"A minor producer of chum salmon, will improve now that forest cover has returned; limited spawning areas and vulnerable to poaching."

SUMMARY OF F381 INFORMATION ON NUMBERS OF CHADSEY CREEK SPAWNERS

Year	Sockeye	Spring	Coho	Pink	Steelhead	Chum
1933						Heavy
1934			15,000	7,500		35,000
1935			7,500	N.O.		35,000
1936			3,500	3,500		35,000
1937			N.O.	N.O.		7,500
1938			3,500	N.O.		35,000
1939			200	N.O.		750
1940			1,500	1,500		7,500
1941			1,500	N.O.		3,500
1942			1,500	N.O.		1,500
1943			400	N.O.		1,500
1944			1,500	25		1,500
1945			U.K.	U.K.		U.K.
1946			Few	N.O.		3,500
1947			N.O.	N.O.		5,000
1948			1,500	N.O.		15,000
1949			750	N.O.		2,000
1950			750	N.O.		10,000
1951			200	N.O.		9,000
1952			1,500	N.O.		7,500
1953			200	N.O.		750
1954			200	N.O.		750
1955			400	N.O.		750
1956			N.O.	N.O.		750
1957			750	N.O.		400
1958			200	200		1,500
1959			N.O.	N.O.		75
1960			N.O.	N.O.		200
1961			N.O.	N.O.		200
1962			75	N.O.		400
1963			U.K.	U.K.		U.K.
1964			N.O.	N.O.		800
1965			40	N.O.		400
1966			75	N.O.		1,500
1967			200	N.O.		1,500
1968			75	N.O.		750
1969			25	N.O.		75
1970			100	N.O.		500
1971			N.O.	N.O.		600
1972			N.O.	500		2,400
1973			N.O.	N.O.		1,000
1974			N.O.	N.O.		400
1975			150	75		100
1976			150	N.O.		100

SUMMARY OF F381 INFORMATION ON TIMING OF CHADSEY CREEK SPAWNERS

(No sockeye, spring, or steelhead observed

Species	Start		Average	End	
	Earliest	Average	Peak	Average	Latest
Coho	Sep.	3rd wk. Sep.	2nd wk. Oct.	3rd wk. Oct.	Nov.
Pink	1st wk. Sep.	2nd wk. Sep.	3rd wk. Sep.	4th wk. Sep.	1st wk. Oct.
Chum	2nd wk. Sep.	4th wk. Sep.	2nd wk. Oct.	3rd wk. Oct.	1st wk. Nov.

SUMMARY OF F381 PARTICULARS OF DISTRIBUTION OF CHADSEY CREEK SPAWNERS

Coho - to impassable rock falls at 2 miles.

Pink - no details given (3 yrs' observations only).

Chum - evenly distributed over lower 1-1/2 miles in high years; heavier in lower reaches in low years.

MISCELLANEOUS F381 OBSERVATIONS - CHADSEY CREEK

Year		Observations
		(lower 1/2 mile only inspected until 1950)
1939	-	"Failure. No chums at all for the first 1/2 mile which has been logged off."
1941	-	"A lot of damage to fish has been done by bear."
1942	-	"This stream has been logged over and streambed was used for hauling logs with tractors this fall."
1947	-	"Creek improving."
1948	-	"Black bear and mergansers destructive (400 chums on banks Oct. 14th destroyed by black bear)."
	-	"The spawning beds are approaching normal conditions...."
1950	-	"...approx. 800 bear-killed chums (spawned and unspawned) observed on stream banks."
	-	impassable rock falls at 2 miles; stream beyond obstruction not suited to spawning.
1951	-	passable logging debris. "Stream reduced to a mere trickle during summer drought."
1953	-	"Subject to very rapid rise and fall in water levels."
1958	-	"This stream inclined to wash during high water...."
1959	-	"Considerable scouring for first 1/2 mile."
	-	"...good spawning gravel for first two miles."
1961	-	"This stream has been ruined by old logging operations and now is only a light, erratic producer of chum salmon. Stream tends to scour due to removal of forest cover, extreme fluctuations of water levels."
1965	-	"This stream is gradually improving...subject to considerable poaching."
1970	-	"This stream scoured badly in last few years--little spawning gravel left."
1974	-	"...forest cover is gradually returning, but there are now limited spawning areas."
1975	-	"Stream bed appears to be stabilizing itself."

SUMMARY OF F381 INFORMATION ON NUMBERS OF MATHERS CR. SPAWNERS

Year	Sockeye	Spring	Coho	Pink	Steelhead	Chum
1934			15,000	35,000		35,000
1935			7,500	3,500		15,000
1936			15,000	7,500		15,000
1937			N.O.	N.O.		3,500
1938			7,500	15,000		7,500
1939			3,500	N.O.		1,500
1940			3,500	15,000		7,500
1941			1,500	N.O.		3,500
1942			7,500	7,500		N.O.
1943			1,500	N.O.		3,500
1944			7,500	75,000		3,500
1945			7,000	N.O.		5,000
1946			N.O.	100,000		N.O.
1947	1,500		7,500	N.O.		7,500
1948	200		7,500	15,000		7,500
1949	200		7,500	3,500	75	3,500
1950	200		7,500	15,000	N.O.	3,500
1951	300		5,500	2,000	N.O.	9,000
1952	N.O.		7,500	75,000	N.O.	15,000
1953	200		750	400	N.O.	1,500
1954	N.O.		3,500	1,500	N.O.	3,500
1955	N.O.		1,500	N.O.	N.O.	750
1956	N.O.		3,500	3,500	N.O.	750
1957	N.O.		3,500	3,500	N.O.	7,500
1958	N.O.		75	7,500	N.O.	400
1959	N.O.		1,500	400	N.O.	1,500
1960	N.O.		3,500	35,000	N.O.	3,500
1961	N.O.		3,500	15,000	N.O.	3,500
1962	N.O.		3,500	100,000+	N.O.	15,000
1963	N.O.		3,500	30,000	N.O.	15,000
1964	N.O.		5,000	7,500	N.O.	6,000
1965	89+	8+	10,000	13,000	9+	7,000
1966	25+	25+	4,000	25,000	N.O.	8,000
1967	15,000	25+	3,500	7,500	N.O.	750
1968	7,500	75	7,500	100,000+	N.O.	7,500
1969	3,500	N.O.	7,500	1,500	N.O.	3,500
1970	3,500	N.O.	7,500	75,000	N.O.	8,000
1971	N.O.	N.O.	N.O.	1,000	N.O.	500
1972	N.O.	N.O.	N.O.	75,000	N.O.	15,000
1973	5,000	N.O.	10,000	N.O.	N.O.	3,000
1974	N.O.	N.O.	N.O.	20,000	N.O.	10,000
1975	10+	N.O.	5,000	2,500	8+	1,000
1976	Present	N.O.	10,000	47,500	Present	17,500

SUMMARY OF F381 INFORMATION ON TIMING OF MATHERS CREEK SALMON STOCKS

Species	Period	Start Earliest	Start Average	Average Peak	End Average	End Latest
Sockeye	1948-76 (17 years only)	Apr.	2nd wk.May	4th wk.May	2nd wk.Jun.	2nd wk.Jun.
Spring	1948-76 (5 years only)	May	May	May	Jul.	Jul.
Coho	1948-76	2nd wk.Jul.	1st wk.Sep.	4th wk.Sep.	3rd wk.Oct.	3rd wk.Nov.
Pink	1948-76	1st wk.Aug.	1st wk.Sep.	2nd wk.Sep.	4th wk.Sep.	4th wk.Oct.
Steelhead	1948-76 (5 years only)	Oct.	Nov.	Feb.	Feb.	Mar.
Chum	1948-76	1st wk.Sep.	3rd wk.Sep.	1st wk.Oct.	3rd wk.Oct.	3rd wk.Nov.

SUMMARY OF PARTICULARS OF DISTRIBUTIONS OF SPAWNERS FROM F381:

Sockeye	- into Mathers Lake and tributaries.
Spring	-
Coho	- into Mathers Lake and tributaries.
Pink	- up to Mathers Lake; in lower reaches in light years; no inter-tidal spawning. In pools during low water.
Steelhead	-
Chum	- in east tributary and in lower reaches of mainstem up to 3 mi and rarely 4 mi (contracts in light years); no inter-tidal spawning.

MISCELLANEOUS F381 OBSERVATIONS - MATHERS CREEK

YEAR	OBSERVATIONS
1942	- "This creek is being logged over."
1946	- "Logging debris to be cleaned out this winter by Powell River Co."
1947	- "It is one of the larger creeks in the area and very difficult during flood waters to observe the number of fish as the water becomes very discoloured. Logging . . . still in operation in this area. The debris in the left-hand tributary does not form impassable obstructions but should be cleared before the Powell River Co. leaves the area."
1948	- "The Kelly Logging Co. employed 3 men for 7 days clearing brush from main stream (July 4th to 11th). Old logging debris in left-hand tributary to be removed by Kelly Co. next May when donkey currently located at Mathers Lake is moved out of present location."
1949	- "See 1949 Mathers Creek report (file 24-2-A) dealing with Kelly Logging Co. 1949 stream clearing . . . and special conditions pertaining to this stream."
1951	- "Logging camp and road adjacent to stream." - "Passable logging debris throughout entire stream length."
1952	- "Partial log jams* and logging debris." - "Very good stream for spawning throughout entire length, including lake and its upper tributaries." *(Noted each year up to and including 1955.)
1956	- ". . . the stream is normally heavily discoloured and only the odd salmon can be seen on the riffles. Consequently escapement figures are not reliable."
1959	- ". . . a fairly serious log jam exists at the entrance to the lake . . . ."
1961	- ". . . the feeder stream into this lake suffers from a lack of water during dry periods, the Biological Staff observed coho fry in this stream."
1962	- "Good flow control throughout . . . stream."
1965	- "Three test sets in this stream in May caught a total of 8 springs, 89 sockeye, 9 steelhead and 4 trout . . . ."
1966	- "Sockeye and spring carcasses reported by Guardian . . . ."
1967	- "No spring salmon observed, however local anglers from Moresby Camp reported dead springs in river."

Miscellaneous F381 Observations - Mathers Creek (cont'd.)

YEAR	OBSERVATIONS
1968	- "A very active but small sports fishery on this river--reports of spring salmon come from this source--one dead spring seen by writer."
1973	- "Test net in this stream in May produced 48 sockeye overnight . . . ."
1975	- "Test net in Mathers on May 12th produced 10 sockeye and 8 steelhead. Proposed bridge crossing on Mathers in 1976."
1976	- "Logging bridge constructed and completed August 14, 1976. Trail to lake on west side completed. Work on this system carried out by biological crew this year."

SUMMARY OF F381 INFORMATION ON NUMBERS OF PALLANT CR. SPAWNERS

Year	Sockeye	Spring	Coho	Pink	Steelhead	Chum
1934			35,000	35,000		15,000
1935			7,500	3,500		15,000
1936			7,500	100,000+		75,000
1937			N.O.	N.O.		7,500
1938			7,500	100,000+		35,000
1939			7,500	N.O.		35,000
1940			3,500	15,000		7,500
1941			3,500	N.O.		7,500
1942			15,000	75,000		15,000
1943			3,500	N.O.		15,000
1944			3,500	100,000+		3,500
1945			7,500	N.O.		3,500
1946			U.K.	350,000		40,000
1947	25		3,500	N.O.		75,000
1948	25		3,500	100,000+	25	15,000
1949	25		3,500	N.O.	75	15,000
1950	25		3,500	200,000	200	15,000
1951	N.O.		4,000	1,000	N.O.	32,500
1952	U.K.		7,500	100,000+	N.O.	35,000
1953	25		3,500	750	N.O.	1,500
1954	25		3,500	15,000	N.O.	3,500
1955	N.O.		1,500	200	N.O.	750
1956	N.O.		1,500	15,000	N.O.	1,500
1957	N.O.		200	3,500	N.O.	35,000
1958	N.O.		200	15,000	N.O.	35,000
1959	200		400	3,500	N.O.	400
1960	200		N.O.	35,000	N.O.	35,000
1961	75		3,500	3,500	N.O.	7,500
1962	N.O.		750	100,000+	N.O.	15,000
1963	N.O.		7,500	15,000	N.O.	15,000
1964	N.O.		5,000	7,000	N.O.	8,000
1965	N.O.		10,000	4,000	N.O.	8,000
1966	N.O.		13,000	45,000	N.O.	9,000
1967	N.O.		3,500	3,500	N.O.	7,500
1968	N.O.		1,500	75,000	N.O.	15,000
1969	N.O.		7,500	35,000	N.O.	15,000
1970	N.O.		8,000	100,000	N.O.	35,000
1971	N.O.		8,000	N.O.	N.O.	20,000
1972	N.O.		4,000	130,000	N.O.	10,000
1973	N.O.		4,500	1,500	N.O.	25,000
1974	N.O.		2,000	5,000	N.O.	8,000
1975	75		4,000	3,500	25	5,000
1976	25		2,000	90,000	25	150

SUMMARY OF F381 INFORMATION ON TIMING OF PALLANT CREEK SALMON STOCKS

Species	Period	Start		Average Peak	End	
		Earliest	Average		Average	Latest
Sockeye	1948-76 (N.O. in most yrs.)	May	4th wk.May	4th wk.Jun.	2nd wk.Jul.	2nd wk.Sep.
Coho	1948-76	2nd wk.Jul.	2nd wk.Sep.	1st. wk.Oct.	2nd wk.Aug.	4th wk.Oct.
Pink	1948-76	3rd wk.Jul.	4th wk.Aug.	2nd wk.Sep.	4th wk.Sep.	4th wk.Oct.
Steelhead	1948-76 (N.O. in most yrs.)	Nov.	Jan.	Feb.	Mar.	Jun.
Chum	1948-76	1st wk.Sep.	3rd wk.Sep	2nd wk.Oct	4th wk.Oct	3rd wk.Nov.

SUMMARY OF PARTICULARS OF DISTRIBUTION OF SPAWNERS FROM F381:

Sockeye - in mainstem.

Coho - up to headwaters; most in south tributary.

Pink - evenly dispersed up to falls on main branch; most of spawning done in south tributary up to headwater in some years, and concentrations in lower reaches in some years.

Steelhead - no particulars given.

Chum - heavy in lower reaches in some years, otherwise evenly dispersed up to falls on main branch; few in south tributary in some years.

MISCELLANEOUS F381 OBSERVATIONS - PALLANT CREEK

Year	Observations
1942	- "This creek has been logged over."
1947	- "A waterfall approx. 2 miles from the mouth of the main branch blocks the passage of all types of salmon . . . . Approximately 2 miles above the falls is Mosquito Lake which is quite large and has numerous small creeks running into it. The area above the falls and the small creeks running into the lake are . . . ideal spawning grounds. The productiveness of this creek could almost be doubled if this area above the falls was accessible."
1948	- (Engineers Report apparently on file somewhere.) - "Mosquito and Swan Lake watershed source was surveyed . . . . No suitable salmon spawning areas were discovered . . . . Two small streams enter Mosquito Lake on N.W. shore . . . badly silted and have muskeg country at source. A small boulder-strewn creek drains into Mosquito Lake on S.W. shore . . . . Subject to rapid runoff but may support a small chum or pink spawning."
1949	- ". . . the Mosquito Lake source of the main Pallant Creek does not freeze up when adjacent lakes are frozen. Above condition believed due to a warm subaquatic source as yet unlocated."
1969	- "This stream subject to a fairly heavy sports fishery on coho-- Rayonier of Canada closing Moresby Camp down . . . ."
1974	- ". . . subject to extreme fluctuations in water levels."
1975	- "Survey work was carried out . . . by engineers (road locations, aerial photos, etc.) . . . ."
1976	- "Road and incubation box sites constructed this fall."

APPENDIX 2

PARTICLE-SIZE ANALYSIS METHOD USED BY CANTEST LTD.

The samples were filtered successively through pre-weighed 14-micron, 5-micron and 0.45-micron membranes. The membranes were air-dried and weighed to give the weight of the material retained, and then ashed to give the volatile content.

An additional aliquot was filtered through the 14-micron membranes, and the membranes were observed under a microscope. The particles retained were measured and counted with the aid of a calibrated measuring eyepiece.

APPENDIX 3

PROCESS OF COLLECTING SCALE SAMPLES

Scale Selection

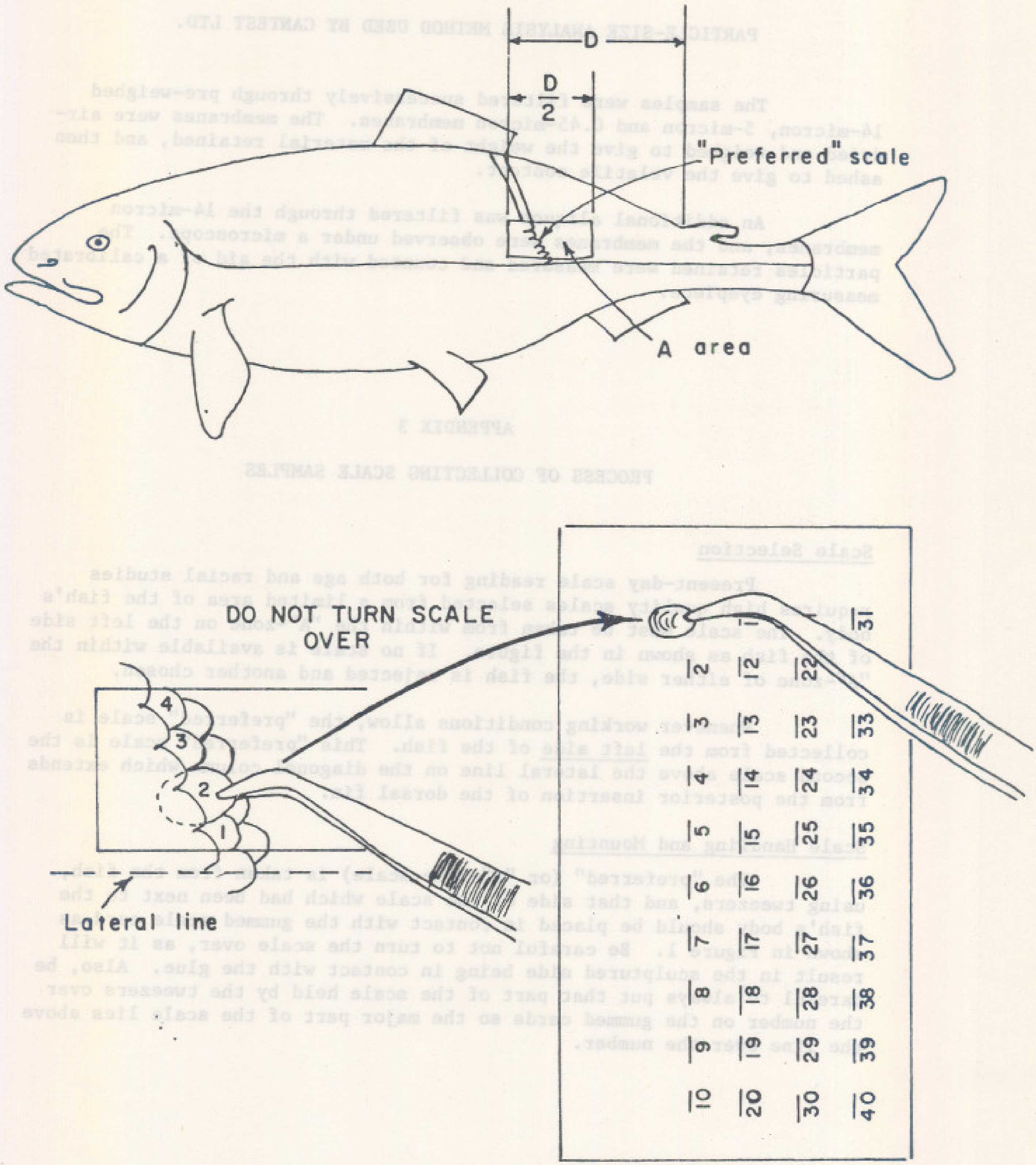
Present-day scale reading for both age and racial studies requires high quality scales selected from a limited area of the fish's body. The scale must be taken from within the "A"-zone on the left side of the fish as shown in the figure. If no scale is available within the "A"-zone of either side, the fish is rejected and another chosen.

Whenever working conditions allow, the "preferred" scale is collected from the left side of the fish. This "preferred" scale is the second scale above the lateral line on the diagonal column which extends from the posterior insertion of the dorsal fin.

Scale Handling and Mounting

The "preferred" (or "A"-zone scale) is taken from the fish, using tweezers, and that side of the scale which had been next to the fish's body should be placed in contact with the gummed scale card as shown in Figure 1. Be careful not to turn the scale over, as it will result in the sculptured side being in contact with the glue. Also, be careful to always put that part of the scale held by the tweezers over the number on the gummed cards so the major part of the scale lies above the line over the number.

SCALE SELECTION AND MOUNTING ON GUMMED CARD



APPENDIX 4: Water Survey of Canada flow data for station 80-B-2, Pallant Creek (1963-73 data from Historical Streamflow Summary, British Columbia to 1973; 1974-76 data from Annual Surface Water Data reports, Inl. Wat. Dir., Wat. Resour. Br., Wat. Surv. Can.).

MONTHLY AND ANNUAL MEAN DISCHARGES IN CUBIC FEET PER SECOND FOR THE PERIOD OF RECORD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN	YEAR
1963	-	-	-	141	117	105	55.8	36.6	31.2	-	-	-	-	1963
1964	-	-	-	174	135	126	108	83.3	44.6	-	-	-	-	1964
1967	-	-	-	-	-	-	-	82.9	445	613	233	456	-	1967
1968	359	238	145	416	171	167	70.5	57.5	311	739	734	312	326	1968
1969	98.5	91.5	143	539	314	194	172	255	130	192	879	712	310	1969
1970	438	387	263	334	273	169	85.9	137	183	330	336	266	266	1970
1971	313	310	314	378	210	181	126	231	333	304	481	256	286	1971
1972	-	-	-	-	302	235	129	87.6	102	405	511	341	-	1972
1973	602	311	309	265	291	207	145	35.2	248	486	173	535	301	1973
1974	227	333	183	253	263	208	126	53.1	55.4	946	448	714	318	1974
1975	-	-	-	-	-	-	-	-	-	-	-	-	-	1975
1976	500	353	289	275	350	196	247	132	195	325	547	507	326	1976
MEAN	423	289	264	308	243	179	127	108	189	482	462	455	305	MEAN

ANNUAL EXTREMES OF DISCHARGE IN CFS AND ANNUAL TOTAL DISCHARGE IN AC FT FOR THE PERIOD OF RECORD

YEAR	MAXIMUM INSTANTANEOUS DISCHARGE	MAXIMUM DAILY DISCHARGE	MINIMUM DAILY DISCHARGE	TOTAL DISCHARGE	YEAR
1963	-	-	28.5 cfs on Sep 11	-	1963
1964	-	-	32.5 cfs on Sep 10	-	1964
1967	2250 cfs at 0930 pst on Sep 23	1880 cfs on Sep 23	45.2 cfs on Aug 7	-	1967
1968	2780 cfs at 2050 pst on Jan 22	1640 cfs on Oct 23	34.2 cfs on Aug 11	237000 ac ft	1968
1969	2940 cfs at 1319 pst on Nov 28	2390 cfs on Nov 28	53.2 cfs on Jul 5	225000 ac ft	1969
1970	1630 cfs at 1305 pst on Jan 23	1180 cfs on Jan 23	59.6 cfs on Sep 16	193000 ac ft	1970
1971	1970 cfs at 1008 pst on Sep 12	1350 cfs on Sep 12	43.2 cfs on Aug 15	207000 ac ft	1971
1972	3500 cfs at 2232 pst on Dec 31	1570 cfs on Oct 24	-	-	1972
1973	3030 cfs at 0001 pst on Jan 1	1990 cfs on Jan 22	20.4 cfs on Aug 22	218000 ac ft	1973
1974	4450 cfs at 0259 pst on Oct 15	3300 cfs on Oct 8	23.6 cfs on Sep 4	230000 ac ft	1974
1975	-	-	-	-	1975
1976	2650 cfs at 0646 pst on Nov 3	2350 cfs on Nov 3	84.3 cfs on Sep 1	237000 ac ft	1976

EXTREME RECORDED FOR THE PERIOD OF RECORD

APPENDIX 5: Daily Variation in fence passage of adult chums.

Date (1977)	Total No. Fish	Passage in Chums/Hr of Observation 4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-2	2-4 (HRS)
							MATHERS						
Sep. 14	1	-	-	0.0	0.0	-	1.3	-	0.0	-	-	-	-
15	3	-	-	0.0	-	-	1.5	2.0	-	0.0	-	-	-
16	0	-	-	0.0	-	-	0.0	-	0.0	-	-	-	-
17	2	-	-	0.0	-	0.0	0.0	0.7	0.0	2.0	-	-	-
18	*69	-	-	0.0	-	0.0	4.0	-	36.0	-	-	-	-
19	25	-	-	5.0	18.0	0.0	14.0	-	15.0	-	-	-	-
20	0	-	-	0.0	0.0	0.0	0.0	-	0.0	-	-	-	-
21	1	-	0.0	-	0.0	-	0.0	2.0		-	-	-	-
22	9	-	-	1.3	-	1.3	0.0	-	28.0	-	-	-	-
23	0	-	-	0.0	-	0.0	-	0.0	-	-	-	-	-
24	*70	-	-	10.0	54.0	19.0	4.0	10.7	4.0	-	-	-	-
25	0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
26	1	-	-	0.0	-	0.0	2.0	0.0	0.0	-	-	-	-
27	5	-	2.0	-	0.0	0.0	0.0	3.2	0.0	-	-	-	-
28	6	-	-	6.0	0.0	-	0.5	8.0	0.0	0.0	-	-	-
29	1	-	-	0.0	0.0	0.0	-	0.8	-	-	-	-	-
30	7	-	-	0.0	0.0	0.0	2.0	0.0	0.0	-	-	-	-
Oct. 1	*56	-	-	0.0	0.0	15.0	23.0	3.0	-	10.0	-	-	-
2	4	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	4.0	-	-
3	18	-	-	0.0	0.0	0.0	0.0	0.0	26.0	10.0	0.0	-	-
4	22	-	-	0.0	0.0	-	11.0	10.0	14.0	-	0.0	-	-
5	*73	-	-	2.0	2.0	2.0	0.0	20.0	20.0	38.0	4.0	-	-
6	14	-	-	0.0	0.0	4.0	-	12.0	0.0	11.0	-	-	-
7	*59	-	-	0.0	0.0	0.0	10.0	2.0	9.0	22.0	39.0	-	-
8	*72	-	0.0	-	8.0	16.0	24.7	12.0	28.0	10.0	-	-	-
9	9	-	-	3.0	0.0	3.0	10.0	4.0	0.0	-	0.0	-	-
10	*350	-	-	34.6	34.6	33.2	7.5	21.0	54.0	28.0	10.0	-	-
(No. Times Checked)			(3)	(24)	(20)	(21)	(24)	(21)	(22)	(10)	(7)		
OVERALL AVERAGE		-	0.7	2.6	5.8	4.6	4.8	5.3	10.6	13.1	8.1	-	-
OVERALL MAXIMUM		-	2.0	34.6	54.0	33.2	24.7	21.0	54.0	38.0	39.0		
			(1)	(5)	(6)	(7)	(7)	(6)	(6)	(5)	(3)		
HIGH-DAYS* AVERAGE		-	0.0	7.8	16.4	12.2	10.5	11.5	25.2	21.6	17.7	-	-
HIGH-DAYS MAXIMUM		-	0.0	34.6	54.0	33.2	24.7	21.0	54.0	38.0	39.0		

APPENDIX 5: (cont'd.)

Date (1977)	No. Fish	Passage In Chums/Hr of Observation 4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	0-2	2-4 (HRS.)
							FALLANT						
Sep. 11	12	-	-	-	-	-	4.4	4.4	0.6	-	-	-	-
12	0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
13	0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
14	0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
15	1	-	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	-	-	-
16	0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
17	2	-	0.0	0.0	0.0	0.0	0.0	0.0	1.0	-	-	-	-
18	9	-	0.0	0.0	0.0	2.0	1.5	1.5	1.2	-	-	-	-
19	*50	-		3.2			4.8						
20	8	-	0.0	0.0	0.0	0.0		1.4		-	-	-	-
21	5	-	0.7	0.0	0.0	0.0	0.0	1.3	1.3	-	-	-	-
22	*122	-	0.0	0.0			12.8			-	-	-	22.5
23	28	-		0.0		0.3	5.6	5.6	6.5	-	-	-	0.0
24	20	-		0.4		0.0	0.0	5.5	5.5	-	-	-	-
25	4	-	1.5	1.5	0.0	0.0	0.0	0.0	0.0	-	-	-	0.5
26	3	-	0.5	0.5	0.0	0.0	0.7	0.7	0.0	-	-	-	-
27	6	-	0.0	0.0	0.0	0.0	0.0	0.0	3.0	-	-	-	-
28	4	-	0.9	0.9	0.7	0.7	0.0	0.0	0.0	-	-	-	-
29	*215	-	0.0	0.0	0.0	0.0	0.9	0.9	22.9	-	86.5	-	-
30	*128	-	1.0	1.0	3.0		1.3		0.0	-	56.5	-	-
Oct. 1	*56	-	0.0	0.0	0.4	0.0	0.0	0.0	15.7	15.7	-	-	-
2	*63	-	6.3	6.3	0.0	0.0	0.3	0.3	11.3	11.3	-	-	-
3	*146	-	0.5	0.5	0.0	0.0	3.5	3.5	33.3	33.3	32.6	-	-
4	6	-	1.0	1.0	0.0	0.0	1.0	1.0		0.3		0.0	-
5	2	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	-	-	-
6	31	-	0.0	0.0	0.0	1.0	1.0	1.0	-	10.7	19.0	-	-
7	8	-			1.0			-	-	-	-	-	-
8	*56	-	0.0	0.0	0.0	0.0	0.0	20.0	8.0	14.0	8.0	-	-
9	*69	-	2.0	0.0	0.0	0.0	0.0	0.0	2.7	-	63.0	-	-
10	*549	-	13.3	0.0	0.0	0.0	0.0	-	354.0	141.0	-	-	-
	(No. Times Checked	(0)	(29)	(29)	(29)	(29)	(30)	(28)	(28)	(10)	(6)	(1)	(3)
OVERALL AVERAGE		-	1.1	0.6	0.7	0.8	1.3	2.4	16.9	22.8	44.3	0.0	7.7
OVERALL MAXIMUM		-	13.3	6.3	12.8	12.8	12.8	20.0	354.0	141.0	86.5	0.0	22.5
			(10)	(10)	(10)	(10)	(10)	(9)	(10)	(5)	(5)	(0)	(1)
HIGH-DAYS* AVERAGE		-	2.6	1.1	1.9	1.9	2.4	4.8	46.6	43.1	49.3	-	22.5
HIGH-DAYS MAXIMUM		-	13.3	6.3	12.8	12.8	12.8	20.0	354.0	141.0	86.5	-	22.5