Bio-systems
aquatic resource consultants

210 - 37 Street N.W., Calgary Alberta T2N 3B7

August 31, 1976

Mr. C. Zinkan
Resource Studies Manager
Western Region
Parks Canada
134-11 Avenue S.E.
Calgary, Alberta
T2G 0X5

Dear Mr. Zinkan:

We are pleased to transmit herewith a report- entitled "Pacific Rim National Park Aquatic Resources Inventory". This study was funded by your branch and the work was done in fulfillment of the requirements of Contracts No. WR 9-75 and WR 11-76.

The purpose of the study was to gather basic qualitative and quantitative limnological data on several lakes and streams in Pacific Rim National Park. This information was required as part of a resource inventory programme being conducted in the Park and also for planning, interpretation, and resource management.

We hope the report meets your expectations. Your comments and suggestions concerning the report will be welcomed.

Yours sincerely,

Dwight R. Mudry, Ph.D.

Roderick B. Green, B.Sc.

PACIFIC RIM NATIONAL PARK
AQUATIC RESOURCES INVENTORY

Prepared by

Dwight R. Mudry
Roderick B. Green

August 31, 1976

This report was prepared by Bio-systems for Parks Canada in cooperation with Dr. R.S. Anderson, Canadian Wildlife Service, University of Calgary, Calgary, Alberta

Acknowledgements

The authors acknowledge with thanks the field, technical, and administrative advice and assistance provided by individuals and organizations at various times throughout this study.

Mr. R. Wickstrom (Canadian Wildlife Service) conducted an initial field trip to Hobiton and Tsusiat lakes during 1974. Samples collected by Mr. Wickstrom and his records and correspondence concerning the study area were made available to us. Mr. Wickstrom was assisted in the field by Mr. T. Wickstrom and Warden B. Bach.

Messers C. Zinkan and J. Kilistoff of Parks Canada provided efficient liason between ourselves and Parks Canada for all project arrangements, and cooperated in many other ways in organizational and administrative matters.

Park Superintendents J. Holroyd and F. Camp and Chief Warden O. Hermanrude were most helpful in providing us with information and assisted in transporting water samples to the laboratory. In the field, Wardens B. Bach and L. McIntosh provided valuable information on trails and suggested potential campsites. Mr. G. Hoskins (Fisheries Research Board, Nanaimo) assisted in securing information on fisheries in the study area.

We thank Mr. F. Mah and Mr. M. Korchinski (Water Quality Branch) for their help in expediting water analysis which was done in the Water Quality Laboratory of the Inland Waters Directorate, Vancouver and Calgary.

Walters Air Services, Ltd., Tofino, provided air transport to and from the study area and for movement of base camps. We are indebted to pilots M. Wood, D. Banks, and G. Richards for their skill in handling the aircraft under sometimes poor flying conditions.

We are especially indebted to Dr. R. S. Anderson (Canadian Wildlife Service) for providing laboratory space and field eouipment used during this study.

Contents

Introduction

The present report on aquatic resources of Pacific Rim National Park (PRNP) forms part of a resource inventory programme being conducted in each National Park in Parks Canada's Western Region. In addition to providing basic aquatic inventory information this study also provides information for planning, interpretation, and resource management.

A three year project was organized in three general sections: (1) field collections: (2) examination and identification of material from field collections; (3) comparative study, interpretation, and report preparation. The first years work on Hobiton and Tsusiat lakes was conducted by Mr. R. Wickstrom of the Canadian Wildlife Service but due to demands for his presence elsewhere this programme was completed by the present authors.

Pacific Rim National Park lies along the southwest coast of Vancouver Island, British Columbia. The Park itself is a relatively new entity with negotiations for land acquisition and establishment of boundaries proceeding at the present time. Boundaries for Phases I and II including the Long Beach section and the Broken Group Islands are now fairly well established. Exact boundaries for the Phase III section which included the "West Coast Trail" between Bamfield and Port Renfrew, B.C., are not yet established. Most of the sites examined during the present study are within the proposed Phase III section of the Park.

The aquatic resources inventory included an examination of 7 stream and 7 lake sites. At most sites several aspects of limnology were investigated including macrophytes, phytoplankton, zooplankton, benthic invertebrates, shoreline invertebrates, water chemistry, stream flow, morphometry, and temperature. The study sites included all of the major lakes in the proposed Phase III section of the Park by only a fraction of the many streams which flow through the Park.

Lakes and streams in Phase I and II sections of the Park offer few opportunites for freshwater fishing. A study by Meyer and Bryan (1974) on the prospects for fish-related recreation in PRNP reported 98% of the vistors surveyed expressed a desire to take part in "some fish-related recreational activity". Only 3.7% of the visitors surveyed indicated they had fished in freshwater. With the inclusion of the Phase III section to PRNP the dominant marine orientation of the Park will be somewhat offset and complimented by several large freshwater lakes in the Nitnat area.

There are no reports of comprehensive limnological studies on any of the lakes or streams in the Park. Ward (1970) reported on the sport fishery potential *of* some of the lakes and streams of the Park. His conclusions were based on observations on streams in the Long Beach area and interviews with local residents. Data on salmon runs to Hobiton and Cheewhat lakes are contained in annual reports on salmon spawning streams (Department of the Environment, Fisheries Service). The presence of sockeye and chum salmon in the Hobiton River has been reported by Northcote et al. (1964) and Aro and Shepard (1967). Bousfield (1958) reported the presence of amphipod species in Kennedy Lake and Lost Shoe Creek.

Methods

1. Physical measurements, temperature, pH, secchi.

Extensive sounding for the establishment of contour lines was done on each lake using a Lowrance Fish-Lo-K-Tor or Furino recording electronic sounder. Lake shoreline and stream gradient were established from 1 : 50,000 scale topographic maps produced by Surveys and Mapping Branch, Department of Mines and Technical Surveys.

Field analysis of water temperature, pH, and light penetration were performed at the time of collection using the following instrumentation:

Yellow Springs Instrument Co. Model 425C thermistor telethermometer (calibrated at each use against a mercury thermometer)

Hellige Pocket Comparator optical pH meter

20-cm diameter black and white Secchi disk

2. Streamflow.

Measurement of water velocity at each stream site was made by immersing a G. M. Mfg. Co. Pygmy flow meter for one minute at two different locations. Calibration of the flow meter was done by the Hydraulics Division, Canada Centre for Inland Waters, Burlington, Ontario.

3. Water chemistry.

Water samples for chemical analysis were collected in 2 liter plastic bottles and 50 millilitre Sovirel bottles supplied by the inland Waters Directorate, Water Quality Branch. The bottles were first rinsed with water and then immersed and allowed to fill. Analysis was done by the Calgary and Vancouver Laboratories of the Inland Waters Directorate, Water Quality Branch.

4. Benthic samples.

Lake benthos were sampled with a 6 inch Ekman dredge. Dredge samples were taken at three or more representative sites or depths at each lake. Samples from each site were washed through a mesh bottomed pail (aperture size 0.36 x 0.52 mm) and sorted live in a white enamel tray.

Stream invertebrates were sampled using a "D" shaped net, measuring 30 cm wide by 27 cm long. The net was placed on the stream bottom and the substrate immediately upstream was then disturbed by kicking it vigorously with one foot for 30 seconds. The area sampled, as well as its depth, was approximate, but was estimated to be about 0.18 to $0.2 m^2$ and 4 to 8 cm deep. Two or three kick samples were taken at representative sites at each stream site. The dislodged invertebrates and debris collected were sorted and preserved in 70% ethanol for later identification and weighing.

5. Shoreline samples.

Shoreline collections of invertebrates were made at each lake site for a 30 minute interval. Shoreline samples were taken from the water's edge to a depth of approximately 50 cm. The shoreline invertebrates were sought by lifting rocks, moving logs, or agitating the bottom or rooted macrophytes. Very active invertebrates were caught with a small hand net, while more sluggish species were removed from the rocks or debris with the aid of forceps. A minimum of 100 metres of shoreline were covered at each site. Invertebrates collected were preserved in 70% ethanol for examination.

6. Phytoplankton.

Phytoplankton samples from all lakes were collected by immersing a 100 ml "cabinet oval" bottle to a depth of 2.0 and 0.5 m in 1974 and 1975, respectively. Samples were immediately preserved for later identification by adding 3 drops of Lugol's iodine to the bottle.

7. Zooplankton.

Zooplankton was collected using a 25 cm diameter Wisconsin style plankton net with a mean aperture of approximately 70 microns. Two vertical tows were made from each of one or more depths near the centre of each lake. Samples were preserved in 5 % formalin for later identification.

8. Fish collections.

Fish were sampled in streams along a minimum stream section of 100 metres with the aid of a Smith-Root Type V Electrofisher. Lake sampling was accomplished using gill nets of several mesh sizes. Nets composed of 10 metre sections of 3/4, $1\frac{1}{2}$, 2, $3\frac{1}{2}$ inch mesh were set overnight in each of the lakes sampled.

9. Macrophytes.

Representative macrophytes from each lake were collected by hand, dried, and pressed for later identification.

10. Laboratory methods.

Laboratory analysis of plankton, benthic, and fish samples consisted of counting the number of individuals in each sample and identifying each species to the lowest taxonomic level possible with available taxonomic keys. The level of identification achieved thus varies with the particular group examined. General taxonomic references used are given in Appendix C.

Preserved phytoplankton samples were examined using a Wild M40 inverted microscope according to the technique of Utermohl (1958). Species were identified and enumerated at magnifications of 750 and 1875X with phase contrast illumination.

During fish examination weight, fork length, sex and age were recorded. Food items in fish stomachs were identified to the family or order level and their presence was quantified as absent, rare, frequent, or abundant. An estimate was made of the percent fullness of each stomach examined.

Fish were aged by examination of otoliths under a binocular dissecting microscope.

A glossary of technical terms is provided in Appendix A.

Results & Discussion

The results of physical, chemical, and biological investigations on lakes and streams in the study area are presented in the following section. Lakes are arranged alphabetically, followed by streams.

Bathymetric maps with collection sites for each lake are presented along with physical and chemical data and a summary of information on aquatic flora and fauna. Following each map sheet a short discussion is provided on the following aspects: morphometry, temperature, Secchi visibility, water chemistry, macrophytes, phytoplankton, zooplankton, benthos, shoreline invertebrates, and fish. Appendix tables 1-8 contain detailed data on water chemistry, macrophytes, phytoplankton, zooplankton, lake benthos, shoreline invertebrates. stream benthos, fish, and fish stomach contents for all the sites examined.

The limnology of lakes in the study area (Figure 1) has not been previously examined. Kichha Lake is located approximately 5 km southwest of Bamfield while the others are in the "Nitnat Triangle" area approximately 22 km southeast of Bamfield. The lakes are 0.5 to 14 km from the ocean in the Coastal Western Hemlock Riogeoclimatic Zone (Krajina 1969) of the Juan De Fuca Provincial Forest. The lakes are not easily accessible as trails in the area are prorly marked and heavily overgrown.

The climate of Pacific Rim National Park is characterized by high rainfall (mean of 307 cm/year) and little seasonal variation in temperature

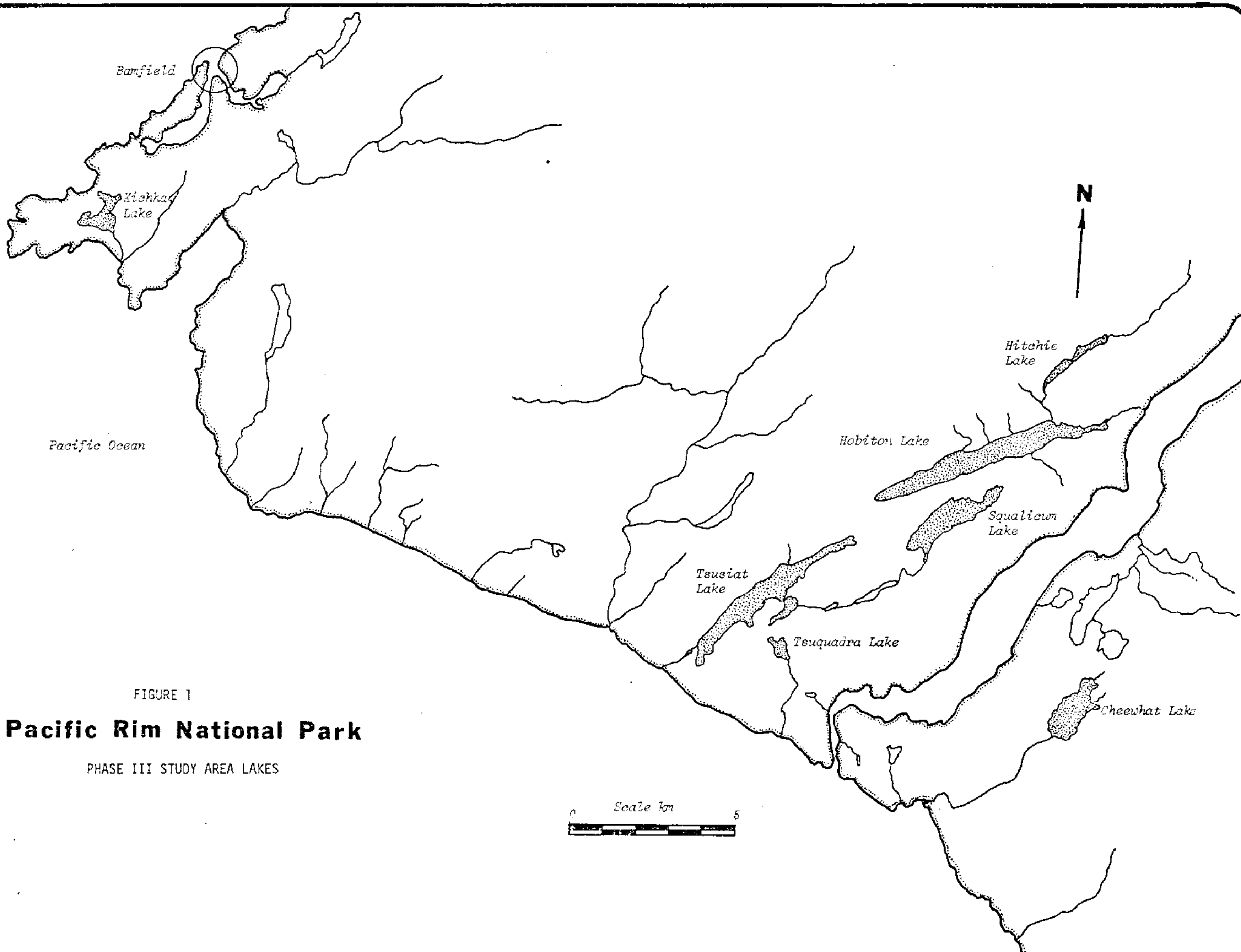


FIGURE 1

Pacific Rim National Park

PHASE III STUDY AREA LAKES

(mean monthly temperature varies from 5-14^{o}). Summers are relatively cool and wet in comparison with the dry conditions existing in mainland British Columbia (Dooling and Turner 1972). Most collections made during the present study were during August, 1975. August is normally the dryest month of the year (8.8 cm mean precipitation) but during 1975 a period of almost continual rain caused lakes and streams to be abnormally high.

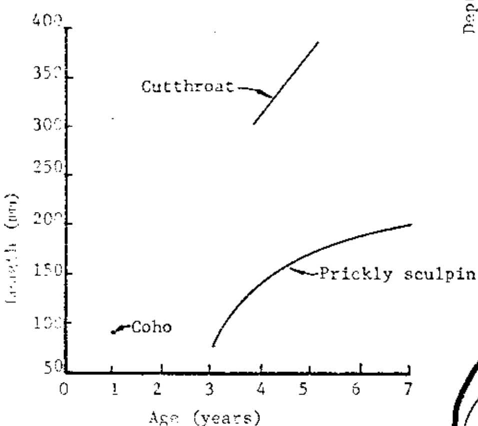
In spite of problems with weather over 225 species of aquatic plants and animals were collected and identified from the study area. Most of these aquatic plants and animals are very small and unnoticed by the casual observer, but all form an important part of aquatic ecosystems in the study area.

	No./l	No./ml	No./m^2	g/m^2	g/30 min. coll.
Zooplankton (mean)	17.9	-	-	-	-
Phytoplankton (mean)	-	1636	-	-	-
Benthic fauna 4 m	-	-	1634	1.3	-
7 m	-	-	1161	6.1	-
15 m	-	-	903	19.0	-
Shoreline fauna	-	-	-	-	0.09

FISH CATCH DATA

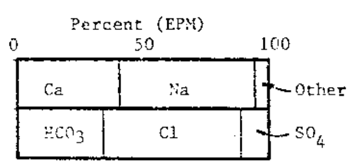
Gear: Gillnet
Time: 1 set, overnight

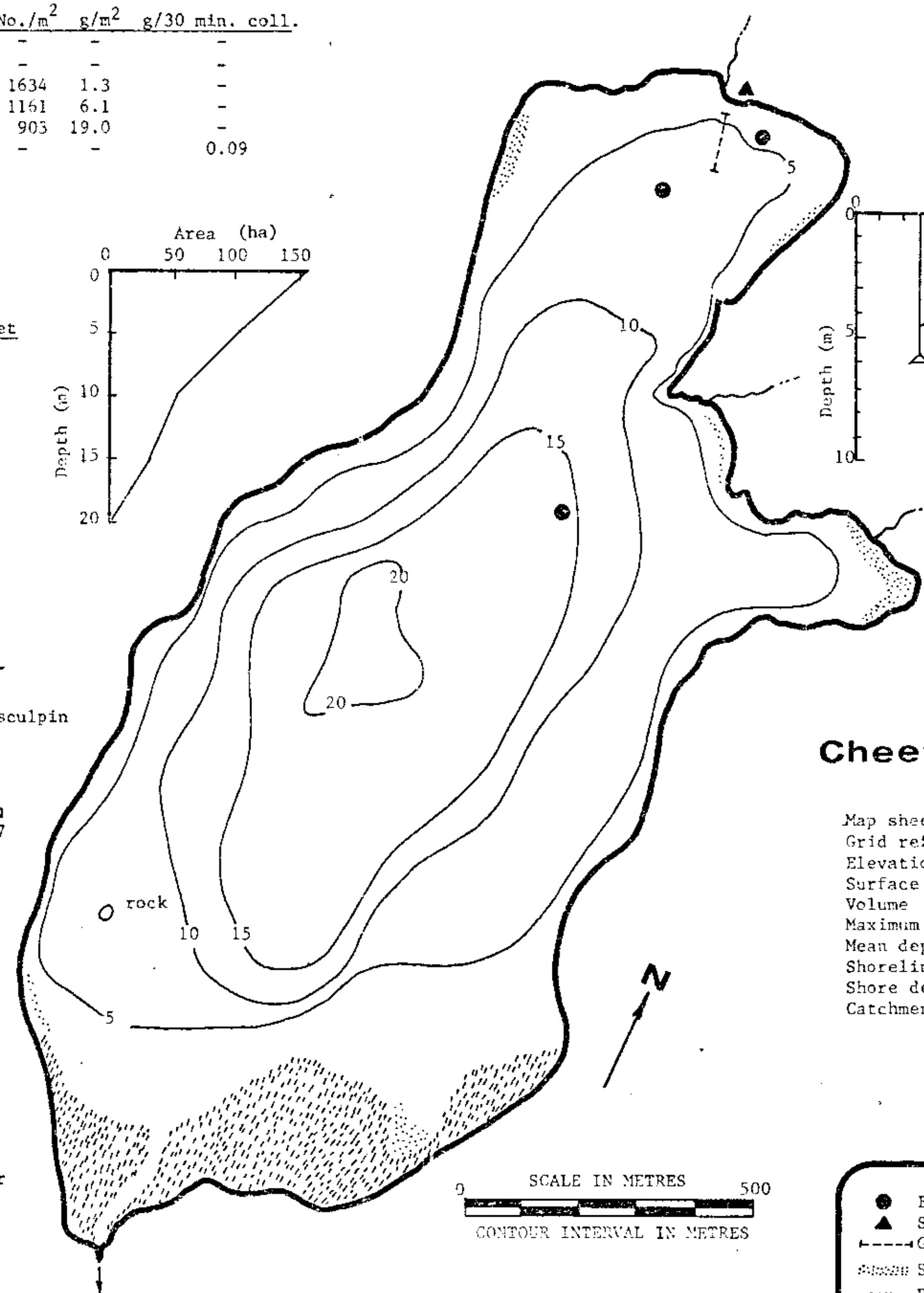
Catch	per 100 yd overnight set
Cutthroat	2
Sockeye	8
Coho	24
Prickly sculpin	30
Threespine stickleback	8

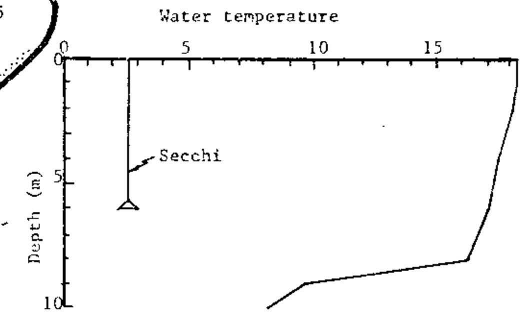


WATER CHEMISTRY

Conductivity (umho)	30.6
pH	6.7
Hardness	5.4
Colour	5







Cheewhat Lake

Map sheet	92C/10W
Grid reference	CJ 705940
Elevation (m/ft)	21/70
Surface area	153.5 ha
Volume	13.1×10^6 m^3
Maximum depth	20.2 m
Mean depth	8.5 m
Shoreline length	6222 m
Shore development	1.41
Catchment area	802 ha

Cheewhat lake

A. Morphometry (see map sheet).

Cheewhat Lake has a surface area of 153.5 ha and *is* fairly shallow with a maximum depth of 20.2 m. The lake has a single main basin with a fairly regular shoreline. Shoreline development is low at 1.41. The catchment area is relatively small and only about 5 times the lake surface area. No major streams enter the lake although a few small ones were noted. The outlet of Cheetwhat connects directly with the Pacific Ocean via the Cheewhat River.

B. Temperature (see map sheet).

A well-established metalimnion was observed at a depth of 8-10 m. Temperatures were 18.2^{o} at the surface and 8.1^{o} at 10 m.

C. Secchi visibility (see map sheet).

Cheewhat lake was moderately clear with a Secchi visibility of 6 m at the time of sampling. Approximately 80% of the bottom was within the euphotic zone.

D. Water chemistry (Appendix Table 1).

Cheewhat lake had a relatively high concentration of dissolved substances when compared with other lakes in the study area.

E. Macrophytes (Appendix Table 2, map sheet)

Large beds of emergent cattails (Scirpus validus) near the lake outlet were a dominant feature of this lake. At least 10 other macrophyte species were found along the shore of this lake. Most common were Potamogeton spp., Brasinia schreberi, and Nuphar polysepalum.

F. Phytoplankton (Appendix Table 3).

Thirty-nine phytoplankton species were identified in water samples from Cheewhat Lake. The phytoplankton biomass in terms of cell numbers was moderately high at 1613 per ml. Chlorophyta, Cyanophyta, Chrysophyta, and Bacillariophyceae (diatoms) each made up from 17-33% of the standing crop. The chrysophyte Chromulina sp. and the diatom Rhizosolenia longiseta were the most common species.

G. Zooplankton (Appendix Table 4).

The standing crop of zooplankton from Cheewhat Lake was intermediate relative to other lakes in the study area. The percentage composition of the zooplankton was almost equally divided between Rotifera and Cladocera. The cladoceran D. brachyurum dominated the community, followed closely by the rotifer Asplanchna sp.

H. Benthos (Appendix Table 5).

Nineteen invertebrate species were collected in dredge samples from Cheewhat Lake. The chironomids Tanytarsis sp. and Phaenopsectra sp. along with the dipteran Chaoborus asticopus were the most common invertebrates collected. The biomass of benthic invertebrates in Cheewhat Lake was the highest of any lake in the study area.

Crayfish (Astacus klamathensis) and rough skinned newts (Taricha granulosa) were collected along with fish in the gill nets. Newts were quite common in Cheewhat Lake and were frequently seen crawling along the bottom. Andrusak and Northcote (1970) found "salamanders" formed an important part of the diet of larger cutthroat trout in Marion Lake, B.C.

I. Shoreline invertebrates (Appendix Table 5).

Shoreline collections made along the north end of the lake yielded 21 invertebrate species. The amphipod Hyalella azteca was very common as were several species of water mites (Acarina).

J. Fish (Appendix Table 7 and 8).

Prickly sculpin (Cottus asper) and young coho (Oncorhynchus kisutch) were the most common fish collected in gill nets. The catch of 24 coho per 100 yds of net set was the highest for this species in any of the lakes examined (see Appendix Table 9). Mature male and gravid female sockeye salmon (Oncorhynchus nerka) caught in Cheewhat Lake indicate spawning activity may take place along the lake shore or in a number of small creeks or springs entering the lake. The importance of small inlet streams or springs as spawning areas for sockeye was not determined. No young sockeye were collected in gillnet samples.

The catch of 2 cutthroat trout (Salmo clark clarki) per 100 yds of net set overnight was the lowest for this species in any lake in the study area. Several other cutthroat trout were collected by angling.

The relative abundance of food items from stomach contents of fish examined from Cheewhat Lake is given in the following Table:

Composition in decreasing order of importance				
Cutthroat	Sockeye	Coho	Prickly sculpin	Stickleback
Fish	Debris	Acarina	Algae	Mist.
Coleoptera		Cladocera	Cladocera	
		Copepoda	Chironomidae	
		Diptera	Plecoptera	

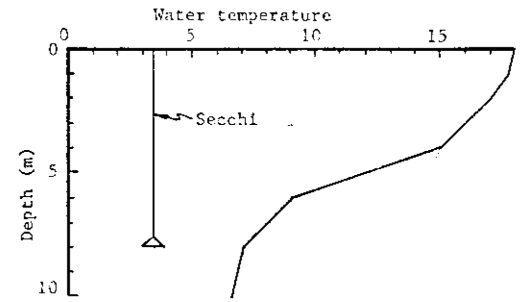
One of the stickleback examined from shoreline collections was parasitized by Ligula sp. The nematode Philonema oncorhynchi was found in 75% of the adult sockeye examined.

Information from residents of the Tofino-Ucluelet area (Ward 1970) indicates that steelhead (Salmo giardneri) may also be present in Cheewhat Lake. No data are available on this species in Cheewhat Lake. Data contained in annual salmon stream spawning reports (Department of the Environment, Fisheries Service) indicate approximately 100-2000 sockeye, 50-500 coho, and up to 400 chum salmon (O. keta) may utilize Cheewhat River during spawning runs. In these reports chum were believed to use only the lower 1/3 of the river; coho were noted in the upper 2/3; sockeye were observed in Cheewhat Lake.

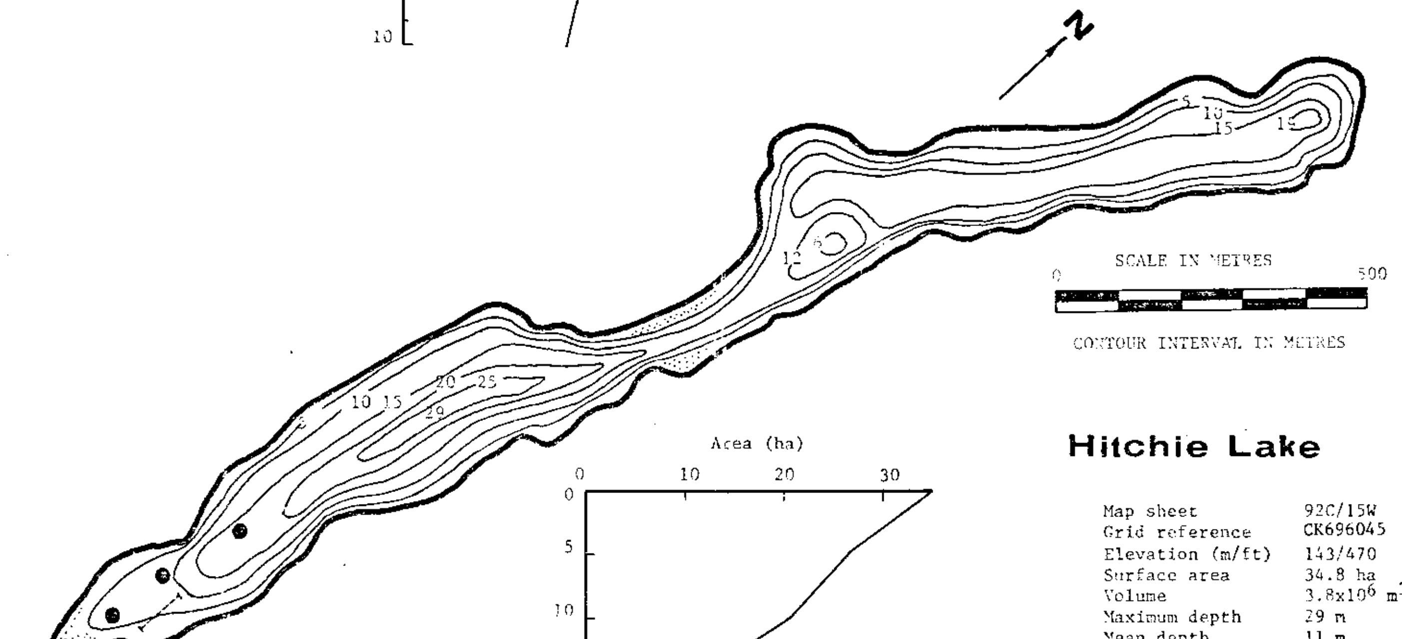
FISH CATCH DATA

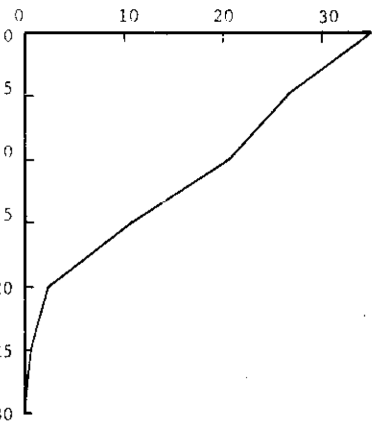
Gear: Gillnet
Time: 1 set, 3 hours

Catch	per 100 yd set
nil	nil



	No./l	No./ml	No./m^2	g/m^2	g/30 min. coll.
Zooplankton (mean)	6.22	-	-	-	-
Phytoplankton (mean)	-	1645	-	-	-
Benthic fauna 6 m	-	-	129	0.04	-
8 m	-	-	301	0.08	-
12 m	-	-	215	0.08	-
Shoreline fauna	-	-	-	-	0.49



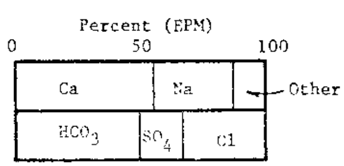


Hitchie Lake

Map sheet	92C/15W
Grid reference	CK696045
Elevation (m/ft)	143/470
Surface area	34.8 ha
Volume	3.8×10^6 m^3
Maximum depth	29 m
Mean depth	11 m
Shoreline length	5263 m
Shore development	2.52
Catchment area	1611 ha
Water renewal time	0.58 years

WATER CHEMISTRY

Conductivity (umho)	21.9
pH	6.6
Hardness	7.1
Colour	6.0



LEGEND

- ● Bottom fauna collection
- ▲ Shoreline fauna collection
- ----- Gillnet set
- Submergent macrophytes

Hitchie Lake

A. Morphometry (see map sheet).

Hitchie Lake, one of the smallest lakes examined in the study area, has a surface area of 34.8 ha and a maximum depth of 29 m. The lake is situated in a narrow valley and is divided into two main basins of almost equal size. The lake is very narrow and has a high shoreline development at 2.52. The catchment area (16611 ha) is quite large for the surface area and results in a fairly rapid water renewal time of 0.58 years. Hitchie Lake is drained by Hitchie Creek into Hobiton Lake. Two large water falls are present on Hitchie Creek about midway between the two lakes.

B. Temperature (see map sheet).

A well defined metalimnion occurred at a depth of 4-8 metres. Temperatures were 18° at the surface and 6.5° at 10 m. During a reconnaissance flight over the study area on February 19, 1975, only Hitchie Lake was found to be ice covered. Small round openings approximately 20 cm in diameter were observed at intervals across the ice surface. These may have been caused by bubbling gases from the lake bottom.

C. Secchi visibility (see map sheet).

Hitchie Lake was fairly clear with a Secchi visibility of 8.0 m. Approximately 93% of the bottom was within the euphotic zone.

D. Water chemistry (Appendix Table 1).

Water chemistry samples indicate Hitchie Lake was similar to other lakes in the study area; very dilute with low TDS, conductivity, and slightly acidic.

E. Macrophytes (Appendix Table 2).

Specimens of Potamogeton gramineus were observed in the shallows of the south-west end of the lake (see map sheet). Lilies (Nuphar polysepalum) and Menyanthes trifoliata were observed in the narrows area near the middle of the lake.

F. Phytoplankton (Appendix Table 3).

Twenty-five phytoplankton species were identified from Hitchie Lake, Blue-green algae (Cyanophyta), mainly Chroococcus sp. and Merismopedia tenuissima dominated the phytoplankton of Hitchie Lake. The chrysophyte Chromulina sp. , and the xanthophyte Chlorocloster sp. were also important. Total cell counts for Hitchie Lake were moderately high at 1645 per ml. The phytoplankton of Hitchie Lake differs from most others in the study area in the almost total absence of diatoms (Bacillariophyceae).

G. Zooplankton (Appendix Table 4).

The standing crop of zooplankton from Hitchie Lake was the lowest of the lakes examined during the fall of 1975 and was only slightly higher than spring samples from Squalicum Lake. The zooplankton counts were dominated by two rotifers (Conochilus sp. and Polyarthra vulgaris) with only small numbers of crustacea. The copepod Diaptomus oregonensis was the most common crustacean.

H. Benthos (Appendix Table 5).

Only seven invertebrate species were collected in benthic samples. Of these, the chironomid Phaenopsectra sp. was the most common. The biomass of benthic animals in Hitchie Lake was the lowest for any lake examined in the study area. The mean weight for the three dredge samples was 0.06 g/m^2.

I. Shoreline invertebrates (Appendix Table 5).

Shoreline collections made approximately 100 m from the outlet yielded only 6 invertebrate species. Amphipods and corixid beetles were common along the shoreline.

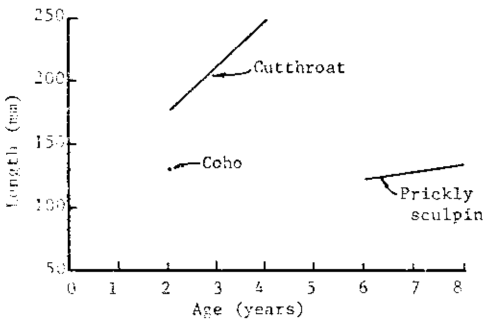
F. Fish.

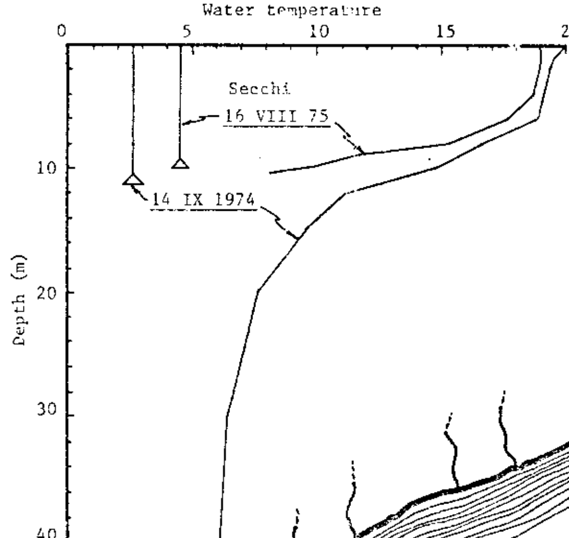
No fish were collected by the gill net set in Hitchie Lake. No fish activity was observed throughout the length of the lake or in the outlet stream during the present study. Hitchie Lake is possibly devoid of fish. The two waterfalls on Hitchie Creek undoubtedly prevent migration to or from Hobiton Lake.

FISH CATCH DATA

Gear: Gillnet
Time: 3 sets, overnight

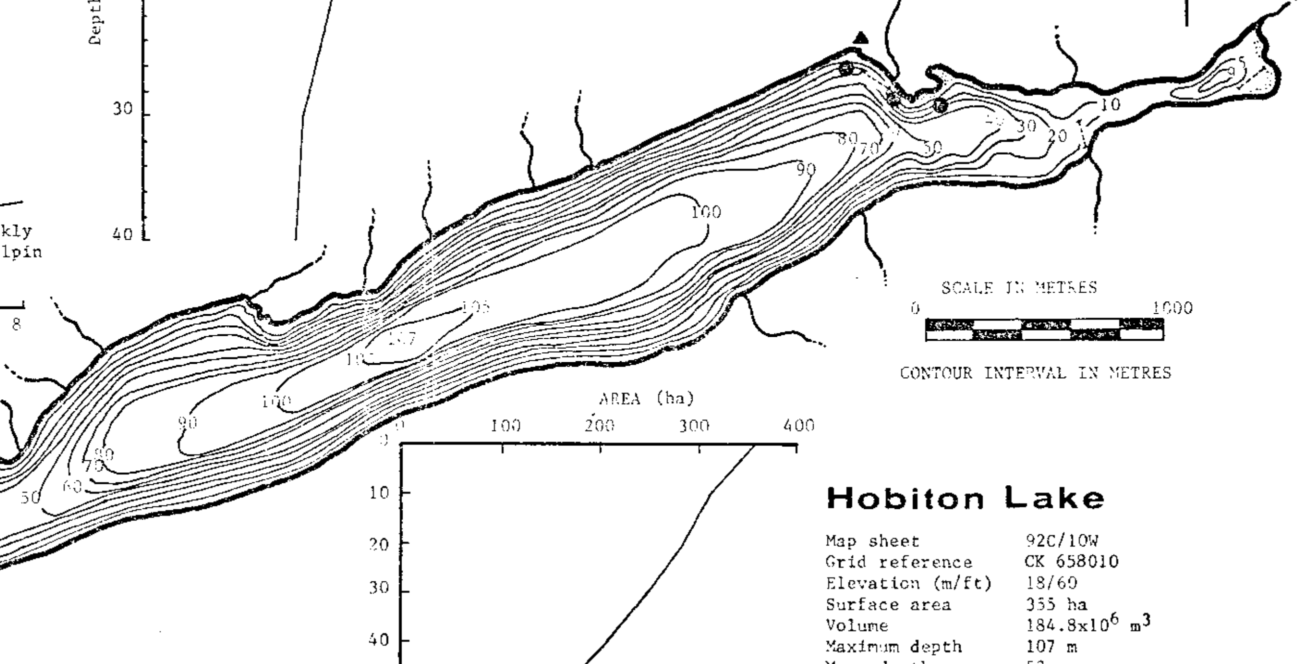
Catch	per 100 yd overnight set
Cutthroat	12.5
Dolly Varden	0.5
Sockeye	3.5
Coho	2.0
Prickly sculpin	16.5
Coastrange sculpin	(shoreline)
Threespine stickleback	(shoreline)



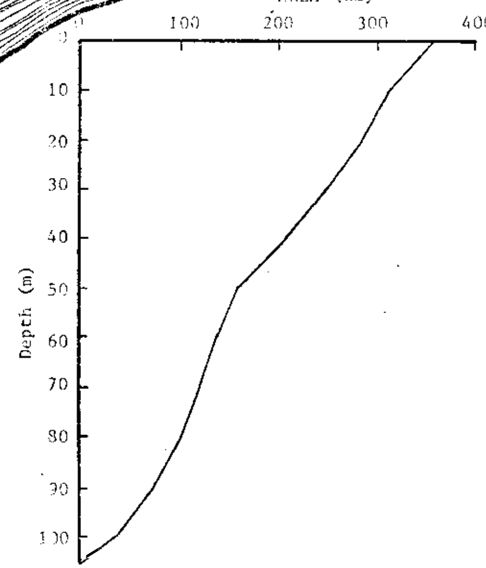


WATER CHEMISTRY

Conductivity (umho)	22
pH	7.3
Hardness	4.7
Colour	5



	No./l	No./ml	No./m²	g/m²	g/30 min. coll.
Zooplankton (mean)	15.9	-	-	-	-
Phytoplankton (mean)	-	629	-	-	-
Benthic fauna 7 m	-	-	1161	8.2	-
18 m	-	-	1161	11.6	-
25 m	-	-	129	0.08	-
Shoreline fauna	-	-	-	-	0.49



Hobiton Lake

Map sheet	92C/10W
Grid reference	CK 658010
Elevation (m/ft)	18/60
Surface area	355 ha
Volume	184.8×10^6 m³
Maximum depth	107 m
Mean depth	52 m
Shoreline length	15008 m
Shore development	2.25
Catchment area	4069 ha

LEGEND

- ● Bottom fauna collection
- ▲ Shoreline fauna collection
- ⊢----⊣ Gillnet set
- Submergent macrophytes

Hobiton Lake

A. Morphometry (See map sheet).

Hobiton is the largest lake in the Park with a surface area of 355 ha and a maximum depth of 107 m. The lake is characterized by a single large deep basin with rather uniform slope. The narrowness of the lake results in a high shore development of 2.25. The catchment area includes the area drained by Hitchie Lake and is the largest of any lake in the study area. The surface of Hobiton Lake is approximately 18 m above sea level.

On September 14, 1974, Mr. R. Wickstrom placed a brass screw bench mark **30** cm above the water line on a rock face along the North shore approximately 1000 m west of the lake outlet. The water level was 42 cm below the bench mark on August 15, 1975.

B. Temperature (see map sheet).

Data collected in 1974 and 1975 indicate that this lake has a well established metalimnion (thermocline) at a depth of 8-10 m during late summer. Epilimnion temperatures were approximately 19° and the hypolimnion temperature was 6.0° at a depth of 40 m.

C. Secchi visibility (see map sheet).

Hobiton Lake was one of the clearest of the lakes examined with a Secchi visibility of 11.5 and 10.0 m in 1974 and 1975, respectively. Approximately 26% of the bottom area was within the euphotic zone.

D. Water chemistry (Appendix Table 1).

Water chemistry data collected in 1974 indicates Hobiton Lake was one of the more dilute lakes in the study area. Conductivity was very low at 22 pmho/cm^2.

An interesting situation occurs in some deep coastal British Columbia lakes which have been found to contain sea water (Northcote and Johnson 1964). Sakinaw Lake lies about 5 m above sea level and has a maximum depth of 140 m. Sea water was found below the 40 m level. A similar situation is possible in Hobiton and Tsusiat lakes. Deep water chemistry samples would help to clarify the situation in these lakes.

E. Macrophytes (Appendix Table 3).

Thirty-eight phytoplankton species were identified in samples collected in 1974 and 1975. Dominant species include the cyanophytes Coelosphaerium pallidum, Merismopedia tenissima, and Rhabdoderma lineare and the chrysophyte Chromulina spp. Total cell counts and major group composition were quite similar to nearby Tsusiat Lake. Standing crop in terms of cells per ml was about average for lakes in the study area.

G. Zooplankton (Appendix Table 4).

Zooplankton samples from Hobiton Lake indicated the presence of 5 rotifer, 2 cladoceran, and 2 copepod species. Most of the zooplankton standing crop was made up by rotifers, and crustacean numbers were low compared to most other lakes in the study area.

H. Benthos (Appendix Table 5).

Twelve invertebrate species were collected in dredge samples (see map sheet). Only the chironomid Brillia sp. was found in the deepest dredge sample (25 m) while the shallower samples were dominated by the isopod Asellus occidentalis. In terms of biomass per unit area the shallow dredge samples from Hobiton Lake were among the highest found in the study area.

I. Shoreline (Appendix Table 5).

Shoreline collections made in a shallow area among macrophytes produced 10 invertebrate species. The trichopteran Lepidostoma sp. and freshwater clams, Margaritifera margaritifera. were common in shoreline areas where macrophytes were found.

J. Fish (Appendix Tables 7 and 8).

Cutthroat and prickly sculpin were the most common fish species collected in gill nets set during 1974 and 1975. A small number of sockeye salmon and Dolly Varden (Salvelinus malma) were collected in 1974, but none in 1975.The catch of 12.5 cutthroat per 100 yds of net set was among the lowest for lakes examined in the area (Appendix table 9). The growth rates for these fish were slightly lower than the mean for lakes examined (see map sheet). The largest cutthroat, weighing 720 g, was collected by R.D. Wickstrom in 1974.

A few specimens of 2 year old coho were caught in the gill nets. Coastrange sculpin (Cottus aleuticus) were collected in the gravelly shoreline areas near Hitchie Creek. Threespine sticklebacks (Gasterosteus aculeatus) were common in the littoral zone.

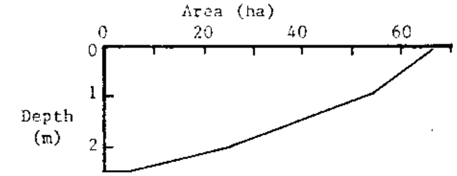
The relative abundance of food items from stomach contents of fish examined from Hobiton Lake is given in the following table:

Comoosition in decreasing order of imoortance			
Cutthroat	Coho	Prickly sculpin	Stickleback
Aerial insects	Aerial insects	Algae	Cladocera
Coleoptera	Acarina	Chironomidae	Amphipoda
Fish	Coleoptera	Pelecypoda	Chironomidae
Diptera	Ephemeroptera	Trichoptera	Trichoptera

Aro and Shepard (1967) reported the only significant sockeye run in the Nitnat area spawned in the Hobiton River, where escapements averaged between 2000 and 5000 sockeye from 1951 to 1962. Most spawning occurs in October. Northcote et al. (1964) indicated chum salmon are also known to ascend the Hobiton River although no data were given. Salmon stream spawning reports (Department of the Environment, Fisheries Service) covering the years 1964-1975 indicate approximately 2000-8000 sockeye, 50-300 coho, and 700-6000 chum salmon annually utilize Hobiton River for spawning. Chum and coho are believed to spawn in the river while coho and sockeye are found in the lake. Hobiton River is the only system in the Nitnat watershed having sockeye (Greenlee 1974). Chinook salmon (O. tshawytscha) have also been reported from Hobiton Lake (Sierra Club 1972) but this has not been confirmed.

Kichha Lake

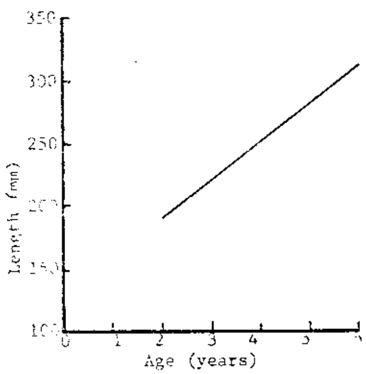
	No./l	No./ml	No./m^2	g/m^2	g/30 min. coll.
Zooplankton (mean)	177.6	-	-	-	-
Phytoplankton (mean)	-	22620	-	-	-
Benthic fauna 1 m	-	-	1548	4.6	-
2 m	-	-	1419	4.4	-
2 m	-	-	817	4.1	-
Shoreline fauna	-	-	-	-	0.19

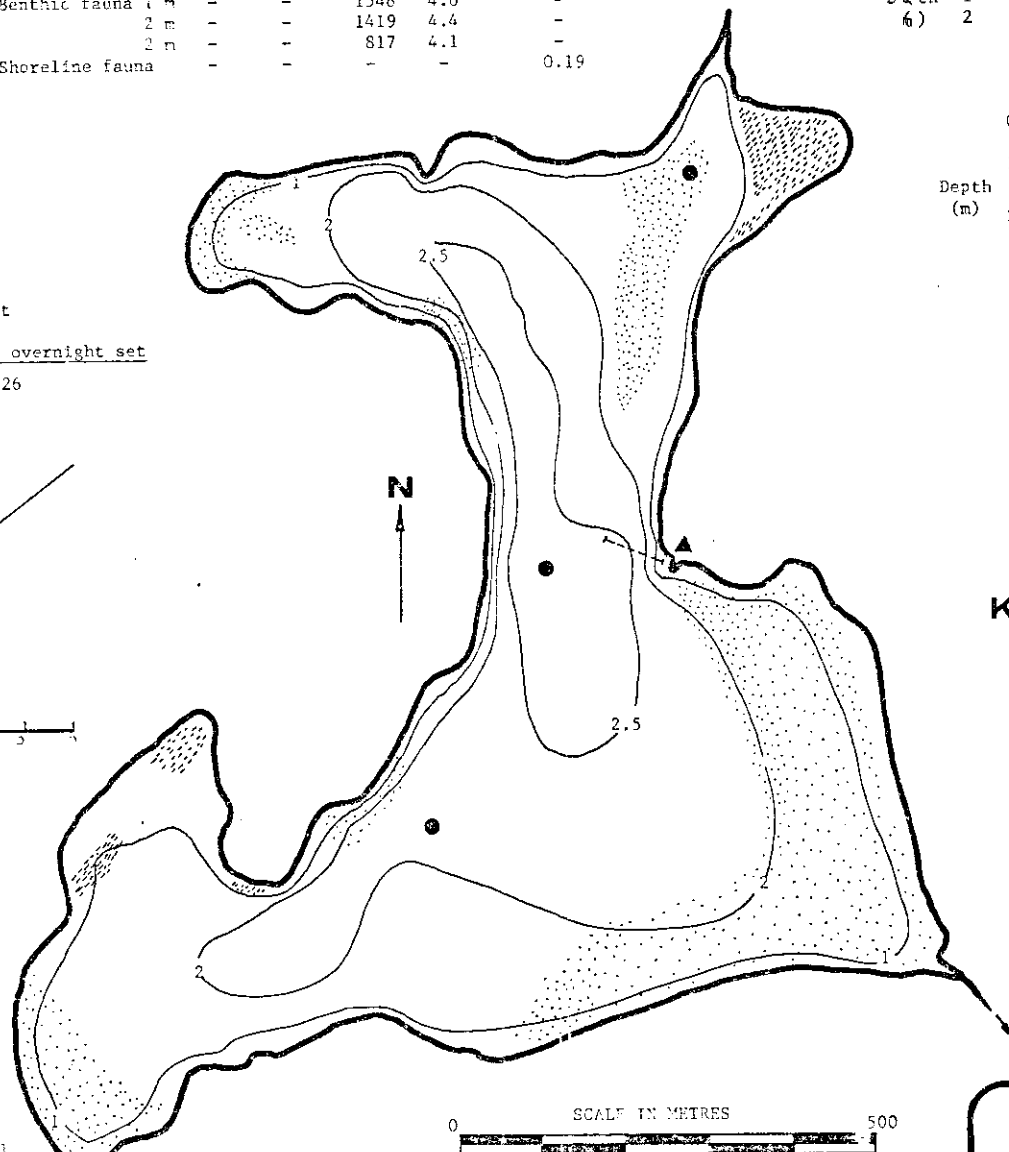


FISH CATCH DATA

Gear: Gillnet
Time: 2 sets, overnight

Catch	per 100 yd overnight set
Cutthroat	26

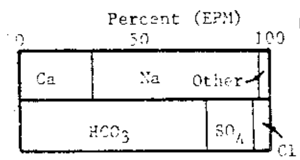




Map sheet	92C/14E
Grid reference	CK 404068
Elevation (m/ft)	12/40
Surface area	66 ha
Volume	1.06×10^6 m^3
Maximum depth	2.7 m
Mean depth	1.6 m
Shoreline length	5615 m
Shore development	1.95
Catchment area	327 ha

WATER CHEMISTRY

Conductivity (umho)	54
pH	5.3
Colour	80



CONTOUR INTERVAL IN METRES

LEGEND
● Bottom fauna collection
▲ Shoreline fauna collection
Gillnet set
Submergent macrophytes
Emergent macrophytes

Kichha lake

A. Morphometry (see map sheet).

Kichha Lake is a shallow lake of approximately 66 ha surface area. The maximum depth was 2.5 m while the mean depth was only 1.6 m. The lake has an irregular shoreline with a development of 1.95. The catchment area is small and included low hills and marshy areas. The outlet of Kichha Lake flows directly to the Pacific Ocean. Heavy precipitation caused noticable flow in small intermittent streams along the northern shoreline.

B. Temperature (see map sheet).

Bottom temperatures in Kichha Lake were higher than surface temperatures when examined during late August, 1975. Because of its shallow depth and exposure to winds this lake probably never establishes a thermal gradient.

C. Sechhi visibility (see map sheet).

The water of Kichha Lake was highly coloured (80 Hazen units) and Secchi visibility was very low, only 2 m. Approximately 100% of the bottom is within the euphotic zone.

D. Water chemistry (Appendix Table 1).

Kiccha Lake had the highest conductivity and lowest pH of any lake examined in the study area. The shallow nature of this lake may make evaporative concentration an important factor and produce somewhat higher concentrations of solutes than might be expected from surface runoff.

E. Macrophytes (Appendix Table 2).

Macrophytes were common in all parts of Kichha Lake (see map sheet).

Brasinia schreberi and Potamogeton spp. are found in most area of about 1.5 m or less in depth. Emergent plants such as cattails (Scirpus validus) and buckbean (Menyanthes trifoliata) formed a dense bed in the small hay at the northwest corner of the lake. Lilies (Nuphar polysepalum) were found in several areas around the lake perimeter. A total of seven aquatic macrophyte species were identified from the lake.

F. Phytoplankton (Appendix Table 3).

Thirty-six phytoplankton species were identified in samples from Kichha Lake. Phytoplankton biomass in terms of cell numbers was by far the highest of any lake examined in the study area (Appendix Table 9). A count of over 22,000 cells per ml was recorded for this lake. The major group composition was also unusual for the lakes studied: over 95% of the phytoplankton were cyanophytes with Cryptophyta, Bacillariophyceae and Pyrrophyta being completely absent. Merismopedia tenuissima and Coelosphaerium pallidum were the dominant. species.

G. Zooplankton (Appendix Table 4).

The zooplankton standing crop in Kichha Lake was the highest (172 individuals per litre) for any lake examined in the study area (Appendix Table 9). A large proportion of the zooplankton were crustaceans with Diaphanosoma leuchtenbergianum, Holopedium gibberum, and Diaptomus oregonensis occurring in high numbers.

H. Benthos (Appendix Table 5).

Fifteen invertebrate species were collected in dredge samples. Invertebrate standing crop in dredge samples was among the highest for lakes in the study area. Dominant species included isopods, amphipods, and Chaoborus asticopus. Biomass was very consistent at the three dredge sites at 4.3 g/m^2.

I. Shoreline invertebrates (Appendix Table 5).

Shoreline collections made near a small point along the east shore of the lake yielded 12 invertebrate species, Amphipods and chironomids were the most common species present.

J. Fish (Appendix Table 7 and 8).

Cutthroat trout were the only fish caught in gill nets set on two successive nights. The catch of 26 cutthroat per 100 yds net set overnight was about average for the lakes examined in the study area. Growth rates and length-weight ratios appear to be about average for the lakes examined.

The relative abundance of food items from stomach contents of fish examined from Kichha Lake is given in the following table:

Composition in decreasing order of importance Cutthroat
Isopoda
Amphipoda
Fish
Trichoptera
Coleoptera
Chironomidae
Odonata
Cladocera
Pelecypoda

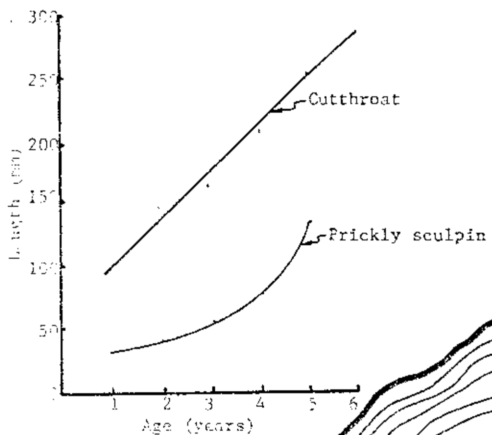
Squalicum Lake

Map sheet	92C/16W
Grid reference	CJ 665995
Elevation (m/ft)	85/280
Surface area	224 ha
Volume	85.0×10^6 m^3
Maximum depth	81 m
Mean depth	37.9 m
Shoreline length	8957 m
Shore development	1.68
Catchment area	651 ha
Water renewal time	3.0-7.0 years

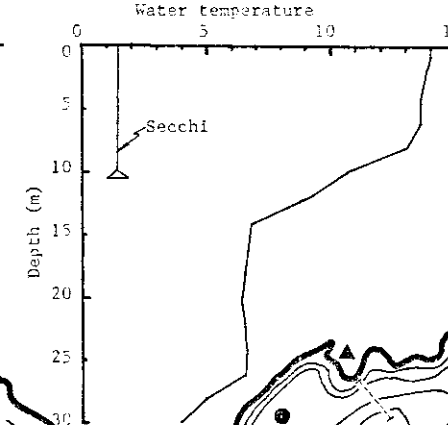
FISH CATCH DATA

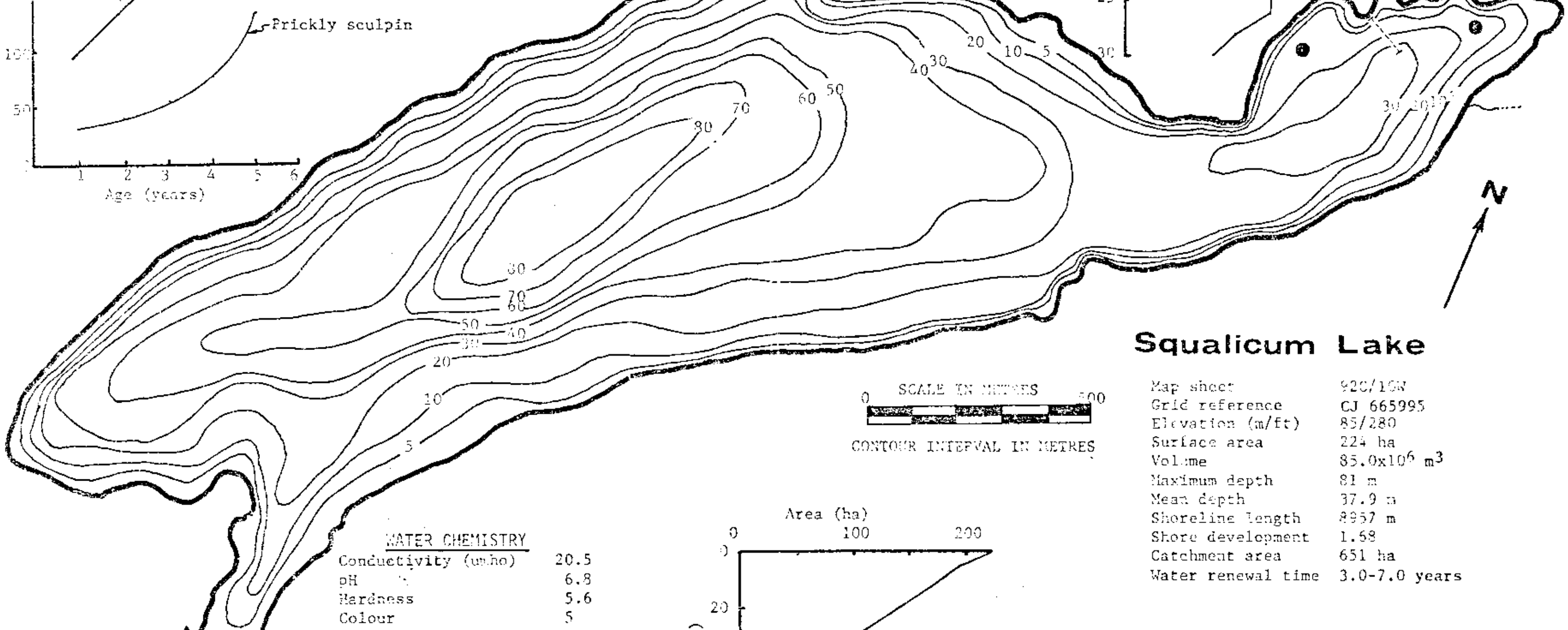
Gear: Gillnet
Time: 3 sets, overnight

Catch	per 100 yd overnight set
Cutthroat	35.3
Prickly sculpin	3.3



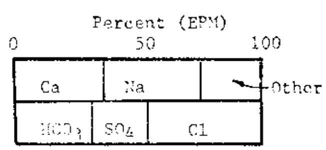
	No./l	No./ml	No./m^2	g/m^2	g/30 min. coll.
Zooplankton (mean)	5.6	-	-	-	-
Phytoplankton (mean)	-	835	-	-	-
Benthic fauna 5 m	-	-	860	5.1	-
10 m	-	-	345	4.6	-
21 m	-	-	2160	6.2	-
Shoreline fauna	-	-	-	-	0.20

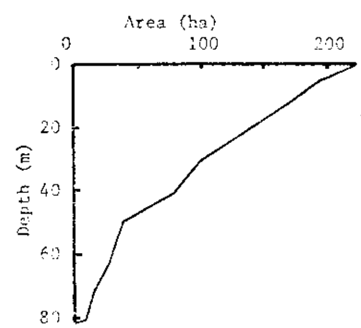




WATER CHEMISTRY

Conductivity (umho)	20.5
pH	6.8
Hardness	5.6
Colour	5





LEGEND

- ● Bottom fauna collection
- ▲ Shoreline fauna collection
- ⊢-----⊣ Gillnet set

Squalicum lake

A. Morphometry (see map sheet).

Squalicum Lake is the third largest lake in the study area with a surface area of 224 ha and a maximum depth of 81 m. The lake drains a small catchment area of 651 ha. Inflowing streams are small and intermittent, Squalicum Creek drains the lake at the south end and had a flow of 0.89 m^3/sec when measured in May and August, respectively. Water renewal time for Squalicum Lake was estimated to be 3-7 years. Squalicum Creek flows through two small ponds before entering Tsusiat Lake. The shoreline of Squalicum Lake is fairly regular with little development (1.68). An abruptly sloping bottom restricts the littoral zone to a narrow area around the lake perimeter.

B. Temperature (see map sheet).

A well established metalimnion was present at a depth of 10-14 m during May, 1975. Epilimnion temperatures were between 13 and 14^{o} while the hypolimnion was about 6^{o}.

C. Secchi visbility (see map sheet).

Squalicum Lake was very clear with a Secchi visibility of 10.8 m. Approximately 50% of the bottom was within the euphotic zone.

D. Water chemistry (Appendix Table 1).

Squalicum Lake had one of the lowest conductivity readings (20.5 $\mu mho/cm^2$) of lakes examined in the Park. Total dissolved solids and values for all parameters indicate this lake was very dilute

E. Macrophytes (Appendix Table 2).

The spring field trip coincided with the germination of most macrophytes. As a result only two species were collected. Lilies (Nuphar polysepalum) and Menyanthes trifoliata were noted in shallow protected areas near the east end of the lake.

F. Phytoplankton (Appendix Table 3).

Twenty-seven species of phytoplankton were identified in water samples from Squalicum Lake. The total cell numbers for this lake were similar to Tsusiat and Hobiton Lakes. The major group composition of phytoplankton from Squalicum Lake differs from the other lakes mainly as a result of the low numbers of Chromulina sp. present in May. Dominant species include Merismopedia tenuissima and Botryococcus protuberans var minor.

G. Zooplankton (Appendix Table 4).

Net samples from Squalicum Lake contained only very low numbers of zooplankton. Cyclops bicuspidatus thomasi and Diaptomus tyrrelli were the most common crustaceans.

H. Benthos (Appendix Table 5).

Eighteen invertebrate species were identified from dredge samples taken at depths of 5-21 m. Chironomidae dominated the benthos with lesser numbers of Hyalella azteca (Amphipoda) and Trichoptera. A mean benthic biomass of 5.3 g/m^2 was above average for lakes in the study area.

Rough skinned newts were quite common in Squalicum Lake and were frequently seen crawling along the bottom. Nineteen newts were caught in a single overnight gill net set.

I. Shoreline invertebrates (Appendix Table 5).

Shoreline collections made in a small bay at the east end of the lake and among logs near the outlet produced 14 invertebrate species. Amphipods, trichoptera, and chironomids were common along the shore. Freshwater clams (Margaritifera margaritifera) were collected in water about 1 m deep near the lake outlet.

J. Fish (Appendix Table 7 and 8).

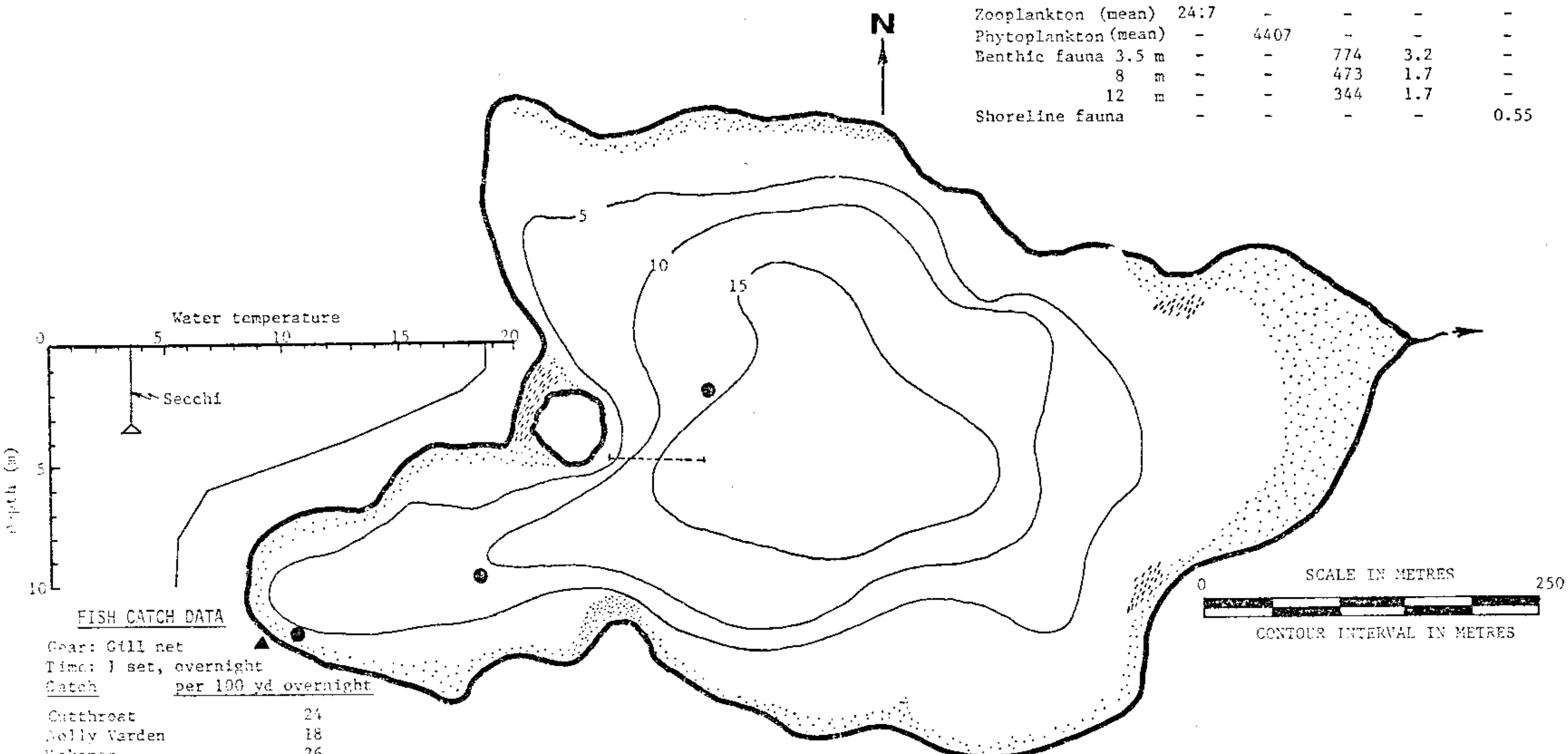
Cutthroat trout and prickly sculpin were collected in gill net sets in Squalicum Lake. The catch of 35.3 cutthroat per 100 yds net set overnight was second only to Tsusiat Lake. The cutthroat in Squalicum Lake appear to have the lowest growth rate of any lake in the study area. Of 53 cutthroat examined the largest weighed 279 g and was 6 years old.

Cutthroat were observed swimming at the surface during morning and evening hours, presumably feeding on copepods. Nearly all of the fish examined had large numbers of copepods (Diaptomus tyrrelli) in their stomachs. The relative abundance of food items in stomachs of fish examined from Squalicum Lake is given in the following table:

Composition in decreasing order of importance	
Cutthroat	Prickly sculpin
Copepoda	Copepoda
Coleoptera	Chironomidae
Chironomidae	Trichoptera
Megaloptera	Gastropoda
Cladocera	Ostracoda
Trichoptera	Amphipoda
Fish	Megaloptera
Acarina	
Amphipoda	
Ephemeroptera	
Odonata	

Most of the cutthroat examined were heavily parasitized by cestode larvae (probably Diphyllobothrium) and several had parasitic copepods on the gills.

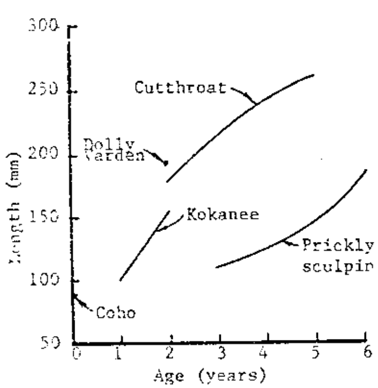
	No./l	No./ml	No./m^2	g/m^2	g/30 min.coll.
Zooplankton (mean)	24.7	-	-	-	-
Phytoplankton (mean)	-	4407	-	-	-
Benthic fauna 3.5 m	-	-	774	3.2	-
8 m	-	-	473	1.7	-
12 m	-	-	344	1.7	-
Shoreline fauna	-	-	-	-	0.55



FISH CATCH DATA

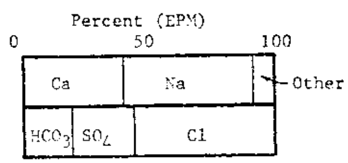
Gear: Gill net
Time: 1 set, overnight

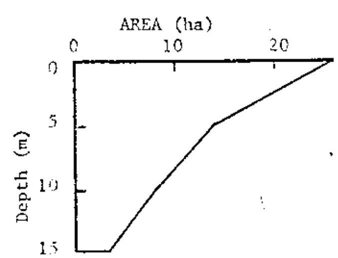
Catch	per 100 yd overnight
Cutthroat	24
Dolly Varden	18
Kokanee	26
Coho	12
Prickly sculpin	12
Threespine stickleback	(shoreline)



WATER CHEMISTRY

Conductivity (umho)	24.7
pH	6.5
Hardness	5.4
Colour	70





Tsuquadra Lake

Map sheet	92C/10W
Grid reference	CJ 617955
Elevation (m/ft)	24/80
Surface area	26.3 ha
Volume	1.81×10^6 m^3
Maximum depth	15 m
Mean depth	6.8 m
Shoreline length	2525 m
Shore development	1.39
Catchment area	306 ha

LEGEND

- ● Bottom fauna collection.
- ▲ Shoreline fauna collection
- ⊢----⊣ Gillnet set
- Submergent macrophytes
- Emergent macrophytes

Tsuquadra lake

A. Morphometry (see map sheet).

Tsuquadra Lake was the smallest lake examined and had a surface area of 26.3 ha and a maximum depth of 15 m. The lake drains an area of low hills and has a relatively large catchment area of 306 ha. A small creek drains the lake at the east end and flows to the sea. The lake is almost rectangular in shape with a shore development of 1.39. A relatively large littoral zone was present with about 47% of the lake less than 5 m deep.

B. Temperature (see map sheet).

The epilimnion occupied only the upper 1-2 m with a temperature of about 18°. A rather broad metalimnion extended from 2-8 m with hypolimnion temperatures of about 5.5°.

C. Secchi visibility (see map sheet).

The water of Tsuquadra Lake was highly coloured (70 Hazen units) and secchi visibility was only 3.5 m. Approximately 68% of the bottom was in the euphotic zone.

D. Water chemistry (Appendix Table 1).

A conductivity value of 24.7 µmho for Tsuquadra Lake was about average for lakes in the study area. Only Kichha Lake was darker in colour.

E. Macrophytes (Appendix Table 2).

Six macrophyte species were identified from Tsuquadra Lake. Water shield, Brasenia schreberi, were found along the lake perimeter wherever depths were about 1 m or less. They formed a band approximately 10 m wide in the bay at the east end of the lake (see map sheet). Menyanthes trifoliata and lilies (Nuphar polysepalum) were also widely distributed around the shoreline. Other species present included Carex sp. and Potamogeton sp.

F. Phytoplankton (Appendix Table 3).

Thirty-three phytoplankton species were identified from Tsuquadra Lake. A cell count of 4407 per ml was the second highest for lakes in the study area (Appendix Table 9). Dominants included the cyanophytes Merismopedia tenuissima and Chroococcus sp. and the chrysophytes Chromulina spp. and Cyclotella spp.

G. Zooplankton (Appendix Table 4).

In terms of numbers per litre the zooplankton from Tsuquadra Lake was second only to Kichha Lake. Rotifers and copepods accounted for 90% of the zooplankton community. Dominant rotifers included Kellicottia longispina and K. bostonensis. The dominant crustaceans included Diaphanosoma brachyurum and Cyclops bicuspidatus thomasi.

H. Benthos (Appendix Table 5).

Eighteen species of invertebrates were identified from dredge samples taken at depths of 3.5-12 m. The dipteran Chaoborus asticopus was the most common species collected. In terms of total numbers and biomass the benthic fauna was about average for lakes in the study area.

I. Shoreline invertebrates (Appendix Table 5).

Shoreline collections made at the west end of the lake yielded thirteen invertebrate species. Amphipods (Hyalella azteca) and Trichoptera (Lepidostoma sp.) were the most common species.

J. Fish (Appendix Tables 7 and 8).

Six fish species were collected in Tsuquadra Lake in one overnight gill net set and shoreline collections. The total catch of 80 salmonids per 100 yds net set overnight was the highest of any lake examined in the study area (Appendix Table 9). Tsuquadra Lake is probably the only lake in the study area where Dolly Varden (Salvelinus malma) form a significant part of the fish population.

Determining the status of potential anadromus species in Tsuquadra Lake is made somewhat difficult by a lack of information on the stream which drains the lake. Definite barriers to fish migration would leave no doubt as to the migratory status of the fish present. The two year old Oncorhynchus nerka collected included mature and gravid specimens indicating these are freshwater resident kokanee. It is possible to have both freshwater resident and anadromous O. nerka in the same lake (Scott and Crossman 1973) however we found no evidence of sockeye in Tsuquadra Lake. The absence of mature coho in the gill net catch may indicate this species migrates to the sea although they might simply have eluded capture. Observations by the Warden Service indicate this stream is probably impassable for migratory fish (personal communication).

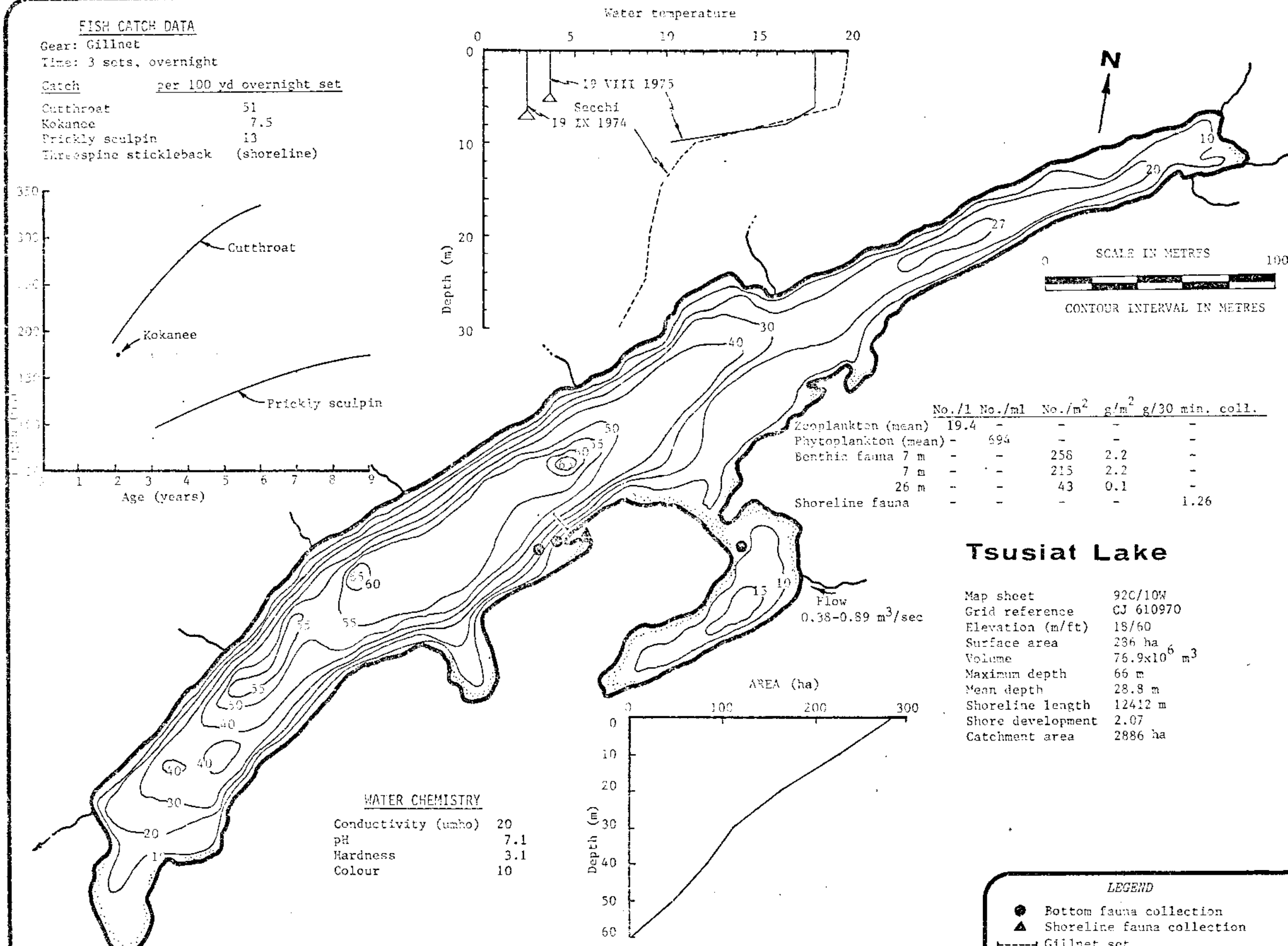
The relative abundance of food items from stomach contents of fish collected in Tsuquadra Lake is given in the following table:

Composition in decreasing order of importance				
Cutthroat	Dolly Varden	Coho	Kokanee	Prickly sculpin
Chironomidae	Isopoda	Cladocera	Chaoborus	Fish eggs
Fish	Chironomidae	Isopoda	Cladocera	Isopoda
Isopoda	Megaloptera		Copepoda	Trichoptera
Trichoptera	Amphipoda		Chironomidae	Chironomidae
Chaoborus	Pelecypoda		Amphipoda	Chaoborus
Acarina	Odonata			
Coleoptera				
Cladocea				

In general it appears that cutthroat, Dolly Varden. and prickly sculpin feed predominantly on bottom and shoreline organisms while coho and kokanee feed predominantly on zooplankton.

Most of the Dolly Varden examined were parasitized by the nematode Salvelinema walkeri. One kokanee was found to be parasitized by Acanthocephala and the nematode S. walkeri.

Tsusiat Lake



FISH CATCH DATA

Gear: Gillnet
Time: 3 sets, overnight

Catch	per 100 yd overnight set
Cutthroat	51
Kokanee	7.5
Prickly sculpin	13
Threespine stickleback	(shoreline)

	No./l	No./ml	No./m^2	g/m^2	g/30 min. coll.
Zooplankton (mean)	19.4	-	-	-	-
Phytoplankton (mean)	-	694	-	-	-
Benthic fauna 7 m	-	-	258	2.2	-
7 m	-	-	215	2.2	-
26 m	-	-	43	0.1	-
Shoreline fauna	-	-	-	-	1.26

Map sheet	92C/10W
Grid reference	CJ 610970
Elevation (m/ft)	18/60
Surface area	236 ha
Volume	76.9x10^6 m^3
Maximum depth	66 m
Mean depth	28.8 m
Shoreline length	12412 m
Shore development	2.07
Catchment area	2886 ha

WATER CHEMISTRY

Conductivity (umho)	20
pH	7.1
Hardness	3.1
Colour	10

LEGEND

- ● Bottom fauna collection
- ▲ Shoreline fauna collection
- ⊢----⊣ Gillnet set
- Submergent macrophytes

Tsusiat lake

A, Morphometry (see map sheet).

With a surface area of 286 ha Tsusiat Lake is the second largest lake in the study area. The lake is long and narrow and has a maximum depth of 65 m. The Tsusiat River drains the lake at its west end and flows directly to the sea. A large waterfall prevents passage of anadromous fish. The catchment basin included the area drained by Squalicum Lake and is about 10 times larger than the lake surface area. Shore development is quite high at 2.07. Approximately 20% of the lake is less than 10 m deep and, as a result, littoral areas are more common in Tsusiat than in Squalicum or Hobiton lakes.

B. Temperature (see map sheet).

A well defined metalimnion was present during both 1974 and 1975 at a depth of 6-10 m. Epilimnion temperatures were about 2° lower in 1975 as a result of a cooler summer. Hypolimnion temperatures ranged from about 9° to 7° at 14 and 40 m, respectively.

C. Secchi visibility (see map sheet).

Tsusiat Lake was fairly clear with a Secchi visibility of 7.5 and 5.5 m in 1974 and 1975, respectively. Approximately 40% of the bottom was in the euphotic zone.

D. Water chemistry (Appendix Table 1).

Tsusiat had the lowest conductivity of any lake examined in the study area, 20 $\mu mho/cm^2$. Total alkalinity was the highest for lakes examined in the study area, 9.3 ppm. Water chemistry samples from near maximum depth in Tsusiat Lake are required to determine if seawater is present as discussed in the Hobiton Lake section of this report.

E. Macrophytes (Appendix Table 2).

Twenty macrophytes species were identified from Tsusiat Lake. This was the largest number of species for any lake in the study area. The large number of species present is an indication of the diverse habitats available along the shoreline, although it may reflect the intensity of collections which were made during both 1974 and 1975. Extensive shallow areas in and near the large bay on the south shore of Tsusiat Lake were particularly productive (see map sheet). Most common were the water shield, Brasenia schrenberi. and species of Potamogeton.

F. Phytoplankton (Appendix Table 3).

Thirty-four species of phytoplankton were identified in water samples from Tsusiat Lake. Cell numbers were quite low and similar to Squalicum and Hobiton lakes. Dominant species included the cyanophyte Merismopedia tenuissima and the chrysophyte Chromulina spp. Total counts were much higher in August 1974, than in 1975 possibly due to warmer temperatures during 1974.

G. Zooplankton (Appendix Table 4).

Zooplankton counts were low and comparable to other deep lakes in the study area. The counts were dominated by the rotifer Kellicottia longispina. The most common crustacean was Cyclops bicuspidatus thomasi.

H. Benthos (Appendix Table 5).

Only nine invertebrate species were identified from dredge samples taken at depths of 7-26m. Total numbers per m^2 were among the lowest for lakes examined in the study area (Appendix Table 9). Most common in the samples were oligochaetes, chironomids, and water mites.

The mysid Neomysis awatchensis was collected in dredge samples from Tsusiat Lake. This species is primarily a brackish-water form occurring in shallow bays near the outlets of streams along the Pacific coast. It is sometimes found in isolated bodies of fresh-water, as in lakes behind the sand dunes along the Oregon coast, and in those fresh-water basins which are still narrowly connected with the sea, such as Lake Washington and Union at Seattle (Edmondson 1959). The presence of Neomysis in Tsusiat Lake is probably an indication of the recent (in geological terms) separation of this water body from the ocean.

I. Shoreline invertebrates (Appendix Table 5).

Thirteen invertebrate species were collected along the south shore in a small protected bay. The most common species were leeches (Placobdella ornata) and beetles (Liodessus sp.)

J. Fish (Appendix Table 7 and 8).

Four species of fish were caught in overnight net sets and shoreline collections. The catch of 51 cutthroat per 100 yds net set overnight was the highest of any lake for this species. The growth rate of cutthroat was above average for lakes in the study area with 4-year-old fish averaging 286 mm in length. Kokanee caught in 1975 were estimated to be 2 years old. Two-year-old kokanee generally form an important part of the spawning run in other areas (Scott and Crossman 1973). The low catch of kokanee in this lake may be the result of sampling error. Kokanee are known to prefer temperatures of from 10-15° and this range was generally available only at a depth of 9-10 m. Only a portion of the gill net extended to this depth.

The relative abundance of food items from stomach contents of fish collected in Tsusiat Lake is given in the following table:

Composition in decreasing order of importance		
Cutthroat	Kakanee	Prickly sculpin
Mysidacea	Cladocera	Pelecypoda
Fish		Gastropoda
Coleoptera		Chironomidae
Ephemeroptera		Isopoda
Trichoptera		Plecoptera
Megaloptera		Trichoptera

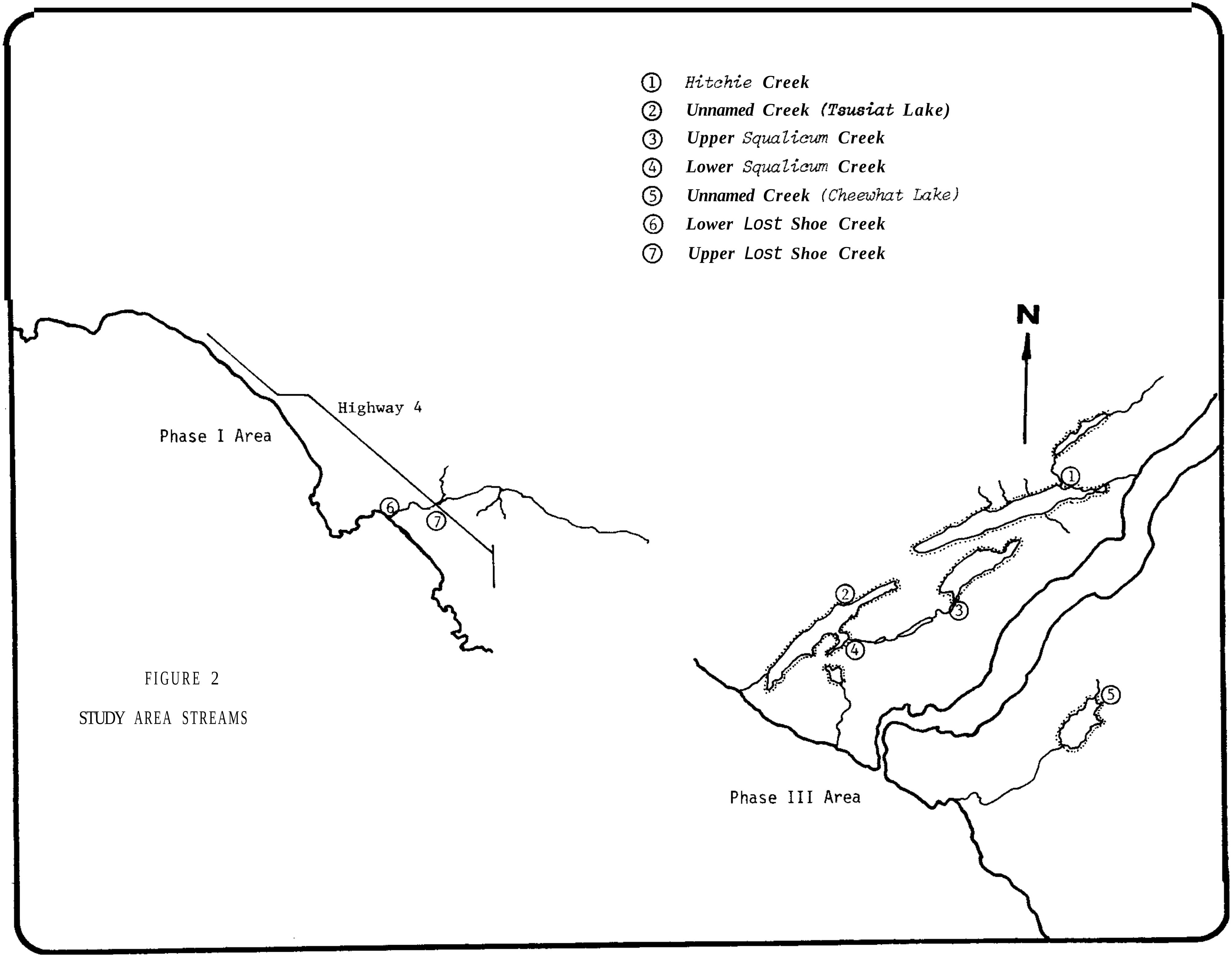


FIGURE 2

STUDY AREA STREAMS

Hitchie Creek

A. Morphometry, flow, temperature.

Hitchie Creek is a small stream which drains Hitchie Lake and enters Hobiton Lake. Two large waterfalls are located about midway between Hitchie and Hobiton Lakes. The sampling site on Hitchie Creek was approximately 100m upstream from Hobiton Lake.

The following parameters were determined for Hitchie Creek:

Total length (km)	8.7
Drainage area (ha)	1700
Width (m)	4.1
Mean depth (cm)	20
Temperature (°c)	17
Flow (m^3/sec)	0.209

B. Benthos (Appendix Table 6).

Kick samples for benthic invertebrates at 3 representative sites yielded a mean weight of 1.73 g/m^2 of the bottom surface. The fauna was dominated by chironomids (Tanytarsus sp.), Ephemeroptera (Baetis sp. and Centroptilum sp.), and Trichoptera (Lepidostoma sp.).

C. Fish (Appendix Table 7 and 8).

Low conductivity appeared to reduce the effect of our electroshocker on salmonids in Hitchie Creek. Prickly sculpin, coastrange sculpin. coho, and cutthroat were collected. Population estimates for sculpins and salmonids in the 100 m section of stream were 100 and 75-100, respectively. Only young-of-the-year coho and cutthroat were collected in Hitchie Creek.

The relative abundance of food items from stomach contents of fish examined from Hitchie Creek is given in the following table:

Composition in decreasing order of importance			
thı ꞉ t	⊃oho	F ickly sculpin	Coastrange scu ꞉ n
ꞌrestrial insects	Terrestrial insects	Trichoptera	Chironomidae
Chironomidae	Chironomidae	Fish	Trichoptera
Ephemeroptera	Coleoptera	Coleoptera	Ephemeroptera
		Orthoptera	Acarina

Unnamed Creek

A. Morphometry.

This small unnamed creek drains a small area along the north shore of Tsusiat Lake and was sampled during 1974.

The following parameters were determined for this creek:

Total length (km)	2.0
Catchment area (ha)	149

B. Water Chemistry (Appendix Table 1).

The unnamed creek had the second highest conductivity and second lowest pH of the streams and lakes examined in the Park. Values for most parameters were among the highest for Park waters.

C. Benthos (Appendix Table 6).

Fourteen invertebrate species were identified in non-quantitative collections. Ephemeropterans were the most numerous at this site. Species of *Ecclisomyia* (Trichoptera) were collected only in this unnamed creek.

Squalicum Creek

A. Morphometry, flow, temperature.

Squalicum Creek drains Squalicum Lake and flows through two small lakes before joining Tsusiat Lake. Two sites were examined on Squalicum Creek; a site approximately 100 m downstream from Squalicum Lake was examined on May 29, 1975 and a site approximately 10 m upstream from Tsusiat Lake was examined on August 22, 1975. A waterfall approximately one mile upstream from the mouth of Squalicum Creek (Sierra Club 1972) probably prevents any migration of fish between Squalicum and Tsusiat lakes.

Considerably different conditions were observed at these sites due to site differences and time of year. The following parameters were determined for Squalicum Creek:

	Upper (May 29)	Lower (Aug. 22)
Total length (km)	-	4.7
Catchment area (ha)	-	1048.
Width (m)	2.8	5
Mean depth (cm)	37	38
Temperature (°C)	13.2	14.3
Flow (m^3/sec)	0.38	0.89

B. Benthos (Appendix Table 6).

Twenty-four invertebrate species were identified from upper Squalicum Creek and 25 from lower Squalicum Creek. Although species numbers were similar a difference was noted in the species present at the two sites. The upper site was dominated by freshwater clams (Pisidium sp.) and blackfly larvae (Simuliidae) while the lower site was dominated by Chironomidae

(Tanytarsus sp.) and Oligochaeta (Nadium sp.). Biomass of the upper site was almost 5 times higher than the lower site. Rough skinned newts (Taricha granulosa) were observed crawling along the bottom at the upper collection site.

Unnamed Stream

A. Morphometry. temperature.

This very small unnamed creek entered Cheewhat Lake along the North shore. The sampling site was an area of sand and leaf litter about 10 m upstream from its mouth. Water in this creek was cold and clear and very likely originated from **a** spring. The following parameters were determined for this unnamed creek:

Width (m)	1.0
Mean depth (cm)	20
Temperature (°C)	11.2
pH	6.7

B. Benthos (Appendix Table 6)

Fourteen invertebrate species were collected from a single kick sample. Ephemeroptera and Trichoptera were dominant members of the benthic fauna.

C. Fish.

Small coho were observed in this creek.

lower Lost Shoe Creek

A. Morphometry, flow, temperature.

Lost Shoe Creek was sampled at its lower end approximately 100 m upstream from the ocean. The bottom was composed of gravel and rocks up to 10 cm in diameter. The stream flow was quite high when examined as a result of recent heavy rains.

The following parameters were determined for lower Lost Shoe Creek.

Total length (km)	10.
Drainage area (ha)	2137.
Width (m)	9.5
Mean depth (cm)	31
Temperature (°C)	12
Flow (m^3/sec)	5.1

B. Water chemistry (Appendix Table I).

Conductivity of water samples from Lost Shoe Creek was about average for lakes and streams sampled in the Park. This stream had the darkest colour (120 Hazen units) and highest turbidity levels (1.5) of any lake or stream examined in the Park.

C. Benthos (Appendix Table 6).

Kick samples from lower Lost Shoe Creek yielded 13 invertebrate species in fairly low numbers. Oligochaetes (Rhynchelmis sp.) were the most common invertebrate. Bousfield (1958) reported the amphipod Anisogammarus ramellus from a small stream entering Wreck (Florencia) Bay and also from Kennedy Lake. The small stream referred to by Bousfield was very likely Lost Shoe Creek and the same amphipod was identified in the present study.

Also collected in the kick samples were a number of ammocetes (larva) of the Pacific lamprey (Entosphenus tridentatus). The ammocetes of this species usually spend 5-6 years in the gravel before migrating downstream to the sea where they prey on fish throughout their adult life (Scott and Crossman 1973).

D. Fish (Appendix Table 7 and 8).

Prickly and coastrange sculpin **were** collected in lower Lost Shoe Creek. Low conductivity probably reduced the effectiveness of the electroshocker on salmonids and their presence at this site was undetermined. Coastrange sculpin were the most common species collected and were quite numerous along the stream margin.

The relative abundance of food items from stomach contents of fish examined from lower Lost Shoe Creek is given in the following table:

Composition in decreasing order of importance	
Prickly sculpin	Coastrange sculpin
Chironomidae	Chironomidae
Ostracoda	Copepoda
Ephemeroptera	Ephemeroptera
Fish	Ostracoda
Copepoda	Acarina
Amphipoda	Amphipoda
Megaloptera	Plecoptera
Diptera	Trichoptera

Ward (1970) indicated Lost Shoe Creek contained a small resident population of cutthroat trout and had a moderate sea-run population of both cutthroat and steelhead. Peterson and Thomas (1968) recorded catches of steelhead in Lost Shoe Creek and other streams including Klanewa and Pachena rivers.

Upper lost Shoe Creek

A. Morphometry. flow, temperature.

The upstream site on Lost Shoe Creek was located about 50 m downstream from the culvert under Highway 4. The bottom was composed of sand and the stream had undergone large fluctuations in flow as a result of heavy rains during the previous month.

The following parameters were determined for upper *Lost* Shoe Creek:

Total length (km)	8.0
Drainage area (ha)	1563.
Width (m)	5.0
Mean depth (cm)	30.
Temperature (°C)	12.
Flow (m^3/sec)	5.7

B. Water chemistry.

See lower Lost Shoe Creek.

C. Benthos (Appendix Table 6).

Only nine invertebrate species were collected in kick samples at this site. The most common species were amphipods (Anisogammarus ramellus) and Ephemeroptera (Cingmula sp.).

D. Fish (Appendix Table 7 and 8).

Due to the low conductivity and high water level of this stream only two specimens were collected: one cutthroat and one coho. Many other small salmonids were seen but attempts to capture them were unsuccessful.

The relative abundance of food items from stomach contents of the fish examined is given in the following table:

Composition in decreasing order of importance	
Coho	Cutthroat
Chironomidae	Chironomidae
Terrestrial insects	Terrestrial insects
Diptera larvae	Coleoptera
	Plecoptera

Aquatic resources: a summary

The physical, chemical. and biotic parameters examined during the present study reveal a diversity in the types of aquatic communities available in the Park. It is of interest to compare some of the morphometric and biological information obtained (Appendix Table 9).

The lakes examined range in size from 26 to 355 ha in surface area for Tsuquadra and Hobiton lakes, respectively. As may be expected the largest lakes were also the deepest: Tsusiat, Squalicum, and Hobiton ranged in depth from 66-107 m. These large lakes had fairly steep sloping bottoms without extensive littoral areas. Smaller, shallower lakes such as Cheewhat, Tsuquadra, and Kichha generally had more widespread littoral areas which supported heavy macrophyte growths.

The water chemistry of lakes in the study area was fairly uniform (Appendix Table 1) and somewhat dilute with a specific conductance ranging from **20** to 54 $\mu mho/cm^2$ for Tsusiat and Kichha lakes, respectively. Northcote and Larkin (1963) noted "the resistant granitic substrate and especially the high annual rainfall (over 150 cm) characteristic of the west coast climatic region are largely responsible for low mineral solution", Water in two of the lakes, Tsuquadra and Kichha, was highly coloured with hazen unit values of 70 and 80, respectively. Other lakes in the study area had colour values ranging from 5 to 10.

Phytoplankton standing crop ranged from 629 cells/ml in Hobiton Lake to over 32.000 cells/ml in Kichha Lake (Appendix Table 3). A total of 87 phytoplankton species were collected in the study area. Of these, 38 were common and were found in 3 or more lakes. Cyanophyta and Chrysophyta formed the major portion of the standing crop in most lakes and frequently made up over 80% of the cells present. Merismopedia tenuissima and Chromulina spp. were the most common species in the lakes as a group although Coelosphaerium pallidum, Chroococcus sp., Cyclotella sp., and Rhizosolenia longiseta were important in a few of the lakes examined.

Altogether, 26 species of phytoplankton are recorded from British Columbia for the first time. This high number results mainly from the lack of published records from many areas of the province. The present study is one of the first to include insular lakes in the wet subzone of the Coastal Western Hemlock Biogeoclimatic Zone. Freshwater algae reported from a similar climatic region in the Queen Charlotte Islands by Stein and Gerrath (1969) were generally from shallower and more acid lakes than in the present study. Other studies in mainland B. C. lakes represent samples from lakes considerably different in morphometry. chemistry, or climatic region.

A large number of macrophyte species were identified from the lakes examined (Appendix Table 2). In three lakes (Cheewhat, Tsuquadra, Kichha) macrophytes covered large areas of the lake surface and generally formed a dominant feature of the lake.

Zooplankton standing crop ranged from 5.6 animals/litre in Squalicum Lake to 177.6 per litre in Kichha Lake (Appendix Table 4). Twenty-eight species of zooplankton were identified including 10 rotifers, 11 cladocerans, 6 copepods, and 1 dipteran. Rotifera made up from 11.4 to 73.5% of the zooplankton standing crop in terms of numbers of individuals. Polyarthra vulgaris, Keratella cochlearis, and Kellicottia longispina were the most common rotifer species and were found in 5 or more of the lakes examined.

Cladocerans made up from 2.5 to 44.7% of the zooplankton in terms of numbers of individuals. Bosmina longirostris and Diaphanosoma brachyurum were the most common cladocerans and were found in 7 and 6 of the lakes examined, respectively.

Copepods made up from 7.2 to 81.2% of the zooplankton in terms of numbers of individuals. Cyclops bicuspidatus thomasi and Diaptomus oregonensis were the most common copepods and were each found in 4 lakes.

The dipteran Chaoborus asticopis was found only in Tsuquadra Lake where it made up a minor part of the zooplankton community.

The standing crop of benthic invertebrates ranged from a mean of 158 organisms per m^2 in Hobiton Lake to 1240 per m^2 in Cheewhat Lake (Appendix Table 5). Seventy five invertebrate species were collected in benthic and shoreline samples. Most common were species of oligochaetes, amphipods, and chironomids.

Eight fish species were identified from lakes and streams in the Park (Appendix Table 7). These included Dolly Varden char (Salvelinus malma), cutthroat trout (Salmo clarki clarki), sockeye and kokanee salmon (Oncorhynchus nerka), coho salmon (O. kitsutch), coastrange sculpin (Cottus aleuticus), prickly sculpin (C. asper), threespine stickleback (Gasterosteus aculeatus), and the Pacific lamprey (Entosphenus tridentatus). Of the lakes examined. only Hitchie Lake was without fish. In the six lakes where fish were collected the catch per 100 yards of net set overnight ranged from 26 to 92 fish. Tsuquadra Lake had the largest catch of salmonids with 80 fish per 100 yds of net set overnight (Appendix Table 9).

Summary & Recommendations

General aspects

1. Seven lakes and seven streams were examined in Pacific Rim National Park. The limnology of these lakes had not been previously studied.

2. Lake studies included examination of morphometry, temperature, Secchi visibility, water chemistry, macrophytes, phytoplankton, zooplankton, benthos, shoreline invertebrates, and fish. Stream studies included an examination of morphometry, temperature, stream flow, benthic invertebrates, and fish.

Phvsical and chemical asoects

3. The largest lake examined in the study area was Hobiton Lake with a surface area of 355 ha and a maximum depth of 107 m. The smallest lake examined was Tsuquadra Lake with a surface area of 26.3 ha and a maximum depth of 15 m.

4. Most of the lakes in the study area exhibited a fairly strong thermal stratification with well defined epi-, meta-, and hypolimnia, An exception was Kichha Lake which probably never stratifies due to its shallow and exposed nature. Hitchie Lake was the only lake in the study area on which ice was observed during an overflight on February 19, 1975.

5. Secchi visibilities ranged from approximately 11.5 *m* in Hobiton Lake to 2.0 m in Kichha Lake. Kichha Lake had the most highly coloured water of any lake examined in the study area.

6. Water samples from lakes examined indicate the waters are very dilute with conductivity ranging from 20 pmho in Tsusiat to 54 pmho in Kichha Lake.

Biological aspects

7. Over 225 species of aquatic plants and animals were identified from the study area.

8. A large number of macrophyte species were identified from the lakes examined. In three lakes (Cheewhat, Tsuquadra, Kichha) macrophytes covered large areas of the lake surface and generally formed a dominant feature of the lake.

9. Approximately 90 phytoplankton species were identified from the lakes examined. Cell counts ranged from approximately 835 cells per ml in Squalicum Lake to over **22,000** cells per ml in Kichha Lake. Cyanophytes and Chrysophytes were dominant in most of the lakes.

10. Twenty-eight zooplankton species were identified from lakes in the study area. Zooplankton numbers ranged from **56** per litre in Squalicum Lake to 177.6 per litre in Kichha Lake.

11. Approximately 90 invertebrate species were identified in benthic and shoreline samples from lakes and streams. The most common species included amphipods and chironomids. Dredge samples from a depth of 15 m in Cheewhat Lake had the highest biomass levels with 19.0 g/m^2. Hitchie Lake had the lowest benthic biomass with only 0.08 g/m^2. In streams the biomass ranged from approximately 0.15 to 1.73 g/m^2 in lower Lost Shoe and Hitchie creeks, respectively.

12. Eight fish species were identified from lakes and streams in the Park. These included Dolly Varden, cutthroat trout, sockeye and kokanee salmon, coho salmon, coastrange sculpin, prickly sculpin, threespine stickleback, and the Pacific lamprey. Of the lakes examined only Hitchie was without fish.

13. Sockeye salmon were collected in Cheewhat and Hobiton lakes; kokanee salmon were found in Tsusiat and Tsuquadra lakes; coho salmon were collected in Hobiton. Tsuquadra, and Cheewhat lakes; cutthroat trout were found in all lakes except Hitchie; Dolly Varden char were collected in Hobiton and Tsuquadra lakes.

15. Tsuquadra Lake had the highest catch of salmonids with 80 fish per 100 yards net set overnight.

Recommendations

1. Only a very small portion of the many streams in the Park were examined. An attempt should be made to determine the status of fish populations in Park streams. A survey should include the collection of information on:
    a. stream morphometry and discharge
    b. species present
    c. population estimates
    d. barriers to fish migration
    e. effects of visitor activities
    f. present and potential fishing pressure

2. Hobiton River is the only system in the Nitnat watershed having a spawning run of sockeye salmon and requires special attention to protect the spawning areas. This stream is a popular canoe route and provides access to visitors to Hobiton Lake from Nitnat Lake. Measures should be taken to protect the sea run populations during sensitive migration periods.

3. Efficient and proper management of aquatic ecosystems requires the control of activities in the entire watershed of each water body. Whenever the opportunity arises for negotiation of boundries an effort should be made to include as much watershed area as possible.

4. The possibility of the presence of seawater in the bottom areas of Hobiton and Tsusiat lakes should be investigated. Water chemistry samples from near maximum depth in both these lakes are required.

5. A second visit to Hitchie Lake to verify the absence of fish should be undertaken.

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Tables

Table 1. Summary of water chemistry data for lakes and streams examined in Pacific Rim National Park. Unless otherwise specified units are parts per million (mg/litre).

Parameter	LAKES						
	Cheewhat	Hitchie	Hobiton	Kichha	Squalicum	Tsuquadra	Tsusiat
Conductivity (µmho/cm2)	30.6	21.9	22.0	54.0	20.5	24.4	20.0
Turbidity (JTU)	0.5	0.2	0.2	1.0	0.2	0.9	0.3
pH (pH units)	6.7	6.6	7.3	5.3	6.8	6.5	7.1
Total alkalinity	4.5	4.8	7.1	0.5	3.8	2.3	9.3
Hardness	5.4	7.1	4.7	–	5.6	5.4	3.1
Noncarbonate hardness	0.9	2.3	–	–	2.6	3.1	–
Total dissolved solids	16.4	14.2	–	–	12.2	16.5	–
Colour (Hazen units)	5.0	6.0	5.0	80.0	5.0	70.0	10.0
Calcium	2.1	2.4	1.7	1.3	1.5	2.0	1.1
Magnesium	<0.1	0.3	–	0.95	0.5	0.1	–
Potassium	0.4	0.2	<0.01	(0.1	0.3	0.15	(0.01
Sodium	3.25	1.6	1.5	6.9	1.8	2.9	1.9
Bicarbonate	5.5	5.9	–	–	3.7	2.8	–
Chloride	5.0	2.2	2.4	1.2	3.0	4.6	3.3
Silica	1.4	3.0	2.6	1.0	1.2	2.4	1.8
Sulphate	1.5	1.6	1.7	4.0	2.1	3.0	2.5
Carbon dioxide	1.8	2.4	–	–	0.9	–	–
Carbon: total inorganic	1.9	2.3	–	<1.0	0.7	1.0	–
Carbon: total organic	9.9	3.1	–	15.0	2.2	14.7	–
Phosphorus	0.004	–	–	0.008	–	0.007	–
Nitrogen (ammonia)	0.011	0.014	–	–	0.08	0.03	–
Nitrogen (Kjeldahl)	–	–	–	0.2	0.112	–	–
Nitrogen (dissolved)	<0.002	0.085	<0.01	0.01	0.009	0.2	(0.01
Fluoride	0.035	0.026	–	<0.05	–	<0.01	–
Chlorophyll *a*	–	–	0.005	–	–	–	<0.005
Arsenic	–	–	<0.0005	–	–	–	(0.0005
Cadmium	–	–	0.001	–	–	–	<0.001
Copper	–	–	0.62	–	–	–	(0.001
Iron	< 0.05	<0.05	0.06	–	<0.05	0.08	(0.04
Lead	–	–	0.47	–	–	–	<0.004
Manganese	–	–	<0.01	–	–	–	<0.01
Nickel	–	–	0.003	–	–	–	0.003
Zink	–	–	0.035	–	–	–	0.001

Table 1. Continued.

Parameter	STREAMS		
	Lost Shoe	Unnamed (Tsusiat)	Squalicum
Conductivity (µmho/cm^2)	28.7	36.0	24.0
Turbidity (JTU)	1.5	0.1	0.2
pH (pH units)	5.9	6.9	7.1
Total alkalinity	3.1	11.0	7.4
Hardness	9.0	9.7	6.8
Noncarbonate hardness	5.8	-	-
Total dissolved solids	20.2	-	-
Colour (Hazen units)	120.0	5.0	10.0
Calcium	2.6	3.1	2.5
Magnesium	0.6	-	-
Potassium	0.2	0.1	< 0.01
Sodium	2.6	3.3	2.0
Bicarbonate	3.8	-	-
Chloride	3.6	3.6	3.1
Silica	3.5	8.1	2.3
Sulphate	5.1	3.5	2.4
Carbon Dioxide	7.7	-	-
Carbon: total inorganic	15.0	-	24.0
Carbon: total organic	7.0	-	5.0
Phosphorus	0.013	-	-
Nitrogen (ammonia)	-	-	-
Nitrogen (Kjeldahl)	0.5	-	-
Nitrogen (dissolved)	0.02	0.05	< 0.01
Fluoride	-	-	< 0.05
Chlorophyll a	-	0.013	< 0.005
Arsenic	-	< 0.0005	< 0.0005
Cadmium	-	< 0.001	< 0.001
Copper	-	< 0.001	< 0.001
Iron	-	0.06	< 0.04
Lead	-	< 0.004	< 0.004
Manganese	-	< 0.01	< 0.01
Nickel	-	0.004	< 0.002
Zink	-	0.001	0.001

Table 2. Summary of macrophyte species distribution in lakes of Pacific Rim National Park. Species collected are indicated by "+".

Species / Lake	Cheewhat	Hitchie	Hobiton	Kichha	Squalicum	Tsuquadra	Tsusiat
ISOETACEAE							
Isoetes nuttallii A. Br.	-	-	+	-	-	-	-
POTAMOGETONACEAE							
Potamogeton gramineus L.	-	+	-	-	-	+	-
Potamogeton filiformis Pers.	-	-	-	-	-	-	+
Potamogeton natans L.	+	-	+	+	-	-	+
Potamogeton pusillus L.	+	-	-	-	-	-	-
Potamogeton zosterifonis Fern.	-	-	-	-	-	-	+
Potamogeton spp.	+	-	+	+	-	+	+
CYPERACEAE							
Eleocharis palustris R.& S. (?)	-	-	-	-	-	-	+
Carex spp.	-	-	-	-	-	-	+
Carex aquatilis Wahlenb.	-	-	-	-	-	+	-
Scirpus validus Vahl	+	-	-	+	-	-	+
GRAMINEAE							
Unidentified	+	-	+	-	-	-	+
JUNCACEAE							
Juncus superiformis Engelm.	-	-	+	-	-	-	-
Juncus flacatus Meyer (?)	-	-	-	-	-	-	+
Juncus covellie var *covellie* Piper	-	-	-	-	-	-	+
Juncus sp.	-	-	-	-	-	-	+
NYMPHAEACEAE							
Brasenia schreberi Gmel.	+	-	+	-	-	+	+
Nymphaea tetragona Georgi ssp. *leibergii* (Morong) Porsild	-	-	+	-	-	-	-
Nuphar polysepalum Engel.	+	+	+	+	+	+	+
FONTINACEAE							
Unidentified	-	-	+	-		-	-
LOBELLIACEAE							
Lobelia dortmanna L.	-	-	+	-	-	-	+
SPARGANIACEAE							
Sparganium sp.	-	-	+	-	-	-	-
LENTIBULARIACEAE							
Utricularia vutgaris L.	+	-	-	+	-	-	-
HIPPURIDACEAE							
Hippuris vutgaris L.	+	-	-	-	-	-	-
GENTIANACEAE							
Menyanthes trifoliata L.	+	+	-	+	t	+	+
EQUISETACEAE							
Equisetum fluviatile L.	+	-	-	-	-	-	-

Table 3. Phytoplankton from seven lakes in Pacific Rim National Park British Columbia. Numbers given are cells/ml.

Lake	Squalicum		Hitchie	Hobiton		Tsuquadra	Tsusiat		Cheewhat	Kichha
Date	23/5/75	25/5/75	15/8/75	14/9/74	16/8/75	20/8/75	19/9/74	21/8/75	23/8/75	28/8/75
CYANOPHYTA										
Chroococales										
Chroococcus limneticus Lemm.	-	-	6	50	3	-	17	-	-	-
C. turgidus (Kutz.) Naegeli	-	-	-	-	-	-	-	-	17	-
C. spp.	-	-	50	-	8	448	-	6	-	34
Coelosphaerium pallidum Lemm.	-	-	-	343	56	-	67	-	112	8535
Gleocapsa sp.	-	-	-	-	-	-	-	-	-	17
Merismopedia tenuissima Lemm.	180	252	717	50	134	2307	800	239	112	12988
**Rhabdoderma lineare* Schm. & Laut.	-		-	120	46	84	8	-	112	-
Nostacales										
Anabaena sp.	-	-	-	-	-	-	-	-	-	17
CHLOROPHYTA										
Volvocales										
**Chlamydomonas frigida* Skuja	14	10							-	-
C. spp.	2	6	36	41	18	32	64	36	8	6
Chlorococcales										
Ankistrodesmus falcatus (Corda) Ralfs	-			I			11	4	17	14
**A. f.* var *acicularis* (Braun) West	-		36		8		14	6	-	-
**Botryococcus protuberans* var *minor* Smith	140	232							-	-
**Crucigenia tetrapedia* (Kirch.) West & West	-					22		-	22	45
Dictyosphaerium ehrenbergianum Naegeli	60	58							-	
D. pulchellum Wood	-					11			11	-
Elakatothrix gelatinosa Wills	-	-	-	-			-		-	11
**Francia ovalis* (France) Lemm.	-	-							3	-
Oocystis borgei Snow	32	8				28				-
O. parva West & West	-		15	48	1	31	6	-	70	177
O. spp.	38	-	17						-	11
Pediastrum tetras (Ehr.) Ralfs	--					39	11		34	-
Quadrigula closteroides (Bohlin) Printz	26	26					-	-		
**Q. lacustris* (Chodat) Smith	--	-	6						56	17
Scenedesmus bijuga (Turp.) Lager.	-						11	3	11	11
Sphaerocystis schroeteri Chodat	16	30			-	-		-	-	22
**Tetraedon caudatum* (Corda) Hans.	-			-	-	-			14	-
T. minimum (Braun) Hansgirg	-	-				11			-	14
Tetrasporales										
Gleocystis vesiculosa Naegeli	-								-	11
G. sp.	-			14	-	34		-	3	-
Zygnemales										
Cosmarium bioculatum Brebisson	-				1				6	-
C. depressum (Nag.) Lund	-						-	-	6	-
Staurastrum near *anatinum* Cooke & Wills	-								3	
Xanthidium sp.										
XANTHOPHYTA										
Mischococcales										
Chloroclaster sp. (?)			56	22		104			50	62
Unidentified sp	-	30							-	-
CHRYSOPHYTA										
Rhizochrysidales										
Bitrichia chodatii (Rev.) Chodat	22	16	3	-	1	28	-	4	-	25
Heliapsis sp. (?)	-		-	-	-	8	-	-	-	-
**Lagynion* near *scherffelli* Pascher	-	--	--	-	-	6	-	4	-	-
Chromulinales										
Chromulina spp.	40	32	629	319	206	862	356	279	229	428
Chrysococcus sp.	-	-	-	-	1	-	3	-	-	-
Kephyrion sp.	12	4	6	-	-		-		3	3
Ochromonadales										
Dinobryon bavaricum Imhof	-	-	6	-		14	-	-	3	17
**D. borgei* Lemmerman	-	-	4	1	3	-	-			
**D. crenulatum* West & West	18	12	-	9	-	-	-			
D. cylindricum Imhof	-	-	-	4		8	-		-	-
D. divergens Imhof	-	-	-	-	-	-	-	-	31	6
D. sp.	2	-	-	-	4	-	-	-	-	-
**Epipyxis polymorpha* (Lund) Hill.	-	-	-	-		-	-	-	3	-
**Mallomonas akromonas* Pascher & Ruttner	-	-	-	-	-	-	-	-	-	17
M. crassisquama (Pascher) Conrad	-	-	-	-	-	20	-	-	-	
M. spp.	-	-	-	-	1	-	-	5	8	-
Ochromonas spp.	-	-	13	-	11	34	14	13	22	3
**Pseudokephyrion ellipsoideum* (Pascher) Conrad	-	2	-	-	-			-	-	-
**P. inflatum* Hilliard	2	2	-	-	-	-	-	-	-	-
**P. planctonicum* Hilliard	-	-	7	-	-		-	-		8
P. spp.	36	24	3		4	3	6	I	-	
**Spiniferomonas bourrellii* Takahashi	-	-	14	-	15	8	6	8	11	25
S. spp.	10	10	7	-	-			-	--	
Unidentified sp. 1								4	-	-
Unidentified sp. 2	-	-	4	8				4	-	39

*Not previously reported from British Columbia

TABLE 3. (Cont.)

LAKE	Squalicum		Hitchie	Hobiton		Tsuquadra	Tsusiat		Cheewhat	Kichha
DATE	23/5/75	25/5/75	15/8/75	14/9/74	16/8/75	20/8/75	19/9/74	21/8/75	23/8/75	28/8/75
CHRYSOPHYTA *(Cont.)*										
Monosigales										
**Monosiga varians* var *varians* Skuja	-	-	4	-	-	28	6	-	11	22
**Proterospongia sp. (?)*	-	-	-		-	-	-	4		-
Prymensiales										
**Chrysochromulina parva* Lackey	-	-	-	7	29	3	14	5	20	8
Coscinodiscales										
**Cyclotella glomerata* Bachmann	40	114	-		3	-	-	-	-	-
C. stelligera Cl. & Grun.		-	-	1	-	9	-	1	118	-
C. spp.	-	16	-	3	-	170	129	18	109	-
Melosira spp.	8	8	-	-	20	-	67	-	129	-
Diatomales										
Asterionella formosa Hassall	-	-	-	-	-	-	-	-	-	3
**Diatoma tenue* Agardh	-	-	1	-	-	-	-	-	-	-
Tabellaria flocculosa (Roth) Kutzing	-	-	-	-	-	-	-	-	6	3
Achnanthales										
Achnanthes sp.	-	-	-	-	-	-	3	-	-	6
Naviculales										
Anomoeoneis sp.	-	-	-	-	1	-	3	-	-	-
Navicula sp.	2	2	-	1	-	-	-	-	-	6
Neidium irridus var *amphigomphus* Mayer	-	-	-	-	-	-	-	-	-	3
**Stenopterobia intermedia genuina* Cleve	-	-	-	-	-	-	-	-	-	3
Rhizosoleniales										
Rhizosolenia longiseta Zacharias	-	-	-	-	1	59	-	-	176	-
PYRROPHYTA										
Peridiniales										
Ceratium hirudinella (Muller) Schrank	-	-	-	1	4	-	-	-	-	-
Gymnodinium near *aeruginosum* Stein	-	-	-	-	-	3	-	-	-	-
G. spp.	-	-	-	-	1	-	-	1	-	-
Peridinium inconspicuum Lemm.	-	-	-	-	6	-	-	-	-	-
P. spp.	-	2	3	4	-	6	14	8	11	-
CRYPTOPHYTA										
Cryptomonadales										
Cryptomonas marssoni Skuja	4	2	-	-	-	8	23	11	-	-
C. ovata Ehrenberg	-	-	-	-	-	-	-	-	6	-
**Rhodomonas minuta* Skuja	-	-	1	46	10	-	42	28	31	-
Total cells/ml	704	966	1645	1090	629	4407	1698	694	1613	22620

Percentage composition by major groups

	23/5/75	25/5/75	15/8/75	14/9/74	16/8/75	20/8/75	19/9/74	21/8/75	23/8/75	28/8/75
CYANOPHYTA	26.9	27.3	46.9	51.6	39.2	64.4	52.5	35.3	21.8	95.4
CHLOROPHYTA	46.5	44.3	6.6	9.5	4.4	5.2	6.8	7.0	16.3	1.4
XANTHOPHYTA	-	3.1	3.4	2.0	-	2.3	-	-	3.0	0.2
CHRYSOPHYTA	27.2	25.0	42.6	32.1	52.9	28.7	35.7	50.5	55.1	2.7
PYRROPHYTA	-	0.2	0.1	0.4	1.7	0.2	0.8	1.2	0.6	-
CRYPTOPHYTA	0.5	0.2	0.06	4.2	1.5	0.1	3.8	5.6	2.2	-

*Not previously reported from British Columbia

Table 4. Summary of zooplankton species distribution in lakes of Pacific Rim National Park. Numbers/litre given.

Lake Date	Cheewhat 23/8/75	Hitchie 15/8/75	Hobiton 16/8/75	Kichha 28/8/75	Squalicum 23/5/75	Tsuquadra 20/8/75	Tsusiat 23/8/75
ROTIFERA							
Asplanchna sp.	4.7	-	-	0.3	-	-	-
Conochilus sp.	1.6	1.6	-	-	-	-	-
Gastropodus sp.	-	-	-	-	-	-	0.005
Kellicottia bostoniensis Rousselet	-	-	-	-	-	2.2	-
K. longispina Kellicott	1.6	-	1.9	-	0.6	8.0	8.7
Keratella near *canadensis* Berzins	-	-	-	0.1	-	-	-
K. cochlearis Gosse	0.2	-	4.2	29.4	0.05	1.3	0.5
Ploesoma hudsoni Imhof	-	-	0.2	0.5	-	-	-
Polyarthra vutgaris Carlin	0.3	2.8	5.1	46.4	-	0.6	2.4
Trichocerca SV.	0.2	-	0.3	-	-	0.4	-
Total	8.6	4.4	11.7	76.7	0.65	12.5	11.605
CLADOCERA							
Alonella nana (Baird)	-	-	-	0.1	-	-	-
Bosmina longirostris (Muller)	0.1	0.1	0.3	0.6	0.1	0.1	0.3
Daphnia longiremis Sars	0.1	-	-	-	0.01	-	-
D. rosea Sara	-	0.2	-	-	0.1	-	0.1
Diaphanosoma brachyurum (Lieven)	6.9	0.5	0.8	-	0.2	2.3	0.3
D. leuchtenbergianum Fischer	-	-	-	30.8	-	-	-
Holopedium gibberum Zaddach	0.7	0.02	-	22.7	-	0.01	-
Leptodora kindtii (Focke)	-	-	-	-	-	0.01	-
Polyphemus pediculus (Linne)	0.2	0.006	-	-	-	-	-
Scapholebris kingi Sars	0.01	-	-	-	-	-	-
Sida crystallina (Muller)	-	-	-	-	0.003	-	-
Total	8.01	0.826	1.1	54.2	0.413	2.42	0.5
COPEPODA							
Acanthocyclops vernalis Fischer	1.3	-	-	0.8	-	-	-
Cyclops bicuspidatus thomasi Forbes	-	-	0.4	-	1.1	2.7	1.1
Diaptomus kenai Wilson	-	0.1	-	-	0.4	-	-
D. oregonensis Lilljeborg	-	0.9	0.6	27.5	-	0.8	-
D. tyrrelli Poppe	-	-	-	-	1.2	-	-
Epischura nevadensis Lilljeborg	-	-	-	-	0.2	-	0.1
Unidentified nauplii	-	-	2.1	18.4	1.7	6.3	6.1
Total	1.3	1.0	3.1	46.7	4.6	9.8	7.3
DIPTERA							
Chaoborus asticopus Dyar 6 Shan.	-	-	-	-	-	0.009	-
Grand Total	17.9	6.226	15.9	177.6	5.663	24.729	19.405

Percentage composition by major groups

	Cheewhat	Hitchie	Hobiton	Kichha	Squalicum	Tsuquadra	Tsusiat
ROTIFERA	48.0	70.6	73.5	43.1	11.4	50.5	59.8
CLADOCERA	44.7	13.1	6.9	30.5	7.2	9.7	2.5
COPEPODA	7.2	16.0	19.4	26.2	81.2	39.6	37.6
DIPTERA	-	-	-	-	-	0.03	-

Table 5. Summary of benthic and shoreline invertebrate species distribution in lakes of Pacific Rim National Park. Numbers shown are mean number/m^2 from benthic dredge samples (D) and numbers collected in 30 minute shoreline (S) collections. Species collected only in 1974 are indicated by "t".

Lake	Cheewhat		Hitchie		Hobiton		Kichha		Squalicum		Tsuquadra		Tsusiat	
Sample	D	S	D	S	D	S	D	S	D	S	D	S	D	S
TURBELLARIA														
Tricladida	-	-	-	-	-	1	-	-	-	1		-	-	-
OLIGOCHAETA														
Nadiwn sp.	57	1	-	-	100	-	-	1	14	-	43	-	28	-
Parnais sp. (?)	-	1	-	-	-	-	-	2	43	-	14	-	-	-
Rhynchelmis sp.	-	-	-	-	57	-	-	-	14	-	-	-	14	-
Nais communis Piguet	-	-	-	-	-	1	-	-	-	-		-	-	-
HIRUDINEA														
Helobdella stagnalis (Linnaeus)	-	-	-	-	-	-	14	-	-	-		-	-	2
Placobdella ornata (Virrill)	-	-	-	-	-	-		-	-	-		-	-	12
GORDIDAE														
Gordius sp.	-	-	-	-	-	1	-	-	-	-		1		
AMPHIPODA														
Crangonyx occidcntalis (Hubricht and Harrison)	-	1	-	5	-	-	71	4	-	1	-	-	-	-
Hyalella azteca (Saussure)	28	9	14	2	-	-	215	10	86	12	43	15	-	3
ISOPODA														
Asellus occidentalis Williams	-	-	-	-	258	-	344	-	-	-	57	1	-	4
MYSCIDACEA														
Neomysis awatchensis (Brandt)	-	-	-	-	-	-	-	-	-	-		-	14	-
DELAPODA														
Astacus klamathensis Stimpson	+	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA														
Habrophelbiodes sp.	-	1	-	-	14	-	-	1	-	-	14	11	-	-
PLECOPTERA														
Capnia sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-
TRICHOPTERA														
Rhyacophilia sp.	-	-	-	-	-	-	-	-	57	1	-	-	-	-
Limnephilus spp.	-	-	-	-	-	+	-	-	-	5	14	-	-	-
Lepidostoma sp.	-	1	-	-	-	4	-	1	-	-	-	13	-	4
Glyphopsyche sp.	-	-	-	-	-	-	-	2	-	-	-	-	-	1
Drasinus sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Ptilostomus sp.	-	-	-	-	-	+		1	-	-	-	-	-	+
Phryganea sp.	-	-	-	-	-	-		1	-	-	-	-	-	-
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	2
DIPTERA														
Alluaudomyia sp.	14	-	14	-	-	-	43	-	14	I	43	-	-	-
Dasyhelia sp.	-	-	-	-	-	-	-	-	14	-	-	-	-	-
Chaoborus asticopus Dyar and Shannon	229	-	-	-	-	-	186	-	-	-	114	-	-	-
CHIRONOMIDAE														
Tanytarsus sp.	286	2	-	-	10	-	28	-	501	3	43	-	-	-
Pentaneura sp.	28	1	-	-	57	-	14	-	43	1	-	-	-	-
Brillia sp.	-	-	14	-	43	-	-	-	28	-	-	-	-	-
Phaenopsectra sp.	329	1	129	-	57	-	86	-	114	-	-	-	28	-
Procladius sp.	43	1	-	-	-	-	43	-	57	1	43	-	14	-
Dicrotendipes sp.	-	-	14	-	-	-	-	-	14	-	-	-	-	-
Corynoneura sp.	-	-	-	-	-	-	-	-	-	4	-	1	-	-
Psectrocladius sp.	-	-	-	-	28	-	-	12	-	7	-	-	-	-
Polypedelium sp.	-	-	-	-	-	-	-	-	-	-	28	8	-	-
Eukiefferiella sp.	-	-	-	-	-	-	-	-	-	-	-	-	14	-
Cryptochironomus sp.	28	1	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Clinotanypus sp.	-	-	-	-	-	-	28	-	-	-	-	-	-	-
Pupae	-	-	-	-	-	-	28	-	71	-	14	-	-	-
Unidentified	-	-	14	-	-	-	28	-	43	-	-	-	-	-
HEMIPTERA														
Gerris notabilis Drake and Hottes	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Trepobates sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Corixidae	-	-	-	3	-	-	-	-	-	-	-	1	-	-

Continued

Table 5. Continued.

Lake / Sample	Cheewhat D	Cheewhat S	Hitchie D	Hitchie S	Hobiton D	Hobiton S	Kichha D	Kichha S	Squalicum D	Squalicum S	Tsuquadra D	Tsuquadra S	Tsusiat D	Tsusiat S
COLEOPTERA														
Gyrinus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Liodessus sp.	-	-	-	-	-	-	-	-	14	2	-	-	-	7
Hygrotus patruelis (?) (LeConte)	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Haliplus sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-
MEGALOPTERA														
Siatis sp.	-	-	-	-	-	-	-	-	28	-	14	-	-	-
ODONATA														
Somatochlora sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Libellula comanche Calvert	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Libellula sp.	-	-	-	-	-	-	14	-	-	-	-	-	-	-
Ishnura perparva Selys	-	1	-	-	-	-	-	-	-	-	14	4	-	-
Ishnura sp.	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Sympetrum vicinum (Hagen)	-	-	-	-	-	-	-	1	-	-	-	1	-	-
Sympetrum madidum (Hagen)	-	-	-	-	-	+	-	-	-	-	-	-	-	+
Aeshna interrupta Walker	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Eurythemis sp.	-	-	-	-	-	-	-	-	-	-	14	-	-	-
Tetragonemia sp.	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Zoniagrion sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
ACARINA														
Hydrodoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Frontipodia sp.	28	1	-	-	-	-	-	-	14	-	-	-	-	-
Porolohmannella sp.	14	-	-	-	-	-	-	1	-	-	-	-	-	-
Limnesia sp.	14	7	-	-	-	-	-	-	-	-	14	1	14	3
Hydrachna sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Arrenurus sp.	28	2	-	-	-	-	-	-	-	-	-	-	-	-
Lebertia sp.	43	-	-	-	-	-	14	-	-	-	-	-	-	-
Hydrochoreotes sp.	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Orbatei	-	-	14	-	-	-	-	-	-	-	-	-	-	-
Pionidae	14	-	-	-	-	-	-	-	-	-	14	-	-	-
Unidentified	43	2	-	-	43	-	-	-	-	-	-	1	28	-
MOLLUSCA														
Gyralus sp.	-	-	-	1	-	-	-	-	9	2	-	-	-	-
Pisidium sp.	5	-	-	-	9	-	4	-	-	-	4	-	4	-
Margaritifera margaritifera Linne	-	-	-	-	-	7	-	-	-	6	-	-	-	1
Spharium sp.	9	-	-	-	-	-	-	-	-	-	-	-	-	-
Ferrisia sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Physa sp.	-	-	-	-	-	2	-	-	-	-	-	-	+	-
Helisoma SD.	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Mean total number per m^2	1204	-	213	-	676	-	1160	-	1178	-	546	-	158	-
Mean biomass g per m^2	8.8	-	0.06	-	6.62	-	4.3	-	5.3	-	2.2	-	1.5	-

Table 6. Summary of invertebrate species distribution in streams of Pacific Rim National Park. Numbers shown are mean number/m^2. Species collected in 1974 are indicated by "+".

Stream	Unnamed (Cheewhat Lake)	Hitchie Creek	Upper Lost Shoe Creek	Lower Lost Shoe Creek	Upper Squalicum Creek	Lower Squalicum Creek	Unnamed (Tsusiat Lake)
TURBELLARIA							
Tricladida	-	1.6	-	-	-	-	
OLIGOCHAETA							
Paranais sp.	-	-	-	-	-	-	+
Nadium sp.	-	-	-	-	-	61	+
Rhynchelmis **sp.**	-	-	2.5	20	-	1.6	-
***Nais communis* Piguet**	5	-	-	-	-	-	
HIRUDINEA							
Helobdella stagnalis **(Linnaeus)**	-	-	-	-	-	13	-
Erpobdella punctata (Leidy)	-	-	-	-	7.5	-	
AMPHIPODA							
Hyalella azteca (Saussure)	-	-	-	-	5	1.6	
Anisogammarus ramellus **(Weckel)**	-	-	50	7.5	-	-	
EPHEMEROPTERA							
Habrophlebiodes **sp.**	125	5	-	-	32	30	
Centroptilum **sp.**	-	21	-	2.5	2.5	19	
Baetis sp.	-	28	5	5	-	-	+
Cingmula sp.	-	3.3	35	10	-	-	
Ephemerella sp.	-	-	-	10	-	-	
Paraleptophlebia **sp.**	-	-	-	-	-	-	+
Unidentified	-	-	-	-	2.5	-	
PLECOPTERA							
Nemoura cinctipes **Banks**	-	-	-	-	-	-	+
Nemoura sp.	-	3.3	-	-	15	-	-
Acroneuria sp.	-	-	-	-	5	1.6	
Alloperla sp.	-	1.6	-	-	-	-	
Capnia **sp.**	20	-	-	-	2.5	-	
Isogenus sp.	-	-	-	2.5	-	-	+
TRICHOPTERA							
Rhyacophilia **sp.**	-	+	-	-	42	-	+
Limnephilus sp.	-	-	-	-	-	1.6	+
Cheumatopsyche sp.	-	+	-	-	47	-	
Hydropsyche **sp.**	-	3.3	-	-	-	-	-
Lepidostoma sp.	65	26	-	-	-	10	-
Drasinus sp.	-	-	-	-	-	1.6	-
Ecclsomyia sp.	-	-	-	-	-	-	+
Ptilostomus sp.	-	-	-	-	-	1.6	-
Limnephilidae	5	-	-	-	-	-	-
Leptoceridae	-	-	-	-	-	1.6	-
DIPTERR							
Alluaudomyia sp.	5	-	-	-	-	1.6	-
Pedicia sp.	15	1.6	-	-	-	-	-
Simuliidae	-	11	-	-	130	-	+
Tipulidae	5	3.3	2.5	5	-	-	
Rhagionidae	-	-	-	-	-	-	+
Tabanidae	-	-	-	-	-	1.6	-

Continued

Table 6. Continued,

Stream	Unnamed (Cheewhat Lake)	Hitchie Creek	Upper Lost Shoe Creek	Lower Lost Shoe Creek	Upper Squalicum Creek	Lower Squalicum Creek	Unnamed (Tsusiat Lake)
CHIRONOMIDAE							
Chironomus sp.	-	-	-	-	-	-	+
Tanytarsus sp.	30	152	-	2.5	-	184	-
Pentaneura sp.	5	-	-	-	2.5	26	-
Brillia sp.	-	-	-	-	-	24	-
Phaenopsectra sp.	-	-	-	-	-	1.6	-
Procladius sp.	5	18	-	-	15	-	+
Corynoneura sp.	-	1.6	-	-	2.5	-	-
Psectrocladius sp.	-	3.3	7.5	10	2.5	-	-
Polypedelium sp.	-	21.5	-	-	-	-	-
Eukiefferiella sp.	-	5	5	-	-	-	-
Cricotopus sp.	5	-	-	-	-	-	-
Clinotanypus sp.	-	-	-	-	-	3.3	-
Pupae	5	29	-	-	15	5	-
Unidentified	5	39	2.5	-	-	-	-
COLEOPTERA							
Hygrotus patruelis (LeConte) (?)	-	-	-	2.5	-	-	+
Laccobius sp.	-	-	2.5	-	-	-	-
Dytiscidae larvae	-	8	-	-	-	3.3	-
ODONATA							
Somatochlora semicircularis (Selys)	-	-	-	-	-	+	-
Somatochlora sp.	-	-	-	-	5	-	-
ACARINA							
Porolohmannella sp.	-	-	-	-	5	-	-
Sperchon sp.	-	-	-	-	12	-	-
Limnesia sp.	-	-	-	15	-	-	+
Lebertia sp.	-	-	-	2.5	-	-	-
Oribatei	-	5	-	-	17	-	-
Unidentified	-	3.3	-	-	-	-	-
MOLLUSCA							
Gyralus sp.	-	6.5	-	-	75	3.3	-
Pisidium sp.	-	-	-	-	2172	35	
Mean total number per m^2	300	401	112	95	2614	410	-
Mean biomass g per m^2	0.36	1.73	0.94	0.15	1.28	0.20	-

Table 7. Summary of age, length, and weight of fish collected in lakes and streams of Pacific Rim National Park. Mean values are shown.

CHEEWHAT LAKE

Species	Cutthroat* n=5		Coho n=12		Sockeye n=4		Prickly sculpin n=15		Stickleback n=4	
Age	L	W	L	W	L	W	L	W	L	W
1	-	-	83.5	7.7	-	-	-	-	-	-
3	-	-	-	-	-	-	71.0	4.1	-	-
4	318	201	-	-	-	-	143	45.2	-	-
5	371	542	-	-	-	-	110	15.0	-	-
7	-	-	-	-	-	-	201	124.0	-	-
?	-	-	-	=	515	1661	-	-	70	3.7

HOBITON LAKE

Species	Cutthroat n=9		Coho n=2		Prickley sculpin n=3		Stickleback n=5	
Age	L	W	L	W	L	W	L	W
0	-	-	78	5.8	-	-	-	-
2	175	70.0	-	-	-	-	-	-
3	212	101.0	-	-	-	-	-	-
4	247	160.0	-	-	-	-	-	-
6	-	-	-	-	120	16.8	-	-
8	-	-	-	-	130	21.8	-	-
?	-	-	-	-	-	-	32	0.35

*n= number of fish examined
L= fork length in mm
W= weight in g

Table 7. Continued.

KICHHA LAKE

Age	Cutthroat n=26 L	Cutthroat n=26 W
2	186	70.6
3	221	124
4	252	173
5	272	204
6	315	334

SQUALICUM LAKE

Age	Cutthroat n=51 L	Cutthroat n=51 W	Prickly sculpin n=21 L	Prickly sculpin n=21 W
1	90	8.1	32.9	0.31
2	145	31.7	43	0.9
3	168	48.8	57	3.6
4	213	101	78	7.3
5	256	167	135	23.5
6	279	217	-	-

TSUQUADRA LAKE

Age	Cutthroat n=12 L	Cutthroat n=12 W	Dolly Varden n=9 L	Dolly Varden n=9 W	Coho n=6 L	Coho n=6 W	Kokanee n=13 L	Kokanee n=13 W	Prickly sculpin n=6 L	Prickly sculpin n=6 W	Stickleback n=5 L	Stickleback n=5 W
0	-	-	-	-	88.6	9.9	-	-	-	-	-	-
1	-	-	-	-	-	-	99	10.2	-	-	-	-
2	173	52.7	193	68.3	-	-	155	39.6	-	-	-	-
3	227	107	-	-	-	-	-	-	109	15.2	-	-
4	231	106	-	-	-	-	-	-	126	24.4	-	-
5	263	163	-	-	-	-	-	-	135	-	-	-
6	-	-	-	-	-	-	-	-	184	96	-	-
?	-	-	-	-	-	-	-	-	-	-	32.8	0.35

Table 7. Continued.

TSUSIAT LAKE

Species	Cutthroat n=16		Kokanee n=2		Prickly sculpin n=9	
Age	L	W	L	W	L	W
2	189	66.4	-	-	-	-
3	245	143	174	56.6	85	6.3
4	286	216	-	-	125	23.8
6	333	359	-	-	-	-
7	-	-	-	-	158	51
9	-	-	-	-	175	71

HITCHIE CREEK

Species	Cutthroat n=2		Coho n=8		Coastrange sculpin n=8		Prickly sculpin n=5	
Age	L	W	L	W	L	W	L	W
0	61	3.1	62	3.4	40.5	0.78	-	-
1	-	-	-	-	52	1.45	-	-
2	-	-	-	-	66	3.9	-	-
3	-	-	-	-	-	-	93	9.3
4	-	-	-	-	95	11.6	-	-
5	-	-	-	-	-	-	113	21.4
6	-	-	-	-	-	-	138	45.2
7	-	-	-	-	-	-	143	45.8

LOWER LOST SHOE CREEK

Species	Prickly sculpin n=6		Coastrange sculpin n=19	
Age	L	W	L	W
0	27.3	0.21	29.7	0.27
2	64	3.1	-	-
3	-	-	73	5.3
4	85	7.6	-	-
5	-	-	105	20.1

UPPER LOST SHOE CREEK

Species	Cutthroat n=1		Coho n=1	
Age	L	W	L	W
0	66	3.6	70	4.4

Table 8. Summary of stomach contents analysis of fish from lakes and streams of Pacific Rim National Park.

SITE / FISH	Cheewhat Lake															Kichha Lake		
	Cutthroat			Sockeye			Coho			Prickly sculpin			Stikleback			Cutthroat		
FOOD ITEY	No. of fish	(%)	Mean abundance*	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance
kmphipoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	46	0.6
Isopoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	100	2.7
Mysidacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copepoda	-	-	-	-	-	-	1	8	0.08	-	-	-	-	-	-	-	-	-
Cladocera	-	-	-	-	-	-	1	8	0.2	1	6	0.2	-	-	-	1	4	0.03
Ephemeroptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plecoptera	-	-	-	-	-	-	-	-	-	1	6	0.1	-	-	-	-	-	-
Trichoptera	-	-	-	-	-	-	-	-	-	1	6	0.06	-	-	-	3	11	0.2
Megaloptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hemiptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colesptera:																		
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Adult	1	20	0.4	-	-	-	-	-	-	-	-	-	-	-	-	2	7	0.07
Diptera:																		
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pupae	-	-	-	-	-	-	1	8	0.08	-	-	-	-	-	-	-	-	-
Chirononidae:																		
Larvae	-	-	-	-	-	-	1	8	0.08	1	6	0.13	-	-	-	2	7	0.07
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaobsrinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odonata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	0.07
Ortnoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acarina	-	-	-	-	-	-	3	25	0.4	-	-	-	-	-	-	-	-	-
Mollusca:																		
Gastropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelecypoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	0.03
Fish	2	40	1.0	-	-	-	-	-	-	1	6	0.06	-	-	-	5	19	0.3
Other	-	-	-	2	50	0.5	1	8	0.08	2	13	0.13	1	25	0.25	-	-	-
No. fish examined	5			4			12			15			4			26		
Mean percent fullness	23			3.7			20			13			1			34		

*Mean abundance on a scale of 0-3: 0- absent
1= rare
2= frequent
3= abundant

Table 8. Continued.

SITE / FISH	Hobiton Lake												Hitchie Creek					
	Cutthroat			Coho			Prickly sculpin			Stikleback			Cutthroat			Coho		
FOOD ITEM	No. of fish	(%)	Mean abundance*	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance
Amphipoda	-	-	-	-	-	-	-	-	-	4	80	1.4	-	-	-	-	-	-
Isopoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mysidacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copepoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladocera	-	-	-	-	-	-	-	-	-	3	60	1.6	-	-	-	-	-	-
Ephemeroptera	-	-	-	1	50	0.5	-	-	-	-	-	-	1	50	0.5	-	-	-
Plecoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichoptera	-	-	-	-	-	-	1	33	0.33	2	40	0.6	-	-	-	-	-	-
Megaloptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hemiptera	-	-	-	-	-	-	-	-	-	-	-				-	-	-	-
Coleoptera:																		
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Adult	4	44	0.66	1	50	0.5	-	-	-	-	-	-	-	-	-	2	25	0.25
Oiptera:																		
Larvae	1	11	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pupa?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae:																		
Larvae	-	-	-	-	-	-	1	33	0.66	3	60	1.0	2	100	1.0	4	50	1.0
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	1	50	1.0	1	12	0.25
Chaoborinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odonata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthoptera	1	11	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acarina	-	-	-	2	100	1.0	-	-	-	-	-	-	-	-	-	-	-	-
Mollusca:																		
Gastropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelecypoda	-	-	-	-	-	-	1	33	0.33	-	-	-	-	-	-	-	-	-
Fish	3	33	0.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	6	66	1.5	2	100	1.5	1	33	1.0	-	-	-	2	100	3.0	8	100	2.0
No. fish examined	9			2			3			5			2			8		
Mean percent fullness	31			30			23			40			SO			38		

Table **8.** Continued.

SITE	Squalicum Lake						Tsusiat Lake								
FISH	Cutthroat			Prickly sculpin			Cutthroat			Kokanee			Prickly sculpin		
FOOD ITEM	No. of fish	(%)	Mean abundance*	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance
Amphipoda	1	2	0.03	1	5	0.04	-	-	-	-	-	-	-	-	-
Isopoda	-	-	-	-	-	-	-	-	-	-	-	-	1	12	0.12
Mysidacea	-	-	-	-	-	-	10	62	1.6	-	-	-	-	-	-
Ostracoda	-	-	-	2	10	0.19	-	-	-	-	-	-	-	-	-
Copepoda	51	96	2.6	13	62	1.66	-	-	-	-	-	-	-	-	-
Cladocera	9	17	0.2	-	-	-	-	-	-	2	100	3.0	-	-	-
Ephemeroptera	1	2	0.01	-	-	-	1	6	0.06	-	-	-	-	-	-
Plecoptera	-	-	-	-	-	-	-	-	-	-	-	-	1	12	0.12
Trichoptera	8	15	0.22	4	19	0.33	1	6	0.06	-	-	-	1	12	0.12
Megaloptera	13	25	0.37	1	5	0.09	1	6	0.06	-	-	-	-	-	-
Hemiptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera:															
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Adult	24	45	0.66	-	-	-	2	12	0.31	-	-	-	-	-	-
Diptera:															
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae:															
Larvae	12	23	0.18	9	43	0.38	-	-	-	-	-	-	1	12	0.12
Pupae	22	42	0.67	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odonata	1	2	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Orthoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acarina	5	9	0.11	-	-	-	-	-	-	-	-	-	-	-	-
Mollusca:															
Gastropoda	-	-	-	3	14	0.23	-	-	-	-	-	-	1	12	0.12
Pelecypoda	-	-	-	-	-	-	-	-	-	-	-	-	3	37	0.37
Fish	5	9	0.18	-	-	-	5	31	0.5	-	-	-	-	-	-
Other	-	-	-	1	5	0.14	1	6	0.06	-	-	-	-	-	-
No. fish examined	53			21			16			2			8		
Mean percent fullness	67			54			14			45			10		

Table **8. Continued.**

SITE / FISH	Tsuquadra Lake														
	Cutthroat			Dolly Varden			Kokanee			Coho			Prickly sculpin		
FOOD ITEM	No. of fish	(%)	Mean abundance*	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance
Amphipoda	-	-	-	2	22	0.55	1	7	0.07	-	-	-	-	-	-
Isopoda	2	16	0.16	7	77	1.6	-	-	-	1	16	0.16	1	16	0.16
Mysidacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copepcda	-	-	-	-	-	-	3	23	0.6	-	-	-	-	-	-
Cladocera	1	8	0.08	-	-	-	4	30	0.7	1	16	0.5	-	-	-
Ephemeroptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plecoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichoptera	2	16	0.16	-	-	-	-	-	-	-	-	-	1	16	0.16
Megaloptera	-	-	-	6	66	1.0	-	-	-	-	-	-	-	-	-
Herniptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera:															
Larvae	1	8	0.08	-	-	-	-	-	-	-	-	-	-	-	-
Adult	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diptera:															
Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae:															
Larvae	3	25	0.4	7	77	1.2	3	23	0.23	-	-	-	1	16	0.16
Pupae	1	8	0.08	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborinae	2	16	0.33	-	-	-	9	69	1.8	-	-	-	1	16	0.16
Odcnata	-	-	-	1	11	0.11	-	-	-	-	-	-	-	-	-
Ortlioptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidcptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acarina	2	16	0.33	-	-	-	-	-	-	-	-	-	-	-	-
Mollusca:															
Gastropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelecypoda	-	-	-	1	11	0.22	-	-	-	-	-	-	-	-	-
Fish	2	16	0.16	-	-	-	-	-	-	-	-	-	1	16	0.16
Other	3	25	0.33	-	-	-	-	-	-	-	-	-	4	66	0.66
No. fish examined	12			9			13			6			6		
Mean percent fullness	18			15			15			19			24		

Table 8. Continued.

SITE / FISH	Hitchie Creek (cont.)						Upper Lost Shoe Creek						Lower Lost Shoe Creek					
	Prickly sculpin			Coastranse sculpin			Cutthroat			Coho			Pricklv sculoin			Coastrange sculoin		
FOOD ITEM	No. of fish	(%)	Mean abundance*	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	tlean abundance	No. of fish	(%)	Mean abundance	No. of fish	(%)	Mean abundance
Amphipoda	-	-	-	-	-	-	-	-	-	-	-	-	1	16	0.16	1	5	0.05
Isopoda	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-
Mysidacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	3	50	0.5	3	15	0.15
Copepoda	-	-	-	-	-	-	-	-	-	-	-	-	1	16	0.33	12	63	1.6
Cladocera	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Ephemeroptera	-	-	-	4	50	0.62	-	-	-	-	-	-	2	33	0.33	5	26	0.26
Plecoptera	-	-	-	-	-		1	100	1.0	-	-	-	-	-		1	5	0.05
Trichoptera	2	25	0.4	4	50	1.2	-	-	-	-	-	-	-	-	-	1	5	0.05
Megaloptera	-	-	-	-	-	-	-	-	-	-	-	-	1	16	0.16	-	-	-
Hemiptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera:	-	-																
Larvae			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Adult	1	12r	0.6	-	-	-	1	100	1.0	-	-	-	-	-	-	1	5	0.05
Oiptera:	-	-																
Larvae			-	-	-	-	-	-	-	1	100	1.0	1	16	0.16	-	-	-
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae:																		
Larvae	-	-	-	7	87	2.0	1	100	2.0	1	100	2.0	4	66	1.3	13	68	1.1
Pupae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odonata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthoptera	1	12	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acarina	-	-	-	3	37	0.37	-	-	-	-	-	-	-	-	-	3	15	0.15
Mollusca:																		
Gastropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelecypoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish	1	12	0.6	-	-	-	-	-	-	-	-	-	1	16	0.33	-	-	-
Other	-	-	-	-	-	-	1	100	2.0	1	100	2.0	-	-	-	1	5	0.05
No. fish examined	5			8			1			1			6			19		
Mean percent fullness	21			43			50			30			45			29		

Table 9. Summary of physical, chemical, and biological characteristics determined for selected lakes in Pacific Rim National Park.

Characteristic / Lake	Cheewhat	Hitchie	Hobiton	Kichha	Squalicum	Tsuquadra	Tsusiat
PHYSICAL							
Elevation (m/feet)	21/70	1431470	18/60	12/40	85/280	24/80	18/60
Surface area (ha)	153.5	38.4	355	66	224	26.3	286
Volume ($x10^6 m^3$)	13.1	3.8	184.8	1.06	85	1.81	76.9
Maximum depth (m)	20.2	29	107	2.7	81	15	66
Mean depth (m)	8.5	11	52	1.6	37.9	6.8	28.8
Shoreline length (m)	6222	5263	15008	5615	8957	2525	12412
Shoreline development	1.41	2.52	2.25	1.95	1.68	1.39	2.07
Catchment area (ha)	a02	1611	4069	327	651	306	2886
Water renewal time (years)	-	0.58	-	-	3-7	-	-
Secchi visibility (m, max. observed)	6.0	8.0	11.5	2.0	10.8	3.5	7.5
CHEMICAL							
Conductivity ($\mu mho/cm^2$)	30.6	21.9	22.0	54	20.5	24.7	20.0
pH (pH units)	6.7	6.6	7.3	5.3	6.8	6.5	7.1
Hardness (mg/litre)	5.4	7.1	4.7	-	5.6	5.4	3.1
Colour (Hazen units)	5	6	5	80	5	70	10
BIOLOGICAL							
Phytoplankton (cells/ml)	1636	1645	629	22620	835	4407	694
Zooplankton (number/litre)	17.9	6.2	15.9	177.6	5.6	24.7	19.4
Benthic fauna (number/m^2)	1240	213	676	1160	1178	546	158
(g/m^2)	8.8	0.06	6.62	4.3	5.3	2.2	1.5
Shoreline fauna (g/30 min collection)	0.09	0.49	0.49	0.19	0.2	0.55	1.26
Number fish species collected	5	0	7	1	2	6	4
Number salmonid species collected	3	0	4	1	1	4	2
Fish catch/100yd, overnight net set	72	0	35	26	38.6	92	71.5
Salmonid catch/100yd, overnight net set	34	0	18.5	26	35.3	80	58.5

APPENDIX A.

GLOSSARY

Note: Only a basic selection of taxonomic and anatomic terms is included in the glossary. The reader is referred to any of the many standard taxonomic, basic limnology, or general biology references listed in the bibliography for assistance with taxonomic and anatomic terms.

Acarina - (see Hydracarina)

activity coefficient - ratio of inorganic carbon uptake by algal photosynthesis to biomass of the algae (expressed as carbon or as freshweight).

aerobic - refers to a condition where oxygen is present more or less abundantly.

affluents - tributaries; not to be confused with affluence; see also "effluents".

alkalinity - excess of bases over strong acids; in most Canadian waters, alkalinity comes from hydrolysis of bicarbonate ions.

Amphipoda - an order of Crustacea; common in marine and freshwater environments; most frequently benthic or meroplanktonic; *one* of many groups called "freshwater shrimps".

albedo - fraction of incident light that is reflected by a surface (e.g. by clouds or a field of snow).

alluvial - transported by water and subsequently deposited (i.e. as soils).

allochthonous - organic matter formed primarily by photosynthesis outside the system under consideration and coming into the system by some form of transport (usually air or water).

alpine - above tree-line; zone of the mountains roughly equivalent to the tundra of the arctic/subarctic.

anaerobic - refers to organisms which facultatively or by obligation thrive in the absence of oxygen; lacking in oxygen.

Anostraca - a group of Crustacea commonly called fairy shrimps and most commonly occurring in temporary waters.

anoxic - condition of inadequate oxygenation.

assimilation - the transformation of absorbed nutrient substances into body substances.

astatic waters - lakes of an endorheic region (outlet rivers lost in dry courses and do not reach the sea) usually having fluctuating water levels.

aufwuchs - microscopic plant and animal forms which encrust submerged surfaces of living organisms and non-living substrates.

autochthonous - organic matter originating within the system under consideration and primarily by photosynthesis.

autotrophic - refers to the nutrition of those organisms able to construct organic matter from inorganic (principally green plants).

autumnal circulation - the overturn or full-circulation during the period of homothermy in autumn; enhanced by wind.

bathymetric - concerning the science of deep-water sounding, especially the sea.

benthos - the association of species of plants and animals that live in or on the bottom sediments of a body of water.

biochemical oxygen demand - decrease in oxygen content in mg/litre of water in the dark over time period, brought about mainly by bacterial breakdown of organic matter.

biocoenosis - community of organisms whose composition and aspect is linked to environmental properties and by the relationships of the organisms to each other.

biomass - mass units of organic matter per unit surface area or per unit volume; mass of living material in an organism,

biota - the flora and fauna of a given habitat.

BOD - (see biochemical oxygen demand)

buffer - mixture of weak acids and their salts which minimizes effects of changes in hydrogen-ion concentration.

^{14}C-method - determination of assimilation or Photosynthesis by "marking" the photosynthate with radioactive carbon (^{14}C), usually as bicarbonate.

catchment area or basin - the entire area from which drainage is received by a body of water; a watershed.

Chironomidae - the chironomids or midges; Diptera; larval stages are aquatic.

cirque - usually a circular valley with precipitous walls and usually formed by glaciation.

Cladocera - small planktonic, meroplanktonic, or epibenthic Crustacea often known as water fleas (e.g. Daphnia, Bosmina).

Coelenterata - jellyfish and their relatives; Hydra is one of the few freshwater forms.

cohort - groups of animals born at the same time.

Coleoptera - the beetles; larvae and adults of many species are aquatic; often highly predaceous; frequent in lakes and often very common in ponds.

coliform bacteria - all of the aerobic and facultative anaerobic gram-negative, non-spore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48h at 35°C.

community - groups of organisms in a habitat, more closely related to each other ecologically than to other groups; the "biocoenosis".

compensation point - the depth at which assimilation and dissimilation are equal (i.e. where production approximately equals destruction).

competition - effect of one organism *(or* group of organisms) on another in the struggle for food, nutrients, living space, or other common needs.

Conchostraca - a group of bivalved meroplanktonic or epibenthic Crustacea known as "clam shrimps" (closely related to Anostraca).

conductivity - (see specific conductance).

congeneric - of the same genus; two species of the same genus are referred to as congeneric species.

convection - movements of particles of a fluid as a result of changes in density (usually as a result of heating or cooling).

Copepoda - the copepods; an order of Crustacea having 3 main free-living groups (Colanoida, Cyclopoida, Harpacticoida) and some parasitic forms.

Corixidae - water boatmen; family of Hemiptera; both nymphs and adults aquatic, although adults can fly for dispersal; common inhabitants of shallow-water habitats.

cosmopolitan - in biology, referring to world-wide distribution.

delta - triangular alluvial deposit at or in the mouth of a river.

detritus - finely divided settleable material suspended in the water; organic detritus = broken down remains of organisms.

dimictic - temperate lakes with spring and fall overturns; two periods of full circulation.

Diptera - two-winged insects, often with aquatic larvae; includes flies and mosquitoes (e.g. Chironomus, Aedes, Chaoborus).

drainage basin - area from which precipitation drains into a given lake or river.

drainage lakes - lakes with a consistent surface outlet through which most water loss (except by evaporation) occurs.

drift - the flora and fauna of running waters being transported passively downstream by the current.

dystrophic - brown-water lakes with low lime content and high humus content, often low in nutrients.

ecological efficiency - ratio (as percent) between energy flow at different points along the food chain; ratio of food consumed at one trophic level and food supplied to comparable point in preceding level.

ecology - the study of the relationships of organisms to their environment (from Greek oikos = house; logos = discourse).

ecosystem - an area of nature where living organisms and non-living substances interact to provide an exchange of materials between the living and the non-living parts.

effluent - the outflow; usually refers to sewage outflow after some form of treatment.

Ephemeroptera - an order of insects including the Mayflies; larvae are common inhabitants of lakes and rivers.

ephippium - resistant, often overwintering, egg form of Cladocera; usually formed by sexual reproduction.

epibenthic - superficially benthic organisms of the mud-water interiace.

epilimnion - turbulent superficial layer of a lake above the metalimnion or thermocline.

euphotic zone - total illuminated stratum of a lake, including limnetic and littoral zones.

eutrophic - waters with a good supply of nutrients and, hence, a rich organic production.

eutrophication - enrichment of waters by nutrients either through man's activities or by natural means. Phosphorus and nitrogen are the 2 most important elements responsible for eutrophication.

extinction coefficients - mathematically and experimentally derived values describing the rates at which light of different wave lengths is extinguished by absorption and diffusion as it passes through natural water.

exuvia - (pl. exuviae) an animal's coat, skin, shell, or outer covering.

fetch - the distance that a wind blows across a lake surface; the longer the fetch, the higher the waves.

food chain - transfer of food energy from the plant source through a series of organisms with repeated eating and being eaten; the shorter the food chain, the greater the efficiency.

food web - interlocking patterns of food chains forming a complex pattern.

Gastropoda - the common single-shelled mollusks of freshwater; the snails.

glacial relict - survivors of the Pleistocene biota usually restricted to certain localities because of glacial history and temperature tolerance.

gradient - a change in a physical property related to a unit of length or height (e.g. temperature per metre).

habitat - the place where the organism lives; an organism's "address".

hard-water lakes - $>$ 60 p.p.m. as $CaCO_3$; 61-120 p.p.m. = medium hard; 121-80 p.p.m. = hard water; $>$ 180 p.p.m. = very hard water.

hardness - anti-lathering (soap) and scale-forming quality of water due to alkaline earth salts, mainly carbonates and bicarbonates of magnesium and calcium (most commonly calcium bicarbonate).

heat budget - balance between heat content and uptake (absorption and transfer) and heat loss (radiation, conduction, evaporation).

hectare - (ha) unit of square measure, 100 metres x 100 metres; approx. 2.47 acres.

Hemiptera - an order of insects; the true "bugs", including Corixidae and giant water bugs.

heterothermic - irregular temperature regulation in primitive mammals; usually considered equivalent to poikilothermic.

heterotrophic - refers to nutrition of plants and animals which are dependent on formed organic matter for food.

Hirudinoidea - leeches; members of phylum Annelida, the segmented worms.

holomictic - refers to lakes which circulate completely to the bottom, especially at the time of autumnal circulation.

homothermy - condition of uniform temperatures throughout, as at fall turnover which begins when water column uniform at 4^{o}C.

Hydracarina - water mites; groups of aquatic arachnids.

hypolimnion - deep layer of a lake lying below the metalimnion or thermocline and normally removed from surface influences.

imago - the "perfect insect" or adult form reached at the conclusion of metamorphosis.

insolation - incoming radiation from the sun; not to be confused with insulation.

interspecific - between species (e.g. competition between species).

intraspecific - within a species (e.g. competition between members of a single species).

internal seiche - standing wave within a lake; oscillations of the discontinuity layer in a thermally stratified lake.

ion - electrically charged particles in aqueous solution; anions are negatively charged ions which migrate to the anode; cations are positively charged ions which migrate to the cathode; molecules which dissociate in water form ions.

isotherms - a line of the same temperature value, usually referring to graphs.

kettle lakes - lakes forming in depressions in terminal moraine formations left by continental glaciers.

lacustrine - pertaining to lakes.

larva - early form of an animal unlike the parent (i.e. as in complete metamorphosis in insects).

lentic - referring to standing-water habitats (lake, swamp, pond, or bog).

limnetic - open water zones to the depth of effective light penetration.

limnology - study of inland waters; from Greek limne = lake, and logos = discourse.

littoral - the shoreward section of a body of water with light penetration to the bottom.

lotic - referring to running-wacer habitats (spring, stream, river).

Lugol's solution - 10 g pure iodine, 20 g KI, 200 cc distilled H_2O, 20 g glacial acetic acid; solution added to algal sample in 1:100 ratio.

macrobenthos - benthic organisms clearly visible to the naked **eye.**

macrophytes - vascular aquatic plants which may grow either free-floating, totally submerged, or emergent above the water surface.

meromictic - lakes undergoing only partial circulation due to thermal or salinity stratification.

meroplanktonic - temporarily planktonic; refers to animals planktonic during part of their lives or for part of the day.

metalimnion - (see thermocline).

micrometre - (µm) = 1/1000 of a millimetre, 1/1,000,000 of a metre.

micron - (see micrometre).

milliequivalents per litre = equivalent parts per million (e.p.m.) - one equivalent of any element will exactly combine with or be equivalent to one equivalent of any other element. Sum of all negative ions in natural waters must equal sum of positive ions in terms of equivalents.

Mollusca - the mollusks (snails and clams).

monomictic - *a* lake in which the water mass mixes or circulates completely once *a* year.

moraine - a ridge or mound of earth, stones, etc., carried or pushed by a glacier and deposited on adjacent ground.

morphoedaphic index - a productivity index for lakes based on morphometric and soil (or sediment) related factors such as water chemistry.

morphometry - measure of external form; branch of limnology dealing with morphologic measurements of lakes and their basins.

naiad - a nymph stage in the life cycle of certain insects exhibiting incomplete metamorphosis; resembles adult in many respects.

nannoplankton - portion of the open-water plankton too small to be collected with nets; usually accepted as those organisms under 60 µm in maximum dimension.

nekton - powerful swimmers among freshwater animals that are capable of moving about voluntarily from place to place.

nematodes - unsegmented roundworms; many free-living forms in the benthos and many parasitic forms.

neuston - community of the surface film of water.

niche - the position or status of an organism within the community or ecosystem; by analogy, the organism's "profession".

Notostraca - a group of epibenthic Crustacea commonly called tadpole shrimps; closely related to the Anostraca.

nymph - immature stage of insect which resembles the adult in many structural features; metamorphosis here involves gradual changes rather than the radical morphological changes of "complete metamorphosis".

Odonata - the dragonflies and damselflies; usually highly predaceous both as aquatic naiads and aerial adults.

Oligochaeta - a group of annelids mainly terrestrial and fresh-water; segmented worms with relatively few chaetae or bristles per segment.

oligotrophic - descriptive term for lakes which are characteristically deep, rich in oxygen, have little macrophyte vegetation around margins, are poor in dissolved nutrients, and have low rates of production.

Ostracoda - the ostracodes; small bivalved crustaceans usually on or in the benthic sediments.

otolith - mass of calcium carbonate crystals in the internal ear; in bony fishes tends to have characteristic shape for each species; forms annuli and, therefore, useful in age determination.

parthenogenesis - development of an egg without the entrance of a sperm.

pelagic - refers to region of free water in seas or inland lakes; of the open-water or limnetic zone; usually refers to the ocean.

Pelecypoda - bivalved mollusks (freshwater clams); common inhabitants of relatively stable substrates free from pollution and excessive silting.

periphyton - minute organisms (both plant and animal) attached to submersed substrates (living or non-living) which project above the sediments; usually accepted as equivalent to German term "Aufwuchs".

pH - a measure of the hydrogen ion concentration; pH of 0 to 7 indicates excess of hydrogen ions over hydroxyl ions = acidity; pH over 7 to 14 indicates excess of hydroxyl ions over hydrogen ions = alkalinity; pH of 7 = neutrality.

photosynthesis - synthesis of organic matter from inorganic carbon (as CO_2 or bicarbonate) with the aid of radiant energy.

phytoplankton - plant portion of the plankton (see plankton).

piscine - of fish.

piscivorous - fish-eating.

planimetry - measurement of surface area of plane figures by tracing their perimeters with a mechanical-mathematical device.

plankton - the total community of the free water (or limnetic zone of lakes); in a strict sense, only the non-motile forms drifting passively, but now usually extended to include all living forms in free water except vertebrates, larger insects and larger Crustacea.

Plecoptera - the stoneflies; nymphs common inhabitants of swift, cool streams and shores of oligotrophic lakes.

poikilothermic - refers to animals whose temperatures fluctuate with that of their environment.

pollution - contaminated, defiled, or degraded with unnatural material; degradation of a natural environment by the addition of foreign material.

polymictic - lakes with almost continuous circulation or very frequent overturns.

population - a group of individuals of one species closely associated with each other and forming a cohesive unit.

potamoplankton - true river plankton.

p.p.m. - parts per million = milligrams per litre (dissolved salts).

primary production - amount of energy stored as organic matter through photosynthetic activity of plants.

production - sum of growth increments of all individuals of a species population (survivors + non-survivors) in a discrete time period.

productivity - trophic nature of a water body or other habitat; a rate assessment often implying characteristics responsible for high or low productivity; approximately equivalent to "bioactivity".

profundal - of the deeper part of a lake; usually considered that deep zone beyond depth of effective light penetration.

proglacial lakes - occurring in front of, at or immediately beyond the margin of a glacier or ice-sheet.

protozoan - single-celled animal.

psammon - the community of the spaces between sand and fine gravel on the shores of lakes and rivers.

pseudoplankton - or "tychoplankton"; organisms "accidentally" in the plankton

pyrheliometer - a device for measuring and recording solar radiation.

rheophilic - referring to organisms which seek a running water habitat.

riffle - shallow section across the bed of a stream over which water flows quickly so that water surface is broken in waves; small wave or a succession of small waves.

Rotifera - the rotifers or "wheel animalcules", so-called because of their apparently-whirling ciliated structures; probably coenocytic; many epibenthic and planktonic forms.

saprobic - referring to dead or decaying organic material or organisms which depend on such material for food.

scree - steep sloping accumulation of rock fragments at the foot of cliffs; frost considered most important single agent creating this fragmented material.

Secchi-disc transparency - a measure of water transparency utilizing a white or black-and-white disc lowered to the point at which it disappears from sight.

secondary production - quantity of food or energy stored as biomass by consumers of primary producers (i.e. plants and some bacteria); third trophic level.

seepage lakes - a lake into which ground water enters and from which water leaves by seeping through the lake basin wall; no consistent surface inlet or outlet.

seiche - (see internal seiche).

seston - collectively, all particulate, free-floating matter, living or dead, and including zooplankton and phytoplankton.

shoreline development - ratio of the actual perimeter of a lake and circumference of a circle having same area.

soft-water lakes - waters with not more than 60 p.p.m. hardness as $CaCO_3$; little or no inhibition to soap lathering and little scale formation in boilers, etc.

specific conductance - the amount of electrical current conducted by water depends on the amount and nature of dissolved salts (ions); measured in micro-mhos (µmho), usually at 20 or 25 C.

stagnation period - time period of thermal stratification where differences in water-mass densities prevent mixing of water mass.

standing crop - in limnology, the biomass present in a body of water at a particular time.

stenothermic - having a narrow temperature tolerance.

stratification - formation of layers exhibiting uniform and distinct physical or other qualities (e.g. thermal stratification in lakes).

stratum - a layer of any deposited substance; also a social or trophic level or grade.

stretched-mesh size - length of the opening in a gill net.

subimago - in Mayflies a "subadult" or apparently mature insect but dull in color with poor power of flight. A second moult occurs shortly after the first and the true adult emerges.

substrate - the material on or in which a plant or animal lives; the material or substance acted upon by an enzyme or ferment.

succession - ecological succession is the orderly process of community change usually involving a sequence of change in a given area.

sum of constituents - usually considered approximately equivalent to salinity or total dissolved solids (TDS); calculated total of quantitative analyses for individual dissolved constituents.

surplus production - in fisheries, production of new net weight by a fishable stock, plus recruits to the stock, minus losses by natural mortality; also called sustainable yield (see Ricker 1975).

talus - usually considered equivalent to scree (see scree).

taxon (pl. taxa) - a taxonomic division such as family, order, class, or species; in discussion, usually refers to the lowest level of identification employed in the study at hand.

TDS - total dissolved solids (see sum of constituents).

tertiary production - production by higher carnivores and insect hyperparasites; fourth trophic level.

thermistor - electronic device utilizing a thermocouple which measures temperature or temperature change as a result of changes in electrical resistance in the thermocouple at different temperatures; technically a resistance thermometer.

thermocline - region of greatest slope of the temperature gradients in a lake; zone is called the metalimnion.

Transeau's solution - for preserving plants; 6 parts water, 3 parts 95% ethanol, 1 part formalin; often with a small amount of copper sulfate.

transparency - (see Secchi-disc transparency).

Trichoptera - caddisflies; larval stages of these insects are common in running and standing waters; larvae of many species build cases of sand, detritus, etc.; some spin webs for trapping their food.

trophic level - "trophic" refers to food or nourishment; a level at which all organisms' food formed with same number of steps from plants.

turbidity - estimate of suspended matter density inhibiting passage of light.

turbulence - unorganized movement in liquids or gases.

turnover ratio (P/B) - in production, the relationship between production per time unit and mean standing-crop biomass during that time.

tychoplankton - (see pseudoplankton).

ultraviolet - region of short-wave radiation beyond the visible violet band of the visible spectrum.

vernal circulation - spring overturn or circulation at time of homothermy; may not occur if water stratifies.

voltine - number of generations in a year (i.e. univoltine, bivoltine).

volume development - ratio of a lake's actual volume and that of a cone with base area and height equal to lake area and maximum depth.

water renewal rate - (or flushing rate) - theoretical time required for total volume of water in a lake or its equivalent to be discharged via outlet stream or river.

yield - (see surplus production).

zoobenthos - animal portion of the benthic community.

zooplankton - animal portion of the plankton (see plankton).

> - abbreviation used to express "greater than" (e.g. >25).

< - abbreviation used to express "less than" (e.g. <25).

APPENDIX B

General and Technical References

This bibliography is not intented to be complete in all areas covered. Rather, it is intended to cover a selection of general references in each area as an aid to further reading for those wanting to pursue certain subjects further and not being familiar with the literature.

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APPENDIX C

Taxonomic References

In this section, no attempt is made to list all available general references or to list more than a few special references for certain groups. Additional special taxonomic reference papers will be listed in the appropriate sections of the report. The references listed here are intended to provide leads to the taxonomic literature and aids to preliminary identification. Because of continual taxonomic revision and the descriptions of new species, it is almost impossible to find thorough and complete keys to more than a few well-known groups.

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