ministry of
environment

Oyster River Water Management Plan

BC MINISTRY OF ENVIRONMENT

OYSTER RIVER WATER MANAGEMENT PLAN

Vancouver Island Region
and
Planning and Assessment Branch

Ministry of Environment

July, 1988

Canadian Cataloguing in Publication Data

Main entry under title:
Oyster River water management plan

Bibliography: p.
ISBN 0-7726-0864-4

1. Water quality management - British Columbia - Oyster River Watershed. I. British Columbia. Ministry of Environment. Vancouver Island Region. II. British Columbia. Ministry of Environment. Planning and Assessment Branch.

TD227.B7097 1988 363.7'3942'0971134 C88-092191-9

MINISTRY OF ENVIRONMENT AND PARKS

OYSTER RIVER WATER MANAGEMENT PLAN

Vancouver Island Region

Planning and Assessment Branch

July, 1988

The objectives in this plan for the Oyster River are approved and major activities may proceed as Ministry and Regional priorities and funding allow.

J. O'Riordan.

J. O'Riordan, Director,
Planning and Assessment Branch,
Ministry of Environment.

September 7/88

Date

EXECUTIVE SUMMARY

The Oyster River Water Management Plan was initiated to establish management strategies in a watershed where water resources are still relatively undeveloped, before options for management are foregone. The activities of forestry and mining companies, limited farming, and increasing residential development have the potential for impacting water quantity and quality in a watershed where the land base is already well developed. A large proportion of the watershed has been logged during this century, and cutting is continuing into the higher elevations of the watershed. There is some demand for mineral extraction (e.g. coal) and placer mining adjacent to or within the drainage. Over 80% of the 376 km^2 area of the watershed is owned by forest companies, with Strathcona Provincial Park occupying 13% at the highest elevations. Approximately 400 people reside within the plan area near the river's mouth, but over 40,000 who may potentially use the watershed for water-based recreation, including fishing, live within a 20-minute drive.

The Oyster River arises on the eastern slopes of the Vancouver Island Mountains, and flows east into the Strait of Georgia midway between Courtenay and Campbell River. In terms of drainage area, the four most significant tributaries to the Oyster River are Piggott Creek, Little Oyster River, Adrian Creek and Woodhus Creek. Helen MacKenzie, Pearl, Wowo and Divers are the largest lakes although all are relatively small. Estimates from the single hydrometric gauge in the watershed and three years of low-season measurements indicate streamflow is highest in November/December (due to fall rains) and May-June (due to snowmelt at high elevations), and lowest in August and September. In the past, the November/December high flows have resulted in flooding problems in the settled parts of the lower Oyster, leading to construction of flood protection works in the 1980s, and detailed floodplain mapping.

Instream supplies of water are required for fisheries habitat, water-based recreation, and for waste dilution. Upstream passage of all fish species is blocked by a series of barriers in the mainstem, 24 km above the mouth. The significant fish species for recreational use in the watershed are steelhead and cutthroat trout. The steelhead fishery has an estimated annual recreational value of approximately $29,000. The sea-run cutthroat fishery is the most important for this species on Vancouver Island. Among anadromous species, the most important are chum, coho, pink, and chinook, which are used for both commercial and recreational purposes. The Oyster mainstem, Little Oyster River, Woodhus Creek and Bear Creek are important areas for anadromous salmon, which had an estimated annual value of over $200,000 in 1986. Estimated optimum annual value is close to $1 million if potential habitat is fully utilized. However, low flows in the watershed are naturally limiting in all tributary streams, indicating that augmentation of supply would be required to fully exploit the potential habitat.

Water-based recreation, including fishing activity, generally occurs in the lower reaches of the mainstem Oyster. Canoeing, kayaking, rafting, tubing and swimming are popular below Woodhus Creek, but low water levels restrict boating activity to non-motorized craft. Water supply for waste dilution is required only in upper Piggott Creek, the site of the only waste management effluent permit in the watershed. Water quality in the watershed can generally be described as good, except treatment is required for human consumption due to high levels of microorganisms in the lower reaches. However, logging has been blamed for both water quality and water quantity problems due to its activities.

Consumptive licensed water uses in the Oyster watershed all occur in the lower part of the drainage, and are for irrigation, domestic, waterworks and industrial resort purposes. The maximum demand under these licences is equivalent to 0.098 m^3/s, or 8.4% of the 7-day 5-year recurrent low flow at the Oyster River gauging station. Potential increases in licensed water use during the next 5-10 years may occur for waterworks and irrigation. A preliminary assessment of 16 possible storage sites was undertaken, for fisheries enhancement or future licensed requirements. Some use of groundwater is made, and potential groundwater areas appear to exist in the lower Oyster basin to above Woodhus Creek.

The Plan concludes with a series of 21 recommendations with respect to streamflow measurements, groundwater assessment and development, fisheries production management, water quality assessment and waste management, water allocation policy, storage, flood control, and water management legislation and policy. In brief, these are:

- continue streamflow measurements, and expand measurement program for storage and fisheries assessments.
- assess and encourage groundwater development in the lower Oyster watershed.
- design and implement a comprehensive fisheries production management plan for the watershed.
- establish water quality objectives and a water quality monitoring program.
- require and encourage resource developers to maintain and improve existing water quality.
- assess Upper Piggott Creek discharge dilution, and determine the source of elevated fecal coliform and dissolved metal levels in the Oyster mainstem.
- only issue further consumptive water licences (except domestic use in single residences) from Bear Creek, Little Oyster River or Woodhus Creek, or large consumptive licences within the Oyster watershed, if supporting storage or fisheries mitigation is provided.
- assess water storage potential at identified sites.
- review benefits of further construction of flood and erosion protection works.
- continue to implement setback and elevation limits to control developments adjacent to floodplains.

- recommend revisions to the Water Act to recognize and protect/conserve instream flow requirements.
- consider revisions to the Water Act to charge water user fees based upon quantities used.
- provide policy and legislation to support water management on a watershed basis.

LIST OF CONTRIBUTORS

VANCOUVER ISLAND REGION

Water Management:
- Bill Hollingshead
- Jim Card
- George Bryden
- Ove Hals

Fish and Wildlife:
- George Reid
- Shawn Hay
- Peter Law
- Lew Carswell

Waste Management:
- Ted Oldham
- Lloyd Erickson
- Duncan McLaren

Administration
- Denise Tierney

Planning and Assessment Branch
- Brian Turner (Plan Coordinator)
- Ron Topham
- David Parsons
- Leah Waddington

Surveys and Resource Mapping Branch
- Erik Thorn

Other Contributors

Brian Tutty, Rick Higgins, Paul Kopas (Department of Fisheries and Oceans)
Ann Ratel (Ministry of Energy, Mines and Petroleum Resources)
Terry Summers (Ministry of Forests, Campbell River)
Arnold Ennik (MacMillan Bloedel Ltd., Campbell River)
Don Jones (Crown Forest Industries, Campbell River)
Tom Jones (B.C. Forest Products, Campbell River)

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

In many eastern Vancouver Island watersheds, the water resource supports a number of instream and consumptive uses. These often compete for the scarce water resource during the late summer low flow period. The water resources of the Oyster River watershed are still relatively undeveloped, providing an opportunity for establishing management strategies before options are foregone due to development. However, the Oyster River watershed's summer low flow period, while not as low as that of many other drainages on the east coast of Vancouver Island, may already be a period when flows are limiting for fisheries and unavailable for large new water users. Natural storage in the basin is limited to small headwater lakes. High flows in the Oyster River over short winter periods can cause flooding damage on the lower portions of the river near tidewater.

The watershed has been extensively logged and the associated land use may have had short-term effects on the Oyster River hydrograph and on water quality. Mining operations (placer, coal and base metals) have existed or are proposed for tributary watersheds, and exploration is ongoing; these could have water quality impacts on the Oyster River. Residential development in the area continues to increase the demand for larger waterworks and domestic water supplies. The Oyster River is important to the fisheries resource, presently subject to enhancement activities. An extensive bank protection program has been carried out and additional dykes have been studied to provide flood protection in the vicinity of the Island Highway.

The purpose of the Oyster River water management plan is to provide strategies to guide future water resource development for the basin, recognizing existing and future land uses.

1.2 SETTING

The Oyster River drainage basin is located on the east coast of Vancouver Island (Figure 1.1), approximately halfway between the northern and southern ends of the island. It arises in the spine of mountains running up the middle of the island, just east of Buttle Lake, in Strathcona Park. The Oyster drains to the east, into the Strait of Georgia midway between Courtenay and Campbell River. Its drainage area of 376 km^2 is approximately the tenth largest of the rivers on the east coast of Vancouver Island. As is typical of these east coast drainages, highest river flows are experienced during the winter rainy months, and later from snowmelt in May and June, with lowest flows in the late summer or early fall.

1.3 LAND TENURE

Approximately 80% of the Oyster River watershed is owned by four forest companies (Table 1.1). MacMillan Bloedel (Tree Farm 19) owns the largest proportion, followed by Crown Forest Industries (T.F.8 and 65), B.C. Forest Products (T.F. 68) and Raven Lumber (Figure 1.2). Strathcona Provincial Park, including a recently-designated Recreation Area north of Helen Mackenzie Lake, occupies approximately 13% of the watershed. The Park areas are located at the highest elevations of the Oyster River, Norm Creek and Piggott Creek drainages. In the lowest reaches, much of the land is non-forest privately-owned, particularly to the south of the Oyster River. More than half of the private land is in the Agricultural Land Reserve, as shown in the Black Creek/Oyster Bay Official Settlement Plan, and the Campbell River Area Community Plan. Land use designations in these two plans for the Oyster drainage east of the B.C. Hydro transmission line are: agriculture, country residential (average lot size 1.5 ha), natural environment (along watercourses), and a limited amount of settlement growth area on both sides of the highway south of the Oyster River.

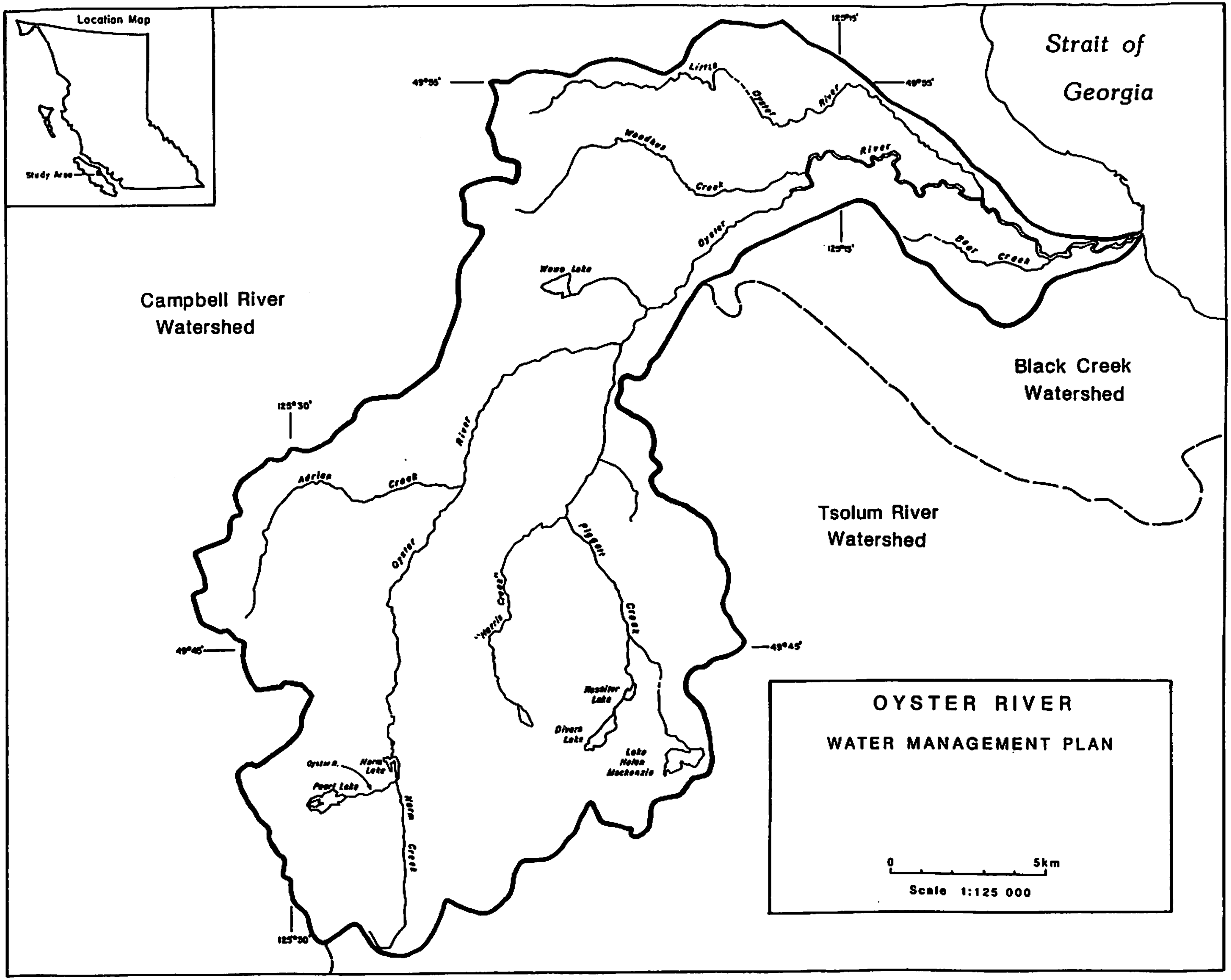


Fig. 1.1 OYSTER RIVER WATERSHED

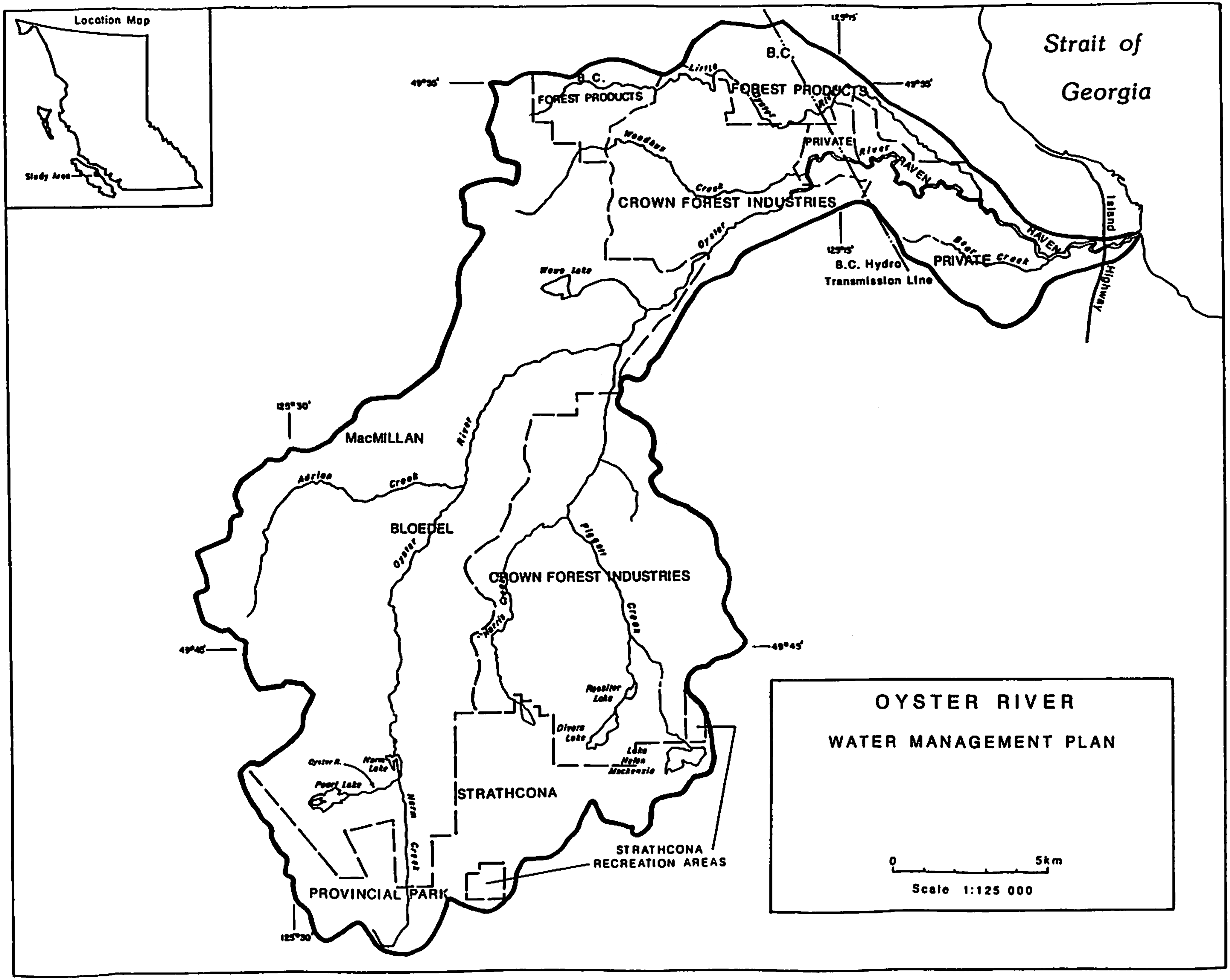


Fig. 1.2 LAND TENURE

1.4 POPULATION AND ECONOMY

1.4.1 POPULATION

From the perspective of this plan, the population of the surrounding area (and the seasonal visitors) is of interest in terms of its use of the water resources of the Oyster watershed.

The entire population of the Oyster drainage resides in the 10% of the watershed area nearest the river's mouth, east of the B.C. Hydro transmission line. Of this population, most live within a few kilometers of the Island Highway, both north and south of the Oyster River. Lower density population is located in the Bear Creek area. Due to limited access, almost everyone living north of the Oyster lives within 1 km of the highway. Assuming an average of 2.5 people per housing unit, a rough estimate of population strictly within the Oyster drainage is less than 400. However, at least that many more live within approximately 2 km of the plan boundary, at the lower end.

TABLE 1.1

LAND TENURE IN THE OYSTER RIVER WATERSHED

	Area (km^2)	% of Total
MacMillan Bloedel	150	41
Crown Forest Industries	114	31
B.C. Forest Products	25	7
Raven Lumber	6	2
Strathcona Provincial Park	48	13
Private	25	7
Total	368	100%

With respect to seasonal visitors, however, tourist accommodation in the area is extensive. Miracle Beach Provincial Park, located on the Strait of Georgia 3 km southeast of the mouth of the Oyster River, has a total annual use of nearly 150,000 visitor-days of day use, and over 30,000 visitor-nights for camping. Use peaks in the July - August period, at approximately 35,000 day use and 9,000 (July) to 13,000 (August) camping (figures for 1986, supplied by Edna Joyce, Parks and Outdoor Recreation). There is also extensive accommodation in resorts, private cottages and recreational vehicle sites in the vicinity, capacity totalling approximately 1,700 persons per night in the Saratoga Beach, Oyster Bay and Salmon Point areas. Use of this accommodation also peaks in July and August, averaging approximately 90% of capacity, or about 1,500 persons per night (nearly 50,000 per month).

However, there are indications that very few of these seasonal visitors make use of the Oyster River for recreation, concentrating their activities instead on the beaches and ocean, except for Pacific Playgrounds which borders the river.

There appears to be more recreational use of the Oyster drainage (e.g. fishing, hunting, firewood cutting, water-contact recreation) by Island residents who live relatively nearby. The downstream portions of the river are within 20 minutes drive of the population centres of Campbell River and Courtenay-Comox. Including surrounding areas, this population exceeds 40,000 who may potentially make use of the Oyster River watershed. The total population of the closest nearby communities of Oyster Bay and Black Creek/Merville is approximately 4,000 (i.e. within 10 km or so). Although these people may use the Oyster River for recreational purposes to some extent (see Section 3.2), licensed water use by residents within the Oyster drainage is minor (see Section 4.1).

1.4.2 FORESTRY

The forest industry is the dominant activity and by far the most important factor in the economy of the Oyster River area. As noted above, a major proportion of the watershed is owned by forest companies, but a significant portion of these forest lands has been harvested and consists largely of second growth timber that is not yet at a marketable stage. Timber

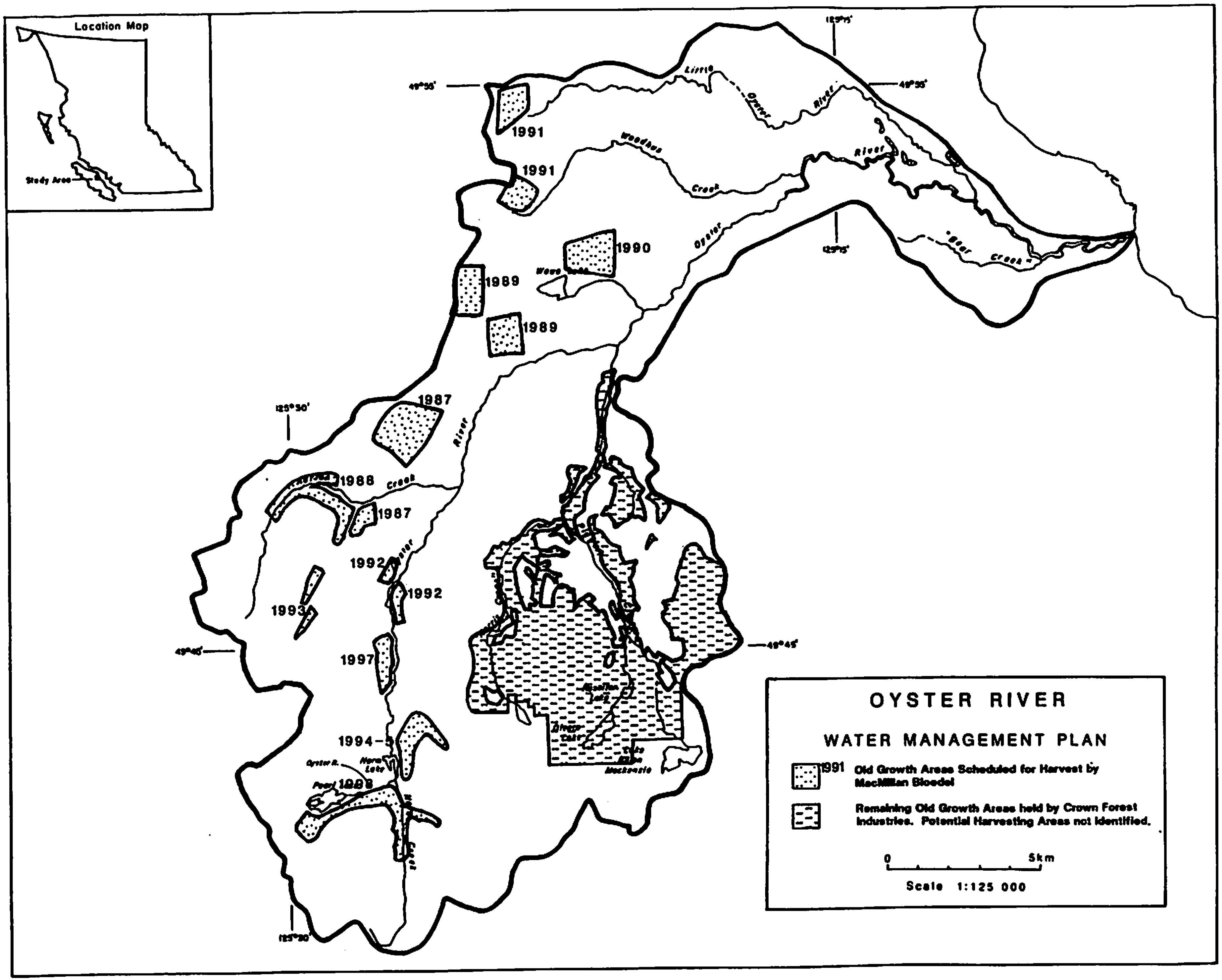


Fig. 1.3 FUTURE FOREST HARVESTING AREAS

harvesting is presently occurring, and future timber harvest areas are under consideration by the forest companies for the next 5 to 10 years. As possible, these have been identified in Figure 1.3. MacMillan Bloedel identified expected cutting areas until 1996, progressively moving higher and into the Adrian Creek, mainstem Oyster River and Norm Creek headwaters. Crown Forest Industries were not able to forecast specific cutting areas, but identification of their remaining old growth timber in the Piggott Creek watershed also suggests future harvesting will progressively occur at higher elevations. Cuts anticipated by B.C. Forest Products in the next 5-10 years cover relatively modest areas in the lower Little Oyster River area. No information was obtained from Raven Lumber with respect to cutting plans, but their holdings on the lower Oyster River are of moderate size and presumably include little or no old growth. It is therefore assumed there will be little influence from Raven Lumber's activities on water management-related concerns. The extent of logging to 1979 was mapped by Buble (1979), who suggested harvesting of secondary growth may commence in the lower Oyster basin in the early 1990s.

Forest harvesting is of concern to water, fisheries and waste managers since it may potentially affect water quantity and quality, and fisheries production. For example, natural vegetation along many of the fish- bearing watercourses has been removed, limiting input of large organic debris which is critical for providing instream stable habitat for rearing fish. Clearing of hillside forests may also increase the volume of runoff and the suspended sediment loads. Therefore, it is important for environment managers to be able to anticipate areas of future logging activity, and seek cooperation in minimizing environmental damage.

In the Oyster watershed, with most of the forest land privately held, very little of the forestry land base is under direct control or regulatory protection of the government. Under Tree Farm tenure, there is no referral to provincial government agencies required for cutting approval, so that cooperation and mutual understanding with the forest companies is stressed over a regulatory approach.

Regulatory control of the watershed is under the Water Act of British Columbia and the Fisheries Act of Canada.

The primary purposes of the B.C. Water Act are to allocate and regulate the diversion and use of water, to protect the acquired rights of licensed water users, to protect the instream environment, and to minimize any potential adverse effects of works and use. The Water Act requires that a developer obtain a Water Licence or Water Approval before work is done in or around a stream. The entire Oyster watershed is under Map Reserve 881024 for watershed purposes, so that any requests for disposition or use of Crown land would be referred to the Ministry of Environment.

The need for regulatory protection of the fishery resources from possible damage resulting from forest harvesting activities is recognized in Sections 30, 31, and 33 of the Fisheries Act, and Section 35(1) and (2) of the B.C. Fisheries Regulations. The federal Fisheries Act requires a review of any proposed activity which may disturb or destroy fish, their habitat or their eggs. Developers are obligated to ensure the safe passage of fish past any project that will use or change the natural flow of any river or stream.

The use of Crown land for development purposes requires authorization under the B.C. Land Act. Those parts of the watershed within Strathcona Park fall under the authority of the Park Act.

1.4.3 MINERAL AND COAL RESOURCES

Much of the watershed study area contains coal-bearing or mineral-bearing formations. Exploration for coal and minerals is currently quite active and is expected to continue well into the foreseeable future. Review of the mining activity is conducted via two processes. Exploration is adjudicated under the Reclamation Advisory Process with permits from the

Chief Inspector of Mines. All production proposals and major bulk samples are subjected to a staged inter-agency review under the Mine Development Review Process.

Nuspar Resources Limited is proposing to develop its Chute Creek coal project in an area including the headwaters of Woodhus Creek. During 1985, Nuspar extracted a 20,000 tonnes bulk sample of coal from the Chute Creek - Woodhus Creek area, and later developed an underground test adit near the same location. Several other coal licences are held by Novamin Resources Limited (Woodhus Creek upper reaches), Weldwood of Canada Limited (lower Woodhus Creek and upper Little Oyster River) and Canadian Occidental Petroleum Limited (Oyster River below Woodhus Creek).

A study is currently underway to seek a solution to an acid mine drainage problem at an old copper mine on Mount Washington. Leaching has had a significant impact on the Tsolum River. Its impact on upper Piggott Creek is also recognized, and efforts are underway to rectify the problem. Studies to date have identified dissolved copper levels which may be toxic to fish.

In the same general Mount Washington area, Better Resources has undertaken a drilling program in 1986 and 1987. In September 1987, this company received permission to remove a 6,000 tonne bulk ore sample for testing, with the majority of the sample to be stored on the west side of the mountain near the adit. Any acid generation from the site will be collected in a catch basin, to be treated as necessary.

Three placer leases were issued in 1974 for the Oyster River just upstream of Woodhus Creek. These leases changed hands in December 1986, and expire by early 1990, but have not yet been operated. Since they were issued, a moratorium on placer development in the Oyster has been declared, so that it appears unlikely any further leases will be issued.

As is common along much of eastern Vancouver Island, several petroleum and natural gas permits have been issued in the lower reaches of the watershed.

1.4.4 AGRICULTURE

The lower portions of the Oyster River drainage, including the Bear Creek area, contain extensive areas of irrigable soils, and are within the Agricultural Land Reserve. However, much of the ALR is presently tree-covered, but not with potentially marketable timber (Black Creek-Oyster Bay Official Settlement Plan). Although a fair proportion of the land within the ALR is not now being farmed, it is considered to have suitable capabilities for future agricultural use, and farming can be expected to increase over the long term, requiring additional irrigation water

CHAPTER 2. SURFACE WATER AND GROUNDWATER

2.1 PHYSIOGRAPHIC SETTING

The Oyster River has its origin in the mountains of the Forbidden Plateau area which is dominated by Mount Albert Edward at 2093 meters above sea level. From there, it flows north and east to the Strait of Georgia, and drains a watershed area of 376 square kilometers (Figure 2.1).

The relationship between watershed area and elevation is illustrated in Figure 2.2. The total area of the watershed may be divided into three zones of elevation, each representing about one-third of the total area. Some 33% of the area is between sea level and 500 meters elevation, 32% is between 500 meters and 1000 meters, and 35% is above 1000 meters.

There are several small lakes in the watershed, including Pearl and Norm Lakes on the mainstem of the Oyster River itself. Wowo Lake is on a tributary in the lower one-third of the basin, while all the rest are in the headwaters. Table 2.1 presents the approximate elevation of the lake surface, the surface area of the lake, and the watershed area, all of which were derived from 1:50000 topographic maps.

There are four significant tributaries to the Oyster River. These are the Little Oyster River, Woodhus Creek, Piggott Creek, and Adrian Creek. A fifth tributary, Bear Creek, drains a flat area of 8.3 km^2 in the lower part of the Oyster River basin. While it does not produce a large volume of runoff it is important because its watershed contains significant developed areas. The watershed areas and basin elevations are given in Table 2.2.

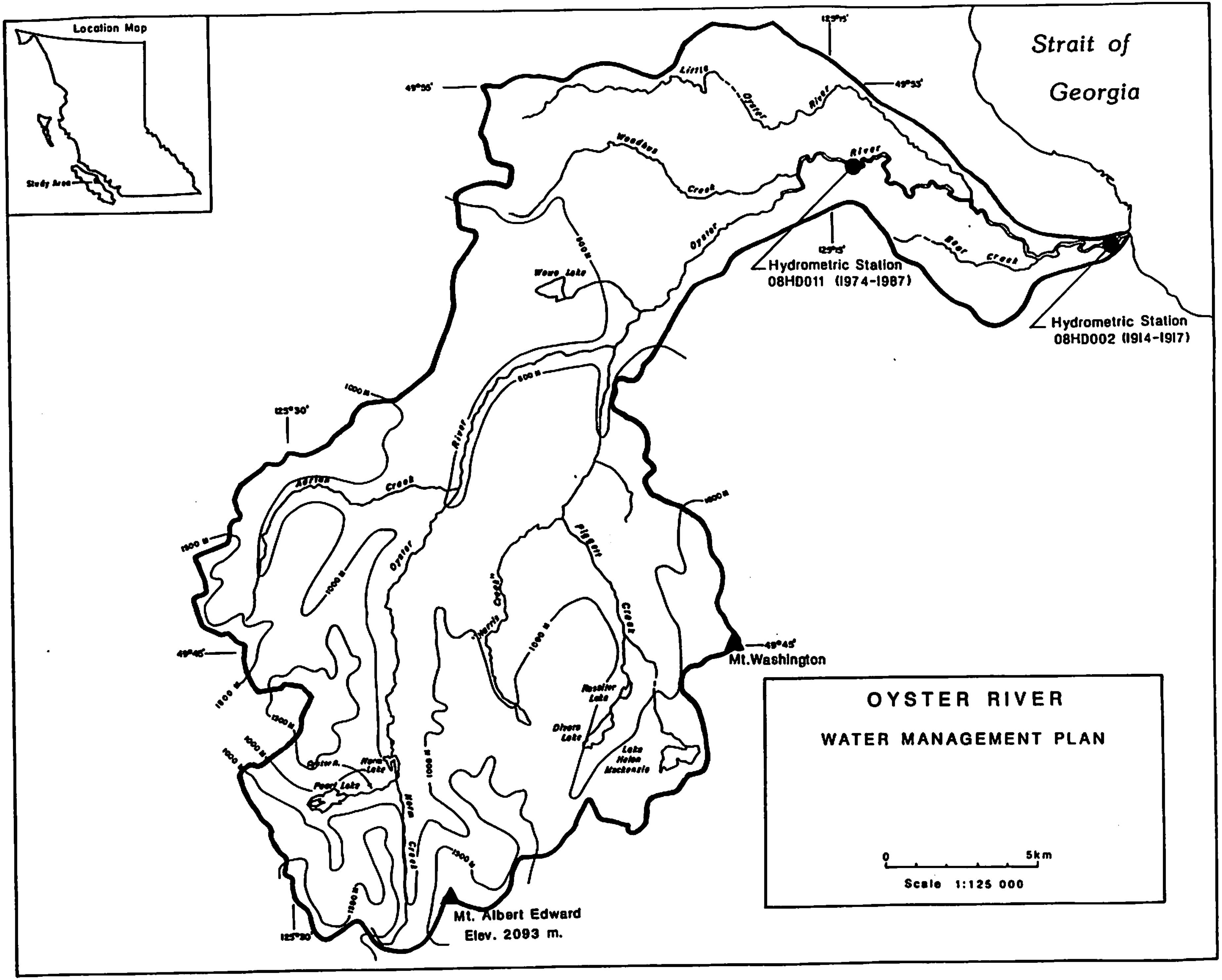
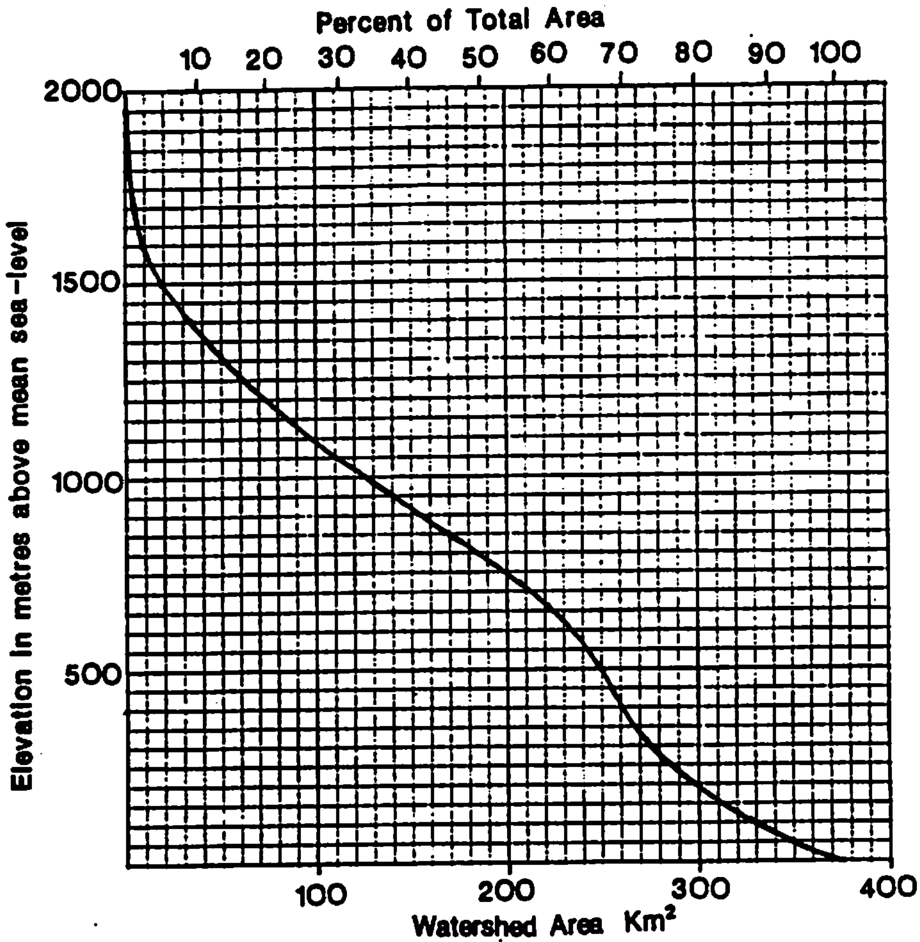


Fig. 2.1 TOPOGRAPHY



Adapted from 'Vancouver Island Area-Elevation Curves'

by Water Investigations Branch,

Dept. of Lands,Forests, and Water Resources 1968

Fig. 2.2 AREA-ELEVATION CURVE FOR THE OYSTER RIVER WATERSHED.

TABLE 2.1

CHARACTERISTICS OF THE LAKES IN THE OYSTER RIVER WATERSHED

Lake	Elevation (meters above sealevel)	Surface Area (km^2)	Watershed Area (including the lake) km^2	Estimated Mean Annual Inflow*(dam^3)
Wowo Lake	600	0.42	4.9	6900
Pearl Lake	850	0.44	17.8	28000
Divers Lake	900	0.37	14.7	23000
Harris Lake	1050	0.15	6.0	9400
Lake Helen MacKenzie	1100	0.65	2.9	4600
Circlet Lake	1150	0.27	1.8	2800
Sunrise Lake	1400	0.23	1.4	2200
Norm Lake	660	0.17	41.0	66000

* Based upon the assumptions and methodology given in section 2.3.

TABLE 2.2

CHARACTERISTICS OF THE TRIBUTARIES TO THE OYSTER RIVER

Stream	Watershed Area (km^2)	Basin Elevation Lowest (m)	Basin Elevation Highest (m)
Little Oyster River	42.0	35	625
Woodhus Creek	37.1	100	610
Piggott Creek	90.6	305	1830
Adrian Creek	39.4	485	1980
Bear Creek	8.3	20	110

2.2 CLIMATE

There is very little data on climate for the Oyster River basin. The climate is one of dry summers and wet winters in the lower reaches while at higher elevations winter precipitation in the form of snow is accumulated until late spring.

Precipitation in the lower reaches of the basin is estimated, from climate station data (see Table 2.3), to average 1350 mm annually based upon the Oyster River U.B.C. station. In the headwaters, there are no annual observations of precipitation, but interpolation of regional data suggests the annual amount is about 1800 mm. Snow surveys from Forbidden Plateau (elevation 1130 meters) show that snow accumulates during the winter months and reaches its maximum in early May, when an average of about 1700 mm of water equivalent will be stored in the snowpack. This water is released as the weather warms and the snowpack is usually depleted by the end of June. More complete data on the snow course is given in Table 2.4. Its location is some 15 kilometers east of Mt. Albert Edward and may not be entirely representative of the Oyster Basin.

TABLE 2.3

PRECIPITATION AVERAGE BASED ON THE 1951-80 PERIOD

Month	Campbell River A Elevation 105m (mm)	Comox A Elevation 24m (mm)	Oyster River UBC Elevation 11m (mm)
January	197	193	192
February	143	125	143
March	136	112	133
April	69	57	62
May	53	37	47
June	48	35	42
July	37	28	34
August	51	44	45
September	65	52	58
October	153	128	141
November	204	192	204
December	250	213	243
TOTAL	1406	1215	1345

TABLE 2.4
FORBIDDEN PLATEAU SNOW COURSE DATA
MEAN WATER EQUIVALENT FOR PERIOD OF RECORD, 1954-1985
(elevation 1130 m)

Date of Observation	Mean Snow Water Equivalent mm
January 1	640
February 1	950
March 1	1300
April 1	1680
May 1	1720
June 1	1350

2.3 STREAMFLOW

The flow of the Oyster River is gauged (see Figure 2.1) at Water Survey of Canada hydrometric station 08HD011 Oyster River below Woodhus Creek. The drainage area above this station is 298 km^2. The station has operated from 1974 to the present, and the streamflow records are summarized in Table 2.5 and Figure 2.3. There are also earlier records from a hydrometric station (08HD002 Oyster River near Campbell River, drainage area 363 km^2) farther downstream, which was in operation from 1914 to 1917. The monthly flows from that station are listed in Table 2.6, and it is worth noting that the flow during September 1915 is the lowest of all recorded, even in the 1974 to 1985 period.

In general, the streamflow is characterized by a high flow in November due to fall rains, and another high flow period in May and June due to the snowmelt from high elevations. August and September are the low flow months.

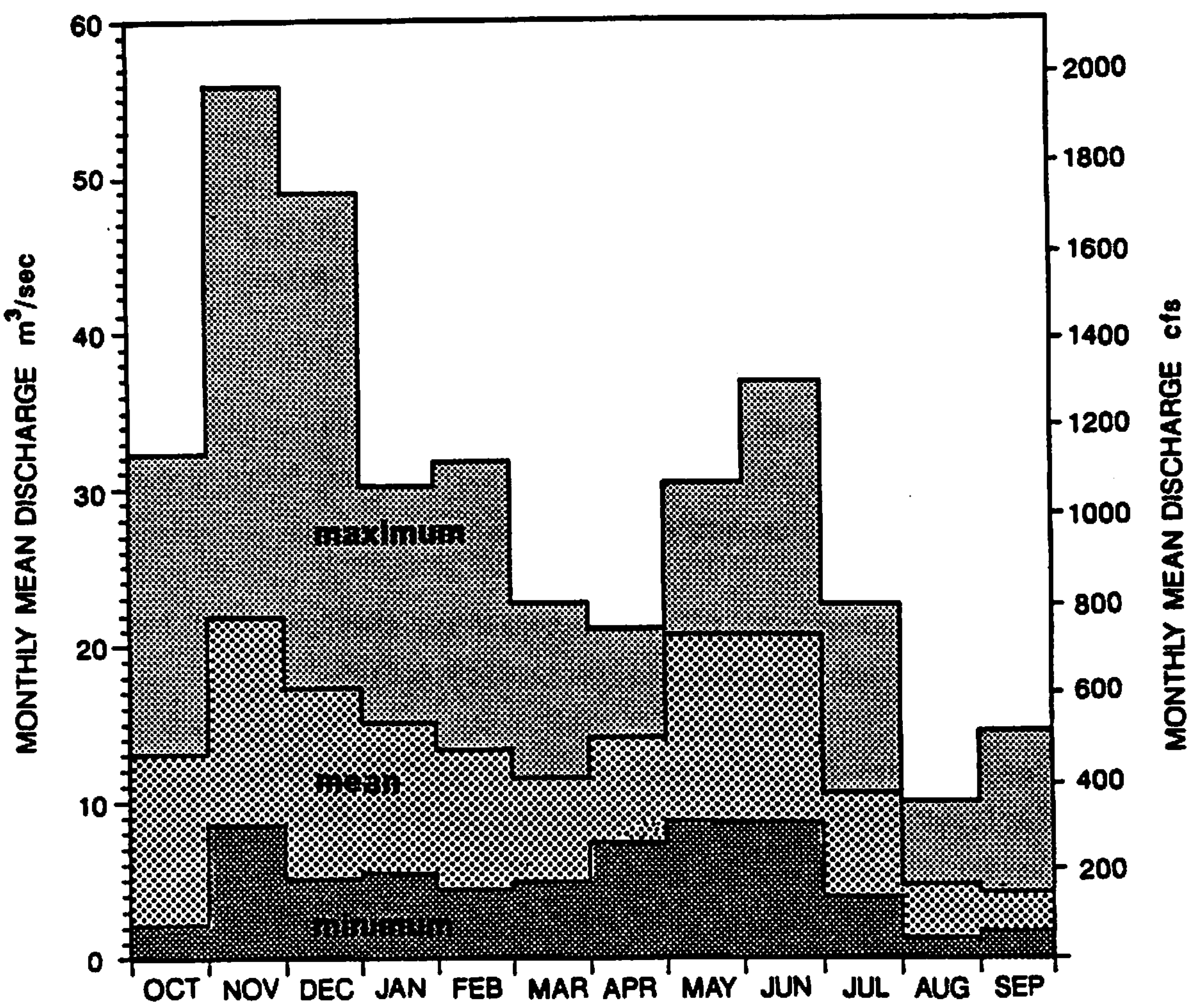
TABLE 2.5

8HD011 OYSTER RIVER BELOW WOODHUS CREEK
MONTHLY MEAN FLOWS
(1974 to 1985)

Month	Mean Monthly Flow (m^3/sec)	Maximum Recorded Monthly Mean Flow (m^3/sec)	Minimum Recorded Monthly Mean Flow (m^3/sec)
October	13.1	32.4	2.36
November	21.9	55.9	8.51
December	17.3	49.0	5.19
January	15.1	30.1	5.28
February	13.2	31.9	4.32
March	11.6	22.7	4.93
April	14.0	21.1	7.39
May	20.8	30.4	8.65
June	20.8	36.8	8.64
July	10.6	22.6	3.90
August	4.70	9.99	1.47
September	4.45	14.5	1.78

TABLE 2.6
8HD002 OYSTER RIVER NEAR CAMPBELL RIVER, MONTHLY MEAN FLOWS
(1914 - 1917)

Month	1913-1914 (m^3/sec)	1914-1915 (m^3/sec)	1915-1916 (m^3/sec)	1916-1917 (m^3/sec)
October		29.5	22.2	2.11
November		36.2	19.5	7.18
December		13.0	25.3	5.73
January		12.6		6.44
February		14.5		11.3
March		19.9		6.62
April		22.2		
May		18.2		
June	26.9	10.2	37.2	
July	19.8	4.33	25.5	
August	7.83	2.06	8.48	
September	9.84	1.39	3.84	



Based upon Hydrometric Station 08HD011
Oyster River below Woodhus Creek
Streamflow Records from 1974 to 1985

Fig. 2.3 OYSTER RIVER MONTHLY MEAN DISCHARGES

Table 2.7 lists the volumes of flow in seasonal totals for the period of record at gauging station 08HD011. The total annual volume of flow averages 436,000 cubic decametres, of which about one third occurs in the fall (October-December) and one third in the spring (April-June). Recently published data for 1986 are listed at the bottom of Table 2.7, but the values have not been included in the calculation of the means.

The mean annual flow is 13.8 m^3/sec, equivalent to a mean annual runoff of 1460 mm. The lowest recorded annual volume is 297,000 dam^3 (68% of the mean) which occurred in the 1976-77 water year. The lowest recorded summer (July, August, September) runoff volume is 19,400 dam^3 (37% of the mean) in 1985. The same period in 1986 and 1915 is almost as dry, with a flow of 20,100 dam^3 and 20,700 dam^3 respectively.

Estimates of mean annual volume of runoff and mean annual flow have been made for several ungauged locations within the Oyster River Basin. These estimates are based upon the following assumptions:

1. The mean annual runoff volume at gauging station 08HD011 is 436,000 dam^3 as recorded during the 1974 to 1985 period.

2. The mean annual precipitation varies with elevation as follows:
   elevation 0 to 500 metres, precipitation 1400 mm
   elevation 500 to 1000 metres, precipitation 1650 mm
   elevation 1000 to 1500 metres, precipitation 1850 mm
   elevation 1500 to 2000 metres, precipitation 2100 mm
   based upon satsifying the water balance at 08HD011, as calculated using assumption number 3.

3. The volume of runoff is 85 percent of the precipitation, except that for elevations above 1500 m it is 95 percent. These values are subjective and are based upon satisfying the water balance at 08HD011.

   All of these assumptions should be reviewed as more data become available.

TABLE 2.7

08HD011 OYSTER RIVER BELOW WOODHUS CREEK: SEASONAL AND ANNUAL RUNOFF VOLUME (1974-86)

PERIOD	Runoff Volume Oct/Nov/Dec (dam^3)	Jan/Feb/Mar (dam^3)	Apr/May/Jun (dam^3)	Jul/Aug/Sept (dam^3)	TOTAL (dam^3)	Annual Mean Flow (m^3/sec)	Annual Runoff (mm)
1973-74	M	123500	210400	94500	M	M	M
1974-75	102800	49800	179600	52700	384900	12.2	1290
1975-76	256900	72000	142500	67300	538700	17.1	1810
1976-77	78800	82000	105700	30900	297000	9.45	1000
1977-78	M	M	135600	88400	M	M	M
1978-79	M	M	M	M	M	M	M
1979-80	M	M	143500	46830	M	M	M
1980-81	207500	131700	78400	34520	452120	14.3	1520
1981-82	173500	74200	187100	39250	474050	15.0	1590
1982-83	149100	218700	168700	54670	591170	18.8	1980
1983-84	136500	143200	118900	48850	447450	14.2	1500
1984-85	111300	37700	133800	19410	302210	9.58	1010
Mean	152000	104000	146000	52500	436000	13.8	1460
1985-86*	70200	185000	130000	20100	405000	12.8	1360
1986-87*	112000						

M = missing data

* Recently published data not included in mean.

Table 2.8 is a summary of the derivation of the unit area runoff, and Table 2.9 presents a listing of the calculated runoff volume and mean flow at the selected ungauged sites.

2.3.1 LOW FLOWS

2.3.1.1 Seven Day Low Flows

The low flows recorded from 1974 to 1986 at 08HD011 Oyster River below Woodhus Creek are listed in Table 2.10. The mean of the annual minimum daily flows is 1.44 m^3/sec and the lowest is in 1986 at 0.729 m^3/sec. The 7-day average flows were examined from two time periods - the twelve month period January to December, and the 6 month period of April to September. For the 12 month period the mean of the 7-day average low flows is 1.58 m^3/sec. A statistical analysis of these values indicates that 7 day low flows of 1.14 and 1.01 m^3/sec or less can be expected to occur an average of once in 5 years (5 year return period) and once in 10 years (10 year return period) respectively. The recorded 7-day low flows occur in October most of the time.

TABLE 2.8
DERIVATION OF OYSTER RIVER WATERSHED RUNOFF, BASED UPON ELEVATION AND PRECIPITATION

Elevation (m)	Drainage Area (km^2)	Precipitation depth (mm)	Precipitation volume (dam^3)	Assume Runoff as % of Precipitation %	Assume Runoff as % of Precipitation (dam^3)	Runoff (mm)*
0 - 500	47.2	1400	66000	85%	5600	1190
500 - 1000	130.6	1650	21500	85%	183000	1400
1000 - 1500	100.5	1850	186000	85%	158000	1570
1500 +	19.2	2100	40000	95%	38000	1980
TOTAL	297.5		507000		435000	

* mm = dam^3/km^2

TABLE 2.9
SUMMARY OF CALCULATED MEAN ANNUAL VOLUME OF RUNOFF AND MEAN ANNUAL FLOW AT SELECTED UNGAUGED SITES

Sub-basin	Total Area (km^2)	0 to 500 m (Runoff 1190 mm) Area (km^2)	0 to 500 m (Runoff 1190 mm) Runoff (dam^3)	500 to 1000 m (Runoff 1400 mm) Area (km^2)	500 to 1000 m (Runoff 1400 mm) Runoff (dam^3)	1000 to 1500 m (Runoff 1570 mm) Area (km^2)	1000 to 1500 m (Runoff 1570 mm) Runoff (dam^3)	1500 m + (Runoff 1980 mm) Area (km^2)	1500 m + (Runoff 1980 mm) Runoff (dam^3)	Total Runoff Volume (dam^3)	Total Runoff flow (m^3/sec)
Bear Creek	8.3	8.3	9900	0		0		0	0	9900	0.31
Little Oyster River	42.0	39.9	47000	2.1	2900	0		0	0	50000	1.6
Woodhus Creek	37.1	24.1	29000	13.0	18000	0		0	0	47000	1.5
Piggott Creek	90.6	1.4	1700	46.3	65000	41.2	65000	1.7	3400	135000	4.3
Adrian Creek	39.4	0	0	10.1	14000	24.5	38000	4.8	9500	62000	1.9
Upper Oyster River	77.4	0	0	31.4	44000	33.3	52000	12.7	25000	121000	3.8
Oyster River at 8HD011	297.5	47.2	56000	130.6	183000	100.5	158000	19.2	38000	435000	13.8
Oyster River at mouth	376	123.6	147000	132.7	186000	100.5	158000	19.2	38000	529000	16.8

TABLE 2.10
08HD011 OYSTER RIVER BELOW WOODHUS CREEK:
MINIMUM FLOWS (1974-78, 1980-86)

Year	Minimum Daily Flow January to December (m^3/sec)	Minimum 7-Day Average Low Flow	
		January to December (m^3/sec)	April to September (m^3/sec)
1974	1.12	1.39	2.49
1975	1.47	1.55	1.61
1976	2.18	2.31	3.42
1977	1.68	1.98	1.98
1978	2.74	2.99	3.23
1979	m	m	m
1980	1.43	1.62	1.62
1981	1.06	1.17	1.17
1982	1.12	1.18	1.25
1983	1.18	1.20	2.08
1984	1.69	1.86	2.29
1985	0.953	0.990	1.03
1986	0.684	0.729	0.919
MEAN	1.44	1.58	1.92

m - data missing

The six month period of April to September yields 7 day low flows that are somewhat higher, at a mean of 1.92 m^3/sec. Statistically the 5 year and 10 year recurrence intervals have expected 7 day low flows of 1.30 and 1.05 m^3/sec respectively.

Estimates of low flows at ungauged sub-basins have been derived from observations of flow in several sub-basins in September 1985, and October 1986. The flows observed at that time are listed in Table 2.11. Based upon those flows, a preliminary map (Fig. 2.4) has been developed which shows the low flows at selected locations as a percentage of the flow at 08HD011 Oyster River. Also listed in Table 2.11 are observed flows in September 1987, which have not been incorporated into the foregoing assessment at this time.

This preliminary assessment of the low flows throughout the basin is the basis for the estimated 7 day low flows at the points of interest listed in Table 2.12. These results are preliminary, but indicate that the 7-day unit low flows (L/s/km^2) vary from very low values in the sub-basins which are below 500 metres elevation, to relatively high values in the headwaters of Pearl Lake and Norm Creek. The 1986 observations suggest that approximately 40% of the low flow which passes the hydrometric station has its origin upstream of Norm Lake. The 1987 observations confirm this conclusion. The presence of a snow field on the north slope of Mount Albert Edward probably is the reason that this sub-basin has significant low flows in September and October.

2.3.1.2 Minimum Monthly Flows

Minimum monthly flows are of interest for the assessment of fisheries habitat. Minimum monthly flows from streamflow records are available only for the Oyster River. These are summarized in Table 2.13, together with the results of a simple statistical analysis. Estimates of the minimum monthly flows were made for the Little Oyster River and Woodhus Creek (Table 2.14), based upon the recorded streamflow data and assumed percentages derived for the miscellaneous flow measurements taken in 1985 and 1986.

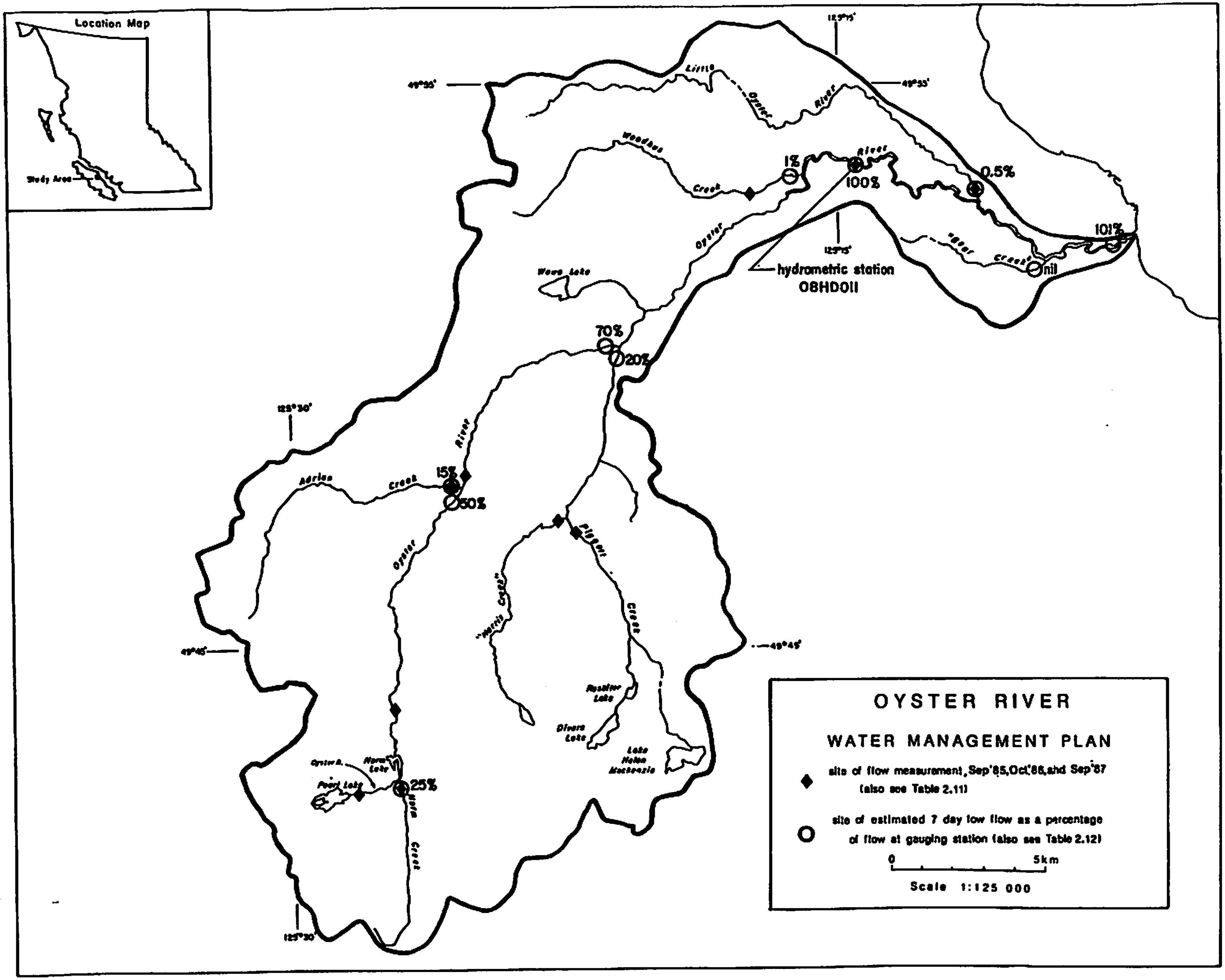


Fig.2.4 LOW FLOWS IN THE OYSTER RIVER BASIN

TABLE 2.11
MISCELLANEOUS MEASUREMENTS OF FLOWS IN THE OYSTER RIVER BASIN IN 1985 AND 1986

Site of Measurement (see Figure 2.4)	Drainage Area (km^2)	Observed Flow in m^3/sec and (L/s/km^2)						
		1985		1986			1987	
		Sept. 5	Sept. 10	Oct. 9	Oct. 10	Oct. 12	Sept. 10	Sept. 11
08HD011 Oyster River	298	1.07 (3.59)	1.30 (4.36)	0.957 (3.21)	0.882 (2.96)	0.822 (2.76)		1.27 (4.26)
Little Oyster River at bridge on Iron River Road	42.0		0.001 (0.024)	0.005 (0.119)				Nil
Woodhus Creek at bridge on logging road	35.3	0.004 (0.113)	0.005 (0.142)	0.010 (0.283)				0.007 (0.198)
Piggott Creek at bridge on logging road above Harris Creek	42.6				0.087 (2.04)		0.120 (2.82)	
Harris Creek at bridge on logging road near mouth	23.6				0.036 (1.53)		0.091 (3.86)	
Oyster R. below Adrian Creek	118				0.574 (4.86)			1.25 (10.59)
Adrian Cr. above mouth	39.4				0.144 (3.65)			0.410 (10.41)
Oyster R. below Norm Lake	49.6					0.418 (8.43)		0.816 (16.45)
Norm Creek at logging road near mouth	18.2					0.211 (11.6)		0.509 (28.0)
Oyster R. below Pearl Lake	17.7					0.101 (5.71)		0.164 (9.27)

TABLE 2.12
PRELIMINARY ESTIMATES OF 7-DAY LOW FLOWS FOR THE OYSTER RIVER BASIN[1]

Location (see Figure 2.4)	Drainage Area (km^2)	Percentage of Flow at Gauging Station	7-day low flow (Jan.- Dec. period)			
			Mean		5 yr. Return Period	10 yr. Return Period
			(m^3/sec)	(lsk)[2]	(m^3/sec)	(m^3/sec)
Oyster River at mouth	376	101	1.68	4.47	1.15	1.02
Bear Creek at mouth	8.3	nil	nil	nil	nil	nil
Little Oyster at mouth	42.0	0.5	0.008	0.190	0.006	0.005
Oyster River 08HD011	298	100	1.66	5.57	1.14	1.01
Woodhus Creek at mouth	37.1	1	0.017	0.458	0.011	0.010
Piggott Creek at mouth	90.6	20	0.332	3.66	0.228	0.202
Oyster River above Piggott Creek	147	70	1.16	7.89	0.798	0.707
Adrian Creek at mouth	39.4	15	0.249	6.32	0.171	0.152
Oyster River above Adrian Creek	77.4	50	0.830	10.72	0.570	0.505
Norm Creek at mouth	18.2	25	0.415	22.8	0.285	0.252

[1]Based upon observations in Table 2.11
[2]lsk = L/s/km^2

TABLE 2.13

MINIMUM MONTHLY FLOW AT OYSTER RIVER HYDROMETRIC STATIONS

YEAR	MINIMUM MONTHLY FLOW m^3/s	Month	GAUGING STATION
1914	7.83	August	08HD002 Oyster
1915	1.39	September	River near
1916	2.11	October	Campbell River
1974	2.36	October	08HD011 Oyster
1975	3.25	September	River below
1976	3.85	October	Woodhus Creek
1977	2.27	August	
1978	5.62	October	
1979	Missing		
1980	2.69	August	
1981	2.17	August	
1982	1.78	September	
1983	3.46	September	
1984	2.49	September	
1985	1.47	August	
1986	1.01	September	
Mean	2.92		
5 Year	1.55		
10 Year	1.22		

TABLE 2.14
ESTIMATED MINIMUM MONTHLY FLOWS AT SELECTED LOCATIONS

	MINIMUM MONTHLY FLOW m^3/s		
LOCATION	Mean	5 yr. return	10 yr. return
08HD011 OYSTER RIVER	2.92	1.55	1.22
LITTLE OYSTER RIVER* at mouth	0.015	0.008	0.006
WOODHUS CREEK** at mouth	0.029	0.016	0.012

* flow is assumed to be 0.5% of the flow at 08HD011 Oyster River gauge

** flow is assumed to be 1% of the flow at 08HD011 Oyster River gauge

2.3.2 FLOOD FLOWS

In the settled parts of the Oyster River basin, flooding and erosion have been problems to the residents over the past 15 years. Following floods in 1975 and 1980 the Province and the local government spent $390,000 on bank protection work on the Oyster River upstream and downstream of the Island Highway bridge. Further flood protection work has been identified by the Ministry (Brown, 1982) at a total cost of $262,000, but there are no plans for implementation at this time.

The flood hazard has been documented by the Ministry of Environment on its floodplain mapping for the Oyster River. The mapping (Drawing No. 5532) indicates the extent of potential flooding in the event of a 200-year return period flood. The mapping, at a scale of 1:5000, extends along the river for about 17 km upstream from the mouth as illustrated in Figure 2.5. (Ministry of Environment, 1984).

High flows occur on the Oyster River at two times in the year. The highest flows on record have usually occurred in the months of October, November or December. These are generally the result of heavy rains throughout the basin, and in some years snowmelt may be a significant factor. Another period of high flows occurs in April, May or June when snowmelt occurs at high elevations, however these flows have not presented flood problems in the past. Peak flow periods cause high sediment transport rates, bank erosion, channel instability and log jamming.

Table 2.15 lists the recorded annual maximum daily flows at the hydrometric stations on the Oyster River. The highest recorded flow was 260 m^3/sec on November 13, 1975. The 200 year flood was estimated to be 620 m^3/sec for the purpose of floodplain mapping. This is the flow that has a 0.5 percent probability of being equalled or exceeded in any year, or to express it another way - it is the flow that will be equalled or exceeded in one year out of 200 years on the average. The 20-year return period flood was estimated to be 440 m^3/sec. The floodplain mapping indicates the water levels that could be expected at these flows and includes an allowance for freeboard.

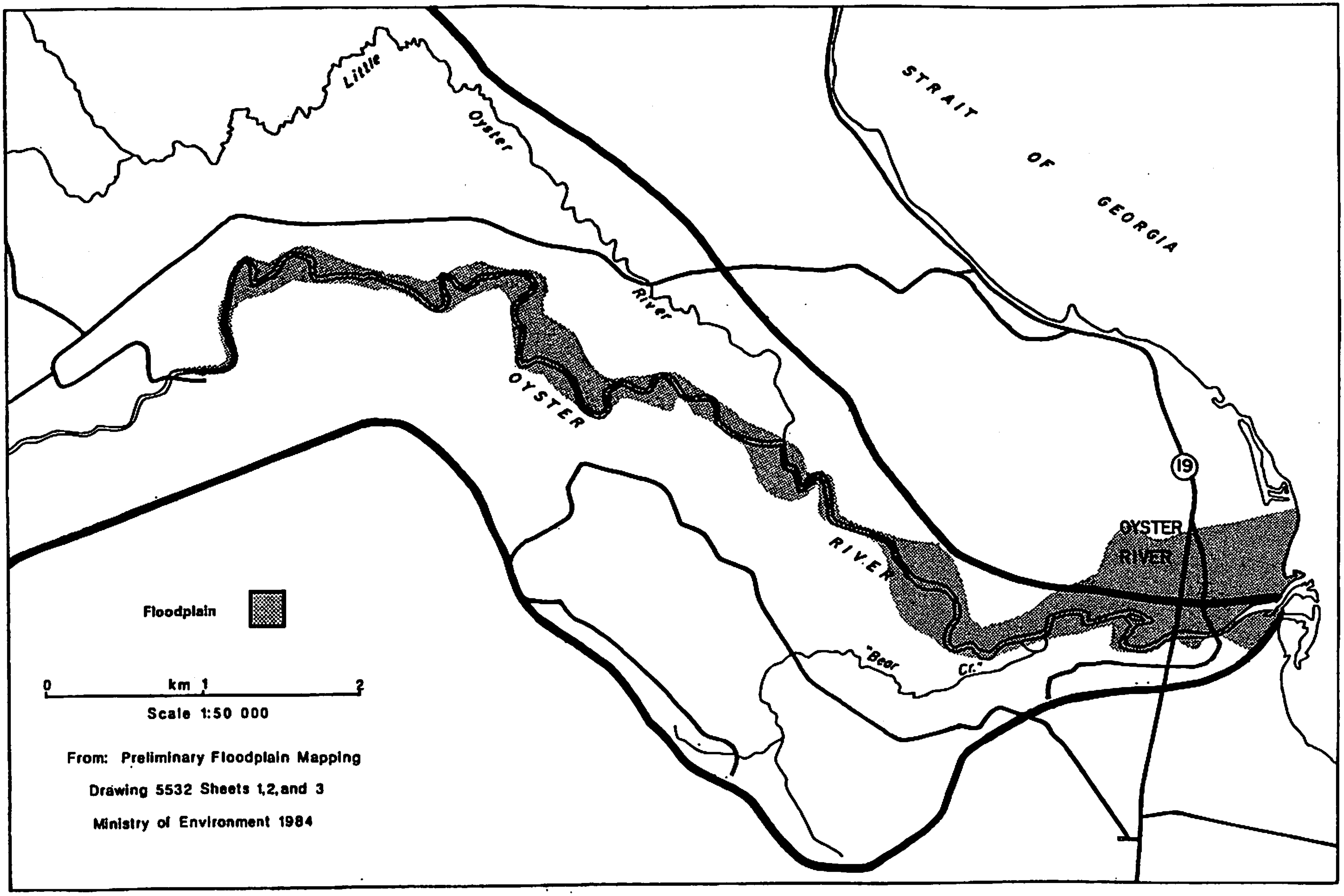


Fig. 2.5 THE FLOODPLAIN OF THE OYSTER RIVER

TABLE 2.15
8HD002 and 8HD011 OYSTER RIVER ANNUAL MAXIMUM DAILY FLOWS

Water Year (Oct. 1 to Sept. 30)	Maximum daily flow (m^3/sec)	Date of Occurrence
1914-15	85.0	November 16, 1914
1915-16	133	October 26, 1915
1916-17	17.6	February 16, 1917
1973-74	131	January 15, 1974 Note: no records in 1973
1974-75	111	November 24, 1974
1975-76	260	November 13, 1975
1976-77	63.4	December 26, 1976
1977-78	Missing	
1978-79	Missing	
1979-80	Missing	
1980-81	220	December 26, 1980
1981-82	161	October 31, 1981
1982-83	225	October 25, 1982
1983-84	144	November 11, 1983
1984-85	105	October 9, 1984
1985-86	106	January 19, 1986

2.4 GROUNDWATER

Sections 2.4.1 to 2.4.3 are taken from a report on groundwater supply in the Fanny Bay to Campbell River area (Zubel, 1979).

2.4.1 SURFICIAL GEOLOGY

Based on the surficial geology as mapped by Fyles (1959), the areas of sand and gravel deposits that may contain substantial amounts of groundwaterare outlined in Figure 2.6. Area A is underlain by deltaic sands and gravels of unknown thickness. Area B is underlain by fluvial sands and gravels and till. Upstream and downstream of this area, the Oyster River flows over bedrock. Area C is underlain by terraced fluvial and floodplain deposits consisting mainly of gravel, sand, silt and till. Along its course within this area, the Oyster River flows over bedrock. Surficial deposits of cobbles, gravel, and sand are exposed along the banks, and are generally less than 20 feet thick.

2.4.2 WELL LOG DATA

In area A, most of the shallow wells have low yields. According to the well logs, it was reported that the water in some of these dug wells contained high amounts of dissolved iron and/or sulfur. At the UBC Experimental Farm, a shallow dug well was constructed in permeable sand and gravel and presently yields an estimated 50 gpm. Near the old bridge across Oyster River, a 42 inch diameter well was dug to a depth of 16 feet and encountered water at less than 7 feet below ground level. The coarse sand and gravel aquifer was pump tested and found to have a potential yield of 300 gpm, with very little drawdown. Some drilled wells in area A have also been successful in obtaining moderate to high yields. A well at the UBC Experimental Farm, drilled in 1968 near the Oyster River, is reported to have encountered sand and gravel to a depth of 40 feet(?) and was pump tested at a rate of 700 gpm.

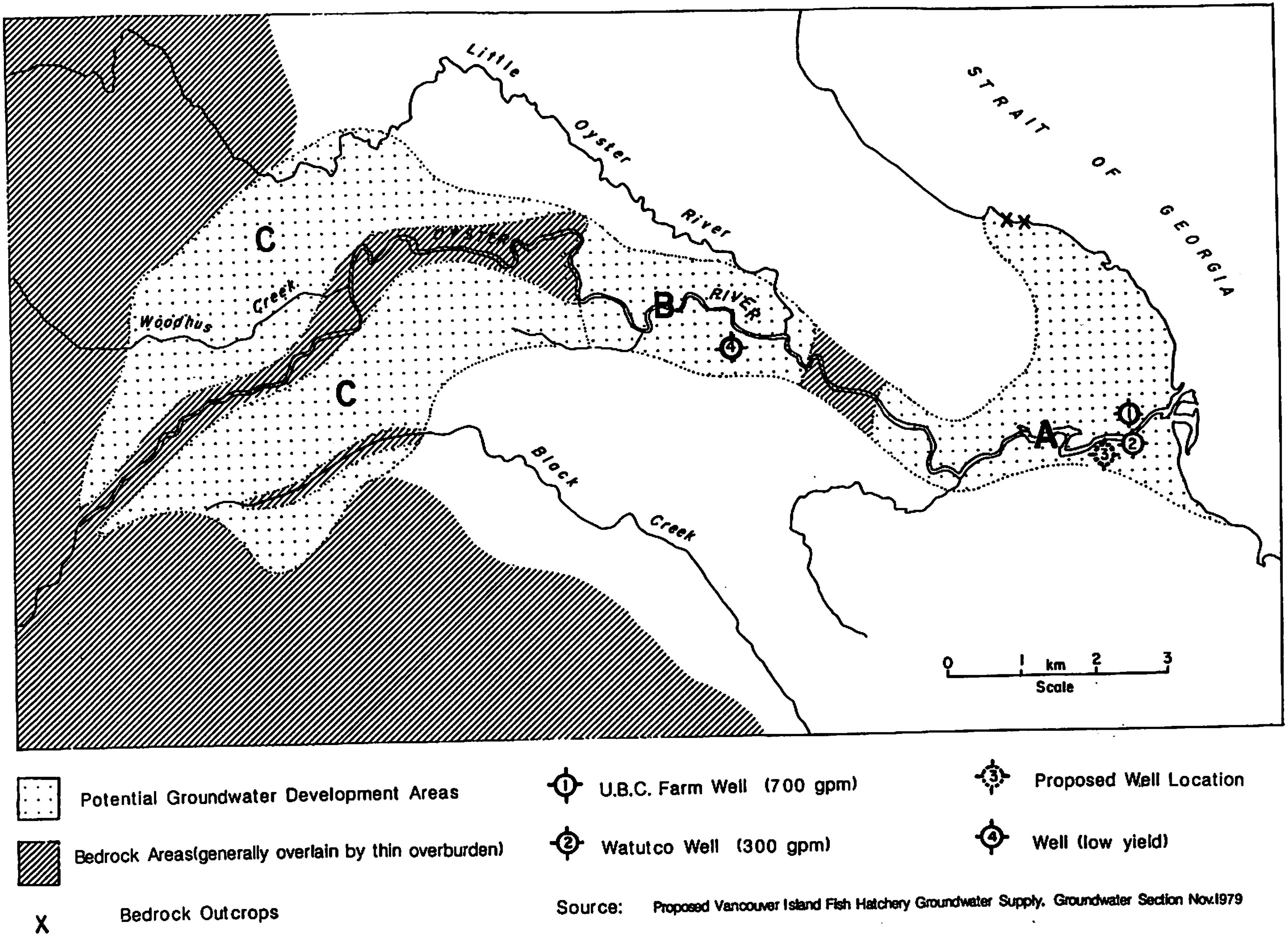


Fig. 2.6 AREAS OF SURFICIAL DEPOSITS THAT MAY CONTAIN SIGNIFICANT AMOUNTS OF GROUNDWATER

The Regional District of Comox-Strathcona has drilled several good yielding shallow wells in the vicinity of the highway bridge. No details are presently available except that one of the wells was reported to have a capacity of 375 gpm. In area B, one drilled well located on the south side of the Oyster River penetrated till to a depth of 100 feet and then encountered sand and gravel to a depth of 107 feet (see Well #4, Figure 2.6). A pump test of this zone was made, but only 4 gpm was the reported yield. No well log data is available for area C. The Regional District supplies an area south to Black Creek from these sources.

2.4.3 ANALYSIS AND RECOMMENDATIONS

The permeable nature of the water-bearing deltaic deposits (area A) and the fact that there is a proven potential of up to 700 gpm from wells located close to the Oyster River indicates that there is a substantial amount of groundwater in the area. Further groundwater exploration and development by way of test drilling and pumping tests is recommended. A tentative test site is located in the area beween the two highway bridges at Oyster River (Well Site #3, Figure 2.6).

Data concerning the 107-foot drilled well in area B indicates that there is a sub-till aquifer in the area, but apparently of low-yielding capacity. Based upon this subsurface data and the surficial geology, it appears that there may be low to moderate groundwater potential from sub-till aquifer(s) in this area. Further exploration by way of test drilling would be required to prove up the potential. Due to the low potential, further exploration in this area is not recommended at this time.

Similar to the Tsable River and the Trent River, the Oyster River upstream of area B flows across bedrock. The surficial deposits above the bedrock are thin and do not appear to be water bearing. Further groundwater exploration in this area is not recommended at this time.

2.4.4 OTHER SUBSEQUENT REPORTS

Groundwater potential reports by Zubel in 1981 and 1982 assessed a site-specific location on the left bank of the Oyster River about 4 miles upstream of the mouth. The investigations concluded that a granular layer about 15 metres thick in the centre of the study area may contain sufficient groundwater potential for moderate-yielding wells of 100 to 500 gpm capacity. Further test drilling was recommended. A subsequent report (Ronneseth, 1985) investigated groundwater potential for irrigation, but did not provide any new findings that would substantially change Zubel's conclusions and recommendations in Section 2.4.3 above.

CHAPTER 3. INSTREAM REQUIREMENTS AND WATER QUALITY

3.1 FISHERIES

The Oyster River and its tributaries provide habitat for several salmonid species which are important for either commercial or recreational purposes. The fish of the Oyster system are managed by two fisheries agencies. The Recreational Fisheries Branch of the Ministry of Environment and Parks, under agreement with the Department of Fisheries and Oceans, administers the freshwater fish resource and seagoing trout. The Federal Department of Fisheries and Oceans (DFO) manages the anadromous salmon species which migrate into, reproduce, or rear in the system. This section of the plan focuses on identifying the characteristics of the resident (Section 3.1.1) and anadromous (Section 3.1.2) fish populations, and presents a flow regime which is necessary for effective fish habitat management in this system.

3.1.1 SPECIES MANAGED BY RECREATIONAL FISHERIES BRANCH

The significant salmonid species for recreational use are steelhead and cutthroat trout. Their distribution (both present and potential), life history, and recreational use and value are summarized below.

3.1.1.1 Steelhead

The Oyster River ranks twelfth in steelhead catch on Vancouver Island. Since 1968, the mean annual effort has been 1,500 angler days (Table 3.1) for an average yearly catch of 500 wild steelhead. Angler effort has increased in recent years after a decline ending in 1982 (Figure 3.1). At $19.50[1] per angler day, the fishery has an annual recreational value of approximately $29,000 (1987 dollars) in recent years.

---

1 Estimated net economic value of a day spent fishing in Vancouver Island Region (Stone, 1988, ms.) expressed in 1987 dollars. In the absence of data specific to steelhead fishing, the average value for all sportfish species is used, which may not accurately reflect the value of the steelhead fishery.

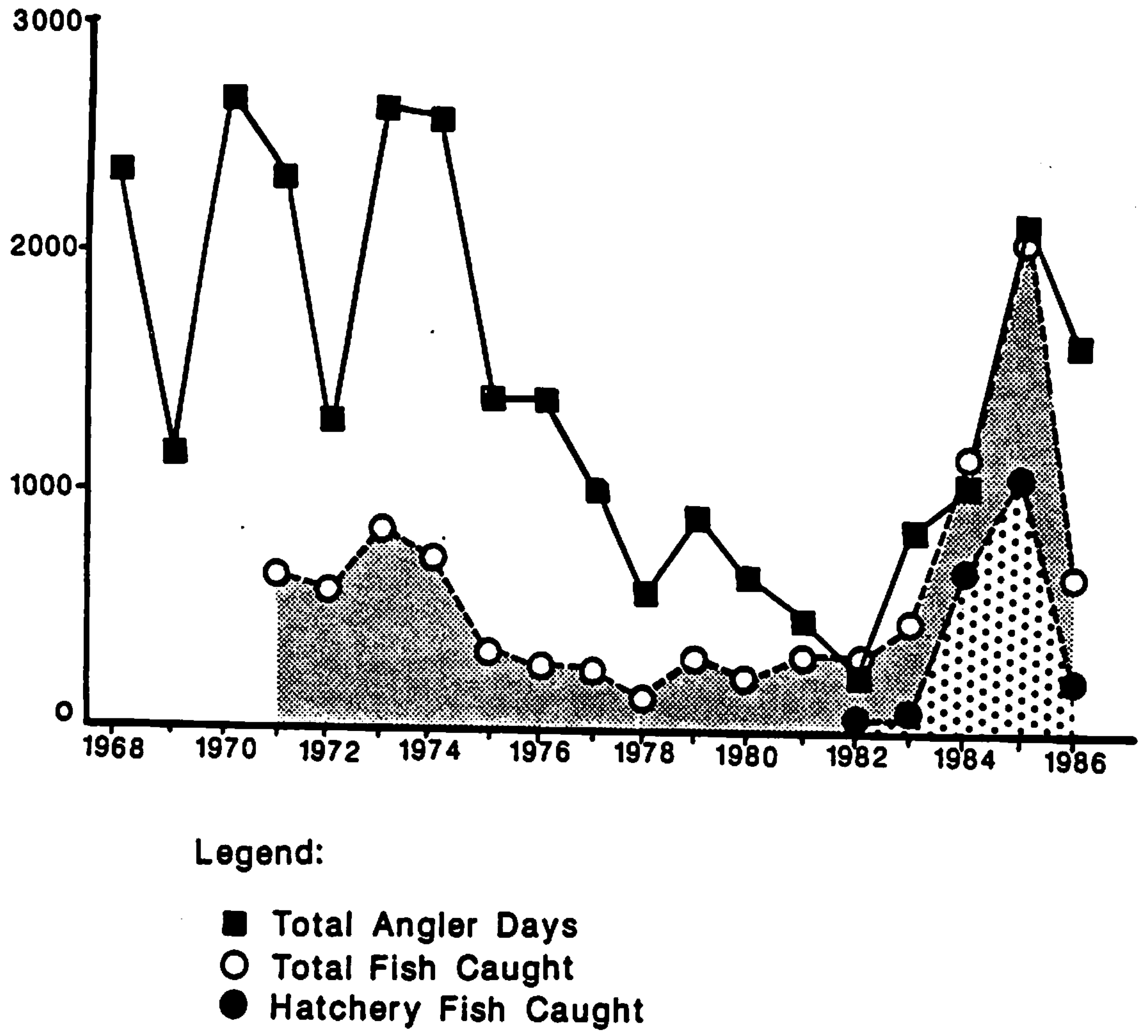


Fig. 3.1 ANGLER EFFORT AND CATCH FOR THE STEELHEAD FISHERY

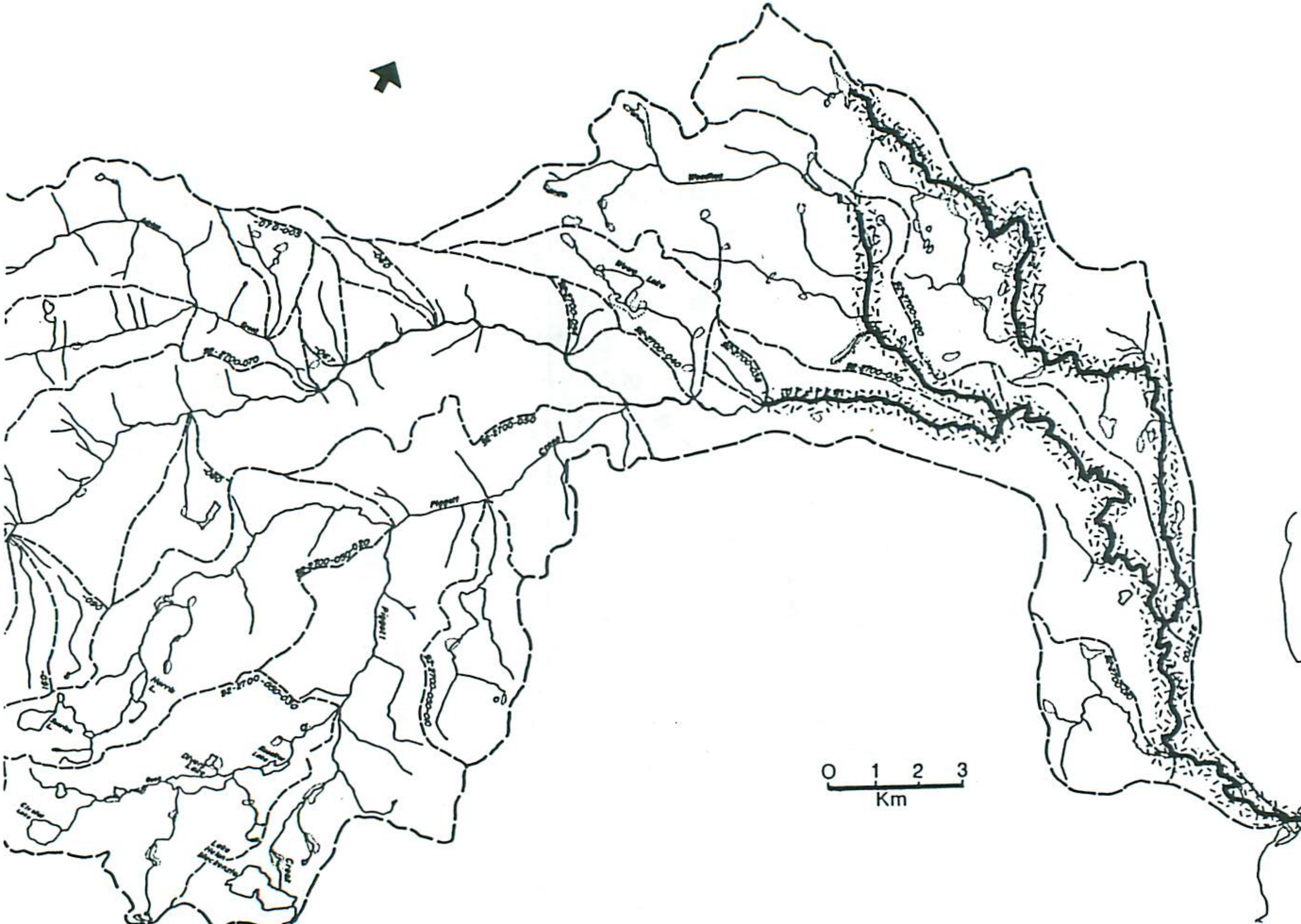


Fig. 3.2 STEELHEAD DISTRIBUTION

The mainstem Oyster River is accessible to steelhead up to a series of falls located 24 kilometres above the mouth (Figure 3.2). Two tributaries, Woodhus and Little Oyster, are accessible through much of their length. The production capability of the system is estimated at 1,300 adult steelhead with the 24 kilometres of mainstem accounting for 90% of that production. The mainstem upstream is potentially accessible to steelhead. except for the barrier falls between Woodhus Creek and Piggott Creek.

Oyster River steelhead have adapted to a spring and early summer snowmelt runoff. They begin to enter the river in mid-January, but the majority of the run enters March through April, resulting in late spawning and emergence (Figure 3.3). These factors, along with the system's low nutrients, low annual temperature, and extreme winter floods, currently limit the capacity to produce wild steelhead.

Steelhead enhancement has involved two years of smolt stocking (1981 and 1982) and four years of headwater fry stocking above the falls (1981 - 1984). This resulted in an additional 2,000 captures of hatchery adult steelhead over the past five years. Future enhancement options include further stocking of smolts and/or fry, stream enrichment and barrier removals.

TABLE 3.1 STEELHEAD ANGLER DAYS FOR THE OYSTER RIVER, 1975-1986

THREE YEAR AVERAGING PERIOD	AVERAGE ANGLER DAYS PER YEAR
1975 - 1977	1,241
1978 - 1980*	699
1981 - 1983	503
1984 - 1986	1,503

* Catch and release regulation implemented.

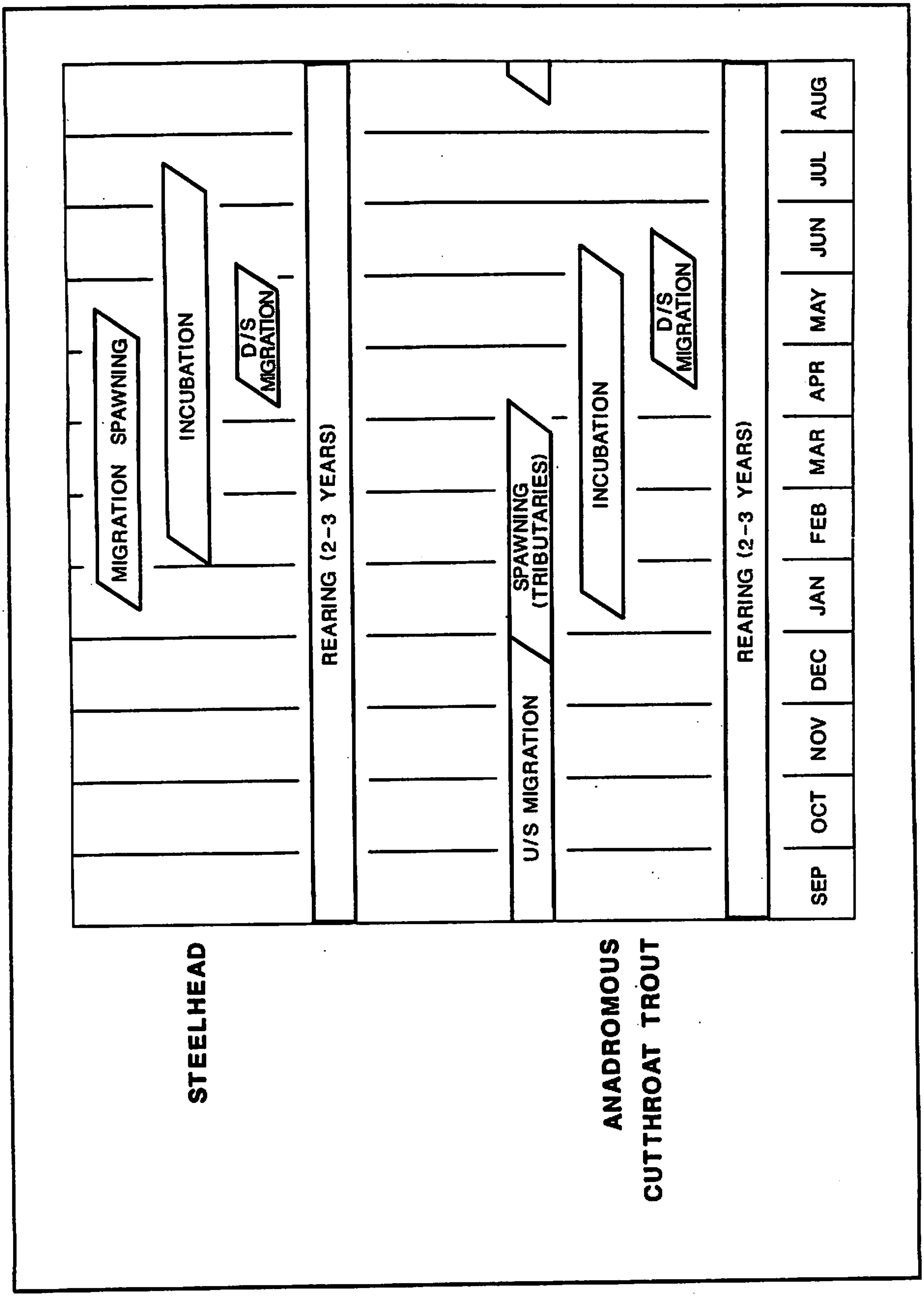


Fig. 3.3 FRESHWATER LIFE CYCLES OF STEELHEAD AND ANADROMOUS CUTTHROAT TROUT

3.1.1.2 Sea-Run Cutthroat Trout

The Oyster River is the most important recreational sport fishery for cutthroat on Vancouver Island. The production of cutthroat in the Oyster is at least partly due to a reasonably high minimum summer flow. In 1984, a creel survey during the peak angling period of July to October estimated that 2,311 angler days were expended to catch 1,693 cutthroat trout (Figures 3.4 and 3.5). The majority of the angling effort occurs on the beach and intertidal area of the river mouth. Cutthroat trout have been caught up to the anadromous fish barrier at 24 km on the mainstem (Figure 3.6). The estimated annual value of this fishery is $44,850 (1987 dollars, at $19.50/day x 2,300 angler days).

Cutthroat trout production occurs in two tributaries to the mainstem, with the Little Oyster the most important, and Bear Creek the other (Figure 3.7). The estimated wild smolt production for these systems is 8,000 and 2,000 respectively, with a total wild escapement of 1,000 adults at optimum. Hatchery introductions of cutthroat yearling smolts have been ongoing since 1980. Currently, the stock is estimated to run at 800 adults, with 50% hatchery and 50% wild origin. During summer periods, cutthroat migrate throughout the mainstem and have been counted in snorkel surveys up to the anadromous barrier. In May, cutthroat smolts and adults enter the estuary and can migrate 5 to 10 km north and south along the foreshore of Miracle Beach. Hatchery fish from this program contribute 70% of the estuary catch and migrate up the Oyster River to the canyon area below the anadromous fish barrier.

Upstream migration takes place over a four-month period, beginning in mid-August, and peaking in early October (Figure 3.3). Adults remain in the mainstem of the river until flows of the tributary streams (Little Oyster, Bear Creek) are high enough to attract them along with spawning salmon. Spawning takes place in the upper reaches of the tributaries in January to February, with most fish surviving to return to the estuary in May.

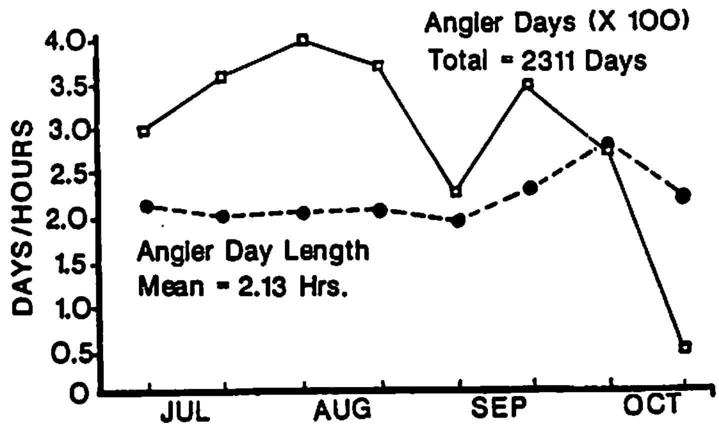


Fig. 3.4 COMPARISON OF MEAN ANGLER DAY AND TOTAL ANGLER DAYS PER BIWEEKLY PERIOD

OYSTER R. CREEL SURVEY, JULY 1 – OCTOBER 31,1984

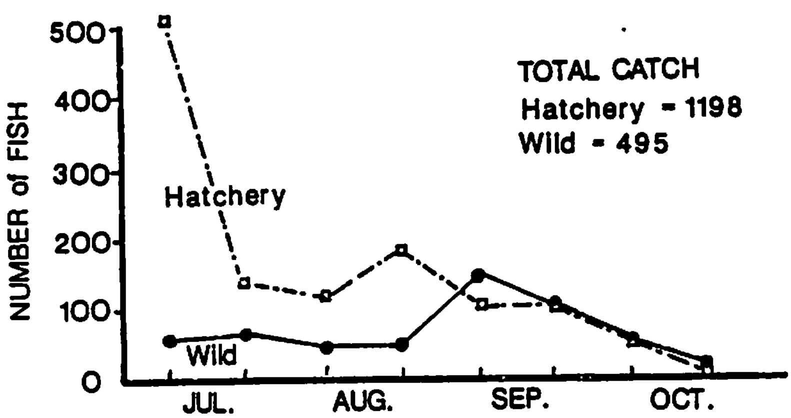


Fig 3.5 COMPARISON OF OYSTER RIVER CUTTHROAT TROUT CATCH (HATCHERY AND WILD) JULY 1 – OCTOBER 31 1984

Source:
Clough, D.,Oyster River Creel Survey,1984. I.C. Lee and Associates Ltd., Nanaimo B.C., 38pp.

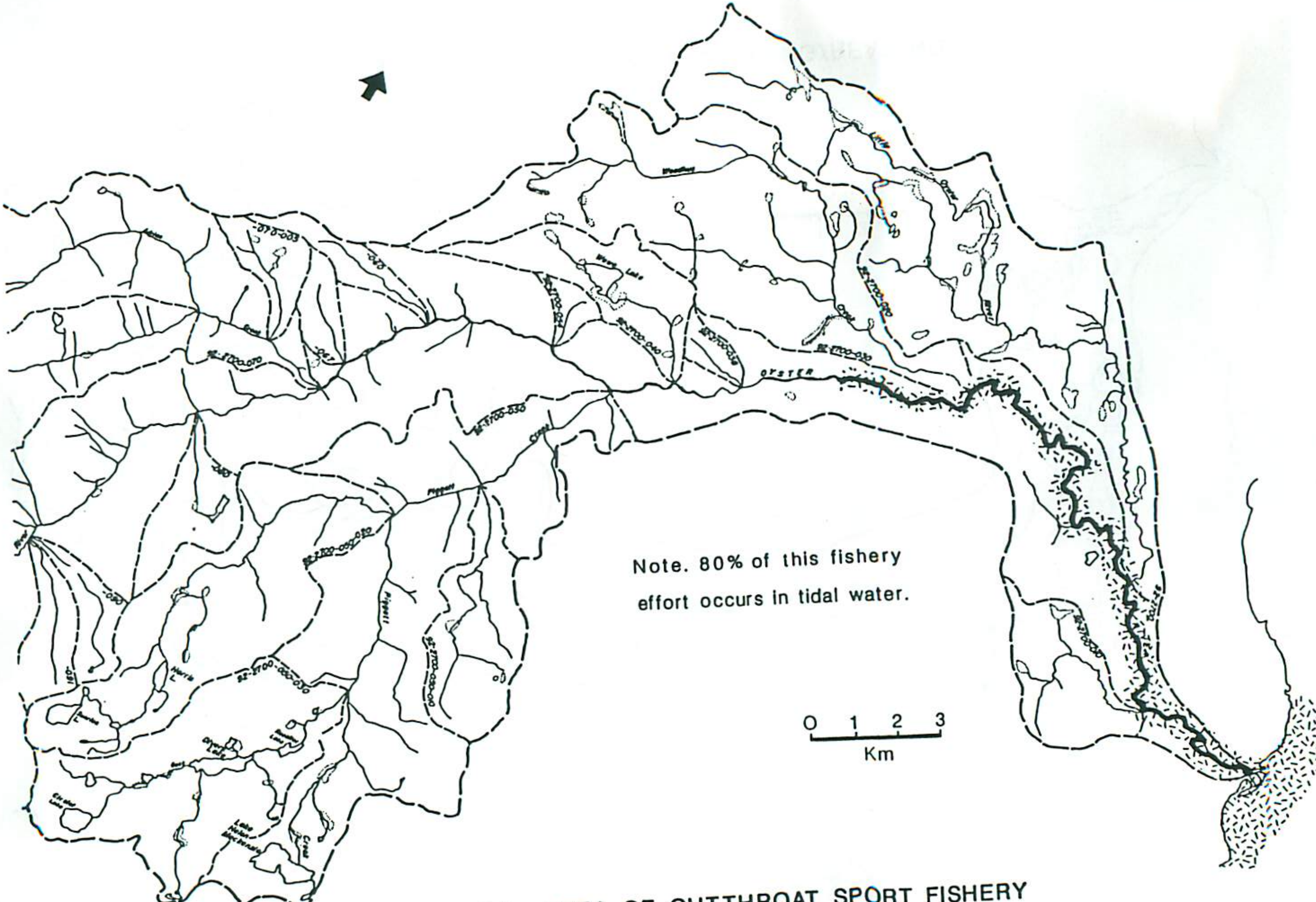


Fig. 3.6 AREA OF CUTTHROAT SPORT FISHERY

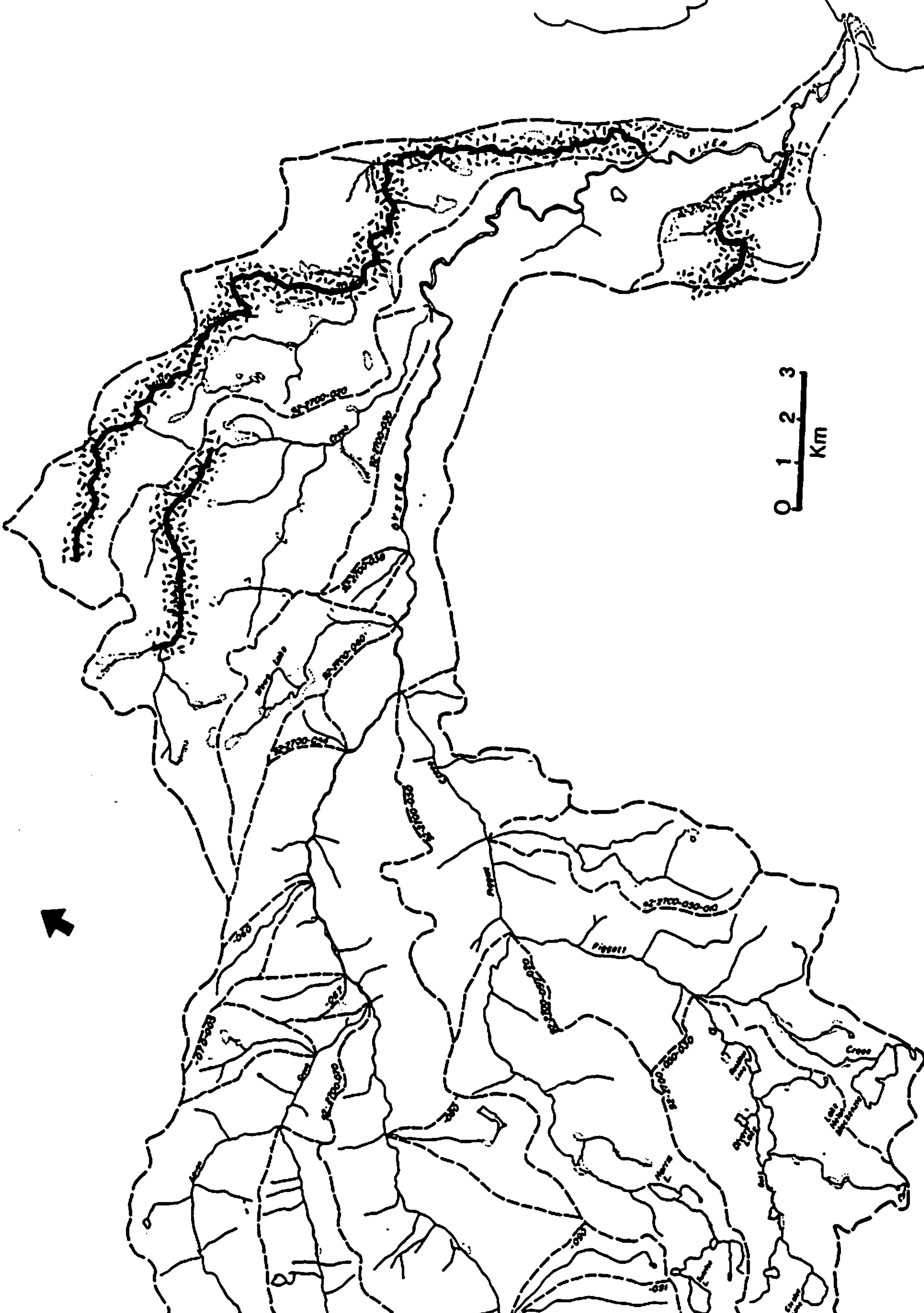


Fig. 3.7 CUTTHROAT TROUT SPAWNING/REARING AREAS

3.1.1.3 Wild Juvenile Cutthroat Production

The majority of juvenile rearing of cutthroat trout takes place in the tributaries (May), with minimal rearing in the mainstream. One of the primary reasons for the stable population of cutthroat trout in this watershed is minimal impacts to the small stream habitat in the past 20 years (i.e. logging, water withdrawals).

The primary constraint to cutthroat trout production in the Oyster River watershed is low flows experienced in Little Oyster River and Bear Creek in September/October. Cutthroat enhancement plans include maintaining a program of stock assessment on this watershed for at least the next five years, to determine the impacts of hatchery smolt stocking on wild populations of cutthroat trout. In addition, Oyster River cutthroat trout stock will be used as a central broodstock source for Central Vancouver Island smolt stocking programs in the near future. To carry out these objectives, the 1987 brood cutthroat production goal is 20,000 smolts, to be raised at the Vancouver Island Hatchery at Duncan.

There is also a resident cutthroat trout population on the Oyster mainstem both above and below the barrier falls. This fishery is used to a limited extent by campers and hikers, who capture an unknown number of these fish. This fishery is also associated with the small lakes fishery in the watershed (Table 3.2), generating 2,600 angler days with a value of approximately $50,700 (1987 dollars).

3.1.1.4 Present and Projected Angler Use

The most direct influence on future angling demand in the Oyster River watershed will be the expansion of the human population in the Campbell River/Courtenay area. Anglers from this area account for 95% of the angling effort within the watershed, and this is not expected to change. One complicating factor to projecting demand, however, is the 20% decline in freshwater angling licence sales which occurred between 1983-1985. However, licence sales have increased in the last two years. The average rate of increase for the past 30 years has been 4% per year.

The reduction in angling licences is not reflected in the number of steelhead angler days, where significant increases were recorded during the 1984-1986 period (Table 3.1). The decline in angler days for the period 1978 through 1983 is attributed to the implementation of a catch and release regulation for steelhead. Following the regulation change, a decline in the number of angling days was recorded region wide. Over the last three years those trends have reversed, and the number of angler days has reached historic levels.

In considering the anadromous cutthroat trout and small lake fisheries associated with the Oyster River watershed, there are only two data points on angler use. Therefore, it is not possible to examine trends similar to the steelhead fishery where annual surveys are conducted. However, it is possible, utilizing statistics from the Vancouver Island Fisheries Management Statement (Reid, 1984), to project angler use for those fisheries. In making the projections the following are assumed:

1. The current fishing pattern will not change;

2. The long-term increase in angler days of four percent per year will not change;

3. The reduction in angling licence sales over the past three years is temporary as were previous declines in licence sales.

The Oyster River currently supports 6,500 angler days per year, evenly distributed between the anadromous cutthroat trout, steelhead trout, and small lakes fisheries (Table 3.2).

TABLE 3.2 PRESENT AND PROJECTED ANGLER USE (ANGLER DAYS PER YEAR) FOR THE OYSTER RIVER

YEAR	SMALL LAKES		STEELHEAD	CUTTHROAT	TOTAL
	HIGH ELEVATION	LOW ELEVATION			
1984	1,000	1,600	1,600	2,300	6,500
2000	1,600	2,500	2,500	3,700	10,300
2000*	1,300	2,100	2,100	3,000	8,500

* Adjusted to reflect 20% decline in angler licences.

It is estimated that the total number of angler days associated with the recreational sport fisheries in the Oyster River watershed will be between 8,500 and 10,300 angler days, a 40% to 60% increase, by the year 2000.

At $19.50 an angler day, the present annual value of the Oyster River recreational sportsfishery is estimated at approximately $127,000 (1987 dollars). By the year 2000 the estimated annual value could increase up to approximately $200,000 (1987 dollars).

3.1.2 SPECIES MANAGED BY THE DEPARTMENT OF FISHERIES AND OCEANS

Anadromous salmon species of varying importance to the commercial and sport fisheries produced by the Oyster watershed are chinook, chum, coho and pink. Their present and potential distributions on the mainstem Oyster are shown on Figure 3.8. Figure 3.8 illustrates similar information for cutthroat and steelhead, discussed in the previous section. The freshwater life histories of the salmon species are presented in Figure 3.9.

3.1.2.1 Chinook

The chinook population is now considered to be a remnant stock; the 1986 escapement is estimated to be approximately 100 fish. The system has an estimated optimum escapement of 4,500 chinook, but this target is currently unattainable due to the high exploitation rate imposed on the

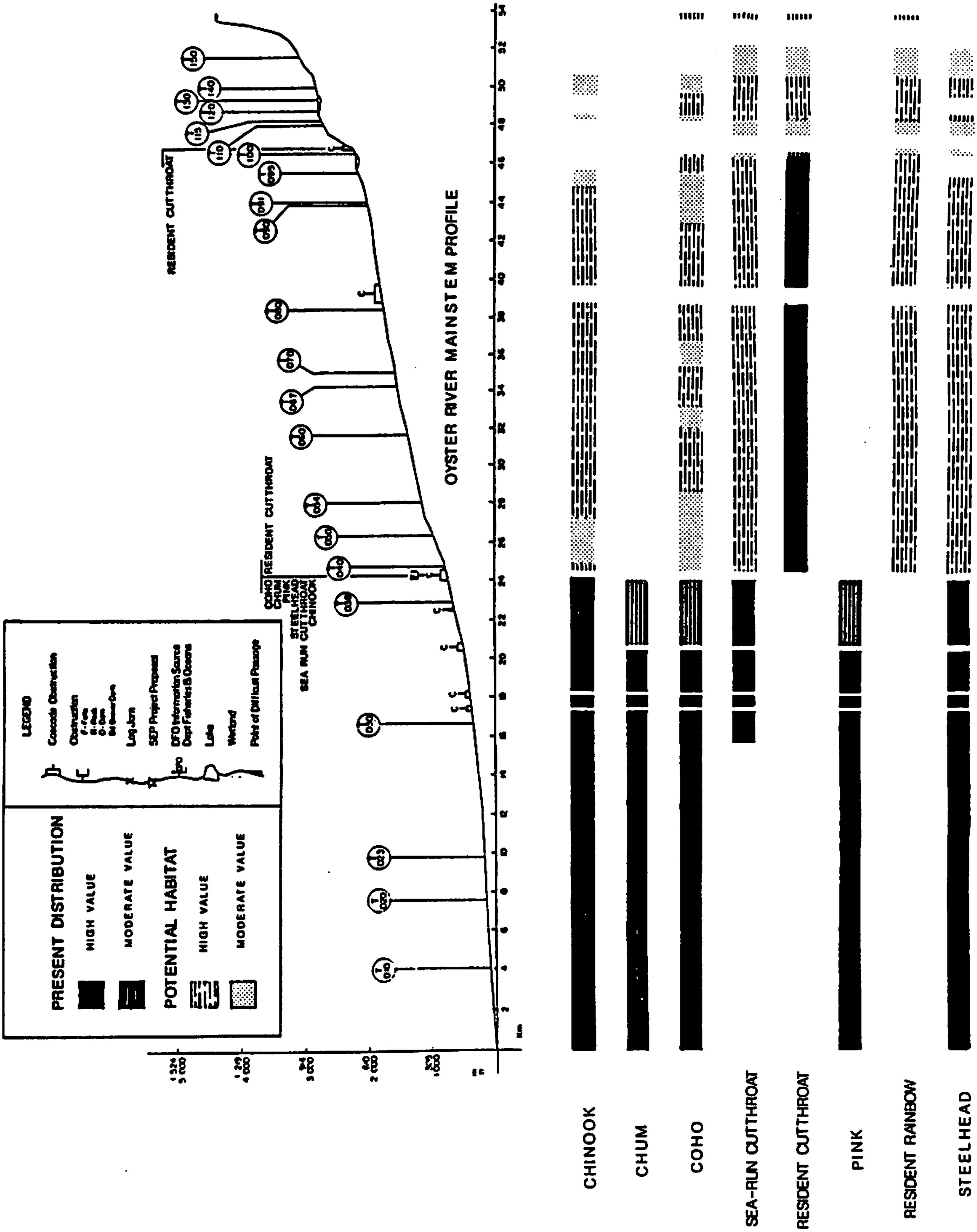


Fig. 3.8 PRESENT AND POTENTIAL FISHERIES HABITAT

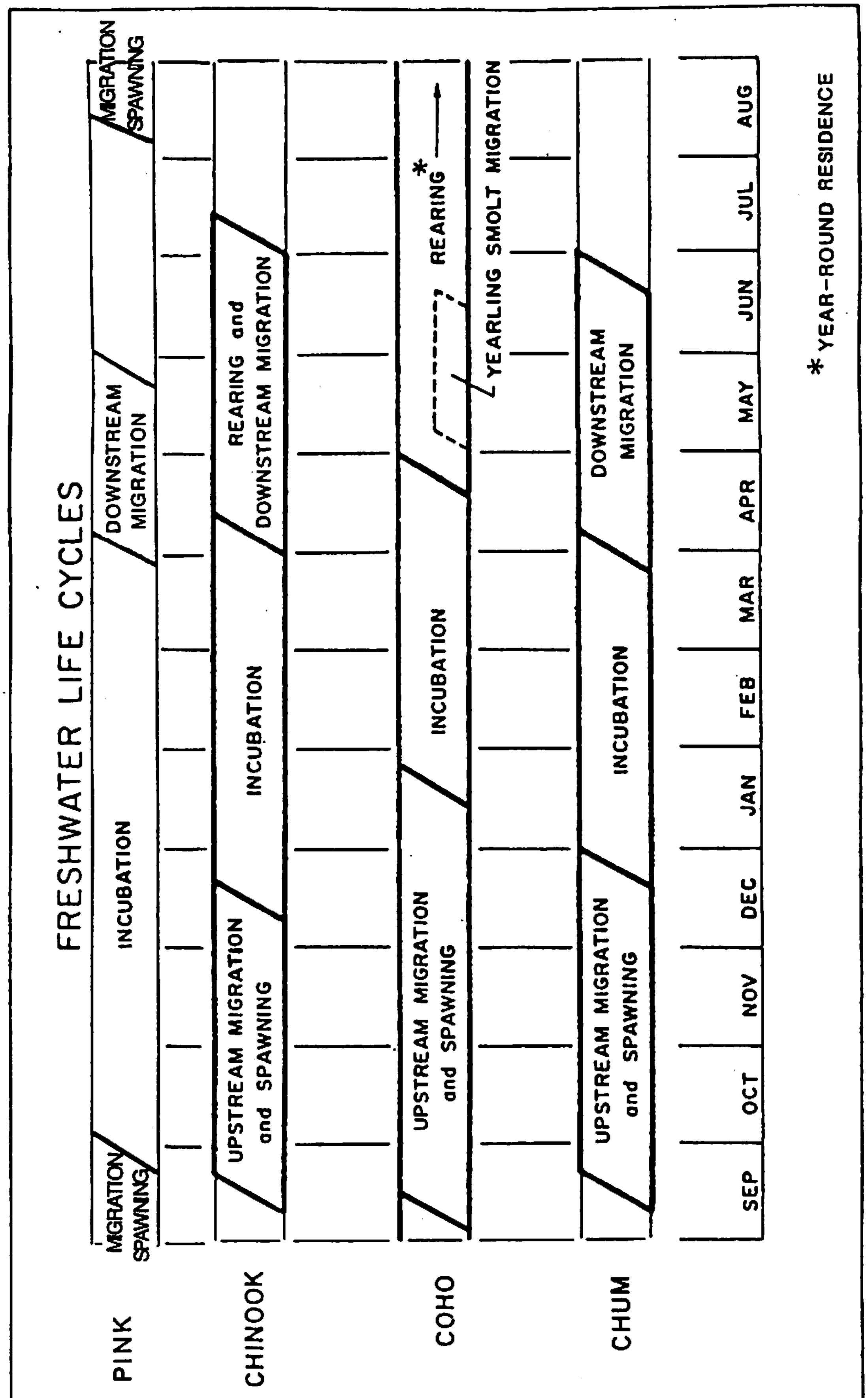


Fig. 3.9 FRESHWATER LIFE CYCLES OF OYSTER RIVER SALMON

Oyster River stock as a result of several saltwater mixed stock commercial fisheries, combined with the sport fishery. The mainstem and tributaries contain viable spawning and rearing habitats which have the potential to support the rebuilding of escapements back to optimal levels, if exploitation rates were reduced.

3.1.2.2 Chum

The 1986 escapement of chum salmon to the Oyster system was approximately 500. Estimated optimum escapement could be as many as 40,000 chum based on potential habitat use. The maximum recorded chum escapement was 850 for the 1965-76 period. Chum migration (Figure 3.10) can extend to the falls at 24 km on the mainstem Oyster, which is an anadromous barrier. Chum are also distributed for an additional 43 km in the Little Oyster sub-basin. Chum spawning distribution occurs throughout the Little Oyster, however chum spawn only in a few kilometres of the mainstem Oyster above its confluence with the Little Oyster River.

3.1.2.3 Coho

Coho distribution in the mainstem occurs to the migration barrier at 24 km, with an additional 43 km in the Little Oyster (Figure 3.11). Spawning can occur throughout this distribution area, but is concentrated in the tributary systems. Potential coho colonization extends beyond the anadromous barrier into the lakes of the upper Oyster, Adrian and Piggott svstems. It will be necessary for DFO and the Recreational Fisheries Branch to develop a comprehensive fisheries management plan before implementing a coho colonization program. The 1986 coho escapement was 2,000. An estimated optimum escapement is 15,000 coho. The maximum recorded escapement during the 1965 - 1976 period was 15,000.

3.1.2.4 Pink

The maximum recorded pink salmon escapement is 100,000 (even year) and 15,000 (odd year), which has declined to a remnant stock as a result of high

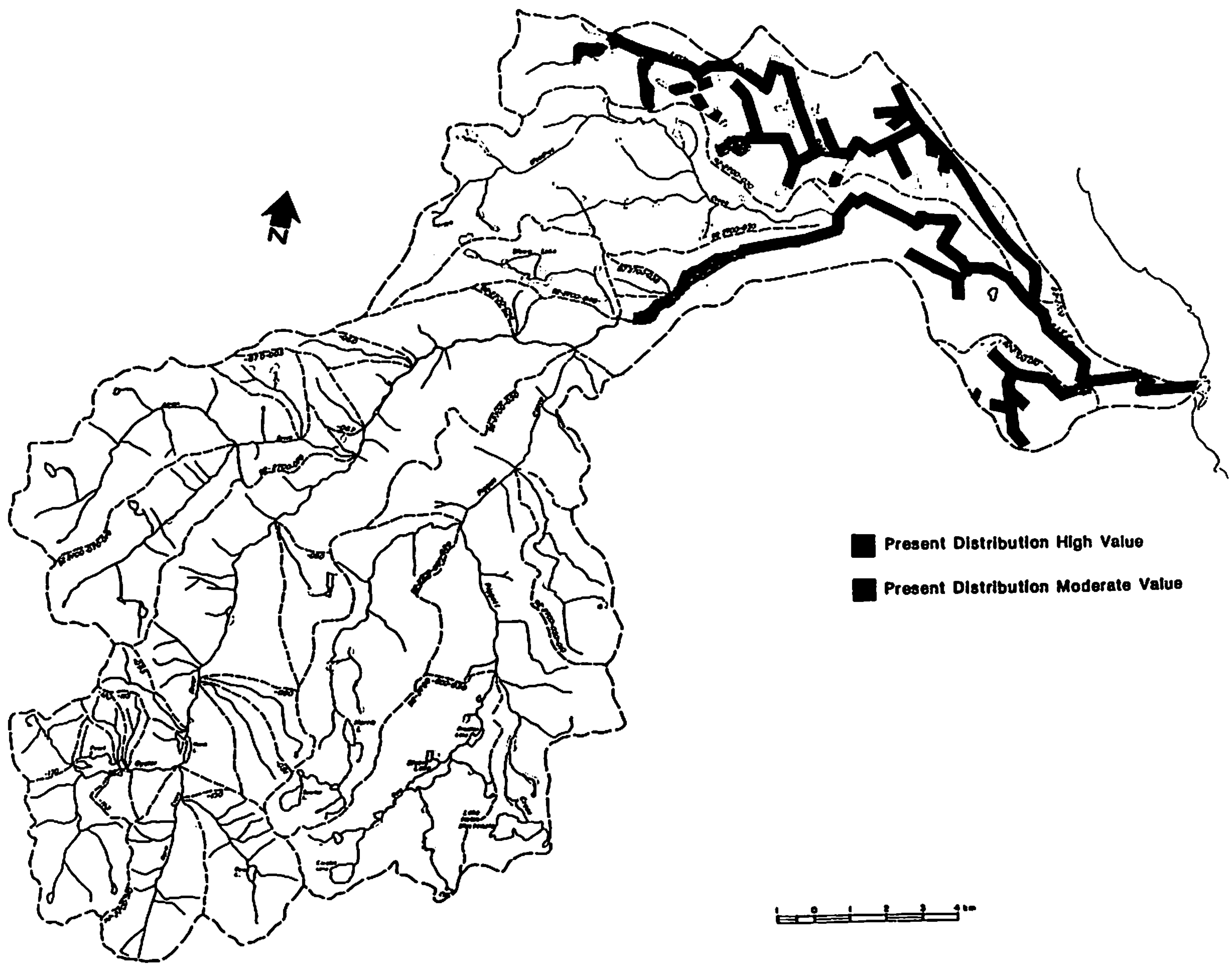


Fig. 3.10 PRESENT DISTRIBUTION OF CHUM SALMON

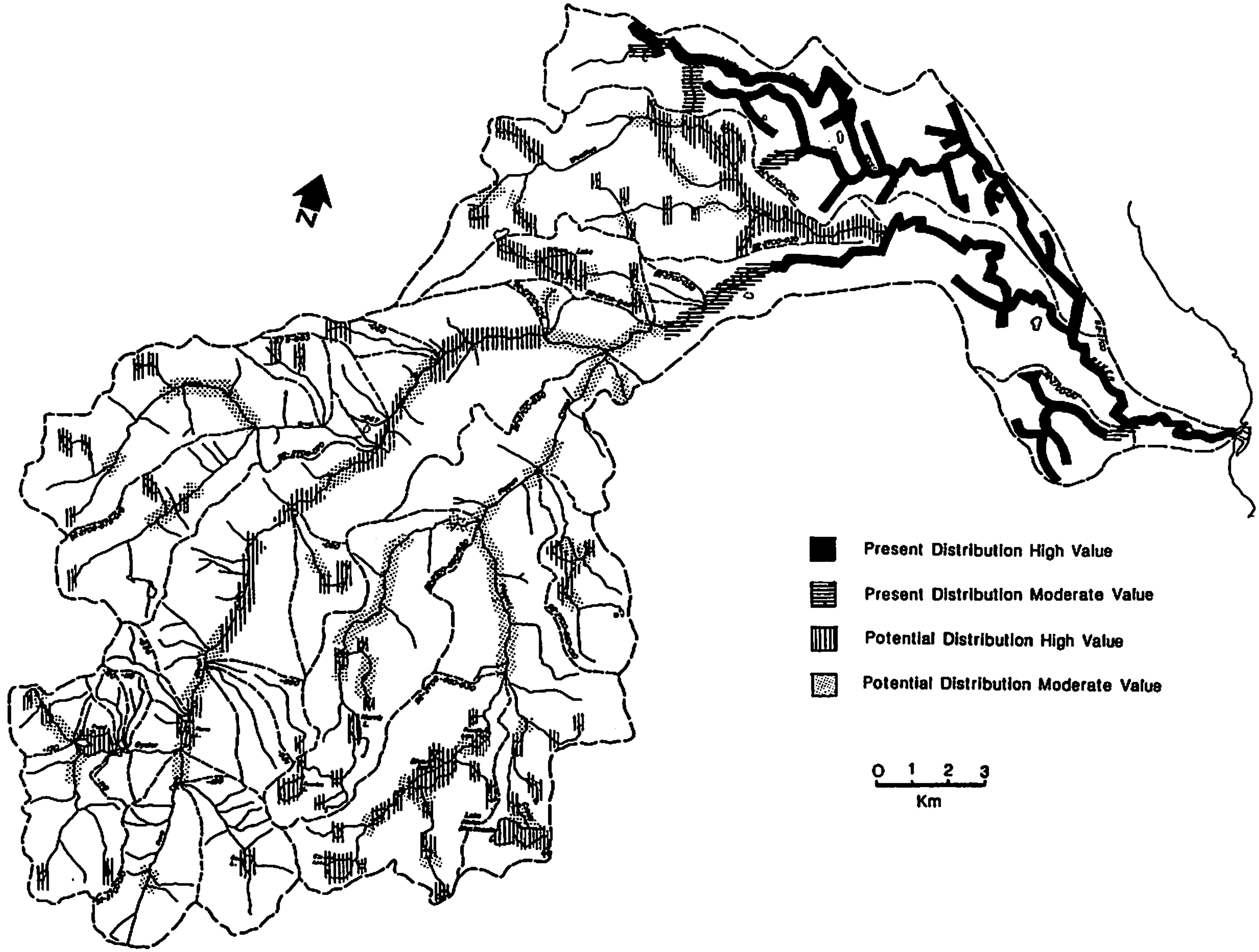


Fig. 3.11 DISTRIBUTION OF COHO SALMON

exploitation in various saltwater mixed stock fisheries, especially in Johnstone Strait. In an effort to rebuild this stock, in excess of 2.0 million pink salmon eggs were transplanted from the Quinsam hatchery to the Oyster watershed in 1986. The returns are expected to create an escapement of 2,000 pink salmon in 1987, which may stimulate the rebuilding of the stock.

The estimated optimum Oyster River escapement for pink salmon is 62,500. The distribution of pink in the Oyster River is illustrated in Figure 3.12, and is similar to that of chum salmon.

3.1.2.5 Existing and Proposed Enhancement Projects (Figure 3.13)

A hatchery is located adjacent to the mainstem Oyster below the Little Oyster River confluence. It has the potential capacity to produce 100,000 coho smolts and 650,000 chinook fry. In addition, a sidechannel enhancement project near the hatchery on UBC lands accommodated the transplant of 2,000,000 pink eggs from the Quinsam watershed in 1986. Further sidechannel developments are planned in the vicinity of the Oyster-Little Oyster confluence (20,000 m^2), and near the Oyster-Woodhus Creek confluence (8,000 m^2). It is estimated that each m^2 of sidechannel habitat could produce as many as 500 chum fry and 3 coho smolts. The proposed removal of a series of beaver dams on Bear Creek could provide rearing habitat that should yield an additional 13,000 coho smolts. The provision of fish passage facilities at the mouth of Woodhus Creek would provide very significant increased coho production, estimated to be 35,000 smolts.

3.1.2.6 Economic Evaluation of Salmon Production

The economic value of salmon production contained in Table 3.3 is divided into two production scenarios - current (actual) and optimum (desired). The optimum level of production was derived through use of a formula which determines the greatest number of fish which could be produced for the least cost. It assumes use only of existing or available habitat,

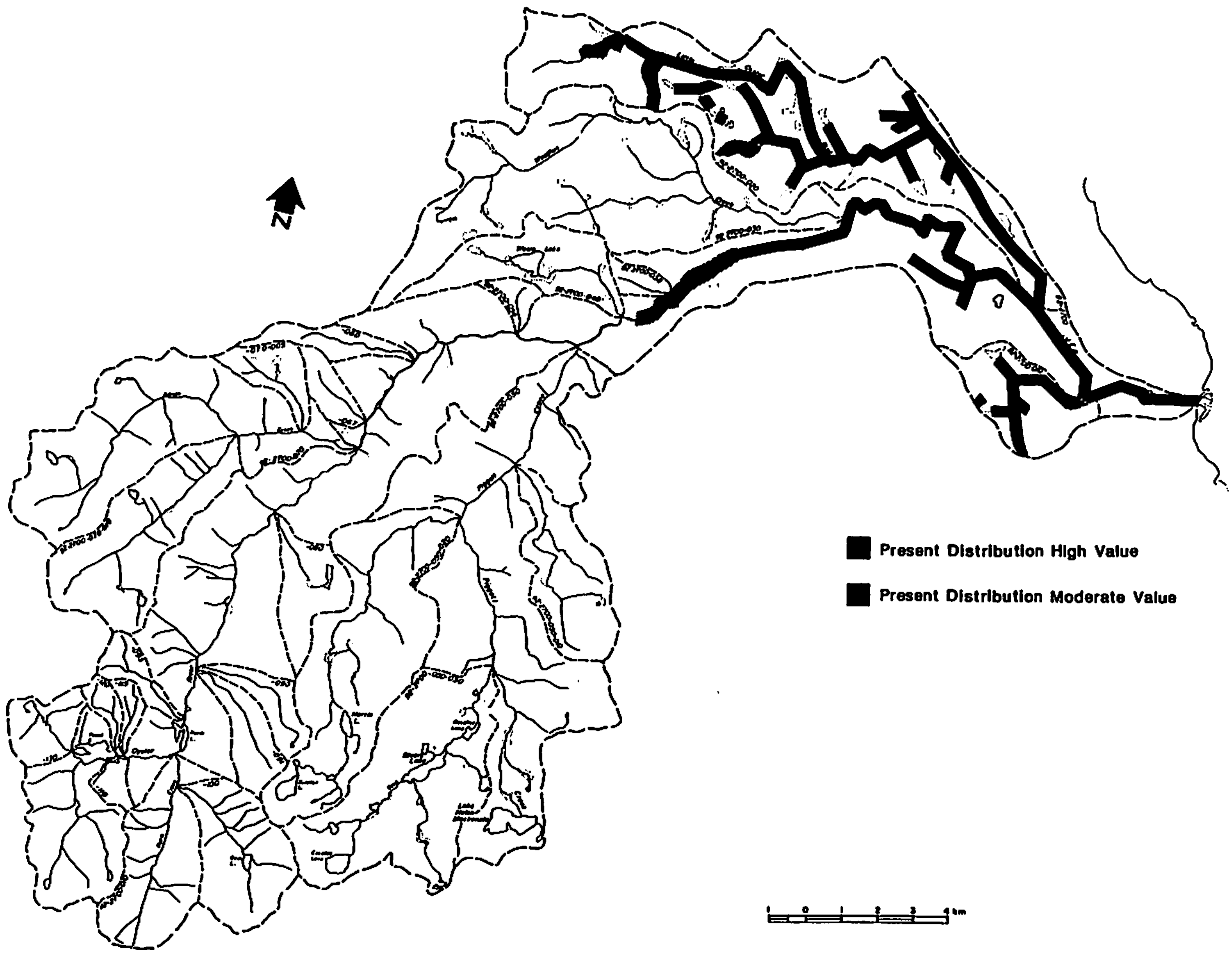


Fig. 3.12 PRESENT DISTRIBUTION OF PINK SALMON

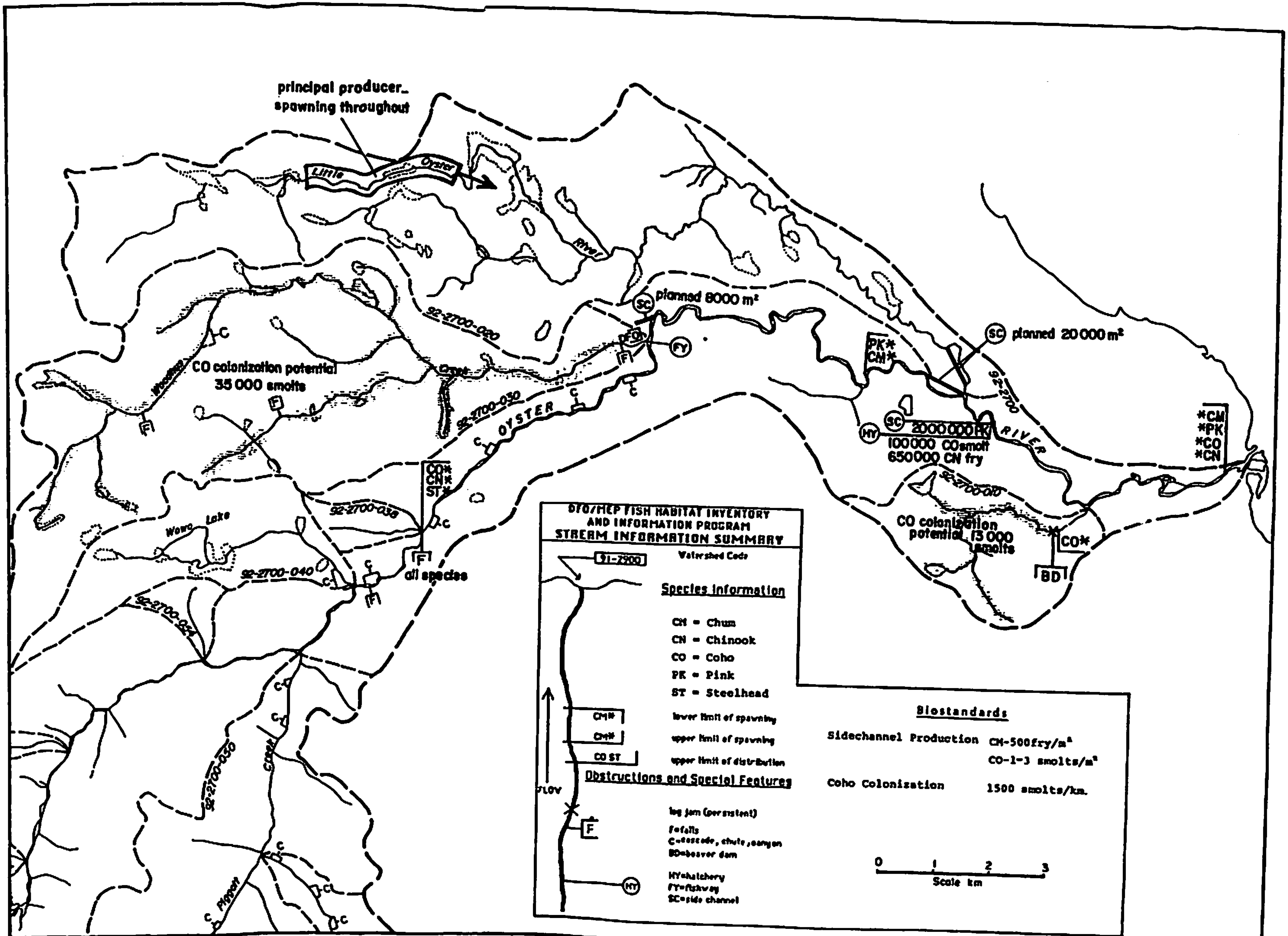


Fig. 3.13 PRELIMINARY ENHANCEMENT CAPABILITY FOR OYSTER RIVER SALMON

TABLE 3.3
OYSTER RIVER SALMON PRODUCTION: ECONOMIC EVALUATION

	ACTUAL					OPTIMUM				
SPECIES	CURRENT ESCAPEMENT (1986)	CURRENT EXPLOITATION RATE (1986)	CURRENT PRODUCTION	CURRENT ANNUAL VALUE ($000)	DISCOUNTED[1] NET PRESENT VALUE (NPV) ($000)	OPTIMUM ESCAPEMENT ($000)	SUSTAINABLE EXPLOITATION RATE	OPTIMUM PRODUCTION ($000)	OPTIMUM ANNUAL VALUE ($000)	DISCOUNTED[1] NET PRESENT VALUE (NPV) ($000)
Coho	2000	.85	13100	186	1910	12500	.60	31500	316	3241
Chinook	100	.85	700	15	167	4500	.65	13000	219	2373
Pink	2000*	.70	7000	11	238	62500	.70	210000	323	7146
Chum	500	.40	850	1	30	40000	.40	67000	100	2351
SALMON RESOURCE TOTAL VALUE ($1986)	-	-	-	$213,000 (current)	$2,345,000 (current)	-	-	-	$958,000 (optimum)	$15,111,000 (optimum)

* Expected transplant stock equivalent.
[1] Over a 40 year period.

and likely approximates the stream's historic production. In each scenario, the escapement and exploitation rates have been estimated by discussion among DFO personnel (Fishery Officers, management and habitat biologists, and enhancement staff). Salmon production is the total number of adults produced from the system, i.e. harvest plus escapement. Production is calculated using escapement and exploitation rates as follows:

$$p = E + \frac{E\ (100H)}{100\ (1-H)}$$

where p = production (escapement plus harvest)

E = escapement

H = harvest (exploitation) rate

Production levels for each species and the appropriate exploitation rates were entered into the Salmonid Enhancement Program (SEP) evaluation model (employing Federal Treasury Board principles for project evaluation). The annual salmon values produced from the Oyster River are displayed in Table 3.3, and are based on the SEP model. Current and optimum annual production values from the Oyster River are approximately $213,000 and $958,000 respectively after costs for harvesting and processing have been subtracted.

The SEP model was also used to calculate the discounted net present value (NPV) of the salmon harvest (1986 dollars) over a forty year time horizon. These are wholesale values, net of variable harvesting and processing costs (i.e. $2,345,000 for current production and $15,111,000 for optimum production levels); no enhancement costs were taken into account. Since these values represent the summed value of the stock over forty years, they are comparable to the capitalized value of a building or machinery where they have an initial construction or purchase price but will provide benefits or services over future years. This is not the same as an annual value.

3.1.3 WATER REQUIREMENTS FOR FISHERIES HABITAT

Flow requirements for fisheries purposes were estimated utilizing the Tennant (1976) or Montana method. Basically the method is founded on the principle that stream width, mean depth and velocity vary as a function of mean annual discharge. The Tennant study demonstrated that a flow of 10 percent of the mean annual discharge resulted in a wetted width of 60 percent of the bank-full condition. For this reason a flow of 10 percent of the mean annual discharge is considered the minimum for short-term survival of rearing salmonids. Similarly, when flows are in the range of 60% to 100% of the mean annual discharge, the wetted width ranges from 90% to 100%, i.e. most of the width is wetted and the rate of change of width is small even when changes in discharge are large. In conditions such as this, the stream environment is considered stable and unaffected by changes in stream discharge.

For Vancouver Island streams, fish census data indicate that negative impacts on fisheries are minimal if both a mean monthly flow of not less than 20% of the mean annual discharge, and a 7-day low flow of not less than 10% of the mean annual discharge, are available.

Within the Oyster River watershed, four main areas are important for the production of anadromous salmonids. These include the Little Oyster River, Woodhus Creek, the Lower Oyster River mainstem and Bear Creek. The upper mainstem Oyster and tributaries do support non-anadromous cutthroat trout populations. However, production of these populations is limited by low water temperature and nutrients, which inhibit growth and fish food production, rather than by habitat restrictions due to reduced flows. For this reason, flows required for fisheries were not estimated above the Oyster River barrier 24 km above the mouth. However, any licence application to extract large quantities of water above the barrier would be a concern for fisheries production because of its downstream effects.

TABLE 3.4. FISHERIES LOW FLOW REQUIREMENTS (m^3/s)

STREAM	FLOWS AND HABITAT RATINGS						ESTIMATED LOW FLOWS[2] AND HABITAT CONDITION	
	Mean Annual Discharge (MAD)[1]	Excellent > 30% of MAD	Good 30-20% of MAD	Fair 20-10% of MAD	Poor < 10% of MAD	Severe Degradation < 5% of MAD	7-Day (1:10 year)	Minimum Monthly (1:10 ye
Oyster River	13.8	4.14	> 2.76	> 1.38	< 1.38	< 0.69	1.01 Poor	1.22 Poor
Little Oyster River	1.6	0.48	> 0.32	> 0.16	< 0.16	< 0.08	0.005 Severe Degradation	0.006 Severe Degradatior
Woodhus Creek	1.5	0.45	> 0.30	> 0.15	< 0.15	< 0.075	0.010 Severe Degradation	0.012 Severe Degradatior
Bear Creek	0.31	0.09	> 0.06	> 0.031	< 0.031	< 0.016	0.0 Severe Degradation	0.0 Severe Degradatior

[1] From Tables 2.7 and 2.9.

[2] From Tables 2.12, 2.13 and 2.14.

Flow requirements for the Oyster mainstem were calculated from data collected at the gauging station (8HD011). Estimates of low flows from the three tributaries (ungauged) were derived from observations of these flows in September 1985, October 1986, and September 1987 (Table 2.11). A comparison of estimated 7-day low and minimum monthly flows with the 10% and 20% respectively required indicates inadequate flows are available in any of the four streams important for fisheries production (Table 3.4). The situation at the Oyster River gauging station is illustrated in Figure 3.14, with habitat condition being in the poor category for both 7-day and monthly minimum flows. For the three tributaries important for fisheries production, severe degradation of fisheries habitat occurs during low flows in all three.

The other streams important for fisheries purposes are the inlet and outlet to Wowo Lake. Both of these streams are important spawning/rearing areas for the rainbow and cutthroat trout caught in the Wowo Lake sportfishery.

3.2 WATER-BASED RECREATION

In general, the Oyster watershed attracts a reasonable amount of recreation, including land-based hunting in the fall, and wood-cutting. There is a riverside trail along the mainstem near the mouth. Water-based recreation is of a varied nature, and is centered on the Oyster itself, mainly downstream of Woodhus Creek.

Fishing activity occurs most commonly in the low reaches and at the mouth of the Oyster River. Steelhead fishing takes place upstream almost to tne confluence of Piggott Creek, and also includes some winter drift-fishing from rafts. Searun cutthroat are fished to above Woodhus Creek, but most activity is in the lower reaches. There is a limited but unquantified amount of angling pressure on the resident cutthroat population. The best lake for fishing in the watershed is Wowo Lake.

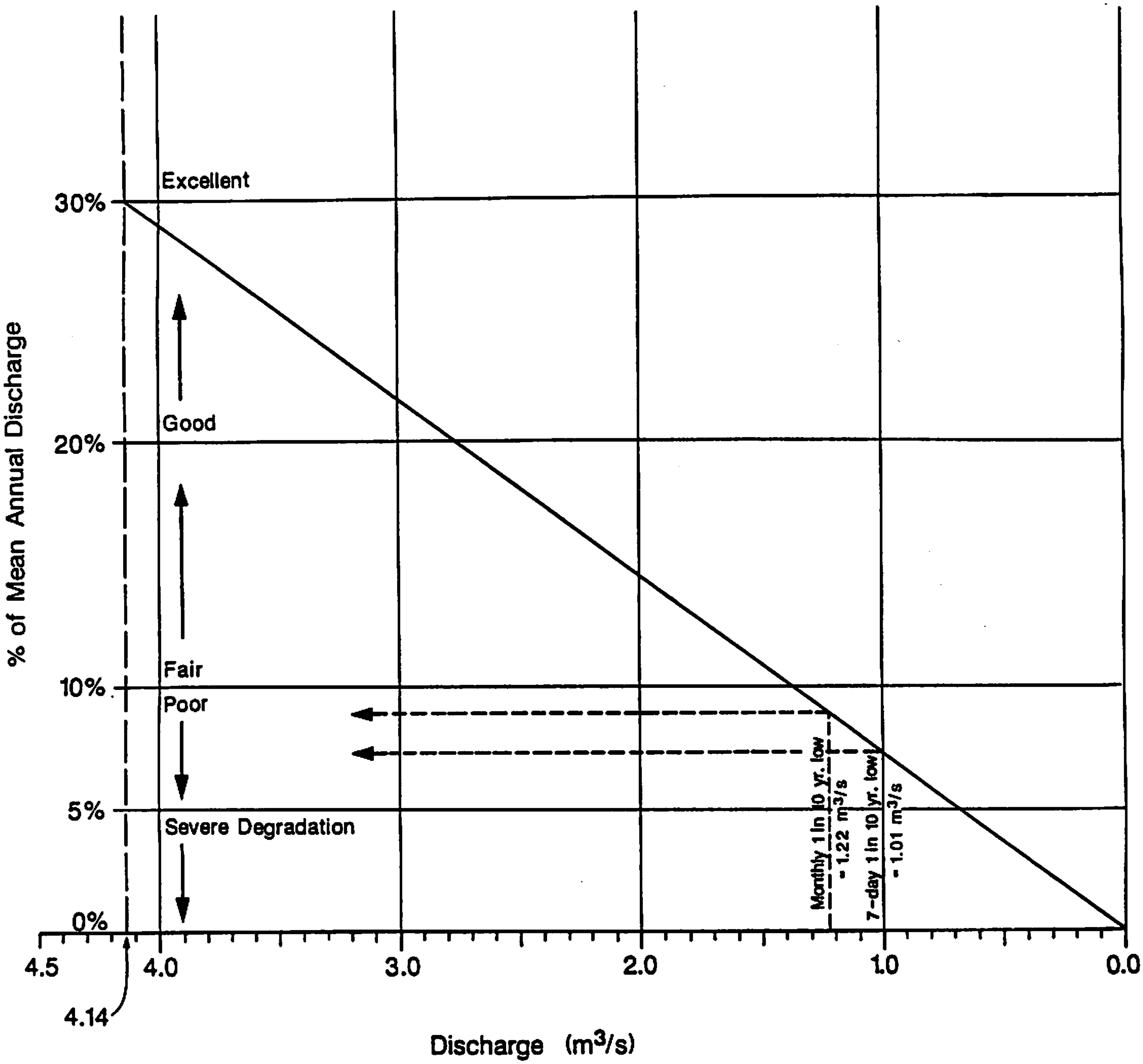


Fig. 3.14 FISHERIES HABITAT CONDITION DURING LOW FLOWS
AT 8HD011 OYSTER RIVER

Boating activity at water levels below medium flows is restricted to non-motorized shallow draft craft. Canoeing and kayaking occur downstream of Woodhus Creek to the ocean. Access to the Oyster is available from Glenora Road, Macaulay Road, Doyle Road, James Crescent, and along the Iron River Road. Rafting and tubing are particularly popular, downstream of Woodhus Creek, and there is a race every year in July. Swimming is also popular, and is centered in the pools from Woodhus Creek to the ocean.

3.3 WASTE MANAGEMENT

There is only one waste management effluent permit in the Oyster watershed (Fig. 3.15). Waste Management Permit PE-5123 was issued to Mt. Washington Ski Resort Ltd. on November 7, 1978, and amended on April 22, 1986. The amended permit authorizes the discharge of a maximum of 480 m^3/day of domestic sewage effluent from a recreational ski development area into Piggott Creek. The effluent is treated in secondary treatment facilities, chlorinated and dechlorinated prior to discharge to the Creek.

For discharges of domestic sewage into rivers or streams, a minimum dilution ratio of 20:1 is required. A higher degree of treatment is required to meet the effluent quality criteria imposed where dilution is near this minimum level. Documented effluent flows during times of summer/fall low flows in Piggott Creek are only 10% of the maximum permitted (480 m^3/day = .0055 m^3/s). The lowest low flow measurement available from Piggott Creek was taken upstream of the confluence with Harris Creek (.087 m^3/s, Table 2.11). Under these conditions, the dilution ratio are approximately 150:1, well above the minimum dilution required. However, data on flows in upper Piggott Creek (the site of the effluent outfall) are not available for any period of the year, so that an authoritative statement cannot be made with respect to the dilution ratio present during either the winter period, when maximum effluent discharge occurs. or during the summer/fall period when low creek flows occur. However, nutrient addition during the winter is not expected to cause any nuisance algae problems because of low water temperatures. No algae problems have been documented.

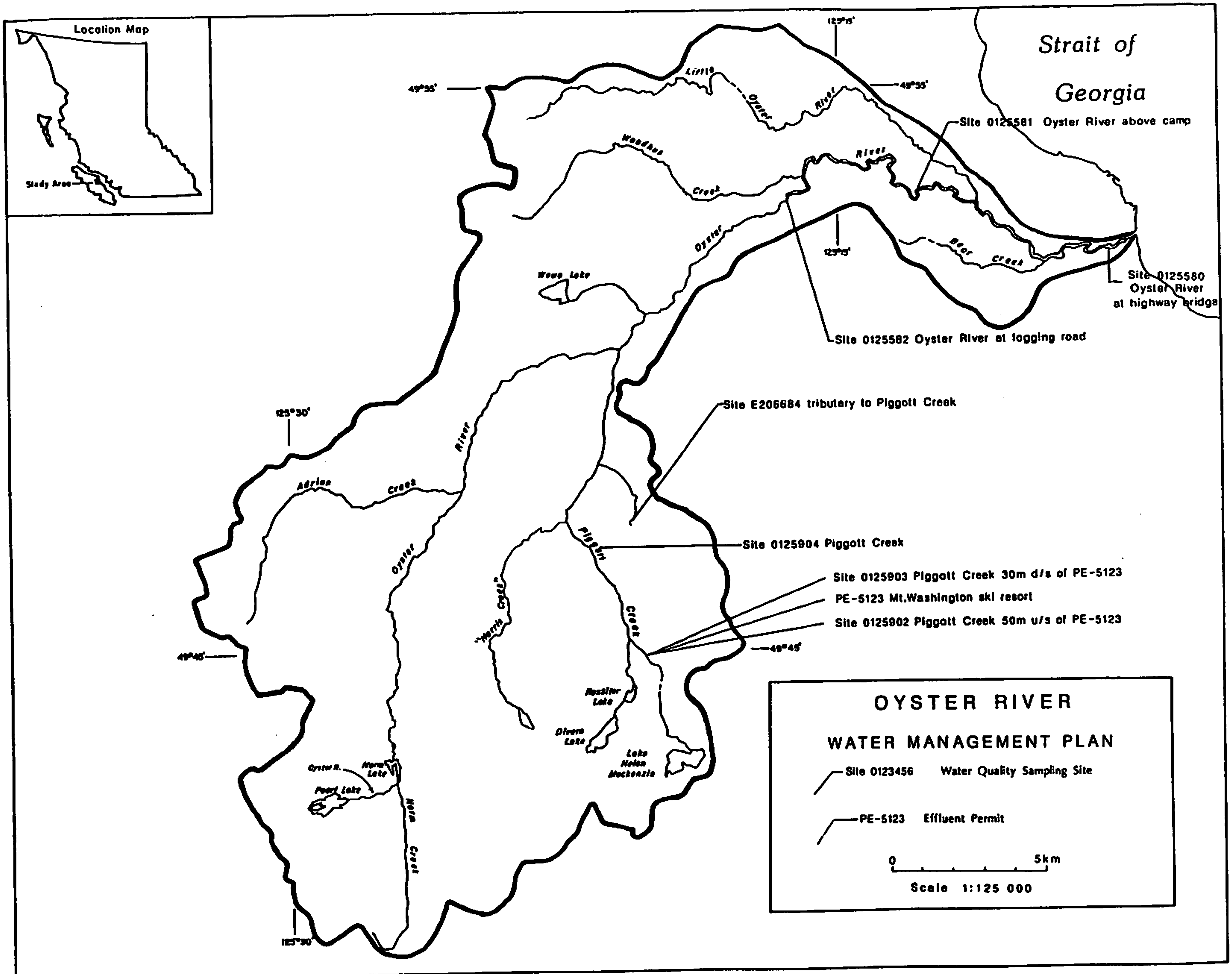


Fig. 3.15 LOCATIONS OF WATER QUALITY SAMPLING SITES AND EFFLUENT PERMIT

A forecast of future activities and/or effluent permits requiring dilution in the Oyster watershed is not currently possible. However, there are several mining proposals currently being assessed.

3.4 WATER QUALITY

3.4.1 DATA AVAILABILITY

Seven water quality sampling sites are located within the Oyster watershed (Figure 3.15), along with those of the effluent permit (which is discussed in Section 3.3). Table 3.5 lists the sampling sites by number and location, and the period during which the sites have been sampled. The best data for the Oyster River are for site 0125580, which has been sampled since 1971, usually twice per year until 1983, and at least monthly since late summer 1986.

TABLE 3.5
OYSTER RIVER WATERSHED WATER QUALITY MONITORING

Site Number	Location	Sampling Period
0125580*	Oyster River - at Highway Bridge	1971 - present
0125581	Oyster River - above Camp	1975 - present
0125582*	Oyster River - at Logging Rd.	1986 - present
0125902	Piggot Creek - 50m u/s of PE5123	1979 - present
0125903	Piggot Creek - 30m d/s of PE5123	1979 - present
0125904	Piggot Creek	1979 - present
E206684	Tributary to Piggot Creek	1986 - present

* Sampled now on an intensive program

3.4.2 AMBIENT WATER QUALITY

This section draws conclusions on present ambient water quality for a variety of water uses: human consumption, industrial purposes, irrigation, contact recreation, aquatic life.

3.4.2.1 Human Consumption

A review of available data indicates that the chemical water quality of the Oyster River meets Public Health standards for drinking water except during peak runoff periods. The physical water quality is of concern due to the colour, turbidity and filterable residue.

The bacterial water quality, on the basis of coliform data only, is poor all year and peaks during heavy runoff periods in the lower portion of the mainstem river. Current data for the lower Oyster indicate that for all-year direct-intake extraction, treatment is needed as follows: coagulation/flocculation, sedimentation, filtration and disinfection. However, more bacterial/viral sampling is needed before a treatment level for water extracted from the Oyster River for human consumption can be confirmed.

Depending on whether or not extraction is directly from the river or from behind a larger size dam, the physical water quality (sediment load) may vary due to sediment settlement. However, due to the high coliform counts, disinfection and filtration of bacteria loading would be needed in all cases. Wells on the river bank also fall into this category, as little filtration actually occurs through the coarse riverbank materials. For the upper Oyster, the domestic sewage effluent from Mt. Washington ski hill and any mine activities may affect the degree of treatment.

3.4.2.2 Industrial Purposes

Forestry and mining activities may have affected water quality in the past (and potentially in the future). However, current ambient water quality is not known to curtail industrial activities in any way.

3.4.2.3 Irrigation

Current Oyster River water quality is apparently suitable for irrigation. Coliform/pathogen levels must be kept in mind when food crops are irrigated through overhead sprinking. However, these can easily be overcome by simple disinfection and contact time. Future use for irrigation may be affected by toxic metals/chemicals that might arise from mining activities. However, if aquatic life standards are met, agricultural standards are also likely to have been met.

3.4.2.4 Contact Recreation

The Guidelines for Canadian Recreational Water Quality (1983) require the following to be reviewed in assessing water quality for recreation:

(a) sanitary survey - as an indication of potential contribution of coliforms, suspended solids and pathogens;

(b) epidemiological studies - recognized recreational beaches are sampled by the Ministry of Health, but there are none in the Oyster drainage;

(c) fecal coliform limitations - surveys for coliforms are useful in evaluating "risk". A health hazard is considered to exist if the fecal coliform concentration in a recreationally used area exceeds 200/100 ml. At lower levels, a lower degree of "risk" exists. A review of total/fecal coliform levels for the Oyster River indicates that (on the basis of data available) the fecal/coliform level is rarely exceeded. The highest readings are for periods of heavy runoff, and these do not normally coincide with recreational water use. The highest level on record is 240/100 ml fecal. The usual range is 2-13/100 ml, at the Highway bridge. However, a Piggott Creek sampling site has recorded 2400 fecal/100 ml on occasion, downstream of Mt. Washington ski hill effluent discharge.

(d) presence of pathogens - there are no past surveys of pathogens in the Oyster drainage.

(e) physical and chemical parameters - it is normally assumed that due to the small amount of water consumed during water-contact recreation, chemical parameters normally found in water are of no consequence. Physical parameters such as colour, turbidity, smell and taste are aesthetic in nature and may deter/detract from recreational usage.

As indicated in Section 3.2, the lower reaches of the Oyster River are used for water-based recreation. At present, on the basis of data available, there is no evidence of health risk exceeding the B.C. standards for recreational waters. However, it cannot be assumed that there are no risk factors present.

3.4.2.5 Aquatic Life

In general, the water chemistry of the Oyster River is better than water quality criteria for aquatic life (Pommen, 1985). Oyster River data suggest low nutrient levels and low nutrient concentrations probably are a limiting factor for biological production. The data for heavy metals in the Oyster River shows substantial variability. Most metals are non-detectable, or are far less than concentrations harmful to aquatic life. However, aluminum, copper and iron have had occasional high values. These high concentrations were for total metals and usually were in samples with high suspended solids. Since there was no data for the dissolved fraction, i.e. the portion that is biologically available, it is not possible to evaluate the impact on aquatic life. For example, aluminum values exceeded the criteria on three occasions in recent data, copper twice, and iron once. The high copper values were below the toxicity levels, but above the working criterion, so that there could be impacts on fish behaviour. It is not anticipated that iron is a problem. However, since concentrations of total aluminum and copper are occasionally high, analysis of the dissolved fraction (biologically available) should be sampled to further examine this potential problem.

CHAPTER 4. PRESENT WATER ALLOCATION AND USE

4.1 EXISTING WATER ALLOCATION

The water resources of the Oyster River are sparsely licensed and used in comparison with other adjoining watersheds. Table 4.1 lists the existing licensed quantities (1986). Table 4.2 provides estimates of the potential amount of water use under existing licences for the maximum day, and by quarter. All of the existing licensed uses are from the lower elevation, low gradient portions of the watershed (within 13 miles of the mouth, see Figure 4.1). Maximum daily existing licensed use is equivalent to a flow of 0.096 m^3/s, which is only 8.4% and 9.5% of the 5-year and 10-year recurrence interval annual 7- day average low flows at 08HD011 Oyster River.

4.1.1 WATERWORKS, INDUSTRIAL (RESORT), AND DOMESTIC

Waterworks and industrial (resort) water uses account for 46.6% of the existing total licensed consumptive use (Table 4.3). This is for a pumped, semi-rural, supply to resort developments and residences along the highway around the mouth of the Oyster River and south to the Black Creek area. Domestic use accounts for only 0.2% of the existing total consumptive demand.

4.1.2 IRRIGATION, STORAGE, AND INDUSTRIAL FROST PREVENTION

Irrigation accounts for 53.2% of the existing total consumptive use, mainly for two farms:

(a) U.B.C. Farms, which irrigates 300 ac. ft. (0.048 m^3/s) at the mouth of the Oyster River (partly supplied from groundwater with minimum effects on the flows in the main channel of the Oyster River).

TABLE 4.1
EXISTING LICENSED QUANTITIES (1986)

Priority Date	Stream	File No.	Lic. No.	Licencee	Purpose	Quantity	Equivalent Flow* c.f.s.	Equivalent Flow* m³/s
1968.07.03	Oyster River	0281343	FL44750	University Research Farm #2	Irrigation	300 ac.ft.	1.681	0.04760
1974.10.11	Oyster River	0323981	CL45104	Ferguson	Domestic	1,000 gpd	0.002	0.00006
1975.01.23	Oyster River	0367459	CL54065	Pacific Playground	Industrial (resort)	45,000 gpd	0.084	0.00238
1975.01.23	Oyster River	0328279	CL54066	Watutco Ent. Ltd.	Waterworks	54,500 gpd	0.101	0.00286
1982.11.09	Oyster River	1000093	CL59087	Watutco Ent. Ltd.	Waterworks	10,000 gpd	0.019	0.00054
1983.04.19	Oyster River	1000158	CL61322	Grutzmacher	Domestic	500 gpd	0.001	0.00003
1984.08.15	Oyster River	1000405	CL61497	Gunn	Domestic	500 gpd	0.001	0.00003
1985.05.24	Oyster River	1000482	CL61430	Reg.Dist. Comox-Strathcona	Waterworks	800,000 gpd	1.486	0.04208
1985.08.06	Oyster River	1000508	CL63951	U.B.C. Research Farm #2	Conservation	8.0 cfs	0	0
1974.07.05	Bear Creek (trib.	0323336	CL48545	Pederson	Domestic	1,000 gpd	0.002	0.00006
1974.07.05	to Oyster River)	0323336	CL48546	Pederson	Storage	1.0 ac.ft.	-0.006	-0.00017
1979.02.26	Oakes Pond (trib.	0355014	CL54223	Edward	Irrigation	1.0 ac.ft.	0.006	0.00017
1979.07.26	Bear Creek)	0355015	CL54224	Edward	Domestic	500 gpd	0.001	0.00003
1972.03.01	Robinson Brook (trib. to Oyster River)	0309678	CL40287	Robinson Lake Rec. Assoc.	Land Improvement	150 ac.ft.	0	0
1980.03.03	Hickok Creek (trib. to Little	0366107	CL57101	Delcor Holdings Ltd.	Irrigation	40 ac.ft.	0.224	0.00634
					Ind.(frost prev.)	100 ac.ft.	0	0
1980.03.03	Oyster River)	0366107	CL57102	Delcor Holdings Ltd.	Storage	40 ac.ft.	-0.224	-0.00634
					Total Equivalent Low Flow Licensed		3.377	0.09567
						Say	3.4	0.096

* Estimated equivalent daily consumptive use during low flow period.

<u>CONVERSIONS TO EQUIVALENT FLOW</u>

Irrigation	1 ac.ft. (per 90 days)	= 0.0056 c.f.s.	= 0.00016 m³/s
Waterworks and Industrial	1 M.g.p.d.	= 1.858 c.f.s.	= 0.05261 m³/s
Domestic	500 g.p.d.	= 0.001 c.f.s.	= 0.00003 m³/s
Storage	1 ac.ft. (per 90 days)	= -0.0056 c.f.s.	= -0.00016 m³/s
Land Improvement and Conservation		= 0.0 c.f.s.	= 0.000 m³/s

TABLE 4.2

EXISTING WATER ALLOCATION (1986)

	Waterworks		Domestic	Irrigation	Industrial Resort	Industrial Frost Prev.	Conservation	Land Improvement	Storage	Total
	Annual (mg)	Max.daily (g.p.d.)	(g.p.d.)	(ac.ft.)	(g.p.d.)	(ac.ft.)	(c.f.s.)	(ac.ft.)	(ac.ft.)	m^3/s
Estimated Equivalent Consumptive Demands	121.3 [1]	864,500	3,000	341	45,000	100	8	150	41	
Maximum Daily during Minimum Flow	-	0.04548	0.00016	0.05456	0.00237	0.00	0.00	0.00	-0.00656[6]	0.09601
October-December	0.01399[2]	-	0.00006[2]	0.00	0.00095[2]	0.008[4]	0.00	0.00320[5]	0.00656[6]	0.02620
January - March	0.01224[2]	-	0.00006[2]	0.00	0.000083[2]	0.008[4]	0.00	0.00	0.00	0.02113
April - June	0.01574[2]	-	0.00007[2]	0.01783[3]	0.00107[2]	0.00	0.00	0.00	0.00	0.03471
July - September	0.02972[2]	-	0.00014[2]	0.03567[3]	0.00201[2]	0.00	0.00	0.00	-0.00656	0.06098

1. Regional District of Comox-Strathcona annual allow.= 109,500,000 gal. + est. Watutco Ent. Ltd. $\frac{54,500 + 10,000}{2}$ x 365 = 11,770,000

2. Quarterly demands for waterworks, domestic, and industrial resort users were estimated by multiplying the estimated average daily demand (max.daily/2) by the factors: Oct.to Dec. - 0.8; Jan.to Mar. - 0.7; Apr.to Jun. - 0.9; Jul.to Sept. - 1.7.

3. Irrigation demands were estimated to occur 1/3 in the period Apr. to Jun. and 2/3 in the period Jul. to Sept.

4. Industrial frost prevention demand was assumed to occur 1/2 in each of the periods Oct. to Dec. and Jan. to Mar.

5. Land Improvement (Robinson Pond Recreation Dugout) is estimated to recoup its estimated evaporation loss of 2 feet over 10 acres (20 ac.ft.) during the fall precipitation of Oct. to Dec.

6. Storage created to support irrigation demands is assumed to supply the equivalent max. daily and Jul. to Sept. period demands and fill during the fall precipitation period of Oct. to Dec.

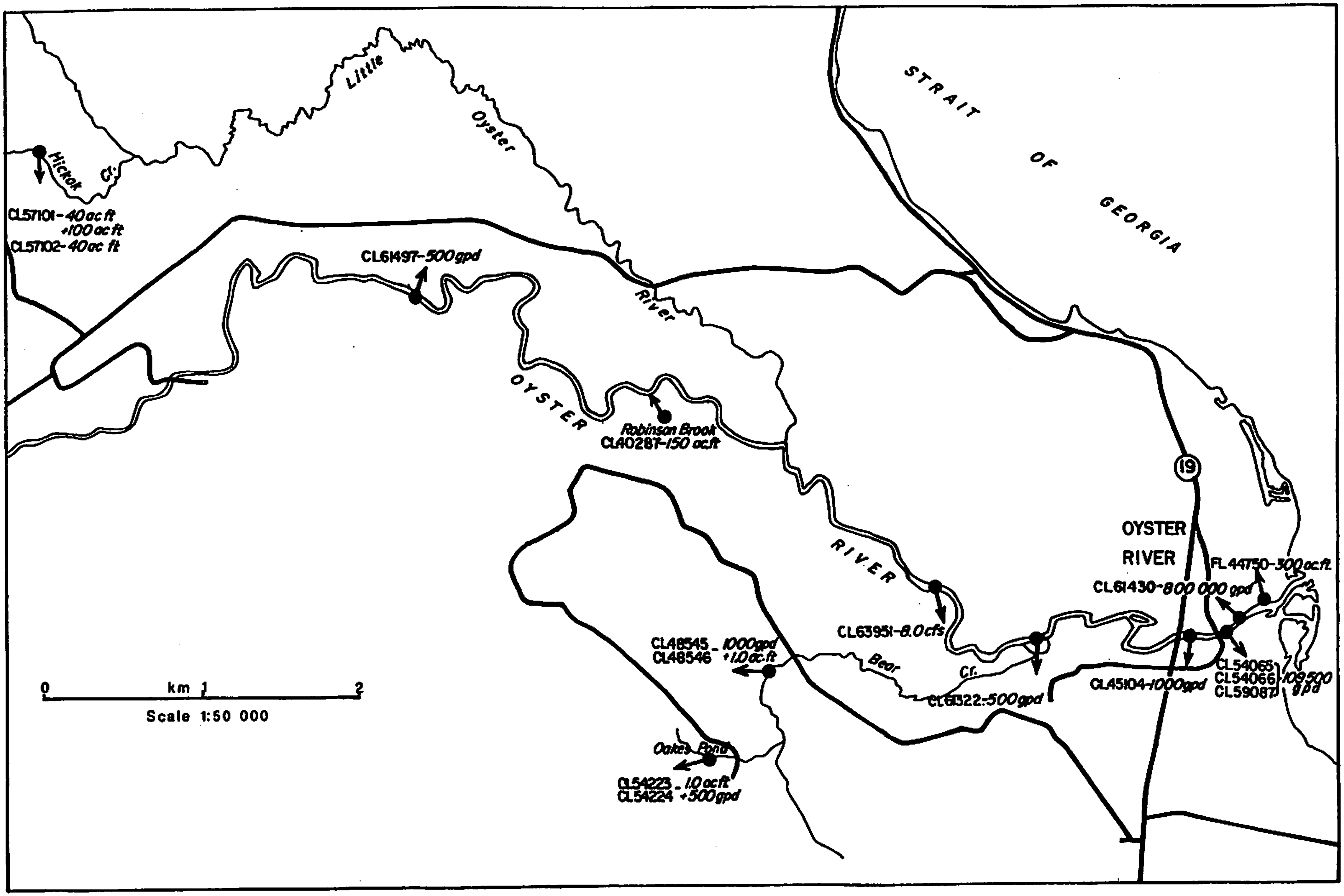


Fig. 4.1 LOCATIONS OF WATER LICENCES

(b) Delcor Holdings Limited, which irrigates 40 ac. ft. (0.006 m^3/s) from a tributary to the Little Oyster River and is totally supported by storage. They also hold a water licence for spraying to prevent frost from killing the cranberry plants during the winter months.

TABLE 4.3

PROPORTION OF CONSUMPTIVE WATER USE BY LICENSED PURPOSE

LICENSED PURPOSE	% OF USE
Waterworks and Industrial Resort	46.6
Domestic Consumption	0.2
Irrigation	53.2
TOTAL	100%

4.1.3 CONSERVATION AND LAND IMPROVEMENT

A spawning channel constructed on U.B.C. farm lands near the confluence of Bear Creek is licensed to divert up to 0.23 m^3/s for conservation purposes from the Oyster River. As the flow diverted for this purpose is returned to the river a short distance downstream, there is no significant consumptive use. Likewise, the land improvement licence held for the construction and maintenance of a dugout and pond for recreation purposes on Robinson Brook does not create any significant use during the low flow period in the Oyster River.

4.2 PRESENT WATER USE

No records are available with respect to the quantities of licensed water actually used, for comparison with authorized water quantities and period of use, except for metered water use by the Regional District of Comox-Strathcona waterworks for the Black Creek area. There is no incentive for other licencees to meter, conserve water, or be accountable for actual water use, since annual fees are based only on the quantity licensed.

CHAPTER 5. POTENTIAL WATER USE

5.1 FISHERIES

As indicated in Section 3.1.2.5, enhancements of various types are being considered to increase salmon production. Sidechannel enhancements in the Oyster-Little Oyster and Oyster-Woodhus Creek confluence areas are being planned. Additionally, beaver dam removal at the mouth of Woodhus Creek may be undertaken. Coho colonization above barriers may also be part of long-term fisheries plans. These fisheries enhancement opportunities have strong local support. However, development of fisheries enhancements is predicated on the maintenance and enhancement of current instream flows at low flow times of the year. Storage development to enhance fish rearing and spawning habitat during low-flow periods may also be considered as a fisheries/water management strategy.

5.2 WATER-BASED RECREATION

Given that water-based recreation (aside from angling) is not currently a major use of the Oyster drainage, despite large numbers of potential users in the vicinity during the summer (Section 1.4.1), it is unlikely that these activities will constitute a dominant use of the Oyster in the near future. However, any reductions in flow would appear to be detrimental to present use, and any increases in flows at low flow periods (from storage) would likely be beneficial.

5.3 WASTE MANAGEMENT AND WATER QUALITY

There are no specific developments now proposed which would be expected to degrade present ambient water quality. However, potential mining developments and continuing upper watershed logging have the possibility of doing so. A program of reclamation to reduce acid mine drainage in upper Piggott Creek is planned over the next few years, with consequent improvement in water quality in the area.

5.4 WATER ALLOCATION

5.4.1 WATERWORKS

Engineering reports (e.g. Associated Engineering Services Ltd., 1975 and 1976) prepared for the Regional District of Comox-Strathcona, the District of Campbell River and the Greater Campbell River Water District indicate that the Oyster River may be considered as a significant future water supply. This would be for any future residential development between the two major population centres of Campbell River and Courtenay-Comox, to serve as an emergency or auxiliary supply to the Greater Campbell River Water District, and as a possible third source of supply between the Campbell River and the Puntledge River for a linked water supply system. An estimated 0.158 m^3/s (3.0 million I.g.p.d. - based on the Greater Campbell River Water Districts water licence application in 1972) may be required for potential waterworks demands in the next 5 to 10 years.

5.4.2 IRRIGATION

A previous report prepared for the Ministry of Environment (Buble, 1979) indicated that there are 3,480 hectares of Agricultural Land Reserve (ALR) lands within the Oyster River watershed. This could possibly require 1.13 m^3/s of irrigation water (based on 10.05 inches of water required per year). A further 6,800 hectares of ALR lands in adjoining watersheds between the Quinsam River and Black Creek could possibly require 2.38 m^3/s of irrigation water. However there is no indication that these total estimated irrigation requirements will be realized from the Oyster River, and it appears unlikely that the irrigation water demands will exceed twice the existing irrigation demand of 0.055 m^3/s within the next 5 to 10 years.

5.4.3 INDUSTRIAL

As the Oyster River is located between the two commercial and industrial centres of Campbell River and Courtenay-Comox, it may be assumed that most future commercial and industrial developments will be attracted to these centres. The possible exception is mining development, which may require water for such purposes as coal washing and placer mining. No other significant consumptive demands are estimated from the Oyster River watershed.

5.5 STORAGE DEVELOPMENT

To assess the potential for storage development to augment projected future low flow demands, and to mitigate instream requirements, an airphoto review, aerial reconnaissance, and preliminary map were made. No detailed field verifications were conducted.

The 1:50,000 N.T.S. maps were reviewed to ascertain locations where the contour lines indicate a natural depression with a reasonably confined outlet. This setting provides a maximum amount of storage with a minimum dam size. This topographic condition usually is indicated by existing lakes. Thus, most of the noted potential storage sites are on existing lakes. An aerial reconnaissance of these sites was made to refine information on outlets, current road access, and other preliminary suitability factors.

Estimates of the watershed area, mean annual inflow, reservoir elevation range, length of dam, reservoir area at full supply, and storage volume for 16 possible storage sites in the Oyster River watershed are given in Table 5.1, and their locations illustrated in Figure 5.1. These estimates are suitable only for rough comparisons, and to give direction for further assessments.

One of the potential storage sites identified is on Bear Creek, where a known storage area called Oakes Pond has been created when culverts were placed through Macaulay Road about 1.2 meters above the natural channel bottom of Bear Creek. The storage volume of Oakes Pond is approximately 185 dam^3. There are other marshes in the headwaters of Bear Creek that may also be considered for the development of small storage volumes, to improve flows in Bear Creek.

TABLE 5.1
POSSIBLE STORAGE SITES IN THE OYSTER RIVER WATERSHED

Map I.D. No. (Fig 5.1)	Storage Site Description	Elevation above mean sealevel (meters)	Watershed Area (km^2)	Estimated Mean Annual Inflow (dam^3)	Estimated Reservoir Elevations			Estimated Length of Dam (meters)	Original Water Surface Area (km^2)	Estimated Reservoir Area at Full Supply (km^2)	Estimated Storage Volume (dam^3)
					high (meters)	low (meters)	range (meters)				
1	Woodhus Cr. - unnamed swamp in headwaters	470	2.7	3,600	490	465	25	150	0.02	0.52	6,500
2	Wowo Lake	600	4.9	6,900	610	600	10	400 + 200	0.42	0.67	5,200
3	Lake Helen MacKenzie	1,100	2.9	4,600	1,138	1,132	6	1,000	0.65	0.70	4,100
4	Rossiter Lake	890	17.9	27,800	920	885	35	600	0.10	1.0	25,700
5	Divers Lake	900	14.7	23,000	935	900	35	500	0.37	0.9	22,000
6	Simms Lake	970	5.9	9,700	970	1,010	40	500	0.05	0.41	8,800
7	Amphitheatre Lake	1,200	1.5	2,700	1,240	1,220	20	200	0.05	0.09	1,490
8	Circlet Lake	1,150	1.8	2,800	1,170	1,162	8	150	0.27	0.34	2,422
9	Harris Lake	1,050	6.0	9,400	1.060	1.020	40	250	0.15	0.27	8,600
10	Sunrise Lake	1,400	1.4	2,200	1,420	1,400	20	150	0.23	0.28	3,100
11	Adrian Cr. - unnamed lake in headwaters	1,420	1.0	1,800	1,440	1,420	20	200	0.07	0.15	2,200
12	Beadnell Lake	1,380	2.3	4,000	1,320	1,310	10	50	0.23	0.38	3,050
13	Norm Lake	660	41.0	65,900	670	650	20	400	0.17	1.0	11,600
14	Pearl Lake	850	17.8	28,000	880	840	40	450	0.44	0.8	24,800
15	Gem Lake	1,060	4.8	8,400	1,100	1,060	40	300	0.08	0.25	8,250
16	Oakes Pond	80	0.5	600	-	-	1.2	8	-	0.10	185

Map I.D. No. (Fig 5.1)	Storage Site Description	Comments/Constraints
1	Woodhus Cr. - unnamed swamp in headwaters	- Chute Creek diversion required to augment existing mean annual inflow to fill max.stor.vol. - Logging/mining road access may have to be relocated; above 490 m. may spill to Chute Creek.
2	Wowo Lake	- 2 dams required (1 main & 1 saddle); good vehicle access; flooded area is mainly marsh land. - good existing sport fishery.
3	Lake Helen MacKenzie	- within Strathcona Park; long, low dam required unless negative storage can be developed.
4	Rossiter Lake	
5	Divers Lake	- no identified road access to site.
6	Simms Lake	- within Strathcona Park; no identified road access to site.
7	Amphitheatre Lake	- within Strathcona Park; no identified road access to site.
8	Circlet Lake	- within Strathcona Park; no identified road access to site.
9	Harris Lake	- within Strathcona Park
10	Sunrise Lake	- within Strathcona Park; no identified road access to site.
11	Adrian Cr. - unnamed lake in headwaters	- no identified road access to site.
12	Beadnell Lake	- 2 outlets and 2 dams required; no road access. - may be primarily in Quinsam River watershed.
13	Norm Lake	- talus fan of large diameter rock over outflow channel; logging access road will have to be relocated if lake developed to maximum storage volume.
14	Pearl Lake	- wide valley and multiple outlet channels from lake. - logging road access to within 1 kilometer of lake.
15	Gem Lake	- no identified road access to site.
16	Oakes Pond	- existing storage created by raised culverts in Macaulay Road. - other marshes at Bear Creek headwaters may provide potential storage sites.

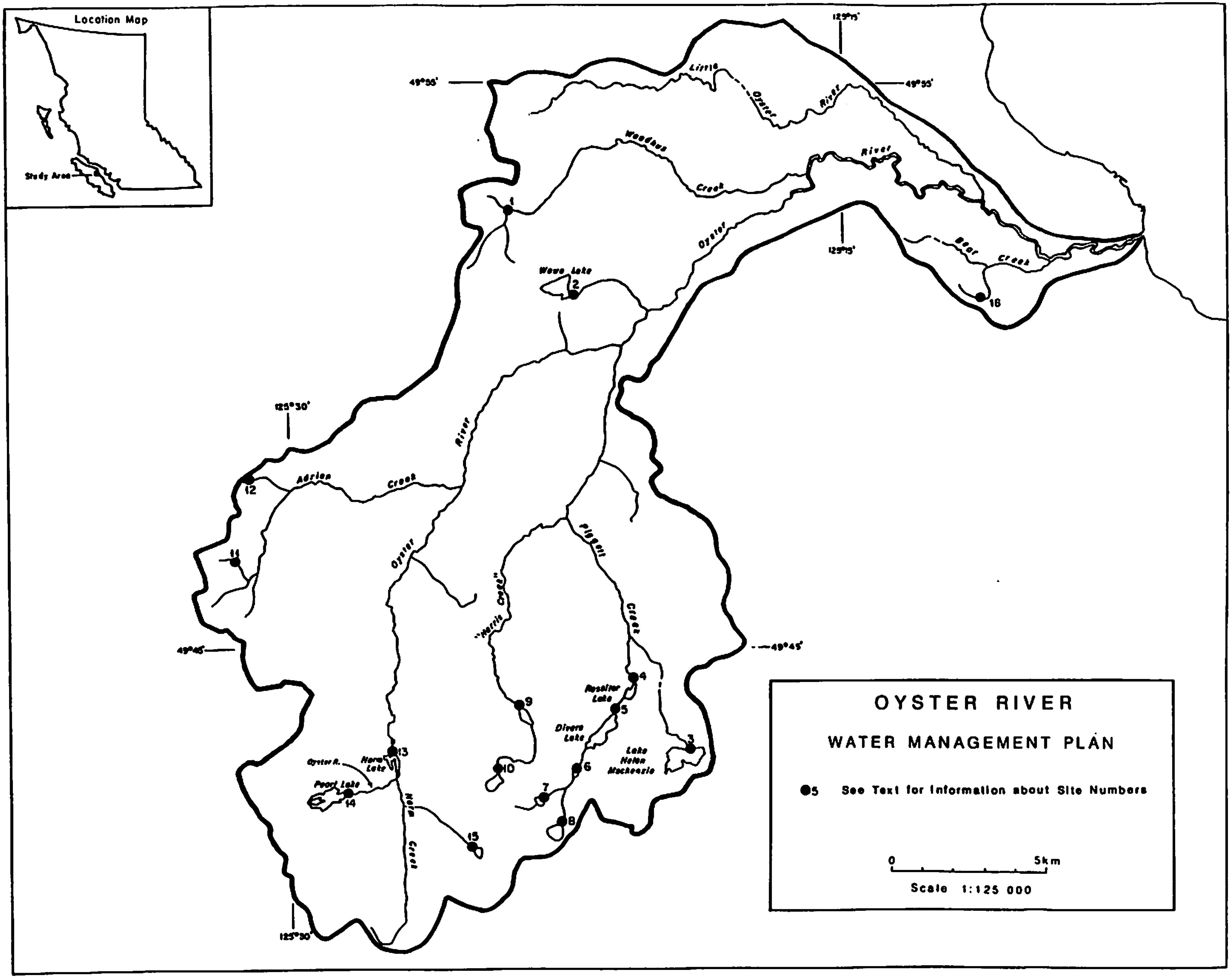


Fig. 5.1 POTENTIAL WATER STORAGE SITES

Further investigations and assessments are required to determine if any of the possible storage sites are viable, including:

a) site access and ownership of lands;
b) detailed topography or profiles and cross-sections;
c) soil/geological foundation conditions;
d) location and costs of materials;
e) costs of land acquisition;
f) costs of design and construction;
g) hydrological/hydrometric investigations.

5.6 FLOOD PROTECTION

The question of flood protection in the lower reaches of the Oyster River was examined by Brown (1982). The report identifies that the flood threat to existing homes is most severe at the west end of Glenmore Road. It is here that the river could overtop the left bank, flood several homes and Glenmore Road. As well, there is a further hazard that flood waters might find their way through the developed residential area north of Glenmore Road.

The report outlines a concept of dyke construction combined with raising of roads in critical areas to provide flood protection. The total length of dykes would be 900 metres, Glenmore Road would need to be raised over a 130 metre length, and the logging road at the west end would need to be raised over a 200 metre length. The cost of dyking was estimated to be $216,000 (1982).

Since 1982 the development of residential areas in the Oyster River floodplain has continued at a slow pace. With the production of floodplain mapping in 1984, the extent of potential flood damage is now better defined and should be re-examined. Estimates of flood damage should be made and related to the cost of dyking or other alternative methods of flood damage reduction, with a view to determining if there are sound economic reasons to pursue flood protection measures. Such estimates should include consideration of any fisheries habitat losses.

CHAPTER 6. CONCLUSIONS

The objective of this chapter is to summarize water availability, and draw conclusions with respect to the various uses of water in the Oyster watershed. Present water requirements are summarized by sub-basin in Table 6.1 together with estimates of water supply.

6.1 SURFACE WATER SUPPLY

Estimates indicate that the 7-day average low flows range from very low values in the sub-basins which are below 500 meters in elevation to relatively high values in the headwaters of Pearl Lake and Norm Creek. Approximately 40% of the low flow in the Oyster River mainstem originates from the headwater part of the watershed. August and September are the low flow months, with the lowest 7-day average flows usually occurring in early October. Estimated 7-day average low flows for selected sites on the Oyster River and some of its tributaries are shown in Table 6.1.

6.2 GROUNDWATER SUPPLY

There are moderate to high-yielding aquifers in and around the deltaic area around the mouth of the Oyster River. Lesser quantities and questionable water supplies are associated with sand and gravel deposits adjoining the Oyster River further upstream.

6.3 FISHERIES INSTREAM FLOW REQUIREMENTS

A high-value trout and salmon fisheries resource exists in the mainstem of the Oyster River (below a set of falls located 24 km above the mouth) and in Woodhus Creek, Little Oyster River and Bear Creek. However, the amount of water available in these four streams during the low flow period is not adequate for maintenance of fisheries production (Table 6.1). Therefore, the realization of the potential production capacity of the fish-bearing streams in the lower Oyster River watershed is limited by these naturally

TABLE 6.1
PRESENT WATER SUPPLY, REQUIREMENTS, AND LOW FLOW BALANCE (m^3/s)[1]

Sub-Basins	Natural Water Supply[2]			Fisheries Instream Requirements[3]		Total Licensed Consumptive Requirements[4]	Low Flow Balance	
	Mean Annual	Minimum Monthly (1:10 yr)	7-day low (1:10 yr)	Minimum Monthly (1:10 yr)	7-day low (1:10 yr)		Monthly	7-day
Bear Creek	0.31	0	0	0.06	0.031	0.00009	-0.06	-0.031
Little Oyster River	1.6	.006	.005	0.32	0.16	0	-0.314	-0.155
Woodhus Creek	1.5	.012	.010	0.30	0.15	0	-0.288	-0.14
Oyster River (at gauge)	13.8	1.22	1.01	2.76	1.38	0.09558	-1.64	-0.466
Oyster River (Total Watershed)	16.8	-	1.02	-	-	0.09567		

[1] This table summarizes only those streams where there is a present water requirement.
[2] From Tables 2.9, 2.12 and 2.14.
[3] From Table 3.4, using 10% of Mean Annual Discharge for 7-day low, and 20% for minimum monthly.
[4] From Table 4.2, taking storage into account.

occurring low flows. Any further reductions in natural low flows would reduce the wetted habitat and the existing fisheries resource in these streams. It is desirable that methods for increasing flows in these streams during the spawning and rearing periods be investigated. In addition, in order that commercial and sports species in the Oyster River system be managed to approach or exceed historic levels, additional activities are required. These may include, for example, provision of improved access to spawning/rearing streams through beaver dam removal or fishway construction, and other programs such as colonization of upstream areas and side-channel enhancements.

6.4 WATER QUALITY

Existing water quality in the Oyster River is estimated to be adequate for all existing and projected uses without further treatment, except for human consumption.

The only stream presently being used for waste dilution is upper Piggott Creek. However, neither streamflow nor required waste dilution are known for all periods of the year at the effluent location, so that conclusions on adequacy of streamflow for this purpose cannot be drawn. It is also recognized that acid mine drainage from an abandoned mine on Mt. Washington has affected a tributary to Piggott Creek and may be a source of metals affecting water quality further downstream.

6.5 WATER ALLOCATION DEMANDS

Present licensed consumptive demand represents only a small proportion of the 7-day low flows (Table 6.1). Estimated future potential demand may represent a considerable proportion of the low flows, especially if extracted from the relatively lower flow tributaries of Bear Creek, Little Oyster River and Woodhus Creek. Any large water extraction from the Oyster River mainstem, or any water extraction from the lower-elevation tributary streams, would reduce the wetted area of the channel and negatively impact the high value fisheries resources in the Oyster River watershed.

6.6 WATER STORAGE

Potential storage development may be available in headwater lakes and a swamp to mitigate licensed water demands during low flow periods, and to increase low flows for fisheries.

In order to augment the natural low flows so that they do not fall below 20% of the mean annual discharge, it is essential to store water during high flow periods, and/or divert water from one sub-basin to another, and/or import water into the Oyster watershed. Initial estimates of the net volume of water that would need to be stored, diverted, and/or imported to be able to supply the 20% criterion during the low-flow period have been made as follows:

Oyster River mainstem	12,000 dam^3
Little Oyster River	3,000 dam^3
Woodhus Creek	3,000 dam^3
Bear Creek	600 dam^3

Based upon preliminary assessments of water storage sites (Section 5.5), there are several locations that could provide the amount of storage required on the Oyster River mainstem. For the Little Oyster River, no storage sites within its watershed have yet been identified. Within the Woodhus Creek basin, site #1 on Figure 5.1 is estimated to have a storage volume of 6,500 dam^3, and could be a suitable flow augmentation storage provided that the inflow to the reservoir were also sufficient (inflow is presently estimated to be an average of 3,600 dam^3 annually). Bear Creek requires about 600 dam^3 for flow augmentation, and while at least 200 dam^3 of storage are believed to be available, the large areas of swamp in the headwaters could likely be developed to provide the balance.

6.7 FLOOD FLOWS AND FLOOD PROTECTION

The highest flows occur in the months of October, November and December, due primarily to heavy rains and possibly snowmelt in some years. Another high flow period, usually of less intensity, occurs in April, May or June, but it does not cause flooding.

The 200-year floodplain has been mapped. However, development in the flood-prone areas is continuing and flood protection measures have been proposed. Estimates of flood damage related to the cost of dyking, or other alternative methods of flood damage reduction, have not been made to determine if there are sound economic reasons to pursue flood protection measures.

CHAPTER 7. RECOMMENDATIONS

7.1 SURFACE WATER SUPPLY

1. Streamflow measurements on the Oyster River below Woodhus Creek (08HD011) should be continued.

2. Additional streamflow measurements (at sites to be specified) will be required to support storage investigations and fisheries enhancement assessments.

7.2 GROUNDWATER SUPPLY

3. The development of groundwater in areas apparently having potential should be encouraged to satisfy future water requirements in the lower yster River watershed (e.g. Bear Creek).

4. Further groundwater exploration and assessment should be made in the deltaic area around the mouth of the Oyster River by test drilling and pump testing the aquifer at the identified test site.

7.3 FISHERIES INSTREAM FLOW REQUIREMENTS

5. Design and implement a comprehensive fisheries production management plan for the Oyster watershed that coordinates strategies for all salmonid species, including but not limited to:
   a) flow enhancement on the mainstem and tributaries.
   b) improved production by providing access to areas presently inaccessible to salmonids.
   c) improvement of habitats to increase salmonid production.

7.4 WATER QUALITY

6. Continue the water quality monitoring program including Woodhus Creek, Piggott Creek, the Little Oyster River, and additional groundwater samples to provide the data to enable the setting of water quality objectives.

7. Establish water quality objectives and a water quality monitoring program for the Oyster River watershed.

8. Encourage forest harvesting operators to comply with the Coastal Fisheries Forestry Guidelines (1987).

9. All surface runoff and process water associated with exploration and mining development shall be collected and treated, and no discharges will be permitted to degrade existing receiving water quality.

10. Assess streamflows and effluent permit discharges (PE-5123) in the Upper Piggott Creek area to determine if adequate dilution is available at all times of the year.

11. Determine the source of elevated fecal coliform and dissolved metal levels observed in the Oyster River mainstem, and pursue the necessary remedial action.

7.5. WATER ALLOCATION DEMANDS

12. No further water licences should be issued for consumptive use of water from Bear Creek, Little Oyster River or Woodhus Creek or any of their tributaries without providing supporting storage or without mitigation of any potential detrimental effects on the fisheries resource.

13. No further large consumptive water licences should be issued for water from within the Oyster River watershed without providing supporting storage or without mitigation of any potential detrimental effects on the fisheries resource.

14. Notwithstanding the above, water licences for domestic use in single residences may be issued.

7.6 WATER STORAGE

15. Carry out further water storage assessments at those sites identified at the reconnaissance level as those most likely for augmenting low flows and reducing peak flows.

7.7 FLOOD PROTECTION

16. Review the social and economic benefits of constructing further flood and erosion protection works.

17 Assess side-channel enhancement opportunities for fisheries as part of any dyking projects for flood protection.

18. Continue to implement setback and elevation limits to control developments adjacent to the Oyster River and tributaries where floodplains exist.

7.8 LEGISLATION AND POLICY

19. Revise the Water Act to recognize instream flow requirements including fisheries, waste dilution and recreation, and provide a means to protect or conserve flows for these uses and requirements.

20. Revise the Water Act Regulations to charge water user fees based upon actual quantities used, in order to encourage conservation of water.

21. Provide policy and legislation to support the planning, allocation and regulation of the water resources (including groundwater) on a watershed basis.

REFERENCES

Associated Engineering Services Limited. 1975. Regional Water Study, School District 71. Nanaimo.

Associated Engineering Services Limited. 1976. Water Study, Black Creek Oyster Bay. Nanaimo.

Brown, A. A. 1982. Preliminary Report on Oyster River Flooding and Erosion. Ministry of Environment, Victoria.

Buble, G. 1979. Oyster River and Adjacent Watersheds Water Use and Water Management. Ministry of Environment, Victoria.

Clough, D. 1985. Vancouver Island Cutthroat Study - Oyster River Creel Survey 1984. J. C. Lee and Associates, Nanaimo.

Coastal Fisheries Forestry Guidelines. 1987. B.C. Ministry of Forests, B.C. Ministry of Environment and Parks, Federal Department of Fisheries and Oceans, and Council of Forest Industries.

Federal-Provincial Working Group on Recreational Water Quality of the Federal-Provincial Advisory Committee on Environmental and Occupational Health. 1983. Guidelines for Canadian Recreational Water Quality. Health and Welfare Canada, Ottawa.

Fyles, J. G. 1959. Surficial Geology - Oyster River, B.C. Map 49 - 1959. Geological Survey of Canada.

Inland Waters Directorate. 1986. Historical Streamflow Summary - British Columbia. Water Survey of Canada, Environment Canada, Ottawa.

Ministry of Environment. 1984. Preliminary Floodplain Mapping - Oyster River. Drawing No. 5532: 1-3.

Pommen, L. W. 1985. Working Criteria for Water Quality. Ministry of Environment, Victoria.

Regional District of Comox-Strathcona. 1983. Black Creek - Oyster Bay Official Settlement Plan.

Regional District of Comox-Strathcona. 1987. Campbell River Area Community Plan.

Reid, G. 1984. Vancouver Island Fisheries Management Statement. Ministry of Environment, Victoria.

Ronneseth, K. D. 1985. Regional Groundwater Potential for Supplying Irrigation Water: Union Bay to Oyster River. Ministry of Agriculture and Food, Victoria.

Stone, M. 1988. Economic Values and Impacts of Freshwater Sport Fishing in British Columbia. Ministry of Environment, Victoria.

Tennant, D. L. 1976. Instream Flow Requirements for Fish, Wildlife, Recreation and Related Environmental Resources. Fisheries 1(4):6-10.

Vancouver Island Area - Elevation Curves. 1968. Water Investigations Branch, Department of Lands, Forests and Water Resources.

Zubel, M. 1979. Proposed Vancouver Island Fish Hatchery - Groundwater Supply (Fanny Bay to Campbell River). Ministry of Environment, Victoria.

Queen's Printer for British Columbia©
Victoria, 1988