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PACIFIC REGION

ENVIRONMENTAL REVIEW OF THE
EUROCAN PULP MILL AT KITIMAT, B.C.

Regional Program Report: No. 81-27

By

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ABSTRACT

The Environmental Protection Service initiated a program to compile and review environmental information on the pulp and paper mills in British Columbia. With the cooperation of various other government agencies and the pulp and paper industry, EPS compiled relevant resource and receiving environment monitoring information. After reviewing and evaluating the existing information, the environmental quality of each area was assessed and the need for additional monitoring studies determined. This report represents an assessment of the Eurocan Pulpmill at Kitimat, B.C.

RESUME

Le Service de la protection de l'environnement a entrepris de compiler et d'étudier les renseignements recueillis sur l'environnement et concernant les usines de pâte à papier de la Colombie-Britannique. Grâce à la collaboration de plusieurs autres agences gouvernementales et de l'industrie de la pâte à papier, le Service de la protection de l'environnement a compilé les données pertinentes et les résultats de l'effet de la pollution sur l'environnement. Après avoir étudié et évalué les données obtenues, on a pu établir la qualité de l'environnement de chaque zone et déterminer dans quelle mesure on avait besoin de nouvelles études susceptibles de fournir d'autres données. Le présent rapport consiste en une évaluation portant sur l'usine de pâte à papier Eurocan Pulp and Paper (Kitimat, C.-B.).

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SUMMARY AND CONCLUSIONS

The Eurocan pulpmill discharges biologically treated kraft pulpmill effluent into the Kitimat River approximately 3.2 km upstream of the estuary. Over the period 1976 to 1980, the yearly average BOD₅ loading from the Eurocan pulpmill ranged between 5 164 Kg/day in 1976 to 7 240 Kg/day in 1980. With the exception of 1977 and 1980 where the average was slightly greater than the Eurocan pollution control permit limit of 6 750 Kg/day, the averages were below the permit limit. For TSS, the yearly average loadings ranged between 5 950 Kg/day in 1980 to 11 454 Kg/day in 1978. Up to 1979, the yearly averages all exceeded the permit limit of 6 750 Kg/day. For the second half of 1979, the TSS loading was 4 713 Kg/day compared to the first-half loading of 11 910 Kg/day. In 1980, the yearly average was 5950 Kg/day and is a significant reduction compared to earlier years. Eurocan made an application to the Waste Management Branch in 1981 to amend their permit to reflect the 1977 Provincial objectives and a new production rating.

The toxicity removal performance of the Eurocan biological treatment system has up to the winter of 1980/81 generally been substandard. Over 1976 to 1978, on an annual basis, 30 to 57% of the samples submitted for bioassay have passed the 100% effluent toxicity standard. The addition of 300 hp of additional aeration capacity in May 1978 seemed to improve on toxicity removal performance as 77% of the samples passed in 1979. Still, there remained a degree of toxicity and for 1979 and 1980 the toxicity seemed to coincide with the winter period. Overall, only 30% of the samples passed the 100% effluent toxicity standard in 1980. A 107 meter extension of floating baffle was added (September, 1980) to the existing 152 meter wooden baffle in the aerated stabilization basin to reduce possible short circuiting in effluent treatment. An improvement in effluent toxicity has been noted since then as no bioassay failures were reported over the 1980/81 winter period.

The Kitimat River annually has periods of very low potential dilution. The months of January, February and March are the minimum flow months and have five-year (1976 - 1980) monthly average flows of $54.5\text{m}^3/\text{s}$, $55.7\text{m}^3/\text{s}$ and $42.6\text{m}^3/\text{s}$ respectively. They are also the months of minimum dilution. For January, February and March, the ratio of the monthly minimum river flow over 1976 to 1980 to the maximum monthly pulpmill discharge over 1976 to 1980 was less than 20:1. The extreme minimum river flow recorded over 1964-1979 by Water Survey of Canada was $9.2\text{m}^3/\text{s}$ on December 22, 1973. At the permitted discharge volume of $0.79\text{m}^3/\text{s}$, the dilution potential was 11.6:1. The effluent is initially channelled along the west side of the river and full potential dilution is reached at some point further downstream. The month of April and the months of August to December can all have periods of low potential dilution.

The Kitimat River and its tributaries support 17.5% of the total salmon escapement for the Butedale subdistrict. All five species of salmon are found in the Kitimat system and the Kitimat River incorporates the major spawning sites in the Butedale subdistrict for chinook and coho and ranks second for chum and even-year pink salmon. There has been a general decrease in salmon escapements to the Butedale subdistrict and it has been suggested it is a response to changing environmental conditions such as ice scouring and flooding of spawning grounds and commercial fishing pressure.

A salmonid enhancement program has been started for Kitimat River chinook salmon which have had declining escapements in recent years. A pilot hatchery is being operated successfully on-site at the Eurocan pulpmill. Over 1977 to 1979 approximately 314,775 eggs were taken for the pilot hatchery. A coded-wire tagging program of fish from this facility will be valuable in determining marine survival, distribution and fishery contribution. From the 1977 to 1979 brood years, approximatley 185,294 hatchery "90 day" smolts were coded-wire tagged and released into the Kitimat River. A major hatchery for the Kitimat River is presently being constructed and a pilot hatchery is operating on the new site.

Adult salmon are found in the Kitimat River when flows and dilution are high comparative to the winter period. A trapping program was conducted in the spring of 1978 (March 31 to mid-June) to establish the timing and population size of emigrant Kitimat chinooks. From that program, 1578 of the 1976 brood chinook smolts were coded-wire tagged. Incidental catches included coho smolts, chum and river rearing sockeye fry as well as steelhead and cutthroat trout and Dolly Varden char. The chinook fry migration commenced prior to March 31 and terminated on May 5. The only chinook yearlings were captured in early April. A juvenile salmon migration and distribution program was conducted in 1980 to provide data needed for the design and operational strategy of the Kitimat hatchery. It was determined that pink, chum and chinook fry emigration commences in March, a month with a low potential dilution of pulpmill effluent. Juvenile chum, chinook and coho salmon were caught in the Kitimat estuary from the onset of sampling in early-April to the end of sampling in August.

The Kitimat River is a major steelhead trout producer and provides a valuable sport fishery. Steelhead are found primarily upstream of the Eurocan pulpmill but spawning occurs over February to May and the adult fish must pass through the river in a low potential dilution period.

The potential effect of the Eurocan discharge on the various life stages of salmonids has never been studied. The pilot hatchery at Eurocan or the new hatchery facility could provide an opportunity to study the effect a kraft pulpmill effluent may have on the various life stages of salmon development and their viability. It is suggested that this type of research should be considered in conjunction with, and in light of, salmonid enhancement activities on the Kitimat River. The uptake of resin acids by salmonids and the effect on juvenile salmon (acclimated to low temperatures) of a short term thermal shock to pulpmill effluent could also be studied.

Since the Eurocan pulpmill started production in 1970, the annual spring run of eulachons to the Kitimat River have been reported to

be tainted. As such, eulachon are not taken from the Kitimat River in any quantity now. The isolation of tainting agents in the pulpmill effluent and eulachon requires investigation. There have not been any complaints of tainted salmonids being caught in the Kitimat River.

Eurocan's environmental monitoring program on the Kitimat River has shown that the mill discharge affects water quality and to some degree benthic invertebrates. The largest impact on water quality is immediately downstream of the diffuser. For the Spring and Autumn periods, sodium, colour and conductivity levels indicate the influence of the effluent is still detectable at the estuary. The largest impact on water quality should be in February and March when dilution is minimal. Dissolved oxygen levels in the Spring and Autumn have remained above 90% saturation and do not appear to be influenced by the pulpmill discharge. The benthic invertebrate portion of the Eurocan monitoring program has indicated that the stations downstream of the outfall have exhibited varying degrees of biological impairment compared to control stations. However, the presence of large numbers of pollution tolerant organisms at the control stations in the 1980 survey has been reported to indicate that care is required in interpreting the biological data. No major trend of serious biological disruption has been established but the findings to date show the importance of maintaining an environmental program. A review of the detailed benthic invertebrate identification data may be of value in assessing if that component has shown any changes over the years. The spring sampling survey, first made in May 1978, is seen as a data gap. A spring survey is expected to be continued by the pulpmill and the survey should preferably be made in April.

Solid wastes landfilled on the Eurocan site have reduced the water quality of Beaver Creek downstream of the mill. Coho salmon once reported to spawn in the creek have not been reported in recent years. Anderson Creek, into which Beaver Creek drains, still supports coho salmon. The inclusion of Anderson Creek in the monitoring program should be considered.

There has been no reported effect of the present pulpmill discharge on the Kitimat River delta or estuary. However, should a bleaching operation ever be realized at Eurocan, an effluent dispersion study and the background levels of chlorinated organics in the sediment and biota of Kitimat Arm should be made.

1 INTRODUCTION

The Eurocan Pulp and Paper Company kraft pulpmill is located at Kitimat on the mainland coast of British Columbia, approximately 715 kilometers northwest of Vancouver by water (Figure 1). The pulpmill was completed in 1970 and is situated adjacent to the Kitimat River which flows into the Kitimat Arm of Douglas Channel. Pulpmill effluent receives biological treatment and is discharged into the Kitimat River approximately 3.2 kilometers upstream of the river mouth.

The Kitimat River has significant salmon resources. All five species of Pacific salmon are present in the Kitimat River as well as Dolly Varden char and cutthroat and steelhead trout.

This review has been restricted to effluent quality for the period 1976 to 1980 as it relates to biochemical oxygen demand (BOD_5), total suspended solids (TSS) and toxicity, to the anadromous fishery resources of the Kitimat River and to the findings of receiving water studies conducted to assess the aquatic impact of the pulpmill discharge. Effluent quality data have been derived primarily from mill monitoring results submitted to the Environmental Protection Service (E.P.S.). Fishery resource information on the Kitimat River has been obtained from the Department of Fisheries and Oceans (D.F.O.). The status of environmental knowledge to 1976 for the Kitimat River and estuary has been reported by Bell and Kallman (1).

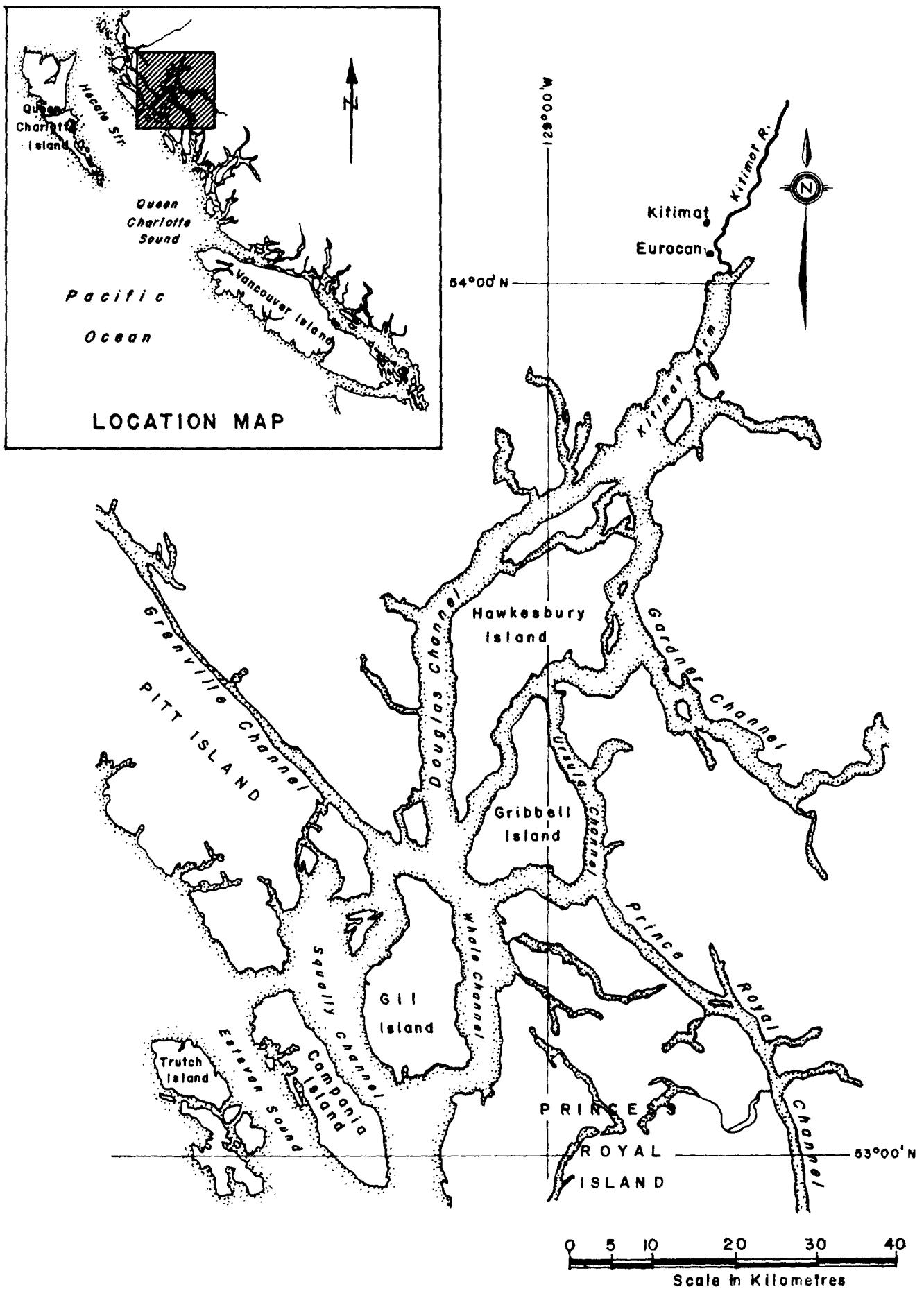


FIGURE I KITIMAT ARM AND CONTIGUOUS WATERS

2 PULP MILL OPERATIONS

2.1 Operational History

The Eurocan Pulp and Paper Limited mill started operations in October, 1970, at a designed production of 830 ADt/day, and has to date not undergone any major modifications to increase production (Table 1). Eurocan had at one time considered the feasibility of adding a bleaching plant to their operation. It was anticipated that this would have increased the mill's effluent discharge from approximately 68 200 m³/d to approximately 80 000 m³/d. The additional discharge would have been made through a marine outfall.

2.2 Effluent Treatment and Disposal

The treatment facilities are designed to treat the total effluent from the pulpmill and wood mill (Table 2). The retention time of the aerated stabilization basin is approximately 5 days. Effluent collection and treatment facilities are shown schematically in Figure 2. The treated effluent flows by gravity through a buried pipe and is presently being discharged through an outfall into the middle of the Kitimat River. River sedimentation problems were experienced with the original ten-port diffuser and this resulted in the use (since February, 1975) of the present single-port outfall.

An additional 300 hp of aeration capacity was added to the aerated stabilization lagoon in May, 1978. In September 1980, 107 meters of floating baffle was added to the 152 meter wooden baffle in the aerated stabilization lagoon to reduce possible short circuiting in effluent treatment.

TABLE 1 MILL DESCRIPTION

Mill Type	Average Production (ADt/day)	Average Annual Flow (m ³ /s)	Wood Furnish
Unbleached kraft producing linerboard and kraft paper	1976 - 766	1976 - 0.77	Hemlock.....30%
	1977 - 801	1977 - 0.81	Balsam.....22%
	1978 - 792	1978 - 0.83	Lodgepole pine.....30%
	1979 - 801	1979 - 0.84	Spruce.....11%
	1980 - 844	1980 - 0.87	Miscellaneous..... 7%

TABLE 2 TREATMENT FACILITIES

Toxic Spill Basin	Primary Clarifier	Settling Ponds	Aerated Stabilization Basin
18 925 m ³	24 meter diameter	two, each of 22 710m ³	- approximately 5 day retention lagoon - 9 (100 hp) floating low speed mechanical aerators plus four (75 hp) aerators installed May, 1978

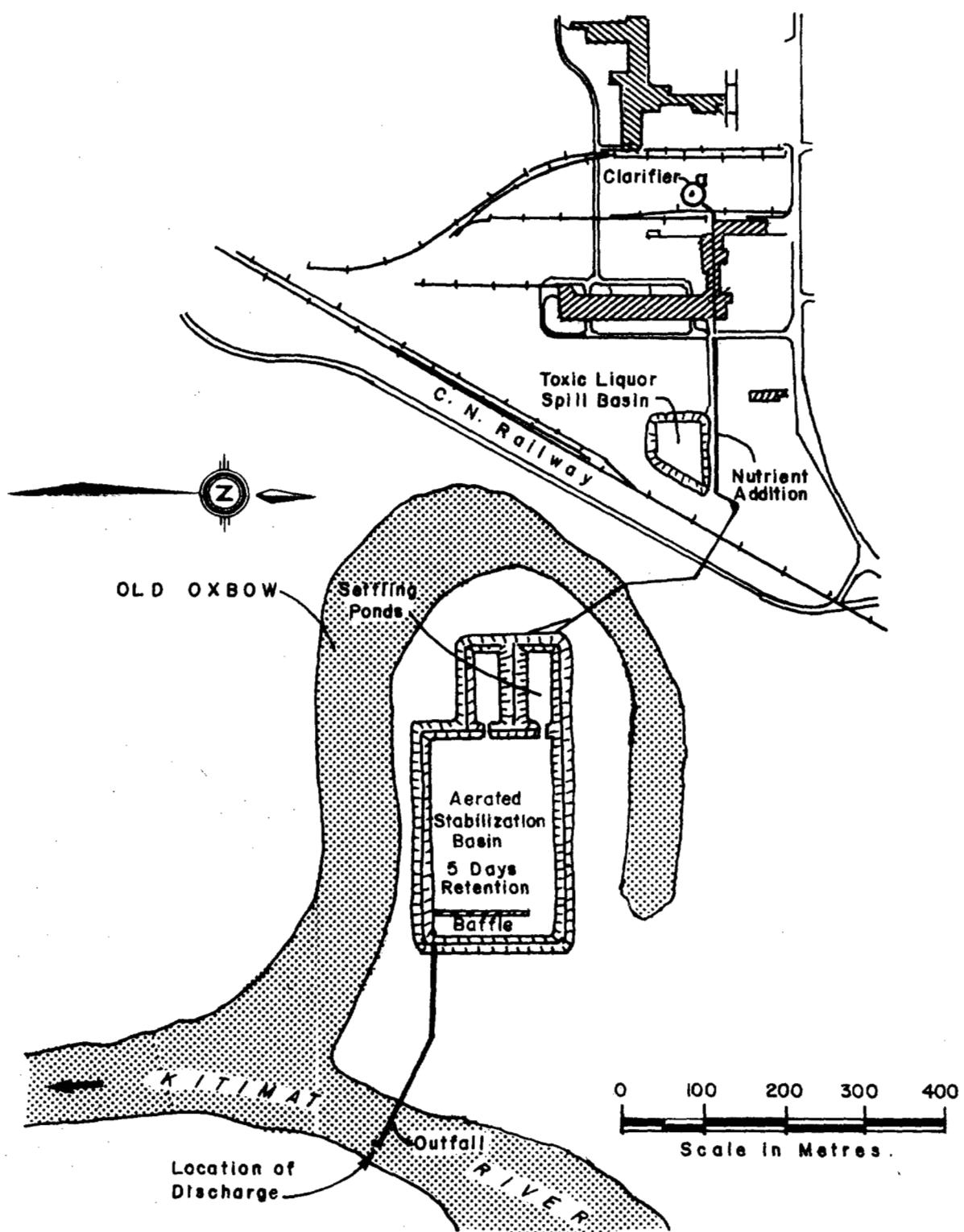


FIGURE 2 EUROCAN PULPMILL EFFLUENT TREATMENT FACILITIES

3 FEDERAL AND PROVINCIAL ABATEMENT REQUIREMENTS

Federal Pulp and Paper Regulations (2,3) were introduced in 1971. The Provincial Pollution Control Objectives for the Forest Products Industry of B.C. were first introduced in 1971 (4) and revised in 1977 (5).

3.1 Federal Requirements for Effluent

Under federal regulations, total suspended solids (TSS), biochemical oxygen demand (BOD_5) and toxic wastes are prescribed as deleterious under the Fisheries Act. To date, the federal approach to regulation implementation has been to achieve compliance via the provincial Waste Management Branch permit system. This approach has generally been workable, especially for mills discharging to freshwater where provincial requirements have paralleled federal regulations. The parameters of TSS, BOD_5 and toxicity have been assessed in Section 4 on that basis.

3.2 Provincial Requirements for Effluent and Solid Waste

The Eurocan pulpmill is required to meet the effluent requirements outlined in permit PE-292, which was last amended December 5, 1975, and which reflects the 1971 Pollution Control objectives. The permit allows for an effluent discharge of 68 200 m^3/d to the Kitimat River. Effluent characteristics prescribed on permit PE-292 for TSS, BOD_5 and toxicity are listed in Appendix I. Eurocan has applied (June 15, 1981) to the WMB to amend permit PE-292 to reflect the 1977 objectives and a proposed production rating of 1040 ADt/day (Appendix I).

Industrial solid waste disposal requirements for the pulpmill are stipulated in permit PR1650 issued November 26, 1974. Refuse includes settling pond solids, green liquor dregs, slaker dregs, power boiler ash and wood mill wastes. A water quality monitoring program is required as part of the permit (Figure 3).

Domestic sewage from the Eurocan pulpmill is discharged to the Kitimat municipal sewage system which consists of an aerated lagoon. The sewage outfall is located just upstream of the pulpmill outfall.

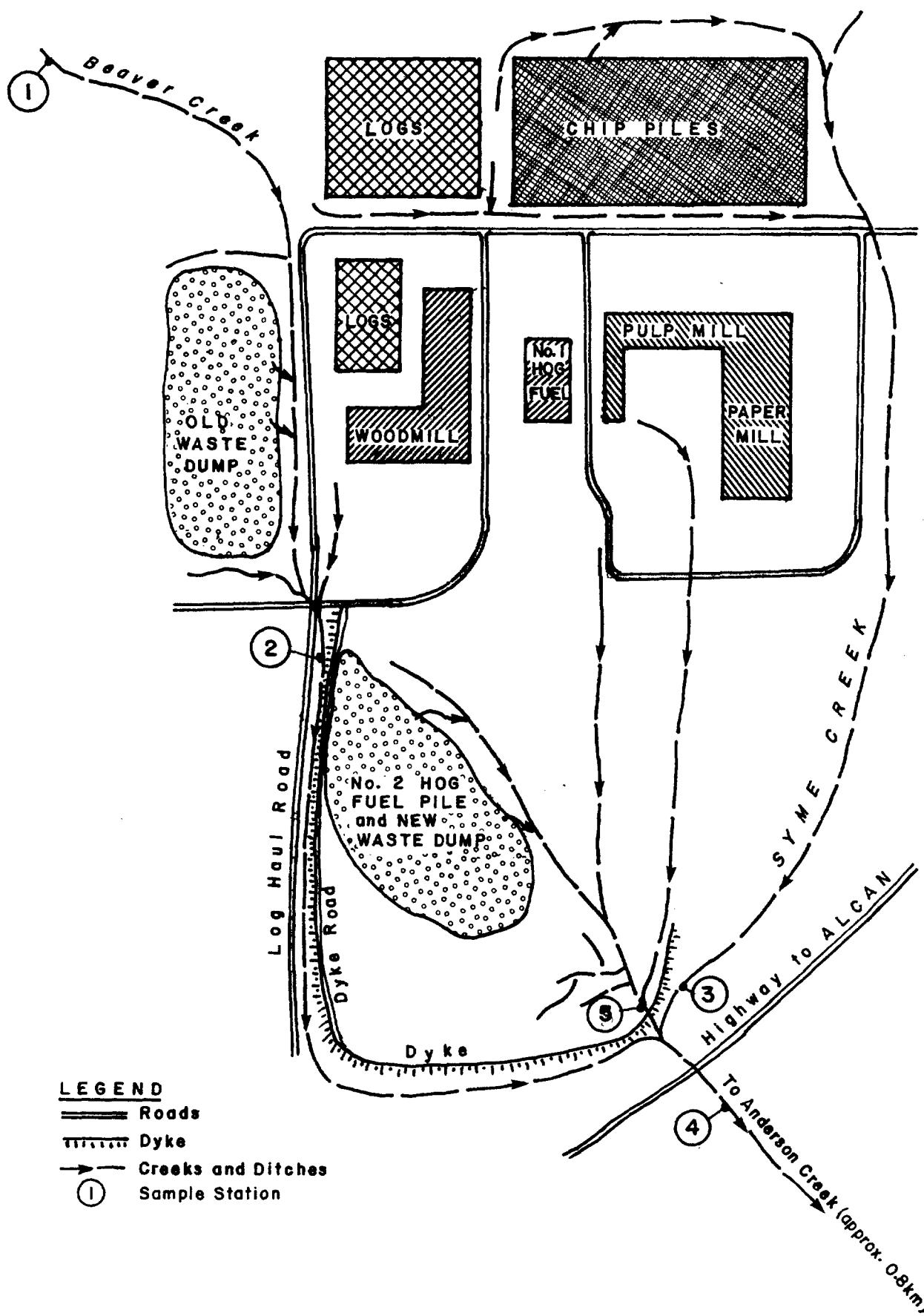


FIGURE 3 EUROCAN PULPMILL SOLID WASTE DISPOSAL AREAS AND SAMPLE STATIONS

4 EFFLUENT ASSESSMENT

4.1 TSS and BOD₅ for 1976 to 1980

Discharges of TSS and BOD₅ from the final aerated stabilization basin have been calculated for 1976 to 1980 (Table 3). The values reflect an approximate daily loading for a given month calculated from a representative number of individual daily production and effluent quality results for that month.

The yearly average loading for BOD₅ ranged between 5 164 Kg/day in 1976 to 7 240 Kg/day in 1980. With the exception of 1977 and 1980, the yearly averages were below the Eurocan permit limit of 6 750 Kg/day. For TSS, the yearly average loading ranged from 5 950 Kg/day in 1976 to 11 454 Kg/day in 1978. Up to 1979, the yearly averages all exceeded the permit limit of 6 750 Kg/day. For the second half of 1979, the TSS loading was 4 713 Kg/day compared to the first half loading of 11 910 Kg/day. In 1980, the yearly average was 5 950 Kg/day and is a significant reduction compared to earlier years.

4.2 Toxicity for 1974 to 1980

Provincial 1971 objectives (4) in force until 1977, specified a static bioassay test in which 50% of the test fish survive a 96-hour exposure to a specific effluent concentration. A 90% effluent concentration was to be used where the final effluent dilution was greater than 20:1 and a 100% concentration where dilution was less than 20:1 in the receiving water (as is the case for the Eurocan pulpmill). Effluent testing was required quarterly, with a provision for weekly testing in the event of failure to meet the specified toxicity level. The 1977 objectives (5) specify 50% survival during a 96-hour static bioassay of 100% effluent irrespective of dilution potential. A monthly monitoring frequency is suggested in the 1977 objectives and if a failure is detected, the frequency should be every two weeks until the objective is met.

Walden et al. (6) reported the provincial objective of 50% survival in a 90% effluent concentration over 96 hours exposure (static test)

TABLE 3 EUROCAN PULPMILL EFFLUENT TSS AND BOD₅ LOADINGS (Kg/d) FOR 1976 TO 1980

	1976		1977		1978		1979		1980	
	BOD ₅	TSS	BOD ₅	TSS	BOD ₅	TSS	BOD ₅	TSS	BOD ₅	TSS
January	2427	7045	8354	8400	11545	11809	7509	11127	9800	6390
February	3991	8282	10427	13664	9209	13454	7227	12300	11000	6150
March	3691	8272	11136	11973	4745	9064	6726	14754	13180	8270
April	4336	6009	8118	6200	5909	10173	7091	10973	9510	7760
May*	3573	9036	4609	6891	5545	10009	6736	10436	3100	8700
June	3191	6645	3527	5973	4082	11936	3891	11873	4420	7130
July	2900	3627	4273	7036	2573	12527	1809	5764	5190	4480
August	6336	5782	3991	9745	3509	14218	3927	4854	5700	4350
September	4245	5391	5073	9009	6036	10818	4518	3254	7750	3660
October**	3700	7127	7173	10891	3709	11173	4609	5391	7030	5870
November	10309	9800	11054	13527	4436	9082	3554	2927	5930	3750
December	11809	7554	4427	10545	5482	13127	6182	6091	4220	4840
Average	5164	7018	6854	9491	5564	11454	5318	8309	7240	5950

* May 30, 1978. 300 hp of aeration capacity added to aerated lagoon.

** On September 24-26, 1980, 107 meters of floating baffle was added to existing 152 meter wooden baffle. Aeration as of October 1, 1980 was 1225 hp.

to be slightly more stringent than the federal routine monitoring bioassay of 80% survival in a 65% effluent concentration over 96 hours exposure (static test).

In December 1975, E.P.S. initiated an effluent monitoring program to determine the extent of compliance of B.C. pulpmills with federal standards. Under the program, each mill sent effluent samples to the E.P.S. laboratory for bioassay. The effluent concentrations tested at 90% and 100% directly related to provincial objectives and those at 65% with federal monitoring requirements.

A listing of all bioassays conducted on the Eurocan pulpmill over 1974 to 1980 are included in Appendix II and a summary of those results is provided in Table 4.

The results show that the toxicity removal performance of the aerated stabilization basin has up to the winter of 1980/81 been highly variable and generally substandard. The annual percent of samples passing the 100% effluent standard ranged from 30% in 1976 to 57% in 1978. The addition of 300 hp of additional aeration capacity to the aerated lagoon in May, 1978 may have contributed to the improvement in toxicity removal noted in 1979 with 77% of the samples passing the toxicity test. However, over the 1979/80 winter period and the 1980 spring period the effluent failed to pass the toxicity standards and overall only 30% of the samples passed the 100% effluent standard in 1980. A 107 meter extension of floating baffle was added to the 152 meter wooden baffle in the aeration stabilization basin in September 1980. The installation was made to reduce possible short circuiting in effluent treatment (G.Tanner, per.comm., EPS). For the last quarter of 1980 and up to May, 1981 (EPS unpublished 1981 bioassay records) the effluent has been non-acute toxic. Thus, the failures usually experienced over the winter period did not occur in 1981.

Should the reader wish to review acute toxicity bioassay monitoring in detail he is referred elsewhere (7,8, 9,10). For detailed information on the toxic fractions in pulpmill effluents the reader is also referred elsewhere (7,11,12,13).

TABLE 4 ANNUAL PERCENT PASS TO FEDERAL (65% effluent - 80% survival)
AND PROVINCIAL (90% and 100% effluent - 50% survival)
TOXICITY REQUIREMENTS FROM 1974 to 1980

Year	Annual Percent Passing		
	Federal Standard	Provincial	
		65%	90%
<u>Eurocan Pulpmill</u>			
1974	73 (15)	--	--
1975	78 (9)	--	--
1976	57 (7)	40 (10)	30 (10)
1977	29 (7)	35 (17)	39 (18)
1978	43 (7)	40 (10)	57 (14)
1979	75 (4)	70 (10)	77 (13)
1980	38 (8)	42 (12)	30 (10)

Note: () = number of bioassays at specified effluent concentration, see Appendix II.

4.3 Monitoring and Miscellaneous Studies

On a monthly basis, the Eurocan pulpmill submits effluent quality results to the Waste Management Branch and E.P.S. A study of the Eurocan treatment system was made in 1973 to determine treatment efficiency (14).

5 RECEIVING WATER FEATURES

5.1 Kitimat River and Kitimat Arm

5.1.1 Kitimat River. The Kitimat River with its main tributaries drains an area of almost 200 000 ha. The major portion of the drainage basin on the east side of the Kitimat Valley is drained by the Kitimat River and by Chist, Hirsch, Davies, and McKay creeks. The west side of the valley is drained principally by the Wedeene and Little Wedeene Rivers, Anderson Creek and Moore Creek (Figure 4).

The substrate composition of the Kitimat River from the Kitimat River Bridge downstream to the old Indian village is typically a combination of boulders, gravel, and sand.

5.1.1.1 Hydrology. Continuous streamflow measurements have been made by the Water Survey of Canada (station #08FF001) on the Kitimat River below Hirsch Creek since 1964. Streamflow data from Water Survey of Canada records for 1976 to 1980 (15) have been analysed in relation to mill effluent output to assess potential dilution (Table 5). Immediate mixing of effluent is limited initially as the effluent is channelled along the west side of the river and full dilution potential is reached at some point further downstream. For the five years summarized, January, February and March had five-year monthly average flows of $54.5\text{m}^3/\text{s}$, $55.7\text{m}^3/\text{s}$ and $42.6\text{m}^3/\text{s}$ respectively and are generally the lowest flow months (Figure 5). As determined by the ratio of pulpmill discharge to the river flow, January, February and March are the months of minimum dilution (Table 5). The extreme minimum daily discharge recorded by Water Survey of Canada (1964-1979) was $9.2\text{m}^3/\text{s}$ on December 22, 1973(39). At the permitted discharge volume of $0.79\text{m}^3/\text{s}$, the dilution potential was 11.6:1. The month of April and the months of August through to December all can have periods of low potential dilution (Table 5). Maximum flows occur during the months of May, June, and July with five-year average flows of $177\text{m}^3/\text{s}$, $226\text{m}^3/\text{s}$, and $182\text{m}^3/\text{s}$, respectively.

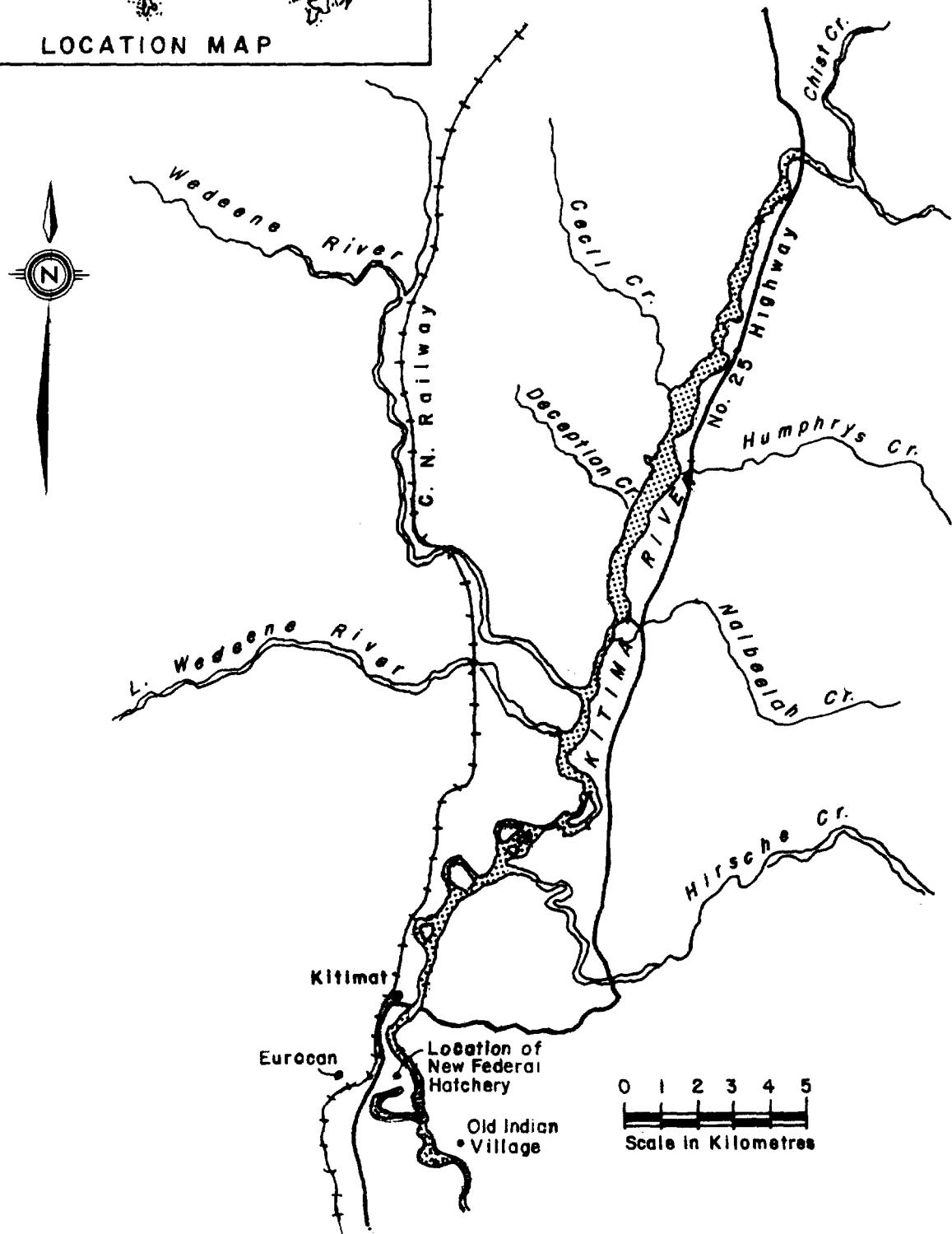
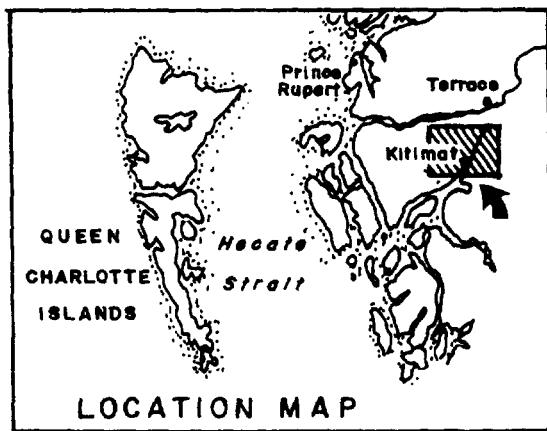


FIGURE 4 KITIMAT RIVER AND MAJOR TRIBUTARIES

TABLE 5 RATIO OF KITIMAT RIVER FLOWS TO THE EUROCAN PULPMILL EFFLUENT DISCHARGE FOR
1976 TO 1980

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.	69:1	69:1	52:1	138:1	216:1	269:1	219:1	171:1	145:1	241:1	196:1	134:1
2.	13:1	17:1	17:1	40:1	74:1	103:1	87:1	43:1	33:1	28:1	33:1	23:1

1. Average of the monthly mean flows for the Kitimat River over 1976 to 1980
Average of the monthly mean flows for the Eurocan Pulpmill over 1976 to 1980
2. Monthly minimum flow for the Kitimat River over 1976 to 1980
Monthly maximum flow for the Eurocan Pulpmill over 1976 to 1980

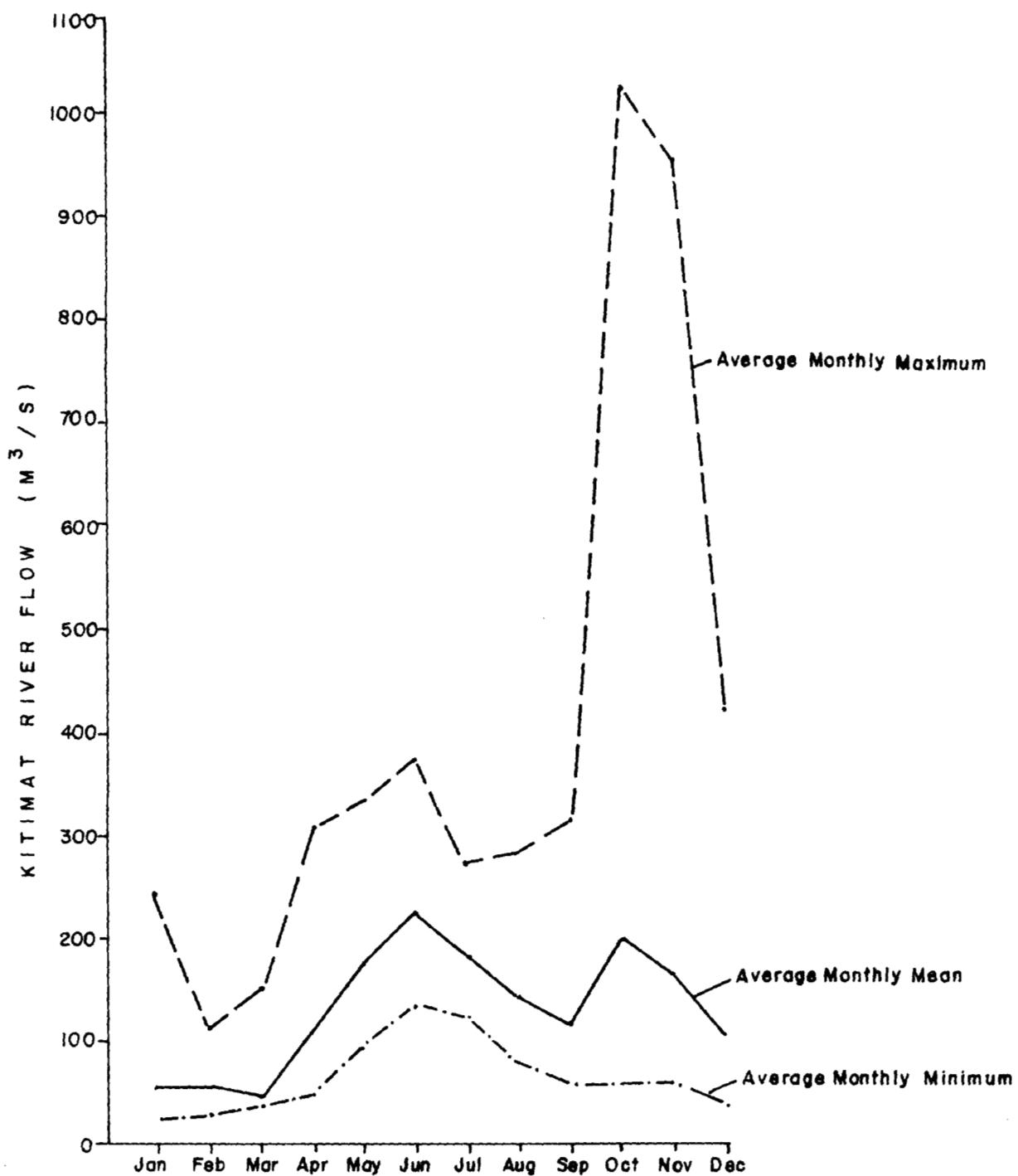


FIGURE 5 AVERAGE MONTHLY MAXIMUM, MINIMUM AND MEAN FLOWS FOR THE KITIMAT RIVER FROM 1976 TO 1980

5.1.2 Kitimat Arm

Bell and Kallman (1) reported that Kitimat Arm might be classed as a typical British Columbia fjord and that it is an extension of the Douglas Channel system (Figure 1). Kitimat Arm is a comparatively deep (220 m) fjord system with freshwater inflow at the head. The Kitimat River flows into Kitimat Arm mainly via the eastern half of the delta. The river fans out over Kitimat Arm in typical estuarine fashion and forms a relatively thin surface layer, usually less than 5 meters, of freshwater (1). In addition to the Kitimat River, Anderson and Moore Creeks drain into the northwest corner of Kitimat Arm. The surface freshwater layer entrains seawater from below as it progresses towards Douglas Channel and the volume of water in the upper layer moving seaward gradually increases with distance from the head of Kitimat Arm (1). Since the brackish layer does not substantially deepen seaward, the flow through the surface layer, and hence the current velocity, increases with distance from the Kitimat River (1). Bell and Kallman (1) reported there is evidence of freshwater hugging the western shore as far south as Bish Creek.

Bell and Kallman (1) concluded that there is a typical two-layered circulation in Kitimat Arm. There is a net surface outflow seaward resulting from the input of fresh water from the Kitimat River and Anderson and Moore Creeks. A net up-inlet flow must exist below the surface brackish layer to replace the seawater entrained into the brackish surface layer and transported seaward. In addition, there is no threshold sill at the entrance to Kitimat Arm and the deep water tends to be replaced quite regularly (1).

Bell and Kallman (1) reported that wind waves are best developed with southerly winds in the winter. The waves have an ecological impact on the deltaic populations of flora and fauna rendering the substrate for attachment of these organisms relatively unstable.

5.2 Fisheries Resource A detailed summary of the fishery resources of the Fisheries Statistical Area 6, including the Kitimat River, has been prepared by Knapp and Lashmar (16) and is reproduced in Appendix III(a). The discussion in this section pertains only to fish found in the Kitimat River and reference should be made to Knapp and Lashmar (6) for information on other fishery resources.

All five species of Pacific salmon as well as Dolly Varden char, cutthroat trout and steelhead trout are present in the Kitimat River system (16). All five species of salmon and steelhead trout which are caught incidental to salmon fishing are important in the commercial catch. Chinook, coho and steelhead are important sportfish in the Kitimat area.

Knapp and Lashmar (16) reported that there has been a general decrease in salmon escapements to the Butedale subdistrict despite restrictions imposed on the fishery. Fluctuations generally seem to be a response to spawning cycles, changing environmental conditions (ice scouring and flooding of spawning areas) and commercial fishing pressures (16). The Kitimat River and its tributaries support 17.5% of the total salmon escapement for the Butedale subdistrict (16). The Kitimat River system incorporates the major spawning sites in the Butedale subdistrict for chinook and coho and ranks second for chum and even-year pinks. Salmon escapements for the Kitimat River and tributaries are reported in Table 5 of Appendix III(a).

The impact of the Eurocan discharge on salmonids has never been studied but Knapp and Lashmar (16) expressed some concerns. They reported that salmon migrations span a period from May, with the start of the chinook migration, to November, the completion of the coho runs. They indicated the effects of effluent discharges on adult spawning success may be pronounced and immediate, as in mortalities due to increased toxicities, or less evident as in the case of decreased egg and adult viability. Further, emergent fry will also be under the influence of the pulpmill effluent during their seaward migration. Their smaller size and longer residence time in the river and estuary make them more susceptible to long-term effects of the mill effluent (16).

A pilot project for beginning enhancement of the Kitimat chinooks was started in 1977. Tray incubation facilities were established in cooperation with the Eurocan pulpmill and utilizing the company's potable water supply (18).

The results of chinook salmon studies conducted on the Kitimat river system to May, 1980 and the pilot hatchery operation have been reported by Hilland et al (20). In the spring of 1978 (March 31 to mid-June) a downstream trapping program was initiated to establish the timing and population size of emigrant Kitimat chinooks. Although an estimate of the size of the migrant chinook fry and smolt population was not obtained, a rough idea of the timing of these migrations was obtained, (20). Fry migration commenced prior to March 31 (the first day of trapping) and terminated on May 5 (peak on May 1). The only chinook yearlings were captured in early April, with an apparent peak on April 9. In total, 1578 of 1976 brood chinook smolts were coded-wire tagged during the trapping program (20). During the program, 27,000 coho smolts were coded-wire tagged to obtain baseline information on the Kitimat stock and incidental downstream catches included 250,000 chum fry, 77,000 river-rearing sockeye fry and 10,000 steelhead and cutthroat trout and Dolly Varden (19).

Since 1977 (1977 to 1979) approximately 314,775 chinook salmon eggs have been taken for the pilot hatchery in spite of donor stock scarcity and relatively high pre-spawning mortality (20). Releases to the Kitimat River for the brood year 1977, 1978 and 1979 were 74,823, 151,771 and 39,199 respectively (20). The number of coded-wire hatchery "90 day" smolts released to the Kitimat River for the brood year 1977, 1978 and 1979 were 74,996, 73,436 and 36,862, respectively (20). The tag returns will be valuable in determining marine survival, distribution and fishery contribution.

To provide additional baseline information on juvenile salmon stocks of the Kitimat River, DFO commissioned a project to collect and assess biological, migration and distribution data needed for the design and operational strategy of the proposed Kitimat hatchery (41). A summary

of the migration timing as determined from that project is provided in Appendix III(b). Birch et al (41) reported that since the field studies didn't start until early-April, an estimated 75-80% of the out migration of pink fry may not have been monitored. In addition, chum fry migration also probably began in March and thus the early run was not monitored (41). Chinook fry migrations in March were also missed in the study.

Paish (17) reported significantly greater catches of juvenile salmon from the vegetated central and east intertidal delta areas than the non-vegetated intertidal areas of the west and central delta. Juveniles of chum, chinook, and coho salmon were seined off the river delta and largest catches were obtained in May. Juvenile salmon were caught throughout the sampling period which extended over May to July. Birch et al (41) reported that juvenile chum salmon were found in all parts of the estuary in April and May, and were the most numerous salmonids. They moved seaward in late May but large numbers subsequently returned in July and remained until August. Juvenile chinook were present in the estuary throughout the study (early-April to late-August)(41). Chinook fry were present in April, peaked in May and most had left the estuary by July (41). Chinook smolt numbers peaked in mid-May and declined through July. Birch et al (41) reported coho juveniles were concentrated in the central estuary. The coho fry numbers peaked in June and they were still present in August while smolts peaked in May and moved offshore in July.

Hilland et al (20) reported that an adequate supply of water for a full scale hatchery on the Kitimat River has been found next to the Eurocan intake. Dave McNeil (per. comm., 1982, Kitimat Hatchery) reported that construction of the new hatchery is well underway and may be completed in 1983. In the interim, a pilot operation is being utilized at the new site for chinook, chum and coho salmon.

During April to June 1977, a creel census of Kitimat River steelhead was made. From earlier 1976 work and the 1977 samples it was shown that steelhead spend three to four years in freshwater before migrating to sea (18). A high percentage were repeat spawners and this

appears to be characteristic of short-run, spring migrant steelhead populations. Major spawning sites were located along the mainstem for approximately 65 Km, however, many tributary streams also contained spawners (18). Knapp and Lashmar (16) reported a trend towards increasing numbers of anglers and catches in recent years in the steelhead sport fishery. Steelhead spawning occurs from February to May, with the peak occurring in April (16).

Eulachon have been an important source of food and oil to the people of the Kitamaat Village, however, recently fewer fish have been taken, possibly as a result of tainting by pulpmill effluent (16). Eulachon spend most of their life in coastal waters, migrating during their second or third years into freshwater to spawn, usually from March to May. The adults die after spawning and the eggs incubate for 2-3 weeks prior to hatching. The newly hatched fry migrate almost immediately to sea (16).

6

ENVIRONMENTAL IMPACT AND ASSESSMENT STUDIES

Bell and Kallman (1) compiled and reviewed the status of environmental knowledge up to 1976 for the Kitimat River and estuary. Additional information has since been collected as part of the Eurocan pulpmill environmental monitoring program to assess the impact of the effluent discharge on the Kitimat River.

6.1 River Studies

Pre-pulpmill surveys of the Kitimat River and upper Kitimat Arm (water quality and benthic invertebrates) were conducted on behalf of Eurocan in 1969-70 (21). Post-pulpmill surveys of a similar nature were made in 1971 (22). Water quality and macroinvertebrate surveys were made concurrently on the Kitimat River in 1973 (23) and 1976 to 1980 inclusive (24, 25, 26, 27, 38). Water quality surveys for mill usage purposes were made over July 1966 to July 1968 (28). Eurocan have also collected water quality data on the Kitimat River on a semi-regular basis over 1970 to 1979.

6.1.1 Water Quality. A summary by the author of the water quality data collected by Eurocan on the Kitimat River over 1973 to 1980 is reported in Appendix IV(a). May and September were summarized as they constitute the months with the largest data base. Samples collected on March 31, 1977 and April 22, 1980 have been included in the May summary on the basis they represent the Spring period. Sample stations referred to are shown on Figure 6. For stations 3 to 6, cross profiles are taken and (a) denotes that the sample was three meters from the west bank, (b) center of the river and (c) three meters from the east bank. Station 2a was located approximately 30.5 meters downstream of the diffuser and station 3a was approximately 400 meters downstream of the diffuser.

The most noticeable effect of the pulpmill discharge is at station 2a, for both Spring and Fall, with elevations above baseline for temperature, sodium, colour, conductivity, and total solids. The effluent

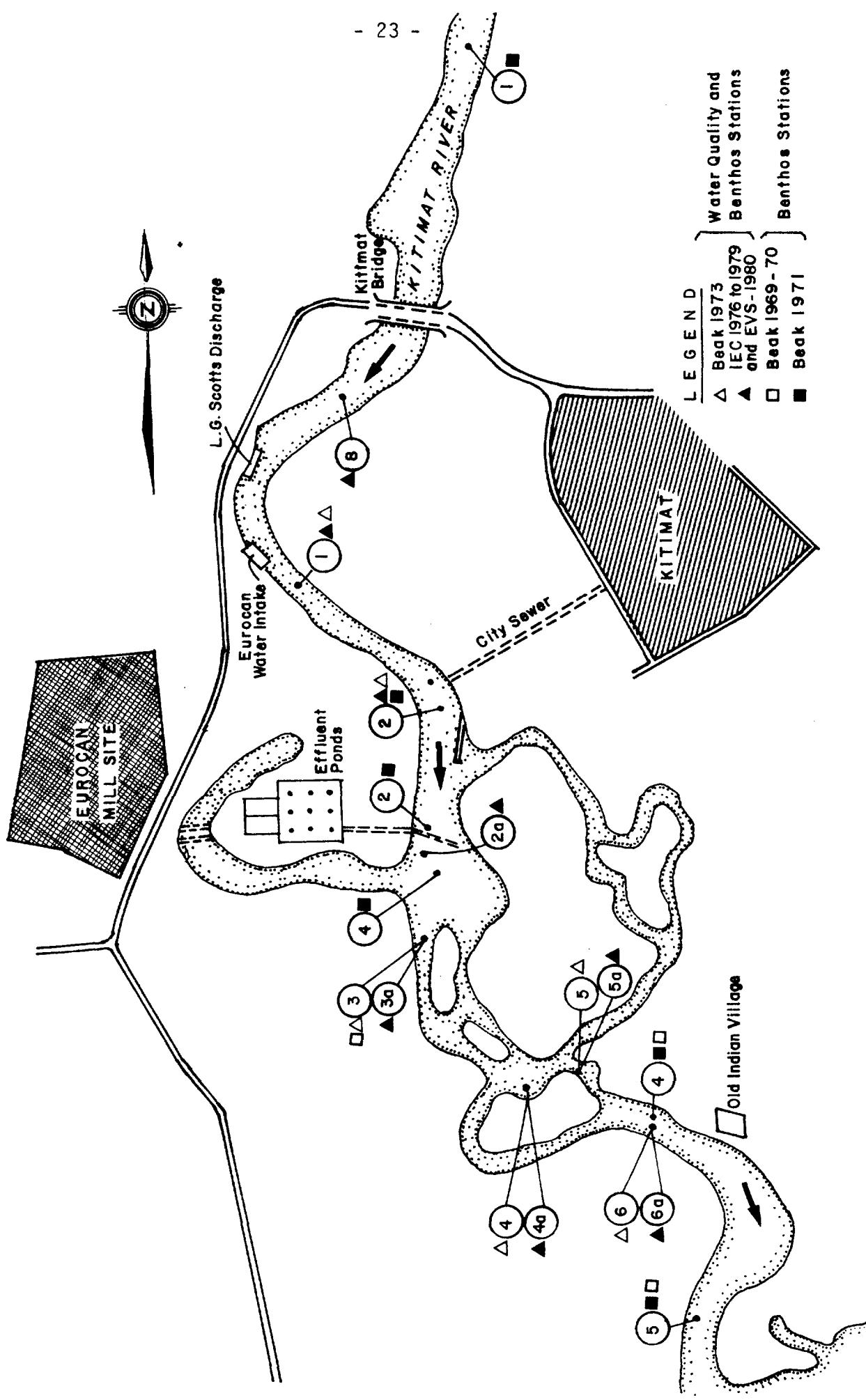


FIGURE 6 VARIOUS SAMPLE STATION LOCATIONS USED IN THE EUROCAN PULPMILL
KITIMAT RIVER MAINTENANCE SURVEY

is initially channelled along the west side of the river before complete mixing is evident right across the river at station 4, 1.6 Km downstream. For Spring (March-April-May) and Fall (September), colour, sodium and conductivity generally remained above background levels to station 6 indicating the influence of the effluent is still detectable 2.4 Km downstream. February and March are generally the minimum river flow months and thus the periods when maximum potential change in water quality due to pulpmill effluent would be expected.

On March 31, 1977 a high temperature of 20°C was measured at station 2a, 30.4 meters downstream of the outfall [Appendix IV(a)]. The upstream river temperature was 5.2°C and the effluent temperature was 28°C [Appendix IV(a)]. The river flow was 46m³/s and the effluent flow was 0.84m³/s for a theoretical dilution ratio of 55:1. Although 20°C is below the upper lethal temperatures for Pacific salmon fry (21.3-22.9°C) at an acclimation temperature of 5°C [Brett (37)], it is a notable temperature increase signifying poor dilution during a period of downstream salmon emigration. Brett (40) reported that pink and chum salmon fry were least resistant to elevated temperatures. For pink salmon, he reported that at the 5°C acclimation temperature, mortality was unexpectedly rapid at the 22.5°C and 23°C temperatures. Unfortunately, sufficient fish weren't available to test lower temperatures (40). A summary of Eurocan's final effluent temperatures for March, April and May (1977-1980) are given in Appendix IV(b). Generally, effluent temperatures are below 28°C in March and April. However, should future effluent monitoring results and/or receiving water studies indicate unacceptably high temperatures during the spring period, consideration should be given to assessing the effect of short-term thermal shocks of pulpmill effluent on juvenile salmon (particularly pink and chum salmon fry) acclimated to low temperatures.

Beak (23) reported that the localized effect of the pulpmill effluent should not constitute a serious hazard to migrating fish but this has never been studied. Dissolved oxygen percent saturation levels were calculated from the temperature and dissolved oxygen levels reported by

Eurocan [Appendix IV (a)]. Saturation levels in Spring and Fall periods remained above 90% saturation, even at station 2a.

6.1.2 Benthos. Various sample station locations used in the Eurocan environmental program to monitor the Kitimat River are shown on Figure 6. Field methods used in the macroinvertebrate surveys are outlined in Table 6.

It should be noted that the original pre-pulpmill surveys and the first post-pulpmill survey utilized artificial substrate samplers for macroinvertebrate collections in July and August while the surveys over 1973 to 1980 utilized sample methods that sampled the natural substrate. Since 1973, for all but the 1976 survey (when a Surber sampler was used) samples have been collected with a Waters and Knapp circular sampler. With the exception of the 1979 survey, which was delayed to the end of October due to high river flows, the Fall surveys have all been made in September. A spring survey was first made in May 1978, but was not repeated in 1979 due to high river flows. A spring survey was conducted again in April, 1980. Comparisons made between the earliest pre- and post-pulpmill surveys and the later post-pulpmill surveys are not warranted, primarily due to the differences in sample methods and to seasonal variability in invertebrate life cycles.

Sample stations downstream of the Eurocan outfall have been reported to indicate that some disruption in the benthic invertebrate community structure occurs. In discussing the survey findings, the consultants have categorized the macroinvertebrates in terms of pollution sensitivity (biotic index). Group 3 organisms are considered pollution sensitive, Group 2 organisms as facultative and Group 1 organisms are pollution tolerant. A summary by the author of the 1973 and 1976-1980 Fall survey findings, as reported in the consultant reports, are reproduced in Table 7. The total average number of organisms per square meter and the average number per pollution sensitivity group is based on an analysis of

TABLE 6 FIELD METHODS USED IN THE EUROPEAN PULPMILL
MACROINVERTEBRATE STUDIES

Report (Year Reference)	Benthos
<hr/>	
<u>Pre-Pulpmill</u>	
1969-1970 (18)	<ul style="list-style-type: none">- 5 sample locations;- artificial substrate steel trays, 1 month colonization, 6 per station, July and August 1969, 1970. <hr/>
<u>Post-Pulpmill</u>	
1971 (19)	<ul style="list-style-type: none">- 5 sample locations;- artificial substrate steel trays, 15" dia., 1 month colonization, 6 per station, July and August, 1971.
1973 (20)	<ul style="list-style-type: none">- 6 sample locations;- circular sampler (Waters and Knapp, 1961) 10 replicates per station in September 1973 (Station 5 not sampled).
1976 (21)	<ul style="list-style-type: none">- 8 sample locations;- Surber sample (.093m²), 4 replicates per station in September 1976.
1977 (22)	<ul style="list-style-type: none">- 8 sample locations;- circular sampler (Waters and Knapp, 1961), (.13m²), 4 replicates per station in September 1977;- also periphyton scrapings.
1978 (26)	<ul style="list-style-type: none">- per 1977 but with a May 1977 sampling added.
1979 (27)	<ul style="list-style-type: none">-- per 1977 but samples collected in October and no spring sampling.Also, no periphyton scrapings.
1980 (38)	<ul style="list-style-type: none">- per 1977, Spring samples collected in April

TABLE 7: SUMMARY OF THE AVERAGE NUMBER PER SQUARE METER OF POLLUTION SENSITIVITY GROUPS OF MACROINVERTEBRATES AND SAMPLE DIVERSITY FROM THE FALL EUROCAN PULPMILL KITIMAT RIVER SURVEYS

	STATION 8					STATION 1						
	1973	(1976)	1977	1978	(1979) **	1980	1973	(1976)	1977	1978	(1979)	1980
Group 3	-	143.0	269.3	202.3	139.2	51.9	67.7	83.9	378.9	517.7	286.5	669.0
Group 2	-	3.2	9.6	0	0	48.1	13.1	5.4	32.7	10.0	1.9	153.8
Group 1	-	0	0	0	0	48.1	0	0	15.4	7.7	0	720.9
Average #/m ³	-	146.2	278.9	202.3	139.2	148.3	80.8	89.3	427.0	535.4	288.4	1424.6
Diversity	-	1.96	2.31	0.83	0.69	2.81	1.10	2.06	3.44	1.89	3.09	3.03
Total Taxa	-	5	10	3	3	9	3	5	19	11	14	14
Total Number	-	12	47	17	16	22	11	9	80	72	46	103
	STATION 2					STATION 2a					1980***	
	1973	(1976)	1977	1978	(1979)	1980	1973	(1976)	1977	1978	(1979)	1980***
Group 3	211.5	740.2	421.2	404.6	136.6	459.5	-	105.4	188.5	16.8	61.6	274.9
Group 2	283.8	101.1	17.3	9.2	5.8	123.0	-	51.7	15.4	33.0	0	49.9
Group 1	14.6	0	0	0	0	59.6	-	0	0	592.3	0	5.8
Average #/m ³	509.9	841.3	438.5	413.8	142.4	642.1	-	157.1	203.9	642.1	61.6	334.5
Diversity	2.81	2.03	2.43	2.55	1.95	3.64	-	2.85	1.92	2.13	2.25	3.15
Total Taxa	14	13	11	11	6	18	-	9	11	5	5	14
Total Number	65	93	53	62	14	95	-	16	47	7	8	47

- 1973 * For 1973 3=3a, 4=4a, 6=6a. Only year Cladocenans included in benthic fauna at station 2.
 (1976) Surber samples, for all other years Waters and Knapp sampler.
 (1979)** Station 8 in 1979 relocated to east shore.
 (1979) Samples collected in October, for all other years the samples were collected in September.
 1980 *** Station 2a in 1980, 46 meters downstream and not usual 30 meters downstream.
 Station 3a in 1980, 213 meters downstream and not usual 400 meters downstream.
 NOTE: Average number per square meter based on four replicates. Diversity, total number and total taxa derived from one sample of four replicates.

(Continued)

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TABLE 7: SUMMARY OF THE AVERAGE NUMBER PER SQUARE METER OF POLLUTION SENSITIVITY GROUPS OF MACROINVERTEBRATES AND SAMPLE DIVERSITY FROM THE FALL EUROCAN PULPMILL KITIMAT RIVER SURVEYS

	STATION 3a					STATION 4a						
	1973*	(1976)	1977	1978	(1979)	1980***	1973*	(1976)	1977	1978	(1979)	1980
Group 3	55.3	64.6	134.6	227	115.3	71.1	156.2	126.5	125	72.3	19.3	92.3
Group 2	8.5	41.9	263.5	28.4	7.6	167.3	97	35	209.7	11.5	1.9	63.4
Group 1	330	0	69.2	7.7	3.8	132.6	71.5	5.4	30.8	7.7	0	82.7
Average #/m ³	398.8	106.5	467.3	263.1	126.7	371.0	324.7	116.9	365.8	91.5	21.2	238.4
Diversity	0.72	2.81	2.83	2.71	3.04	2.69	3.20	3.34	3.29	2.63	0	3.13
Total Taxa	5	9	14	12	11	11	15	11	15	7	1	11
Total Number	52	17	94	52	20	69	56	17	57	12	2	32

	STATION 5a					STATION 6a						
	1973	(1976)	1977	1978	(1979)	1980	1973*	(1976)	1977	1978	(1979)	1980
Group 3	-	16.1	9.6	9.2	69.2	11.5	22.4	43	15.4	155.4	13.5	94.2
Group 2	-	0	240.3	0	0	123.0	39.2	8.6	7.7	48.4	0	336.4
Group 1	-	0	3.8	0	0	90.4	50	3.2	6308.0	90.8	0	1814.8
Average #/m ³	-	16.1	253.7	9.2	69.2	224.9	111.6	54.8	6332.1	293.8	13.5	2245.5
Diversity	-	1.48	2.65	1.00	0.50	2.59	2.87	2.12	0.18	3.12	0	2.81
Total Taxa	-	3	9	2	2	8	10	5	4	12	1	9
Total Number	-	3	37	2	9	33	15	11	123	46	1	21

1973 * For 1973 3=3a, 4=4a, 6=6a. Only year Cladocerans included benthic fauna at station 2

(1976) Surber samples, for all other years Waters and Knapp sampler.

(1979) Samples collected in October, for all other years the samples were collected in September.

(1979)** Station 8 in 1979 relocated to east shore.

1980 *** Station 2a in 1980, 46 meters downstream and not usual 30 meters downstream.

Station 3a in 1980, 213 meters downstream and not usual 400 meters downstream.

NOTE: Average number per square meter based on four replicates. Diversity, total number and total taxa derived from one sample of four replicates.

all the replicate samples. The individual station diversity index, total taxa and total number of organisms were determined from one sample which received a detailed identification to the highest taxonomic level feasible, usually to genus or species.

Since 1973, the environmental monitoring surveys have been designed to separate the effects of the Kitimat City sewage outfall and the Eurocan pulpmill outfall. From Table 7 it is evident that the two control stations, stations 8 and 1, have generally been dominated by Group 3 organisms. However, EVS (38) showed this not to be the case in every year as large numbers of oligochaetes were reported at the control stations in 1980. There is also a large degree of yearly variability evident in terms of the standing crop (#/m²) of organisms (Table 7).

Beak (23) reported that in 1973 the benthic community at station 3, below the pulpmill diffuser, shifted to a dominance of oligochaeta (Group 1 organisms) but the community composition further downriver (stations 4 and 6) indicated a partial return to control conditions. The organic enrichment found downstream of the pulpmill outfall was reported not to constitute significant biological degradation (23). An increase in the number of Group 2 organisms was reported at station 2 downstream of the Kitimat sewage outfall (23). Cladocerans which were included in the sample analysis as Group 2 organisms, are often found associated with sewage lagoon discharges and do not constitute a part of the benthic fauna. The change in the resident fauna at station 2 was considered not to reflect biological degradation (23). IEC (24) reported that in 1976, at stations 2a and 3a downstream of the pulpmill outfall, a shift in the benthic invertebrate population was noted with a larger number of Group 2 organisms occurring at both stations. The oligochaeta present at station 3 (3 equivalent to 3a) in 1973 were absent altogether at that station in 1976 and although present, oligochaetes were found in much reduced numbers at the stations further downstream in 1976 (24). A dramatic increase in population numbers occurred downstream of the sewage outfall (station 2) again in 1976 but this was reported to be largely due to Cladocerans and

which were subsequently excluded from the final data summary (as seen in Table 7) since they were not truly a benthic species (24). A substantial increase in the number of Group 3 organisms (primarily the caddisfly Agapetus) also occurred at station 2 in 1976 and this was reported to indicate an enriched condition (24). IEC (25) indicated that in 1977 biological impairment was evident at station 6a, 2.4 Km downstream of the diffuser, where oligochaeta dominated the benthos. This impairment was reported to appear to coincide with low velocity conditions in the river. In 1977, station 2a was dominated by Group 3 organisms and primarily the mayfly Rithrogena. Stations 3a, 4a and 5a exhibited larger populations compared to 1976 and were dominated by Group 2 organisms (25). There were no signs of biological enrichment at station 2 in 1977 and population numbers remained similar to the control stations (25).

IEC (26) conducted river surveys in May and September, 1978 to assess seasonal differences. For both months, a shift in dominance from group 3 organisms to Group 1 organisms was observed at station 2a immediately downstream of the diffuser (26). The organism that accounted for this change was an oligochaete (Stylodrilus heringianus). With the exception of station 4a in May, Group 3 organisms dominated the benthos at stations 3a to 5a for May and September compared to the Fall of 1977 when Group 2 organisms prevailed (26). The highest density of Group 2 organisms occurred at station 4a in May. At station 6a in 1978, there was a decrease in the density of Group 1 organisms for both the May and September surveys, reflecting, a significant change from September 1977 (26). A dominance of Group 3 organisms was reported to occur in 1978 at station 2 downstream of the sewage discharge. In 1979, a May survey was not conducted due to high river flows and changes in the river bottom profile (27). A similar situation in September 1979 necessitated a postponement of the benthic survey to the end of October (27). IEC (27) reported that in 1979, the benthic populations at the stations were dominated by Group 3 organisms and that invertebrate density was lower than in the September 1977 and 1978 surveys. In 1979 the species diversity at stations 1, 4a and 6a was reduced

and it was suggested this might be due to streambed scouring during high flows earlier in October.

EVS (38) conducted river surveys in April and September, 1980. They reported there was very little difference in the percentage of organisms within each pollution sensitivity grouping at stations 8, 1 and 2 suggesting little effect due to the sewage discharge. The number of species and individuals decreased at station 2 and this was thought to reflect difficulties in sampling at that site or due to a change in substrate. At station 3a, Group 2 organisms dominated in April and this change was reported to suggest a moderate effect due to the Eurocan discharge (38). In April, Group 2 organisms dominated at station 5a and the most Group 1 organisms (oligochaetes) were found at station 6a. EVS (38) reported that oligochaetes prefer to live in fine sand or mud and station 6a was the only site where silt was observed. They reported that for April, the effects of the Eurocan effluent appeared to be slight and localized to site 3a. In September, 1980 the interpretation of the biotic index was complicated by the presence of large numbers of Group 1 organisms at control stations 1 and 8 (38). EVS (38) reported that their appearance may be due to a number of factors unrelated to industrial discharges and the influence of those factors stresses the need to interpret biological data carefully. In September, 1980 the highest number of species and fewest pollution tolerant organisms were found at stations 2 and 2a downstream of effluent discharges (38).

IEC (25,26) reported that the attached algae on the river substrate was generally too sparse to warrant quantitative sampling. In 1979, a photographic record of the station substrate was started.

The continuation of the present environmental program is warranted in light of findings to date on the influence of the pulpmill discharge. Continued monitoring of the Kitimat River in the Spring is needed, preferably no later than April. The presence of large numbers of oligochaetes at the control stations has been reported to indicate that the biotic index system is not always reliable and factors such as substrate

type, river flow and time of year must be considered in the interpretation of such data. In the annual reports, little attention has been given to the detailed invertebrate identification data. A review of that data in the annual report may be of value in assessing if that component indicates any specific trends related to the two effluent discharges.

6.1.3 Organic Pollutants. There is no data available on the levels of the toxic organic chemical constituents of the Eurocan kraft mill effluent (resin acids). There is no information on the levels of resin acids in the resident biota of the Kitimat River or estuary. Research into documenting their presence or absence may be of value in assessing the influence of the pulpmill discharge. Holmbom (35) reported that although resin acids constitute a key group of compounds in pulpmill effluents which are acutely toxic to fish, little is known about the fate of these fish-toxic compounds in effluent treatment systems and in the receiving waters. Holmbom (35) sampled fish caged in a lake system receiving biologically treated bleached kraft pulpmill effluent. He reported that significant bioaccumulation of resin acids in fish (plasma and bile) was found to occur in water containing only 20 ug/l of resin acids and there appeared to be a threshold level for bioaccumulation of resin acids between 5 ug/l and 20 ug/l. This concentration range in water might also constitute a threshold for physiological stress on the fish (35). He reported that the study results indicated that resin acids did not have any appreciable effects 3.5 Km from the pulpmill. Study of fish bioaccumulation may be one possible approach for determination of how far, in distance, from a pulpmill that the "stress on fish" of toxicants is extended (35). Kruzyński (36) reported on the uptake of dehydroabietic acid (DHA) in laboratory exposed sockeye salmon smolts, mature rainbow trout and the marine amphipod Anisogammarus. Kruzyński reported that laboratory exposure experiments established that salmon can rapidly accumulate DHA in major organs such as the brain, liver and kidney, and that high residue levels were probably related to the observed physiological dysfunctions in the test fish.

6.2 Fish Tainting

With the start-up of the Eurocan pulpmill in 1970, the annual spring run of eulachon to the Kitimat River allegedly became tainted (1). Bell and Kallman (1) reported that, since 1972, eulachon have not been taken from the Kitimat River in any quantity due to the alleged tainting by pulpmill effluent.

Eulachon samples were collected by the Fisheries and Marine Service in 1973 from the initial run up the Kitimat River. It was considered these fish would have had the least exposure to a tainting source (29). The eulachon were netted along various stretches of the river and thus had all been exposed to pulpmill effluent for some undetermined period. A taste panel judged the fish caught immediately below the diffuser to be the worst. Fish that had moved upstream of the Eurocan outfall were found to be tainted and the sample with the best score was obtained at the river mouth but was still judged to be of poor quality. This may indicate that the eulachons may be becoming tainted prior to actually entering the river. EPS (31) conducted trial tainting tests utilizing static assay methods, Fraser River eulachons and Eurocan pulpmill effluent. The results indicated that taste and odour of eulachons showed a stepwise progression of poorer quality with increased pulpmill effluent concentration.

The Fisheries and Marine Service, concerned that tainting of salmon returning to the Kitimat River would occur, conducted a study utilizing sockeye salmon (30). Sockeye salmon (45-80 gram mean weight) obtained from Nanaimo were exposed in a static test to various concentrations of Eurocan pulpmill effluent. It was found that the degree of tainting was directly related to the concentration of effluent to which the fish were exposed. Slight off-flavour was detected in the control fish held on the pulpmill site but not in controls held at Nanaimo and West Vancouver and aerial contamination was suspected.

Bell and Kallman (1) reported that complaints have not been received regarding the tainting of resident trout or anadromous species from the Kitimat River.

6.3 Solid Waste Disposal

Solid wastes generated at the Eurocan pulpmill are landfilled in the mill yard through which Beaver Creek flows to Anderson Creek (Figure 3). Both creeks once supported small coho salmon runs but no fish have been observed in Beaver Creek in recent years (J. MacDonald, per. comm., DFO, Kitimat). Coho still utilize Anderson Creek as a spawning and rearing area.

A summary by the author of water quality data collected by Eurocan on Beaver Creek is provided in Appendix IV(c) and sample stations are shown on Figure 3. The results show a deterioration in water quality does occur as a result of leachates and runoff from the mill yard. Turbidity, colour, sodium, BOD₅, TSS and temperature all increase between control Station 1 and Station 4. Dissolved oxygen levels decreased between Station 1 and Station 4 and saturation levels as low as 75% have been calculated. Two other sample stations (3, 5) are used to monitor millyard runoff. Monitoring of Beaver Creek should continue, especially at Stations 1 and 4. It should be determined if the deterioration in water quality of Beaver Creek can be detected in Anderson Creek which still supports coho salmon.

6.4 Marine Studies

Much of the oceanographic work on Kitimat Arm has dealt with the originally intended siting of a marine outfall from the Eurocan pulpmill. There has been very little survey work done on the Kitimat River estuary or delta in relation to assessing the influence of the present pulpmill discharge.

Marine stations were included at the head of Kitmat Arm in the original pre-pulpmill (21) and first post-pulpmill (22) surveys. Paish (17) made a biological assessment of the estuary delta in 1974 and has reported on the flora and fauna of the delta. Packman and Bradshaw (32) reported on submersible dives made in October 1976, as well as the findings of a physical oceanography and benthos survey made in June 1975. Levings

et al. (33) and Levings (34) have reported on the observations made in 1974 on the biologic community of the estuary delta.

6.4.1 Kitimat Arm Submarine Topography and Benthos

Packman and Bradshaw (32), in October of 1976, conducted two submersible dives (Pisces IV) to characterize the submarine topography of Kitimat Arm and the dive tracks are shown in Figure 7. The following observation was made based on the second dive.

"The second dive aboard Pisces was conducted closer to the delta from on the Kitimat River. The bottom here was also generally rugged, apparently the result of active sedimentation and slumping processes. It also appeared as though some dumping of dredge material from various construction projects in Kitimat had occurred here. Life was sparse with the dominant forms being the pink shrimp (Pandalus borealis), eelpouts (Zoarcidae) and sole (Pleuronectidae). There was a conspicuous absence of both infaunal and epifaunal Actinarians along this track."

Beak Consultants (21), in their pre-pulpmill work, summarized the biological status of the head of Kitimat Arm as being typical of an undisturbed marine environment. In their 1969-70 sampling program utilizing a Petersen Dredge, polychaetes and bivalves were found to be the most abundant benthic organisms. They concluded that the area studied was not highly productive with respect to invertebrate diversity.

Beak Consultants (22), in their post-pulpmill study utilizing a Ponar Dredge, reported no significant changes over their pre-operational benthos work. The area near the Alcan smelter and Minette Bay were identified as local areas of degradation not attributed to the Eurocan discharge. Sample stations 7 and 9 (8.2 m and 11 m depths respectively, Figure 7), nearest the river mouth, reflected a higher order of production than in 1969-70 but whether this was caused by organic enrichment or because these stations were relocated (due to dredging operations) to previously unsampled areas closer to the river mouth was not certain.

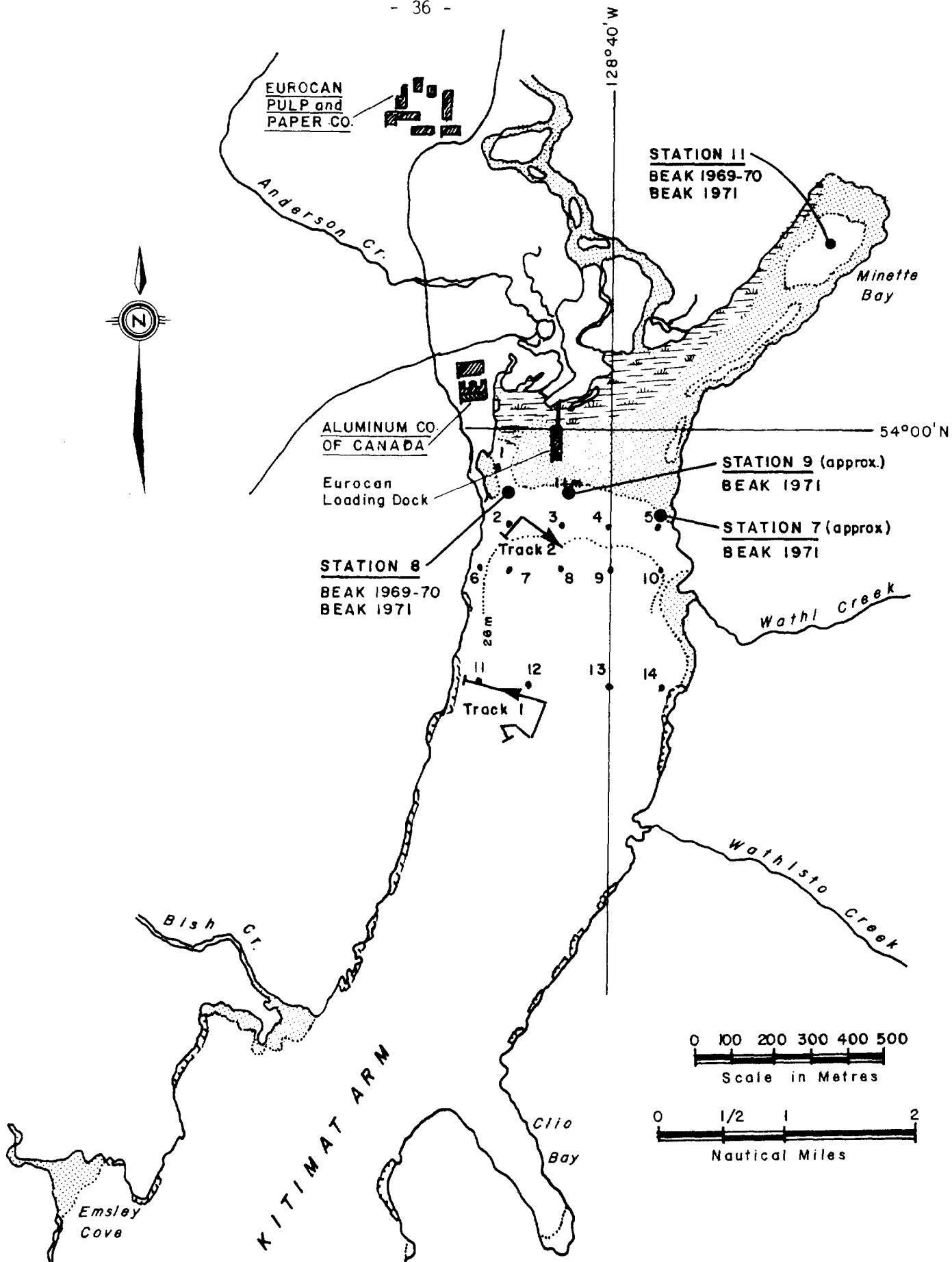


FIGURE 7 ENVIRONMENTAL PROTECTION SERVICE, "PISCES IV"
DIVE TRACKS AND BENTHOS STATIONS
(After Packman and Bradshaw (32))

Polychaetes were the most common organism reported at Stations 7 and 9 off the delta. Beak (22) summarized that it was generally felt that the Eurocan discharge into the Kitimat River had little or no effect on the biological condition of Douglas Channel.

From the benthic fauna collected (Ponar dredge), Packman and Bradshaw (32) reported that, although the specific representation of benthic organisms was low in abundance, it contained the types of animals which would be expected on the type of substrate present. Polychaetes were the most numerous and diversely represented group. No trends in diversity of benthic populations attributable to industrial development were apparent (32). Packman and Bradshaw (32) reported that the submersible dives and grab sample program confirmed that the benthic fauna was of a low density, probably due to the constant state of flux which the substrate appeared to be in.

6.4.2 Kitimat River Delta. Paish (17) estimated that the Kitimat River delta was in the order of 567 hectares of which 152 hectares had been disrupted.

The importance of the intertidal area in terms of vegetation associations with waterfowl and aquatic organisms and the food associations of juvenile salmonids were reported. Paish (17) reported that juvenile salmon utilized prey organisms from freshwater, estuarine and marine food chains. Dipterans represented the major freshwater food source while the amphipods Anisogammarus sp. and Corophium sp. and the isopod Exosphaeroma oregonensis and mysids represented the major estuarine food source.

Levings (34) reported that the intertidal community was considered to be characterized by extremely low diversity in terms of the number of species and indicated that freshwater processes dominate the habitats. A complete absence of polychaetes and the rarity of mussels and barnacles supported that theory (34).

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APPENDIX I

PROVINCIAL POLLUTION
ABATEMENT REQUIREMENTS

APPENDIX I

PROVINCIAL POLLUTION ABATEMENT REQUIREMENTS

Production Rating	BOD ₅ (Kg/d)	TSS (Kg/d)	Toxicity
<u>Eurocan Pulpmill</u>			
1 898 ADt/d	6 750	6 750	50% survival in 100% effluent concentration over a 96 hour exposure time.
2 898 ADt/d	6 750	9 000	Same as 1.
3 1040 ADt/d	7 800	10 400	Same as 1.

1 Based on level A of 1971 Objectives for the Forest Products Industry of B.C. of TSS (15 lb/ADT, 7.5 ADt) and BOD₅ (15 lb/ADT, 7.5 Kg/ADt).

2 Based on level A of 1977 Objectives for the Forest Products Industry of B.C. of TSS (20 lb/ADT, 10 Kg/ADt) and BOD₅ (15 lb/ADT, 7.5 Kg/ADt).

3 Proposed amendment and 1977 objectives.

APPENDIX II

EUROCAN PULP AND PAPER
BIOASSAY RESULTS, 1974 to 1980

APPENDIX II EUROCAN PULP AND PAPER BIOASSAY RESULTS, 1974 to 1980

Year	Sample Date	Species	Loading Density (gm/l)	% Survival (65% concentration)
<u>B.C. Research Bioassays</u>				
1974	January 7	Coho Salmon	1.46	100
	February 4		1.65	100
	March 4		1.88	100
	March 11		1.88	100
	April 3		2.12	100
	May 6		0.20	100
	June 3		0.33	90
	July 3		0.50	100
	August 5		0.63	100
	September 3		0.73	0
	September 16		1.00	100
	October 14		0.83	0
<u>Beak Consultants Ltd. Bioassays</u>				
1974	November 4	Rainbow Trout	1.00	100
	December 2		0.40	0
	December 9		0.40	0
1975	January 7		0.40	0
	January 20		0.40	0
	January 27		0.40	100
	February 3		0.40	100
	March 4		0.60	100
	May 5		0.21	100
	July 7		0.66	100
	November 3		0.90	100
	December 1		0.19	100

L Less than
- Concentration not tested

Note: All bioassays are for final effluent samples. The procedure to the end of 1975 was for a 96 hour static bioassay without solution replacements at 65% v/v effluent. As of 1976, the effluent concentration was raised to provincial levels. Federal pass/fail reported only if 65%v/v effluent reported.

continued...

APPENDIX II (Cont'd)

Year	Sample Date	Species	% Survival			Federal 96 hr LC50 %	
			Provincial		65% conc.		
			90% conc.	100% conc.			
<u>Environmental Protection Service Monitoring</u>							
1976	February 23	Rainbow Trout	0.09	0	0	0	
	March 22		0.40	100	100	100	
	April 12		0.15	0	0	32	
	April 26		0.18	20	20	90	
	May 3		0.22	100	80	100	
	July 5		0.50	100	100	-	
	October 4		0.15	60	20	90	
	November 2		1.19	0	0	0	
	November 15		0.58	0	0	L32	
	December 6		0.57	0	0	L32	
	January 3		0.53	100	100	-	
	February 9		0.68	0	0	-	
	February 18		0.35	100	80	100	
	March 7		0.50	60	60	-	
	April 1 4		0.68	0	0	-	
	April 12		0.28	0	0	0	
	May 3		0.45	50	50	L10	
	June 6		0.53	-	100	-	
	July 4		0.44	100	100	-	
	August 2		0.48	100	100	-	
	September 9		0.58	0	0	-	
	September 19		0.68	0	0	-	
	October 7		0.15	0	0	44	
	October 19		0.25	0	0	L10	
	November 1		0.35	0	0	L10	
	November 14		0.30	0	0	-	
	December 5		0.30	0	0	0	
	December 15		0.40	0	0	-	
						17.5	

continued...

APPENDIX II (Cont'd)

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Year	Sample Date	Species	Loading Density (gm/l)	% Survival			Federal	96 hr LC50
				90% conc.	100% conc.	65% conc.		
Environmental Protection Service Monitoring								
1978	January 5	Rainbow Trout	0.50	0	0	0	0	17.5
	January 26		0.50	0	0	0	0	L10
	February 7		0.60	0	0	0	0	17
	February 28		0.60	0	0	0	0	L30
	March 14		0.40	100	100	100	100	
	March 28		0.40	0	0	0	-	
	April 11		0.40	100	100	100	100	
	May 2		0.20	10	0	-	-	
	May 18		0.40	100	100	100	100	
	June 6*		0.50	-	90	-	-	
	July 6		0.40	-	100	-	-	
	October 3		0.40	-	100	-	-	
	November 14		0.50	-	100	-	-	
	December 11		0.50	100	100	100	100	
1979	January 9		0.50	-	0	-	-	
	January 16		0.50	71	57	100	100	
	February 6		0.50	0	0	-	-	
	February 14		0.50	20	-	60	70	
	March 6		0.50	50	83	100		
	April 3		0.50	100	87.5	-		
	May 7		0.50	-	85.7	-		
	June 18		0.50	-	100	-		
	July 11		0.50	100	100	100	100	
	August 22		0.50	100	100	100	100	
	September 4		0.60	100	100	100		
	October 11		0.40	100	100	100		
	November 6		0.50	-	100	-		
	December 11		0.30	0	0	-		

* 300 hp of aeration capacity added in May, 1978

APPENDIX II (Cont'd)

Year	Sample Date	Species	Loading Density (gm/l)	% Survival		Federal	96 hr LC ₅₀ %
				90% conc.	100% conc.		
Environmental Protection Service Monitoring							
1980	January 4	Rainbow Trout	0.4	90	-	90	
	February 5		0.6	0	0	30	65
	February 26		0.5	0	0	0	10, 30
	March 4		0.5	0	0	0	10, 30
	March 25		0.5	0	0	0	30, 65
	April 8		0.5	0	0	-	10
	April 30		0.4	0	0	0	44
	May 14		0.5	100	100	100	
	October 7*		0.6	0	0	-	
	October 28		0.5	100	-	100	
	November 4		0.5	100	100	-	
	December 2		0.5	100	100	-	

* In September, 1980, 107 meters of floating baffle was added to the 152 meter wooden baffle in the biobasin.
Aeration as of October 1, 1980 was 1225 hp

APPENDIX III

FISHERIES INFORMATION

- a) Fisheries Resources of Fisheries and Marine Service Statistical Area 6
- b) Juvenile Salmon Migration Timings on the Kitimat River Below Haisla Bridge

APPENDIX III(a)

EUROCAN PULP AND PAPER MILL
KITIMAT, B.C.

FISHERIES RESOURCES OF
FISHERIES AND MARINE SERVICE
STATISTICAL AREA 6

by

W. Knapp
M. Lashmar

Internal Report, March, 1978

Water Quality Division
Habitat Protection Unit
Resources Services Branch
Fisheries and Marine Service
Pacific Region

APPENDIX III(b) JUVENILE SALMON MIGRATION TIMINGS ON THE KITIMAT RIVER BELOW HAISLA BRIDGE

SPECIES	AGE CLASS	START	10%	50%	90%	END
Pink*	fry	-	April 8	April 11	April 23	May 25
Chum*	fry	-	April 8	April 12	April 19	June 4
Chinook*	fry	-	April 8	April 16	June 5	-
Chinook	smolt	-	April 13	April 26	May 12	-
Coho	fry	April 22	May 22	June 15	July 9	-
Coho	smolt	-	April 12	April 27	June 22	-

* After Birch *et al* (41). Pink, chum and chinook fry downstream migration was considered to have started in March, prior to the onset of sampling on April 7, 1980.

APPENDIX IV

WATER QUALITY DATA

- a) Summary of Kitimat River Water Quality Data
Collected as Part of the Eurocan Pulpmill
Receiving Water Program
- b) Summary of Eurocan Pulpmill Final Effluent
Temperatures for March, April and May (1977 to
1980)
- c) Beaver Creek Water Quality

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	May					
		1973	1974	1975	1977*	1978	1980**
1	Temperature (°C)	5.01	6.0	7.5	5.2	6.0	5.5
	Dissolved Oxygen (mg/l)	11.8	-	13.0	12.9	12.4	13.9
	Percent Saturation (%)	95.5	-	111.8	104.9	102.8	113.8
	pH	7.05	7.0	7.2	6.6	7.0	6.9
	Na ⁺ (mg/l)	0.7	0.9	0.7	3.0	1.4	1.5
	Colour (APHA)	20	23	40	30	20	8
	Total Phosphate (mg/l)	-	-	-	-	0.1	BDL
	Conductivity (umhos/cm)	24.0	30.0	30.0	43.5	38.0	31.0
	Total Solids (mg/l)	71.0	-	-	45.2	9.0	124
2	Temperature (°C)	5.0	6.0	7.5	5.2	6.1	5.5
	Dissolved Oxygen (mg/l)	11.7	-	12.8	12.8	12.4	13.9
	Percent Saturation (%)	94.7	-	110.1	104.1	103.0	113.8
	pH	7.05	7.05	7.25	6.8	7.0	6.9
	Na ⁺ (mg/l)	0.7	0.9	0.7	2.3	1.4	1.5
	Colour (APHA)	22	40	35	30	20	16
	Total Phosphate (mg/l)	-	-	-	0.1	0.1	BDL
	Conductivity (umhos/cm)	32.0	36.0	40.0	42.0	43.0	34.0
	Total Solids (mg/l)	67.0	-	-	42.0	12.8	108
2a	Temperature (°C)	-	-	10.0	20.0	9.5	5.5
	Dissolved Oxygen (mg/l)	-	-	12.3	9.5	10.2	13.6
	Percent Saturation (%)	-	-	112.7	107.4	92.4	111.4
	pH	-	-	7.4	7.3	7.4	7.3
	Na ⁺ (mg/l)	-	-	16.4	168.0	77.	15.0
	Colour (APHA)	-	-	165	400	213	86
	Total Phosphate (mg/l)	-	-	-	0.3	0.2	BDL
	Conductivity (umhos/cm)	-	-	250.0	1060.0	310.0	120.0
	Total Solids (mg/l)	-	-	-	858.8	364.0	160.0

* = March 31, 1977

** = April 22, 1980

BDL = below detectable limits

Note: Percent saturation calculated by author

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	May					
		1973	1974	1975	1977*	1978	1980**
3a	Temperature (°C)	5.0	7.0	8.0	7.0	6.0	5.5
	Dissolved Oxygen (mg/l)	11.8	-	12.8	11.9	12.0	13.8
	Percent Saturation (%)	95.5	-	111.5	101.1	99.5	113.0
	pH	7.05	7.15	7.4	7.2	7.2	7.1
	Na ⁺ (mg/l)	2.0	5.4	1.9	18.0	4.6	6.5
	Colour (APHA)	25	55	50	270	50	33
	Total Phosphate (mg/l)	-	-	-	0.1	0.2	BDL
	Conductivity (umhos/cm)	32.0	65.0	50.0	160.0	56.0	60
	Total Solids (mg/l)	77.0	-	-	109.6	21.2	132
3b	Temperature (°C)	5.0	6.0	7.9	6.0	6.0	5.5
	Dissolved Oxygen (mg/l)	11.7	-	12.7	12.2	12.0	13.8
	Percent Saturation (%)	94.7	-	110.4	101.1	99.5	113.0
	pH	7.0	7.05	7.35	7.0	7.3	7.1
	Na ⁺ (mg/l)	0.8	0.9	0.7	4.0	3.5	7.6
	Colour (APHA)	22	40	35	40	45	33
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	24.0	36.0	30.0	50.0	52.0	60
	Total Solids (mg/l)	-	-	-	-	32.0	124
3c	Temperature (°C)	5.3	6.0	7.9	5.8	6.0	5.5
	Dissolved Oxygen (mg/l)	11.8	-	12.8	12.3	12.2	13.8
	Percent Saturation (%)	96.2	-	111.3	101.4	101.1	113.0
	pH	7.0	7.05	7.25	7.0	7.3	7.0
	Na ⁺ (mg/l)	0.7	0.9	0.7	2.5	1.7	2.5
	Colour (APHA)	22	40	35	30	30	2.5
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	24.0	36.0	30.0	41.0	54.0	39
	Total Solids (mg/l)	-	-	-	-	12.8	106

* March 31, 1977

** April 22, 1980

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	May					
		1973	1974	1975	1977*	1978	1980**
4a	Temperature (°C)	5.1	7.0	8.0	6.0	6.0	6.0
	Dissolved Oxygen (mg/l)	11.6	-	13.0	12.2	12.1	13.9
	Percent Saturation (%)	94.1	-	113.3	101.1	100.3	115.2
	pH	7.15	7.10	7.3	7.0	7.0	7.0
	Na ⁺ (mg/l)	2.2	2.8	1.3	8.2	3.5	4.6
	Colour (APHA)	30	53	50	70	40	33
	Total Phosphate (mg/l)	-	-	-	0.1	0.2	BDL
	Conductivity (umhos/cm)	32.0	47.0	38.0	69.0	42.0	56
	Total Solids (mg/l)	67.0	-	-	65.5	16.4	104
4b	Temperature (°C)	5.0	6.2	8.0	6.0	6.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	12.8	12.2	11.9	13.9
	Percent Saturation (%)	95.5	-	111.5	101.1	98.6	115.2
	pH	7.1	7.0	7.25	7.0	7.2	6.9
	Na ⁺ (mg/l)	1.0	1.2	1.0	8.1	3.3	3.4
	Colour (APHA)	25	53	42	70	40	25
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	25.0	35.0	32.0	68.0	47.0	48
	Total Solids (mg/l)	-	-	-	-	46.0	90
4c	Temperature (°C)	5.0	6.0	7.9	6.0	6.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	12.8	12.2	12.0	13.9
	Percent Saturation (%)	95.5	-	111.3	101.1	99.5	115.2
	pH	7.1	7.0	7.25	7.0	7.2	6.8
	Na ⁺ (mg/l)	0.8	0.9	0.7	7.4	3.3	1.9
	Colour (APHA)	20	43	40	60	50	8
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	24.0	35.5	30.0	65.0	50.0	40
	Total Solids (mg/l)	-	-	-	-	80.0	79

* March 31, 1977

** April 22, 1980

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	May					
		1973	1974	1975	1977*	1978	1980**
5a	Temperature (°C)	5.0	6.0	8.0	6.0	6.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	13.0	12.2	12.1	13.9
	Percent Saturation (%)	95.5	-	113.3	101.1	100.3	115.2
	pH	7.1	7.10	7.25	7.0	7.2	7.0
	Na ⁺ (mg/l)	1.6	1.8	1.3	7.9	3.6	4.4
	Colour (APHA)	22	43	45	80	45	25
	Total Phosphate (mg/l)	-	-	-	-	0.1	BDL
	Conductivity (umhos/cm)	29.0	41.0	35.0	66.0	50.0	51
	Total Solids (mg/l)	60.0	-	-	56.4	28.8	116
5b	Temperature (°C)	5.0	6.0	8.0	6.0	6.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	13.0	12.2	12.2	13.9
	Percent Saturation (%)	95.5	-	113.3	101.1	101.1	115.2
	pH	7.1	7.05	7.3	7.1	7.3	6.9
	Na ⁺ (mg/l)	1.1	1.4	1.3	7.6	3.3	3.2
	Colour (APHA)	20	43	42	60	50	25
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	25.0	42.0	40.0	66.0	48.0	45.0
	Total Solids (mg/l)	-	-	-	-	30.8	127
5c	Temperature (°C)	5.0	6.0	8.0	6.0	6.4	6.0
	Dissolved Oxygen (mg/l)	11.7	-	13.0	12.2	12.0	13.9
	Percent Saturation (%)	94.7	-	113.3	101.1	100.4	115.2
	pH	7.1	7.08	7.4	7.0	7.3	6.9
	Na ⁺ (mg/l)	0.8	1.3	0.9	7.0	3.3	2.4
	Colour (APHA)	20	47	35	60	65	16
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	24.0	42.0	30.0	63.0	46.0	42
	Total Solids (mg/l)	-	-	-	-	30.0	109

* March 31, 1977

** April 22, 1980

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	May					
		1973	1974	1975	1977*	1978	1980**
6a	Temperature (°C)	5.0	6.2	7.8	6.0	7.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	12.8	12.2	12.2	13.9
	Percent Saturation (%)	95.5	-	111.0	101.1	103.6	115.2
	pH	7.1	7.0	7.25	7.1	7.3	6.9
	Na ⁺ (mg/l)	1.4	1.8	1.2	7.7	3.7	3.4
	Colour (APHA)	22	40	42	60	40	25
	Total Phosphate (mg/l)	-	-	-	-	0.1	BDL
	Conductivity (umhos/cm)	28.0	40.0	30.0	66.0	43.0	46
6b	Total Solids (mg/l)	64.0	-	-	54.0	58.4	115
	Temperature (°C)	5.0	6.5	7.8	6.0	7.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	12.8	12.3	12.1	13.9
	Percent Saturation (%)	95.5	-	111.0	101.9	102.8	115.2
	pH	7.1	7.12	7.25	7.1	7.3	6.9
	Na ⁺ (mg/l)	1.4	1.5	1.0	7.5	3.4	3.5
	Colour (APHA)	22	40	42	78	40	25
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
6c	Conductivity (umhos/cm)	28.0	47.0	30.0	65.0	46.0	47
	Total Solids (mg/l)	-	-	-	-	46.4	110
	Temperature (°C)	5.0	6.1	7.8	6.0	7.0	6.0
	Dissolved Oxygen (mg/l)	11.8	-	13.0	12.2	12.1	13.9
	Percent Saturation (%)	95.5	-	112.7	101.1	102.8	115.2
	pH	7.05	7.10	7.4	7.0	7.3	6.9
	Na ⁺ (mg/l)	1.7	1.5	1.0	7.4	3.6	3.7
	Colour (APHA)	20	30	40	85	40	16

* March 31, 1977

** April 22, 1980

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	September					
		1973	1976	1977	1978	1979	1980
1	Temperature (°C)	8.2	10.0	10.0	8.3	12.4	8.0
	Dissolved Oxygen (mg/l)	11.0	11.2	10.8	10.6	11.3	11.3
	Percent Saturation (%)	96.4	102.6	98.9	93.1	109.3	98.5
	pH	6.9	7.1	7.2	7.5	7.7	7.2
	Na ⁺ (mg/l)	0.9	0.9	0.2	1.8	1.0	1.3
	Colour (APHA)	15	10	10	16	25	8
	Total Phosphate (mg/l)	-	2.1	0.6	0.1	-	BDL
	Conductivity (umhos/cm)	25.0	34.0	25.0	52.0	35.0	40.0
	Total Solids (mg/l)	28.0	81.6	95.6	30.0	54.0	128.0
2	Temperature (°C)	8.2	10.5	10.0	8.3	12.5	8.5
	Dissolved Oxygen (mg/l)	11.1	11.0	11.0	11.0	11.5	11.1
	Percent Saturation (%)	97.2	101.9	100.8	96.6	111.5	98.0
	pH	6.9	7.1	7.3	7.6	7.9	7.1
	Na ⁺ (mg/l)	1.2	1.0	0.4	2.2	1.1	1.3
	Colour (APHA)	16	10	18	26	25	8
	Total Phosphate (mg/l)	-	2.1	0.4	0.1	-	BDL
	Conductivity (umhos/cm)	28.0	43.0	24.5	40.0	37.0	41.0
	Total Solids (mg/l)	32.5	71.6	104.6	25.0	40.0	95.0
2a	Temperature (°C)	-	15.5	14.0	13.0	16.0	11.5
	Dissolved Oxygen (mg/l)	-	10.5	10.2	10.1	10.4	11.5
	Percent Saturation (%)	-	108.7	102.5	99.1	108.7	108.9
	pH	-	7.5	7.4	7.4	7.7	7.6
	Na ⁺ (mg/l)	-	34.0	29.1	113.0	34.0	155.0
	Colour (APHA)	-	300	110	449	132	76
	Total Phosphate (mg/l)	-	2.8	0.5	0.2	-	BDL
	Conductivity (umhos/cm)	-	240.0	167.5	430.0	195.0	166.0
	Total Solids (mg/l)	-	237.6	199.2	549.5	278.0	213.0

continued...

APPENDIX IV(a)
(continued)

SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	September					
		1973	1976	1977	1978	1979	1980
3a	Temperature (°C)	11.5	11.0	11.5	8.7	13.0	9.8
	Dissolved Oxygen (mg/l)	9.8	11.1	10.9	10.7	11.3	11.2
	Percent Saturation (%)	92.8	104.0	103.3	94.9	110.8	102.2
	pH	6.8	7.2	7.3	7.5	7.8	7.4
	Na ⁺ (mg/l)	17.0	4.7	5.1	5.1	4.6	5.7
	Colour (APHA)	160	35	30	43	33	50
	Total Phosphate (mg/l)	-	2.5	0.3	0.1	-	BDL
	Conductivity (umhos/cm)	185.0	57.0	39.0	48.0	55.0	64.0
	Total Solids (mg/l)	65.3	99.6	98.8	35.5	25.5	105.0
3b	Temperature (°C)	9.0	9.5	11.0	8.8	13.0	9.5
	Dissolved Oxygen (mg/l)	10.8	11.4	10.8	10.6	11.2	11.6
	Percent Saturation (%)	96.6	103.3	101.2	94.3	109.9	105.1
	pH	6.9	7.15	7.0	7.4	7.8	7.3
	Na ⁺ (mg/l)	1.2	0.9	4.9	6.1	4.0	7.7
	Colour (APHA)	15	10	25	48	51	68
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	28.0	33.0	37.5	52.0	53.0	77.0
	Total Solids (mg/l)	34.7	-	-	47.5	46.0	101.0
3c	Temperature (°C)	8.5	9.5	11.0	8.6	12.5	9.0
	Dissolved Oxygen (mg/l)	10.9	11.4	10.8	10.6	11.3	11.4
	Percent Saturation (%)	96.2	103.3	101.2	93.8	109.5	101.9
	pH	6.9	7.15	7.2	7.5	7.8	7.2
	Na ⁺ (mg/l)	1.1	0.9	-	2.3	0.8	1.8
	Colour (APHA)	15	10	20	23	25	25
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	28.0	33.0	26.5	37.0	35.0	45.0
	Total Solids (mg/l)	32.0	-	-	25.0	26.5	79.0

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	September				
		1973	1976	1977	1978	1979
4a	Temperature (°C)	8.0	8.9	11.5	8.5	12.9
	Dissolved Oxygen (mg/l)	10.6	11.2	11.0	10.5	11.1
	Percent Saturation (%)	92.4	99.9	104.2	92.7	108.6
	pH	6.8	7.15	7.1	7.3	7.8
	Na ⁺ (mg/l)	5.5	2.1	3.0	4.2	3.0
	Colour (APHA)	15	25	25	35	42
	Total Phosphate (mg/l)	-	2.0	0.5	0.1	-
	Conductivity (umhos/cm)	50.0	42.0	33.0	44.0	40.0
4b	Total Solids (mg/l)	53.0	76.8	115.2	29.5	50.5
	Temperature (°C)	7.8	8.7	12.0	8.3	12.8
	Dissolved Oxygen (mg/l)	11.1	11.4	11.0	10.8	11.2
	Percent Saturation (%)	96.2	101.2	105.4	94.8	109.3
	pH	6.9	7.1	7.0	7.3	7.8
	Na ⁺ (mg/l)	1.4	2.05	3.3	4.6	1.8
	Colour (APHA)	50	28	30	42	16
	Total Phosphate (mg/l)	-	-	-	-	-
4c	Conductivity (umhos/cm)	28.0	41.0	32.5	46.0	40.0
	Total Solids (mg/l)	55.0	-	-	30.0	8.5
	Temperature (°C)	8.2	8.3	12.0	8.8	13.4
	Dissolved Oxygen (mg/l)	10.9	11.3	11.1	10.7	11.2
	Percent Saturation (%)	95.5	99.2	106.4	95.2	110.9
	pH	6.9	7.1	7.2	7.3	7.7
	Na ⁺ (mg/l)	1.0	1.2	3.6	4.5	1.8
	Colour (APHA)	20	25	18	40	33
Total Phosphate (mg/l)						
Conductivity (umhos/cm)						
Total Solids (mg/l)						

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	September				
		1973	1976	1977	1978	1979
5a	Temperature (°C)	8.0	8.6	12.0	8.4	12.8
	Dissolved Oxygen (mg/l)	10.9	11.3	11.1	10.5	11.2
	Percent Saturation (%)	95.0	100.0	106.4	92.4	109.3
	pH	6.95	7.2	7.3	7.5	7.5
	Na ⁺ (mg/l)	4.0	2.0	3.2	4.2	2.9
	Colour (APHA)	20	35	20	33	33
	Total Phosphate (mg/l)	-	1.9	0.7	0.1	-
	Conductivity (umhos/cm)	42.0	44.0	30.0	44.0	48.0
5b	Total Solids (mg/l)	44.0	50.8	95.1	68.0	33.5
	Temperature (°C)	8.0	8.7	12.0	8.4	12.8
	Dissolved Oxygen (mg/l)	10.9	11.3	10.8	10.5	11.2
	Percent Saturation (%)	95.0	100.3	103.5	92.4	109.3
	pH	6.9	7.15	7.1	7.5	7.8
	Na ⁺ (mg/l)	2.5	2.0	3.2	4.0	2.5
	Colour (APHA)	25	25	20	38	86
	Total Phosphate (mg/l)	-	-	-	-	-
5c	Conductivity (umhos/cm)	34.0	43.0	31.0	45.0	44.0
	Total Solids (mg/l)	41.3	-	-	60.0	61.5
	Temperature (°C)	8.0	9.0	12.0	8.4	12.9
	Dissolved Oxygen (mg/l)	10.9	11.4	10.6	10.5	11.3
	Percent Saturation (%)	95.0	102.0	101.6	92.4	110.6
	pH	6.95	7.2	7.0	7.4	7.7
	Na ⁺ (mg/l)	1.8	1.7	3.6	4.3	2.8
	Colour (APHA)	20	28	21	40	25

continued...

APPENDIX IV(a) SUMMARY OF KITIMAT RIVER WATER QUALITY DATA COLLECTED
(continued) AS PART OF EUROCAN PULPMILL RECEIVING WATER SURVEY

Station	Parameter	September					
		1973	1976	1977	1978	1979	1980
6a	Temperature (°C)	8.0	8.6	12.0	8.3	12.9	10.0
	Dissolved Oxygen (mg/l)	10.9	11.1	10.8	10.4	11.1	11.2
	Percent Saturation (%)	95.0	98.2	103.5	91.3	108.6	102.6
	pH	6.9	7.1	6.8	7.3	7.5	7.1
	Na ⁺ (mg/l)	3.6	2.0	4.1	4.1	2.8	3.5
	Colour (APHA)	20	35	20	40	16	16
	Total Phosphate (mg/l)	-	1.9	0.7	0.1	-	BDL
	Conductivity (umhos/cm)	36.0	41.0	39.5	45.0	45.0	52
6b	Total Solids (mg/l)	29.7	56.8	60.8	53.0	31.5	143
	Temperature (°C)	8.0	8.6	12.0	8.3	12.8	10.0
	Dissolved Oxygen (mg/l)	10.9	11.1	10.8	10.6	11.1	11.3
	Percent Saturation (%)	95.0	98.2	103.5	93.1	108.4	103.5
	pH	6.9	7.1	6.6	7.3	7.7	7.1
	Na ⁺ (mg/l)	2.9	1.9	3.6	4.1	2.3	3.3
	Colour (APHA)	17	25	18	35	8	16
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
6c	Conductivity (umhos/cm)	36.0	43.0	33.0	45.0	42.0	54
	Total Solids (mg/l)	30.2	-	-	48.5	56.0	94
	Temperature (°C)	8.0	8.9	12.0	8.5	13.3	10.2
	Dissolved Oxygen (mg/l)	10.8	11.0	10.6	10.4	10.9	11.3
	Percent Saturation (%)	94.1	98.1	101.6	91.8	107.7	103.9
	pH	6.95	7.12	7.2	7.2	7.7	7.2
	Na ⁺ (mg/l)	3.3	2.3	4.4	5.2	2.0	3.3
	Colour (APHA)	20	25	20	40	33	8
	Total Phosphate (mg/l)	-	-	-	-	-	BDL
	Conductivity (umhos/cm)	36.0	46.0	34.5	50.0	41.0	54
	Total Solids (mg/l)	28.6	-	-	57.5	55.0	104

APPENDIX IV(b) SUMMARY OF EUROCAN PULPMILL FINAL EFFLUENT TEMPERATURES FOR MARCH, APRIL AND MAY (1977 to 1980)

DAY	March (°C)				April (°C)				May (°C)			
	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980
1	28	22	23	21	26	14	25	26	27	26	26	26
2	28	22	24	21	26.5	14	26	24	27	27	24	26
3	28	21	24	20	29	14	25	25	27	27	26	26
4	25	22	24	19	28	14	26	24	26.5	27	26	27
5	26	23	24	20	27.4	18	26	26	27	28	26	27
6	27.1	23	23	20	28	20	26	18	28	29	27	27
7	27	24	24	20	28.5	22	26	18	28	29	27	27
8	27	25	--	20	29	23	26	15	29	29	26	26
9	27	24	24	20	28	25	26	14	29	28	27	25
10	27	25	24	21	--	25	26	13	27	28	27	25
11	27	25	24	21	24	25	26	12	27	27	27	27
12	27	24	25	20	24.2	26	25	13	27	27	26	26
13	27	24	25	20	20	25	25	13	28	27	28	25
14	27.5	24	26	22	20	22	25	17	27	28	28	26
15	27	24	25	22	18	26	22	19	28	29	27	26
16	27	24	25	23	17	27	22	21	27	29	27	26
17	27	24	25	23	15	28	20	22	29	28	26	26
18	27.5	25	25	24	13.3	27	18	23	29	28	27	26
19	27	26	26	24	14	27	18	23	27	28	27	26
20	28	25	25	24	15	28	15	24	29	28	28	26
21	28	26	25	25	17	28	16	24	30	28	28	25
22	28	26	25	24	21.5	28	15	23	29	28	28	26
23	28	26	24	24	23.5	28	16	24	28	28	27	26
24	27	27	25	25	25	29	20	25	30	28	26	26
25	27	26	25	24	25	28	21	24	28	28	27	27
26	28	26	25	25	26	28	23	25	30	28	26	28
27	27	22	25	25	25	28	24	26	29	28	27	28
28	28	22	25	25	26	29	24	25	30	28	27	28
29	28	20	25	25	26	28	25	25	30	28	26	28
30	28	18	25	26	26	29	26	26	31	29	27	28
31	28	16	25	26	--	--	--	--	30	29	27	28

APPENDIX IV(c)

BEAVER CREEK WATER QUALITY

Date/Station*	Colour (APHA)	Turbidity (mg/l SiO ₂)	Na ⁺ (mg/l)	BOD ₅ (mg/l)	D.O.			Dissolved Oxygen (mg/l)	Temperature (°C)	pH				
					Solids (mg/l)	Saturation (%)	Total Suspended Solids (mg/l)							
1	2	4	1	2	4	1	2	4	1	2	4	1	2	4
10/07/79	16	50	6	25	12	1.4	6.5	1.6	0.3	5.7	7.5	2.4	6.8	0.8
21/03/79	0	16	76	1.5	3.8	40	1.5	7.3	13	0.6	2.1	11.8	3.4	6.2
16/08/78	8	95	207	2	10	19	1.9	14	19	0.5	3.7	8.2	5.2	6.4
25/01/78	13	35	163	1	23	69	3	29	39	1	8.3	50	2.8	36
08/03/77	15	50	120	0.5	4.5	13	2	12.5	27	1.6	3.5	67.2	0.4	2.4
09/06/77	10	65	95	-	-	-	1	7	14	1.1	4.8	39.6	3.2	7.2
22/11/76	45	125	0.7	33	33	2.3	6.3	21.5	0.9	8.3	16.5	1.9	109	123
23/08/76	25	60	85	0	1	12	2	8.9	21.5	0.9	2.1	56.4	1.7	2.4
20/05/76	10	18	27	1	1.5	2.5	1.2	5	16.8	-	-	111	0	4.8
02/07/75	10	65	175	1	1	1.5	1.4	13	24	1	0.9	6	6	10
04/04/75	10	20	27	1.5	3	3	2.7	24.3	29.3	1.4	2.7	8.6	9	32

* Station shown on Figure 3

DEPARTMENT OF FISHERIES AND THE ENVIRONMENT
FISHERIES AND MARINE SERVICE

EUROCAN PULP AND PAPER MILL, KITIMAT B.C.
FISHERIES RESOURCES OF FISHERIES AND
MARINE SERVICE STATISTICAL AREA 6

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Water Quality Division
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Resource Services Branch
1978

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EUROCAN PULP AND PAPER MILL - KITIMAT, B.C.
FISHERIES RESOURCES OF
FISHERIES AND MARINE SERVICE STATISTICAL AREA 6

I INTRODUCTION

The Eurocan pulp and paper mill at Kitimat is located within Butedale Statistical Area 6, a Subdistrict of Kitimat Conservation District 7. (Figure 1) The Subdistrict lies along the coast from the southern end of Pitt and Banks Island in the north to Price Island in the south, and includes all the drainage systems west of the Coast Range divide. Kitimat with a population of about 13,000 is the major population center within the Subdistrict. The Eurocan mill began operation in 1969 with the completion of the woodmill and by 1970, pulp mill production began.(1)

The areas of potential influence by effluent from the pulp and paper mill were divided into those water bodies above the effluent outfall i.e., the Kitimat River and its tributaries, and those below, including the tidal waters of the Kitimat River and estuary, and the upper portions of Kitimat Arm. (Figure 2)

II SALMON

A. Stocks

All five species of Pacific salmon are present in Statistical Area 6. Ten year averages of the stock (commercial catch plus escapement) for 1966 to 1975, indicate that pinks are present in the largest numbers, followed by chum, coho, sockeye and chinook salmon (Table I). Low numbers of some species in recent years (especially chinook which decreased from 80,500 in 1972 to 37,000 in 1975), have suggested the necessity for enhancement. At present, proposals have been made for construction of hatchery facilities for chinook and coho salmon and steelhead trout, followed at a later date by spawning channels for pink and chum salmon.(2)

There is considerable potential for increasing the coho fishery, particularly in the Douglas Channel streams, while the Kitlope River, and to a certain extent the Kemano River, offer room for expansion of the chinook fishery.(1) Pink stocks during peak year runs are probably close to the optimum attainable.

B. Commercial Fishery

The commercial salmon fishery of Area 6 is confined to the outside waters since Douglas Channel, Gardner Canal, and adjacent waters are closed to commercial fishing (Figure 2). Fishing has been limited to these waters because of the extent

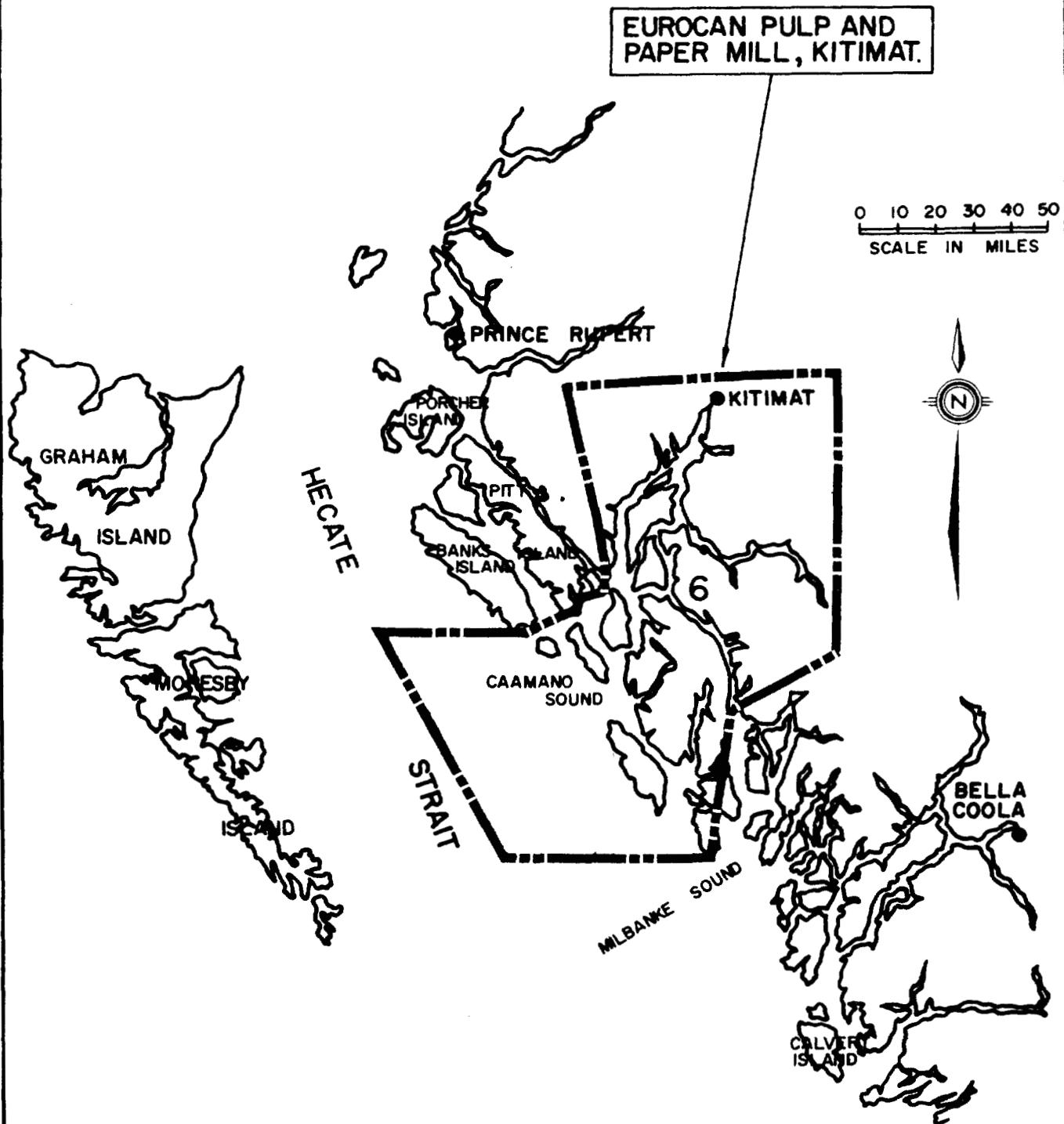


FIGURE 1—LOCATION OF EUROCAN PULP MILL (KITIMAT)
IN STATISTICAL AREA 6

TABLE I: AREA 6 - TOTAL SALMON STOCKS, BASED ON CATCH PLUS ESCAPEMENT

YEAR	SOCKEYE	COHO	PINK	CHUM	CHINOOK
1975	41,104	66,539	352,082	93,874	37,189
1974	94,248	156,784	954,416	425,659	54,478
1973	112,027	131,869	658,528	412,091	43,496
1972	111,027	300,292	6,588,398	745,685	80,528
1971	59,475	110,871	606,311	162,741	59,737
1970	120,717	271,720	4,101,993	408,521	53,082
1969	45,058	70,510	137,555	130,878	49,541
1968	139,383	283,604	4,626,929	743,700	53,866
1967	148,007	140,066	187,647	395,418	54,846
1966	136,787	236,609	4,740,483	654,544	70,054
AVERAGE	100,783	176,886	2,282,547	417,311	55,681

TABLE II: AREA 6 - COMMERCIAL SALMON CATCH (PIECES)⁽³⁾

YEAR	SOCKEYE	COHO	PINK	CHUM	CHINOOK
1975	21,104	22,539	41,082	16,874	32,189
1974	57,248	105,784	576,416	166,659	39,476
1973	67,029	93,869	417,528	163,091	27,496
1972	102,027	233,292	5,612,398	473,685	66,528
1971	32,475	52,871	242,311	66,741	34,737
1970	92,717	191,720	3,236,993	276,521	37,582
1969	34,058	42,510	35,555	59,878	25,541
1968	74,383	207,604	3,396,929	353,700	29,866
1967	62,007	56,066	103,647	72,418	29,846
1966	71,787	191,609	3,540,483	254,544	40,054
AVERAGE	61,483	119,786	1,720,334	190,411	36,331

TABLE III: AREA 6 - SALMON ESCAPEMENTS (PIECES)⁽⁴⁾

YEAR	SOCKEYE	COHO	PINK	CHUM	CHINOOK
1975	20,000	44,000	311,000	77,000	5,000
1974	37,000	51,000	378,000	259,0000	15,000
1973	45,000	38,000	241,000	249,000	16,000
1972	9,000	67,000	976,000	272,000	14,000
1971	27,000	58,000	364,000	96,000	25,000
1970	28,000	80,000	865,000	132,000	15,500
1969	11,000	28,000	102,000	71,000	24,000
1968	65,000	76,000	1,230,000	390,000	24,000
1967	86,000	84,000	84,000	323,000	25,000
1966	65,000	45,000	1,200,000	400,000	30,000
AVERAGE	39,300	52,100	574,500	226,900	19,300

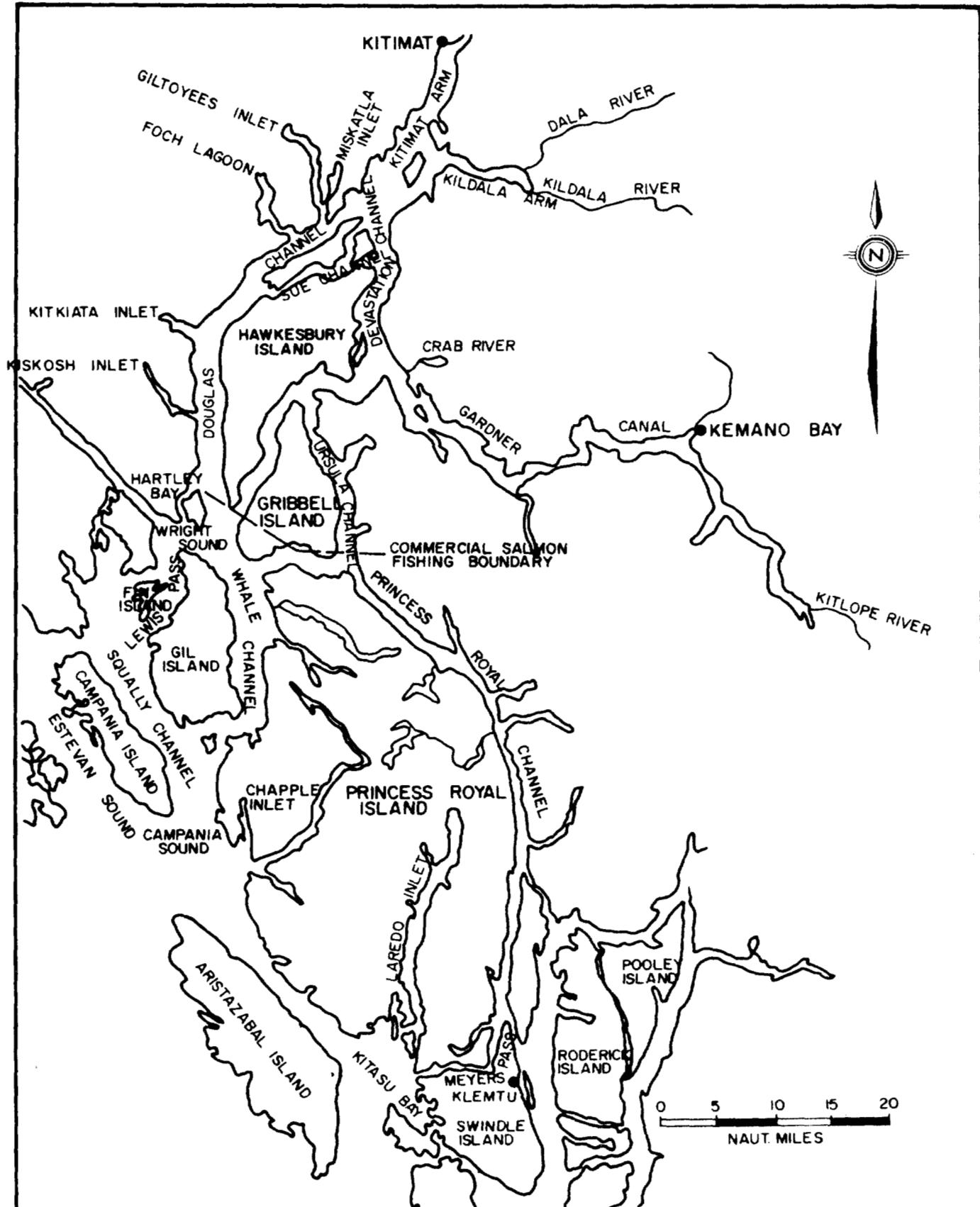


FIGURE 2—WATERWAYS OF STATISTICAL AREA 6
AND COMMERCIAL FISHERIES AREA 5

to which inner waters are used for rearing chinook juveniles. The restrictions prevent overfishing and also provide a sanctuary for pink and chum adults.(6,7)

Generally, the largest catches of all five species of salmon tend to be in the Wh&e Channel - Campania Sound area, followed by Wright Sound - Squally Channel and Lewis Passage. The third major fishery is the Kitasu Bay - Aristazabal Island area.(1) Gill-nets, purse seines and trolls are the primary gear types used.

True exploitation rates for the area as a whole cannot be precisely established since a large percentage of the sockeye, coho and chinook catch do not originate from local stocks. A similar problem arises in trying to determine the proportion of salmon caught which originate from the head of Kitimat Arm. Catch statistics for the Butedale Subdistrict for the years 1966-1975, are given in Table II. Of the past 10 years, the highest catches for all five salmon species occurred in 1972. Conversely, in 1975, minimum catches occurred for sockeye, coho and chum for the same ten year period.

C. Escapement

The Butedale Subdistrict contains 108 spawning streams which range in size from large rivers to small creeks. These result in a total of about 500 miles of spawning beds. Table III gives the area escapements by year and species for 1966-1975. Since 1967-1968, there has been a general decrease in escapements despite attempts to improve the situation by restricting commercial, sport and Indian food fisheries.(5) Gross fluctuations in populations and in particular escapements generally seem to be a response to spawning cycles, changing environmental conditions (ice scouring and flooding of spawning areas) and commercial fishing pressures.(1,8)

Table IV ranks the important escapement rivers (including tributaries) in Area 6.(4)

TABLE IV
Area 6 - Ranking of Major Salmon Spawning Streams*

RANK	SOCKEYE	CHINOOK	COHO	CHUM	PINKS ODD YEAR	PINKS EVEN YEAR
R	1. Kitlope	Kitimat	Kitimat	Kemano	Quaal	Quaal
I		Kemano	Kitlope	Kitimat		Kitimat
V	2.					
E	3.	Kitlope	Kemano	Kitlope		Kitkiata
R	* calculated from 10 year average, 1966 to 1975					

TABLE V

Salmon Escapements, High Potential Impact Area (Kitimat River and Tributaries (4))

a) PINK SALMON

YEAR	CHIST CREEK	HIRSCH CREEK	HUMPHREYS CREEK	KITIMAT RIVER	NALBEELAH CREEK	BIG WEDENE	LITTLE WEDENE	TOTAL	WATHL CREEK
1975	N.O.	50	25	2,000	N.O.	100	200	2,375	25
1974	250	2,500	5,000	80,000	4,000	8,000	6,000	105,750	N.O.
1973	N.O.	200	100	1,000	50	300	200	1,850	25
1972	1,500	15,000	7,500	20,000	7,500	N.O.	7,500	246,500	75
1971	N.O.	200	200	1,000	N.O.	N.O.	200	1,800	N.O.
AVERAGE	350	3,590	2,565	56,800	2,310	1,680	2,820	71,655	25
AVERAGE	80	7,040	3,220	88,200	2,800	NIL	8,570	118,460	205
1966-70									

b) CHUM SALMON

1975	50	200	400	1,000	100	150	100	2,000	N.O.
1974	200	4,000	1,500	40,000	1,000	4,000	3,500	54,200	25
1973	1,000	3,000	1,500	25,000	700	6,000	5,000	42,200	25
1972	N.O.	1,500	1,500	60,000	750	3,500	1,500	68,750	75
1971	N.O.	750	750	25,000	200	750	750	28,200	N.O.
AVERAGE	250	1,890	1,130	30,200	550	2,880	2,170	39,070	25
AVERAGE	NIL	480	610	14,500	220	3,450	3,080	22,340	130
1966-70									

c) CHINOOK SALMON

1975	200	100	No	1,000	No	50	25	1,375	No
1974	300	300	No	2,000	No	1,000	600	4,200	No
1973	750	300	No	3,500	No	3,500	200	8,250	No

TABLE V

Salmon Escapements, High Potential Impact Area Kitimat River and Tributaries (Cont'd)

c) CHINOOK SALMON (Cont'd)

YEAR	CHIST CREEK	HIRSCH CREEK	HUMPHREYS CREEK	KITIMAT RIVER	NALBEELAH CREEK	BIG WEDENEEN	LITTLE WEDENEEN	TOTAL	WATHL CREEK
1972	750	200	No	3,500	No	1,500	400	6,350	No
1971	750	400	No	5,500	No	3,500	750	10,900	No
AVERAGE	550	260	No	3,100	No	1,910	395	6,215	No
AVERAGE 1966-70	50	190	No	6,800	No	1,900	530	9,580	No

d) COHO SALMON

1975	50	200	75	1,500	150	400	100	2,475	No
1974	1,000	500	800	3,000	300	1,500	1,000	8,100	No
1973	400	300	N.O.	2,000	100	400	400	3,600	No
1972	3,500	750	750	3,500	750	1,500	1,500	12,250	No
1971	1,500	400	750	3,500	750	3,500	750	11,150	No
AVERAGE 1966-70	1,290	430	475	2,700	410	1,460	750	7,515	No
AVERAGE 1966-70	450	940	190	9,850	150	1,230	1,040	13,850	25

TABLE V

Salmon Escapements, etc High Potential Impact Area (Kitimat River and Tributaries) (Cont'd)

e) SOCKEYE SALMON

YEAR	CHIST CREEK	HIRSCH CREEK	HUMPHREYS CREEK	KITIMAT RIVER	NALBEELAH CREEK	BIG WEDENE	LITTLE WEDENE	TOTAL	WATHL CREEK
1975	N.O.	N.O.	N.O.	75	N.O.	N.O.	N.O.	75	N.O.
1974	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.
1973	N.O.	N.O.	N.O.	75	N.O.	N.O.	N.O.	75	N.O.
1972	N.O.	N.O.	N.O.	750	N.O.	N.O.	N.O.	750	N.O.
1971	N.O.	N.O.	N.O.	400	N.O.	N.O.	N.O.	400	N.O.
AVERAGE	-	-	-	260	-	-	-	260	-
AVERAGE 1966-70	-	-	-	240	-	-	-	245	-
	-	-	-	-	-	-	-	-	-

f) STEELHEAD

1975	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-
1973	-	-	-	NOT RECORDED	-	-	-	-	NO RECORD
1972	-	200	200	3,500	200	750	200	5,050	RECORD
1971	400	400	75	3,500	200	750	200	5,525	
AVERAGE	80	120	55	1,750 (years)	80	300	80	2,115	
AVERAGE 1966-70	-	-	-	1,125 (years)	-	-	-	450	

N.O. - None Observed

TABLE VI.
Summary of Kitimat River Escapement Records (5)

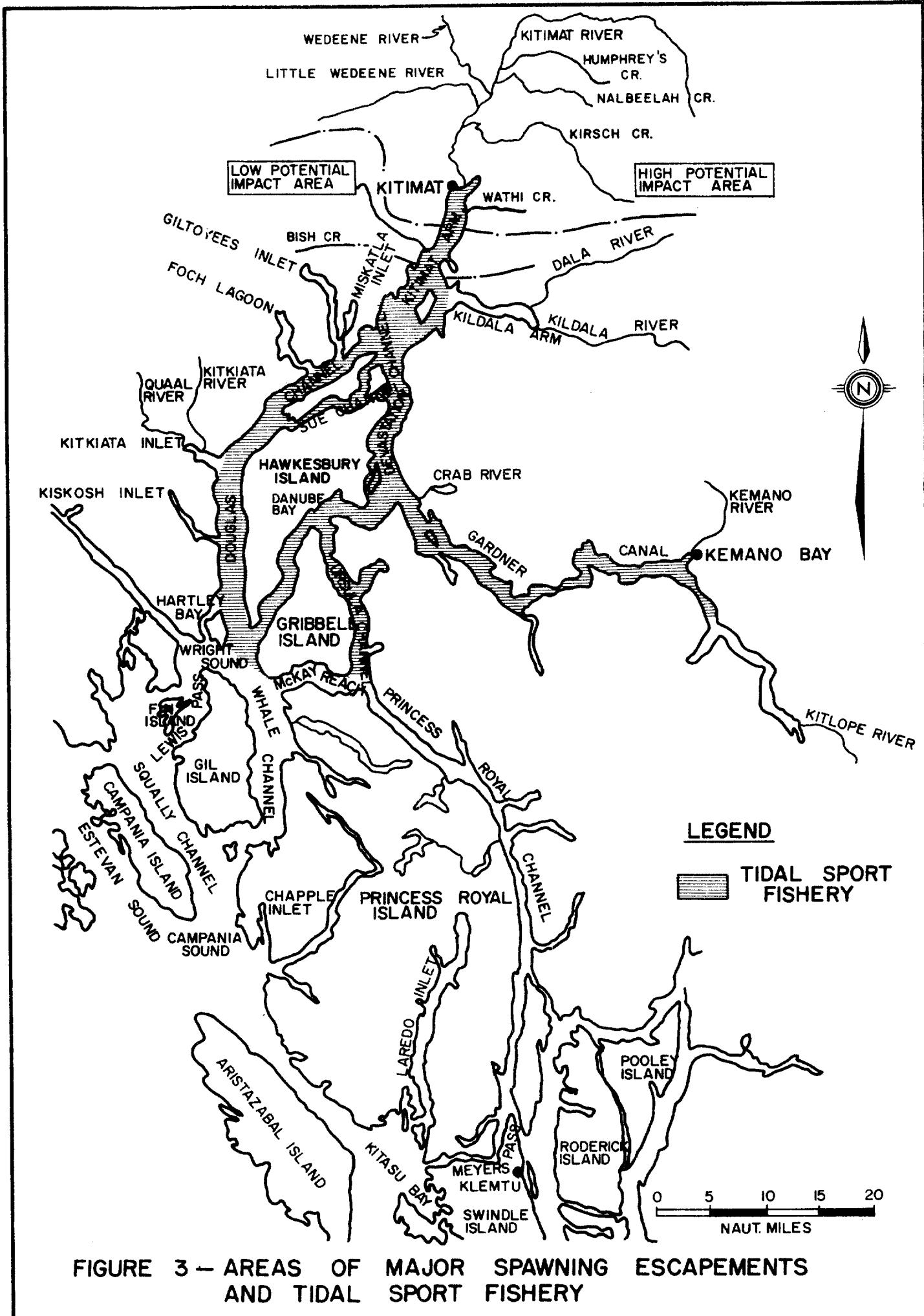
SPECIES	YEARS OF ENUMERATION	AVERAGE ESCAPEMENT 1966-1975	DATE AND SIZE OF MAX. ESCAPEMENT*	DATE AND SIZE OF MIN. ESCAPEMENT*	PERIOD OF SPAWNING (PEAK UNDERLINED)
SOCKEYE	1927, 1929-				
	1956	Transient	(1938)	(1970)	<u>Sept.</u>
	1966, 1969		10,000-20,000	0	
CHINOOK	1971-1975				
	1927-1947		(1934)		
	1949-1951	7,408	50,000-100,000	(1975)	<u>May-July</u> -Aug.-Sept.
COHO	1953-1975			1,375	
	1927-1947		(1934)		
	1949-1951	10,634	100,000+	(1967)	<u>July-Sept.</u> -Oct.-Nov.
PINK	1953-1975			1,500	
	1927, 1929-				
	1947	88,416	(1972)	(1971)	<u>July-Aug.</u> -Sept.
STEELHEAD	1949-1951		246,500	1,800	
	1953-1975				
	1927-1928				
CHUM	1933-1944		(1935)	(1962-1968)	
	1947, 1949	Transient	10,000-20,000	0	<u>Feb.-April-May</u>
	1951, 1954-				
	1958, 1969-				
	1971				
	1927-1947				
	1949-1951	28,050	(1972)	(1965)	<u>July-Aug.</u> -Sept.
	1953-1975		68,750	1,500	

* most recent max. and min. figures given when several years have the same values.

TABLE VII
Salmon Escapements, Low Potential Impact Area - Bish Creek (4)
(Wathlsto and Emsley Creeks have no Escapement Records for the Time Period 1966-1975)

YEAR	SOCKEYE	CHINOOK	COHO	CHUM	PINK	STEELHEAD
1975	N.O.	N.O.	400	100	1,000	N.O.
1974	N.O.	N.O.	500	6,000	8,000	N.O.
1973	N.O.	N.O.	500	3,000	2,000	N.O.
1972	N.O.	N.O.	400	2,700	20,000	N.O.
1971	N.O.	75	750	400	25	N.O.
AVERAGE	-	15	510	2,440	6,205	-
AVERAGE 1966-70	-	-	510	2,250	6,900	-

N.O. = None Observed



The Kitimat River system incorporates the major spawning sites in the Butedale Subdistrict for chinook and coho and ranks second for chum and even year pinks. Tables V and VI summarize the escapements for the Kitimat River and its tributaries from 1966 to 1975. The importance of the system is illustrated by the fact that it supports 17.5% of the total salmon escapements for the Butedale Subdistrict. Salmon migrations span a period from May, with the start of the chinook migration, to November, the completion of the coho runs (Table VI). During this period, one or more species may be in the vicinity of the Eurocan outfall. Effects of effluent discharges on adult spawning success may be pronounced and immediate, as in mortalities due to increased toxicities, or less evident as in the case of decreased egg and adult viability. Since salmon do not feed after entering freshwater and are on a fixed energy reserve, delays can often result in prespawn mortalities.(9)

Emergent fry will also be under the influence of the mill effluent during their seaward migration. Their smaller size and longer residence time in the river and estuary make them more susceptible to long term effects of the mill effluent, than adults. Studies carried out in 1974 (10) and 1975 (5) showed that juvenile coho, chinook and chum utilized the estuary as a rearing area from May to August, with the highest numbers being found in May. It was also found that the juvenile salmon tended to frequent the vegetated as opposed to the non-vegetated intertidal areas, probably because these areas provided suitable habitats for amphipods and other invertebrates which constitute a major portion of the juvenile salmonid diet.(5,10)

The previous discussion emphasizes the importance of the Kitimat River system and upper estuary to the reproductive success of the salmon in this area. Therefore, the area south to the Kitimat Village can be considered a potentially high impact area in terms of pulp mill effluent. In contrast, that portion of Kitimat Arm below Kitimat Village, south to Kildala Arm, and including Bish, Wathl and Wathlsto Creeks can probably be considered a low potential impact area due to the distance from the outfall, the small number of spawners utilizing those streams, and the lack of rearing areas (Table VII) Figure 3 shows the major escapement streams and the high and low potential impact areas.

D. Sport Fishery

i) Tidal

The tidal salmon sport fishery in Area 6 occurs throughout most of the major inner channels north of Wright Sound and McKay Reach (Figure 3). Douglas Channel in particular is second only in preference to the Kitimat River for sport fishing.(11) A seasonal boat rental resort operates at Danube Bay on Hawkesbury Island. The number of chinook taken averaged 1,382 for 1966-1975, while other salmon averaged about one-third of that at 439 pieces (Table VIII). The pressure and extent of the tidal sport fishery has increased considerably over the past years with the advent of new and more powerful boats. From 1968 to 1976 there

has been an increase from approximately 30 boats to the present estimate of 200 to 300 boats.(5) The increase is reflected in increases in both the effort in boat days and total number of salmon taken for the two 5-year periods 1966 to 1970 and 1971 to 1975. Effort in boat days increased from an average of 951 to 3,938 annually while the total number of fish taken increased from 1,399 to 2,394. Tidal sport fishing catches for other species are discussed under their respective headings.

ii) Non-Tidal

Like the tidal fishery, the non-tidal fishery has also experienced a marked increase in popularity. It has resulted in an increasing tendency to fish in the more distant areas such as Gardner Canal and Douglas and Princess Royal Channels. (8) Nevertheless, the Kitimat River still remains one of the most heavily favoured fishing sites. Eighty-two percent of Kitimat's residents consider the Kitimat River their first or second favourite fishing location.(11) Furthermore, as one of Canada's most active sport fishing rivers, it was subjected in 1974 to almost 104,000 angler days of effort, with 77% of that by Kitimat residents. This is in comparison to the Mirimachi in New Brunswick, a well known Atlantic fishing river which, during 1972, recorded 54,412 salmon sport fish angler days. (11)

Salmon sport catch statistics for non-tidal waters are not very reliable and are taken only infrequently. Table IX gives approximate numbers of chinook and coho salmon catches.

iii) Other Sport Fish

Three other major species of anadromous fish utilize the Kitimat area - Dolly Varden char, cutthroat trout and steelhead trout. Of the three species, steelhead are probably the most important in the area, being of value in the sport, Indian food and commercial fishery. Numbers of cutthroat and Dolly Varden taken in the sport catch are not available.

As a sport fish, the steelhead is one of the top five sport fishes in North America and the most important west of the Rocky Mountains.(13) Sport fishing catches (by post card survey) of steelhead between 1966 and 1975 for the Kitimat River plus Wedeene River and Hirsch Creek averaged 150 with a range from 43 to 529 pieces (Table X). These figures gave estimated catches which ranged from 239 to 1,367, with an average of 553 fish. The table shows the trend toward increasing numbers of anglers and catches in recent years. Commercially, steelhead are caught in relatively small quantities incidental to salmon fishing. Table XII gives the number of pieces per year. From 1966 to 1975, numbers ranged from 56 to 716 with an average of 277.

TABLE VIII
Area 6, Butedale - Salmon Sport Catch,
Tidal Waters (in pieces) and Effort (12)

YEAR	CHINOOK	COHO	PINKS & OTHERS*	TOTAL	EFFORT BOAT DAYS
1975	2,452	305	110	3,466	5,810
1974	1,583	1,020	101	2,704	2,540
1973	2,108	520	NIL	2,628	4,010
1972	1,317	418	400	2,135	6,400
1971	980	60	NIL	1,040	930
AVERAGE 1971-75	1,688	465	122	2,394	3,938
1970	925	25	250	1,200	1,150
1969	750	100	NIL	850	1,125
1968	560	300	60	920	530
1967	1,250	225	50	1,525	1,000
1966	1,900	400	50	2,500	950
AVERAGE 1966-70	1,077	210	82	1,399	951
10 YEAR AVERAGE	1,382	337	102	1,897	2,444

For 1966-68, coho and chinook grilse were expressed as a separate total of "combined-grilse". Values were 50, "few" and 150,
 * Sockeye and chum.

TABLE IX
Salmon Sport Catch, Non-Tidal Waters(8)

YEAR	CHINOOK	COHO
1974	350	475-675
1973	500	1,000
1972	500	900-1,000
1971	500-600	1,000-1,800
1970	525	1,200
1968	1,150	2,840
1966	1,200 (Kitimat R. Only)	

Monitoring of steelhead stocks is under the jurisdiction of the B.C. Fish and Wildlife Branch, thus observations by the Fisheries and Marine Service are sporadic. Available information shows escapements in only three water bodies since 1947; the Kitimat and Kemano Rivers and Evelyn Creek (East Hawkesbury Island). Only the Kitimat River shows escapements over the last 10 years.(4) Escapements ranged from 750 in 1969 to 3,500 in 1972. None have been recorded in recent years. Annual catches in other areas represented less than one-third of the total steelhead escapement.(5) On this basis, the Kitimat River escapement for the years 1966 to 1975 ranged from approximately 1,200 to 2,500 fish. Steelhead spawning occurs from February to May, with the peak occurring in April. After spawning, the adults return to salt water, while the young remain in fresh water for 2 to 3 years before migration to the sea.(13,15)

TABLE X

Area 6 - Steelhead Sport Fishing Estimates*(14)

YEAR	DAYS FISHED	NUMBER OF ANGLERS	CATCH
REPORTED	ESTIMATED	REPORTED	ESTIMATED

A) High Potential impact area - Kitimat River including the Big and Little Wedeene Rivers and Hirsch Creek

1974-75	2380	6172	223	590	529	1367
1973-74	1413	6029	158	657	202	864
1972-73	1250	5050	150	594	150	604
1971-72	1373	4598	157	502	150	491
1970-71	859	4207	119	552	43	239
1969-70	1019	6616	137	831	97	650
1968-69	1232	4834	172	657	172	686
1967-68	798	3356	122	495	82	348
1966-67	203	781	106	407	75	288
Average	1169	4627	150	587	166	615

B) Low potential impact area - Bish Creek

1973-74	2	8	1	4	0	0
1972-73	1	4	1	4	1	4
1966-67	-	-	2	11	0	0

* Steelhead reported figures are obtained from postcard surveys. Estimated values are compiled from these results.

E. Indian Fishery

Three Indian villages utilize the fisheries resources of the Butedale Subdistrict. Klemtu village people fish mostly in the outside waters around Kitasu Bay and Laredo Inlet. Hartley Bay, (located at the outer end of Douglas Channel), center their fishing in the immediate area, with some fishing in the waters outside the commercial fishing boundaries.(8) In relation to the Eurocan pulp mill, it is the Kitamaat Indian village fishery which is of utmost significance. Most of their catch (composed of all five Pacific salmon, steelhead, herring and eulachon) is obtained using set nets, in the area of Kitimat Arm from Kitamaat Village, south to the Kitsaway Anchorage. Fishing is permitted four days per week year round. Table XI gives the catch breakdown by species from 1966 to 1975.

TABLE XI

Indian Food Fishery - Kitamaat Village (catch in pieces) (1)

YEAR	SOCKEYE	COHO	PINK	CHUM	CHINOOK	STEEL-HEAD	NON-SALMONID
1975	200	400	300	800	100	Unknown	2 Tons (herring)
1974	400	420	50	1,400	800	Unknown	Unrecorded
1973	200	400	100	1,500	200	150	50 Tons (eulachon)
1972	150	600	1,000	2,000	350	150	25 Tons (eulachon)
1971	150	700	150	2,000	200	100	80 Tons (eulachon)
1970	100	800	1,000	700	250	150	30 Tons (eulachon)
1969	200	600	100	500	400	75	
1968	100	1,200	1,000	800	300	150	
1967	396	1,196	160	744	464	18	
1966	500	800	5,000	100	300	NIL	
AVERAGE (1966-75)	239	711	886	1,050	336	99	

In past years, the Kitamaat Village eulachon fishery has been an important source of food and oil for the Indians. Recently, fewer fish have been taken, possibly as a result of tainting by pulp mill effluent which renders the fish unpalatable. The susceptibility of the eulachon to tainting agents is thought to be related to their high oil content.(16) The fishery has more recently been limited to rivers other than the Kitimat such as the Kitlope, Kemano, Kildala and Kowesas.

Eulachon spend most of their life in coastal waters, migrating during their second or third years into fresh water to spawn usually from March to May. The adults die after spawning and the eggs incubate for 2-3 weeks prior to hatching. The newly hatched fry migrate almost immediately down to sea.(13)

The Kitamaat Indian band also harvests herring for food and roe in the Minette and NK Bay areas during the spring spawning period.

III HERRING

The commercial roe herring fishery of statistical area 6 is centered in two areas, both outside Kitimat Arm: Kitasoo Bay on the south end of Princess Royal Island and Higgins Pass (North of Price Island).⁽¹⁾ Some herring are also taken for food and bait in Meyers Pass.⁽⁷⁾ Table XII gives total catch (food and bait plus roe herring) for Area 6. It is unlikely that the Eurocan mill would have a significant effect on these fisheries as the herring caught at these locations are migratory stock not originating in the Kitimat area. The Kitimat Arm populations are slow growing residents whose roe is too small to be of commercial use.⁽⁵⁾

TABLE XII
Area 6, Butedale - Commercial Fishery Catch
Other Species - Hundredweight (cwt) (3)

Year	Steelhead (Pieces)	Herring	Halibut	Groundfish	Abalone	Clams
1975	65	55,600	1,320	930	360	1,200
1974	235	39,860	390	610	140	720
1973	92	NIL	1,770	300	10	NIL
1972	365	NIL	110	960	NIL	NIL
1971	56	36,200	610	NIL	NIL	NIL
1970	268	5,363	1,911	859	NIL	NIL
1969	128	NIL	2,332	307	NO RECORD	
1968	369	370	1,002	72	NO RECORD	
1967	716	33,900	1,108	191	NO RECORD	
1966	483	126,760	1,197	204	NIL	NIL
AVERAGE	277	29,805	1,175	443	51	192

Spawning within Kitimat Arm occurs primarily on the east side between Minette and NK Bays. Figure 4 shows the location of spawning sites in this area from 1971 to 1976.

Egg deposition occurs within the shallows where the eggs adhere to kelp, rockweed, eelgrass, rocks and other stable substrate. Fertilization occurs "en masse", the milt visible as a milky colouration of the water. Hatching occurs in about

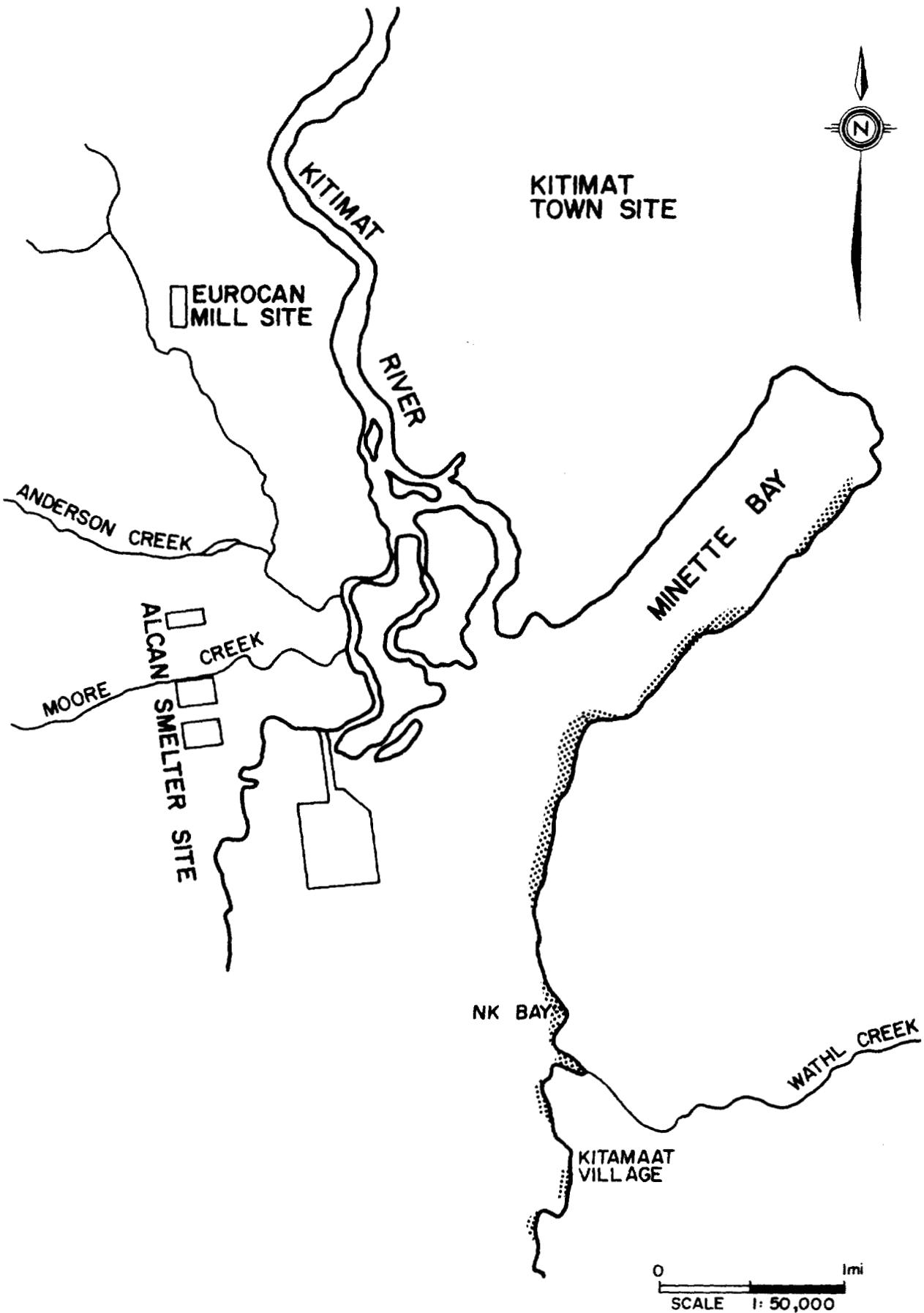


FIGURE 4 - HERRING SPAWN LOCATIONS 1971-1975 (18)

10 days, after which the developing larvae become dependent on the intertidal area for food such as diatoms, copepods, bryozoans, rotifers, invertebrate larvae and later, young fish. After reaching a length of 7 to 10 cm, usually around October, they migrate into deeper waters.(18)

The condition of the intertidal zone of the Kitimat Arm area is thus important to herring from March through to mid-fall.

Examination of spawning records over the past few years indicates that the Kitimat Arm population is usually the first to spawn in the area, with depositions usually in March. This is in contrast to the closest other major spawning area in the vicinity, Hawkesbury Island, where spawning is much later (May in 1976).(17) At the present time, little is known of their migratory patterns within Kitimat Arm and Douglas Channel.(19)

Although there is no commercial fishery in the Kitimat Arm area, the local Indians often utilize the deposited spawn for food. Some herring may also be taken during the sport fishery for both food and bait.(5) In addition herring provide a major link in the marine food chain, being utilized extensively by coho, chinook and steelhead as well as a variety of other species. (18)

IV HALIBUT AND GROUNDFISH

Although the commercial halibut fishery centers on the west coast of Aristazabel Island, Laredo Channel and Millbank Sound (Figure 2), significant catches have been taken in Douglas and Ursula Channels and Campania Sound. Two boats also fish regularly in Kitimat Arm, for both halibut and cod.(7) Table XII shows catch statistics for the Butedale Subdistrict from 1966 to 1975.

In the vicinity of Kitimat Arm, the sport fishery for halibut occurs primarily during slack periods in the salmon fishery. Most of the halibut taken at that time are caught by jigging (Table XIII).

Other than halibut there is no major fishery for groundfish; most are caught incidentally while fishing for other species. Chief species landed include grey, ling and black cod. These are caught primarily by trawl. However, some potential for a commerical cod fishery of 2-3 boats in the outside waters does exist!(7) In the tidal sport fishery, a variety of groundfish are caught by jigging. Table XIII gives approximate numbers caught in recent years.

TABLE XIII

Area 6, Butedale - Sport Fishery, Tidal Waters - Other Species(7)

(Numbers of Fish)

YEAR	HALIBUT	LING COD	ROCKFISH	ABALONE	CRABS
1975	75-100	500	2,000-2,500		
1974	120-140	400-600	1,500-2,000	small numbers	7,200-8,400
1970	125	300			
1969	150				

V CRUSTACEANS

Although shrimp and prawn are not commercially important in Kitimat Arm, some may be taken by sport fishermen.(7) Crabs, on the other hand, are second only to salmon in both commercial and sport fishing importance. Although sites may vary slightly from year to year, Kitimat Arm, several Douglas Channel inlets (Kiskosh, Kitkiata, and Giltoyes) and the area adjacent to Crab River have produced commercial yields (1,5,7) (Table XII). The above areas are also important for sport fishing. Within Kitimat Arm, the Kitimat waterfront is the favoured site. While there are no precise figures available on effort or catch, estimates of a total harvest of 15,000 crabs for 5,000 fisherman days have been reported.(7) Up to 1974 (when a sport catch of 7,200-8,400 crabs were taken) the effort and catch appeared to have been quite constant. Most crabs caught commercially are sold in local markets.(7) Tables XII and XIII show the available commercial and tidal sport catch statistics.

VI MOLLUSCS

Both abalone and clams have been harvested intermittently within the last few years. The two main stocks of abalone in the Butedale Subdistrict are in outside waters, at Higgins Pass and Chapple Inlet (Figure 2). Both the commercial and sport fishery are concentrated here although the latter is limited due to the distance from Kitimat. Little is known of the potential for greater utilization of the stocks.

By far, the most significant factor preventing the successful utilization of clams is their almost continuous toxicity due to paralytic shellfish poisoning, or red tide, that necessitates a commercial closure. From 1970 to 1973, no clam harvests have been reported.(5,8) Tables XII and XIII give available harvests statistics for molluscs.

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