ENVIRONMENTAL PROTECTION BRANCH
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PACIFIC REGION

PULP MILL ENVIRONMENTAL ASSESSMENT
CANADIAN CELLULOSE LIMITED
NORTHERN PULP OPERATIONS
PORT EDWARD, BRITISH COLUMBIA

Regional Program Report: 79-7

by

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ABSTRACT

In October 1976, the Environmental Protection Service initiated a program to assess the environmental impact of pulp and paper mills in British Columbia. With the co-operation of various other government agencies and the industry, EPS compiled relevant resource data 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 the environmental impact assessment for the Canadian Cellulose Northern Operations pulp mill.

RÉSUMÉ

Au mois d'octobre 1976, le Service de la protection de l'environnement a entrepris d'évaluer les répercussions mésologiques des fabriques de pâtes et papiers de la Colombie-Britannique. Aidé de l'industrie et de divers autres organismes gouvernementaux, il a réuni une documentation concernant les ressources ainsi que certains résultats de contrôles portant sur l'environnement affecté. Après avoir étudié ces données, le Service a évalué la qualite environnementale de chacune des régions et déterminé quelles seraient les études supplèmentaires qui resteraient a réaliser. Ce rapport fait connaître les résultats ayant trait à l'évaluation des contrecoups imputables à la fabrique de pâte de la Canadian Cellulose Northern Operations.

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SUMMARY AND CONCLUSIONS

The Canadian Cellulose mill is located on a series of enclosed marine embayments connected by constricted turbulent passages near Prince Rupert, British Columbia. The water column in these embayments (Porpoise Harbour and Wainwright Basin) is stratified to a limited degree. There has been an historic problem of low dissolved oxygen (DO), fibre deposition and toxicity stemming from CanCel's effluent.

The Company has replaced its former Sulphite Mill with a new Kraft Mill, resulting in a predicted 90% reduction in BOD_5, 80% reduction in total suspended solids (SS) and an 80% reduction in toxicity. The new Kraft Mill (Mill B) discharges its effluent along with the effluent from the old Kraft Mill (Mill A) via a foam tower, through a submarine diffuser into Porpoise Harbour. The Provincial Pollution Control Branch has stipulated that DO levels in Porpoise Harbour remain above 5.0 mg/l in the top five metres of the water column. It is the opinion of the Environmental Protection Service that this requirement should be extended such that DO is maintained at 5.0 mg/l throughout the water column.

CanCel has been permitted a one year trial period from the time of start-up of Mill B to assess the impact of the combined discharge from the two mills upon Porpoise Harbour. The Company, as well as Provincial and Federal agencies will conduct chemical and biological monitoring programs to assess impact during that time. Further pollution abatement measures may be required subject to the needs of the receiving environment.

Prior to the establishment of a mill complex at Porpoise Harbour, the area had a high level of biological productivity. This productivity has been decreased drastically and it is hoped that through the incorporation of appropriate pollution control measures some of the former productivity can be restored.

1 INTRODUCTION

1.1 Location

The Canadian Cellulose Company Limited, Northern Pulp Operations pulp mill is located on Watson Island, 10.2 km due south of the City of Prince Rupert at Port Edward, British Columbia. Prince Rupert is located on Kaien Island on the north coast of British Columbia near the mouth of the Skeena River, at the eastern extremity of the Dixon Entrance - Chatham Sound system (Figure 1). The pulp mill is situated on a series of partially enclosed embayments; Morse Basin, Wainwright Basin, and Porpoise Harbour, which are connected with one another via constricted turbulent passages. The pulp mill is separated from Chatham Sound by Ridley Island while a connection exists between Chatham Sound and Porpoise Harbour through Porpoise Channel.

1.2 Climate

The climate of the Prince Rupert area is a modified maritime climate. Monthly mean temperatures range from 1.8°C in January to 13.5°C in July. The mean annual precipitation is 95.06 inches (241.45 cm). The prevailing winds are from the southeast with an annual mean velocity of 11.4 kmh (Hoos, 1975).

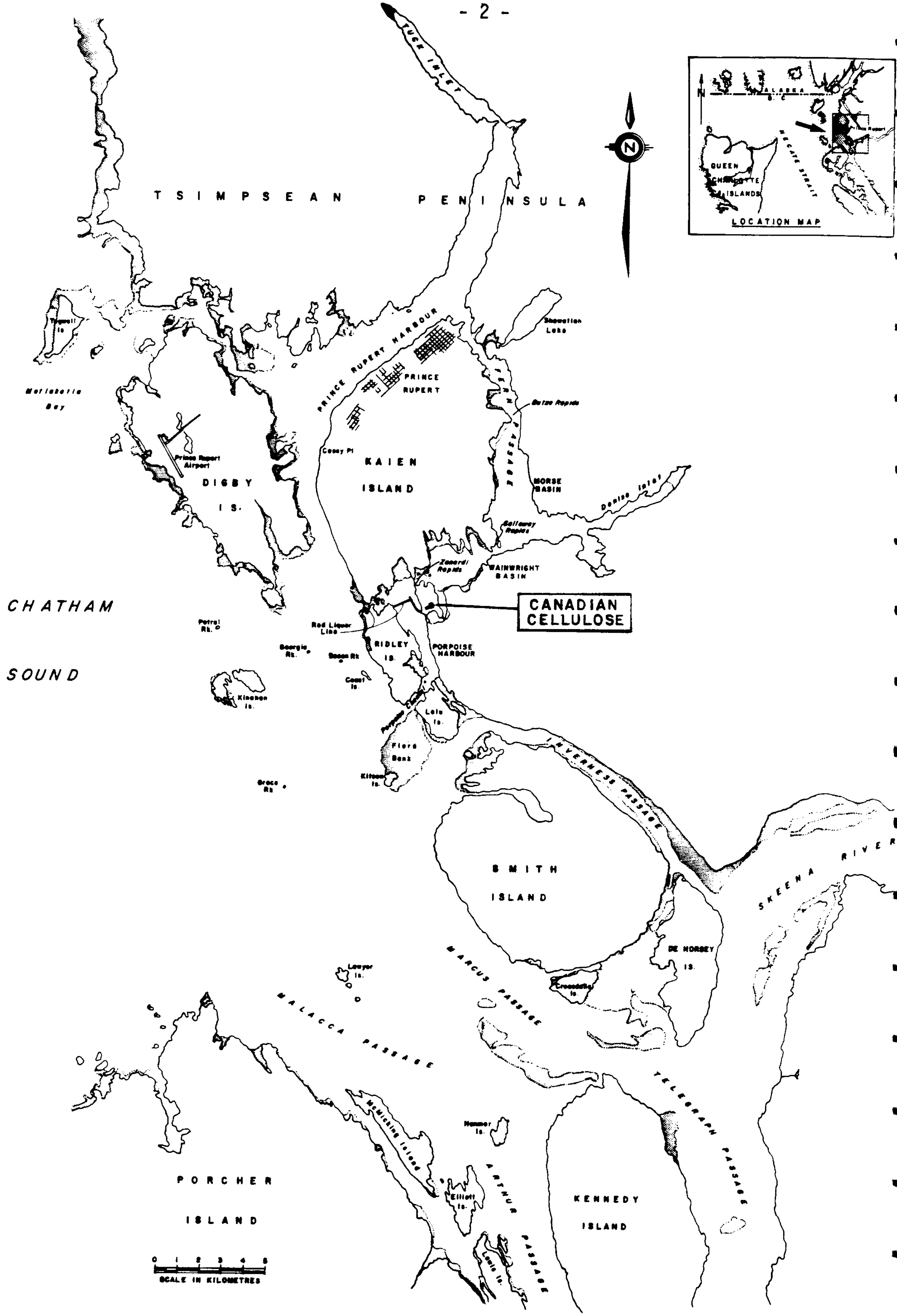

FIGURE I LOCATION MAP

2 MILL OPERATIONS

2.1 Mill History

In 1950, a Bleached Sulphite Pulp Mill was established on the Watson Island site near Prince Rupert. Production commenced in 1951, producing mainly cellulose acetate grade wood pulp which is the principal raw material used in the production of textile grade continuous filament acetate yarn and cigarette tow for filters. The mill was initially designed as a 200 Air Dry Ton Per Day (ADTPD) operation, but was expanded over the years to a maximum capacity of 600 ADTPD. It was operated at an average daily production level of 530 ADT with an annual output of approximately 180 000 ADT until it was closed permanently on October 8, 1976.

In 1966, a Bleached Kraft Mill was also constructed on the site. The mill had a designed capacity of 1000 TPD of chemical pulp, but has been averaging 800 TPD (Ker et al, 1970). The pulp is finished in bale form, mainly for export, at the rate of approximately 280 000 tons per year.

In January 1976, CanCel requested an amendment to their Pollution Control Board Permit which involved the shutdown of most of the Sulphite Mill and construction of a 525 ADT Bleached Kraft Mill adjacent to the existing Kraft Mill. Construction of the new Kraft mill began in May 1976, with start-up taking place in October 1978. Thus far this project appears to be on schedule.

2.2 Mill Discharges

2.2.1 Sulphite Mill. Initially the Sulphite Mill discharged through Lagoon #1 which was used as a settling and retention basin. However, with the expansion of the Sulphite Mill's capacity Lagoon #1 filled rapidly with fibre resulting in a suspended solids carry over into Wainwright Basin.

In 1961, a B.C. Research Council study recommended that in order to increase the dissolved oxygen levels in Wainwright Basin the high B.O.D. effluent from the Sulphite Mill be piped under Porpoise Harbour and across Ridley Island to effect a discharge into Chatham Sound which has superior flushing characteristics. This measure was implemented in 1966 concurrent with the construction of the Kraft Mill which discharged into Wainwright Basin.

Many problems were encountered with the pipeline to Chatham Sound, in the form of cracks and ruptures. This resulted in a great deal of experimentation with different sizes and materials of pipe, the net result of which was extended periods of discharge of high BOD_5 spent sulphite liquor into Lagoon #2 via Lagoon #1.

2.2.2 Kraft Mill. The original Kraft Mill (Mill A) discharged via 3 sewers, the Utility Recovery, Alkali and Acid Sewers into Lagoon #2 (Figure 2). With the completion of the new Kraft Mill (Mill B), the combined effluent of both Mill A and Mill B is now discharged via a foam tower through a diffuser placed at a depth of 18 meters in Porpoise Harbour (Figure 3). The total volume of this combined effluent amounts to approximately 26 million Imperial gallons per day (98.8 million liters/day). The discharge into Porpoise Harbour does not have a clarifier at the present time.

2.2.3 Recausticizing Area. The discharge from the recausticizing area includes wastes from the #4 boiler, the mud filter and the dregs washer. According to Ker et al (1970) these wastes were discharged through a natural drainage ditch to Zanardi Rapids. This is shown as discharge D in Figure 2. Recommendations included in this study were that the foul water from the hot caustic stages would be discharged into Chatham Sound. With the completion of the new complex the recausticizing solid wastes will be dewatered and disposed of as landfill at the rate of 59 tons per day. Any emergency mud dumping from this area will go to a land sump and/or be trucked away. All effluent is now discharged via the total mill diffuser system.

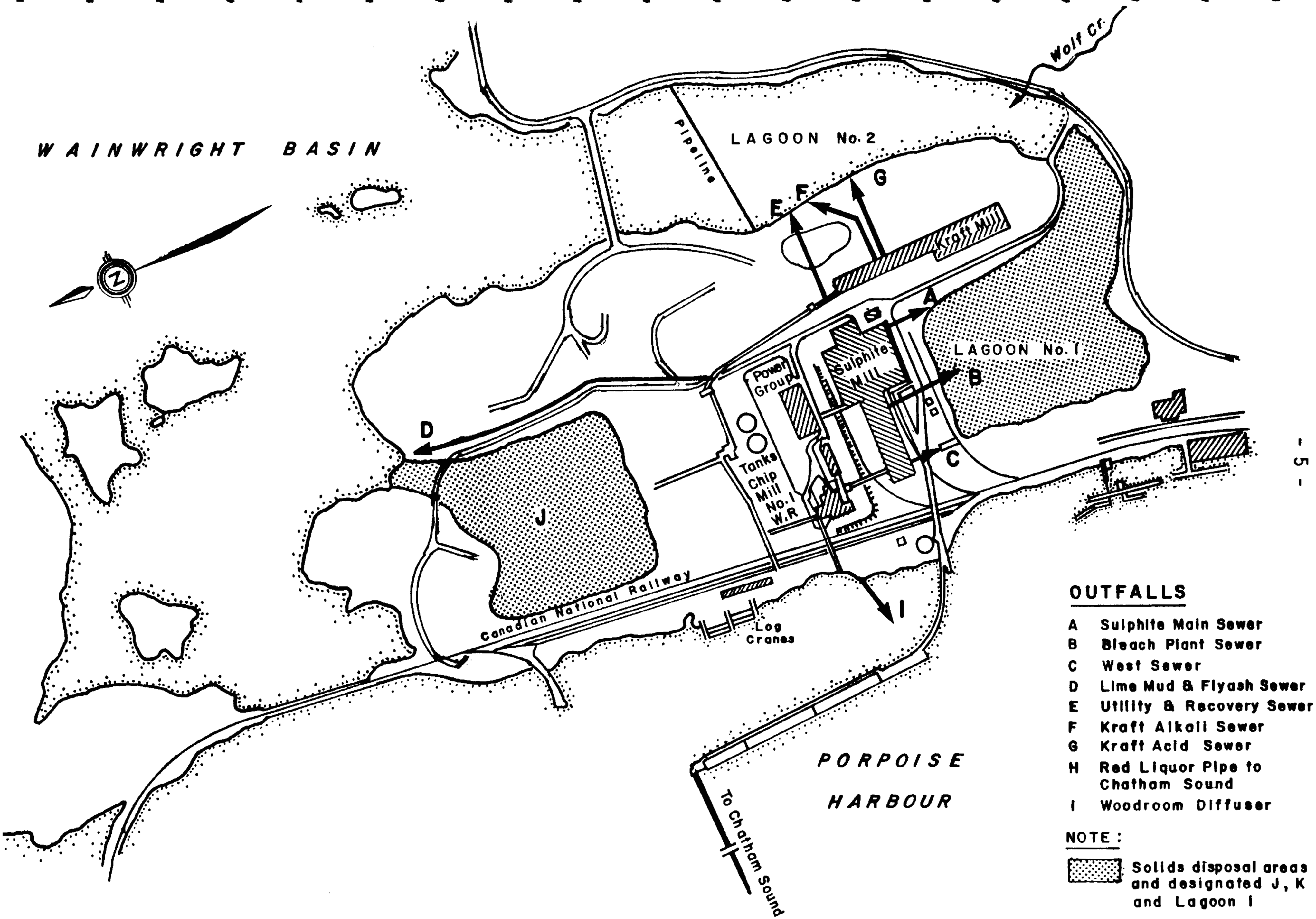

FIGURE 2 WATSON ISLAND SITE AND DISCHARGES PRIOR TO NEW MILL CONSTRUCTION

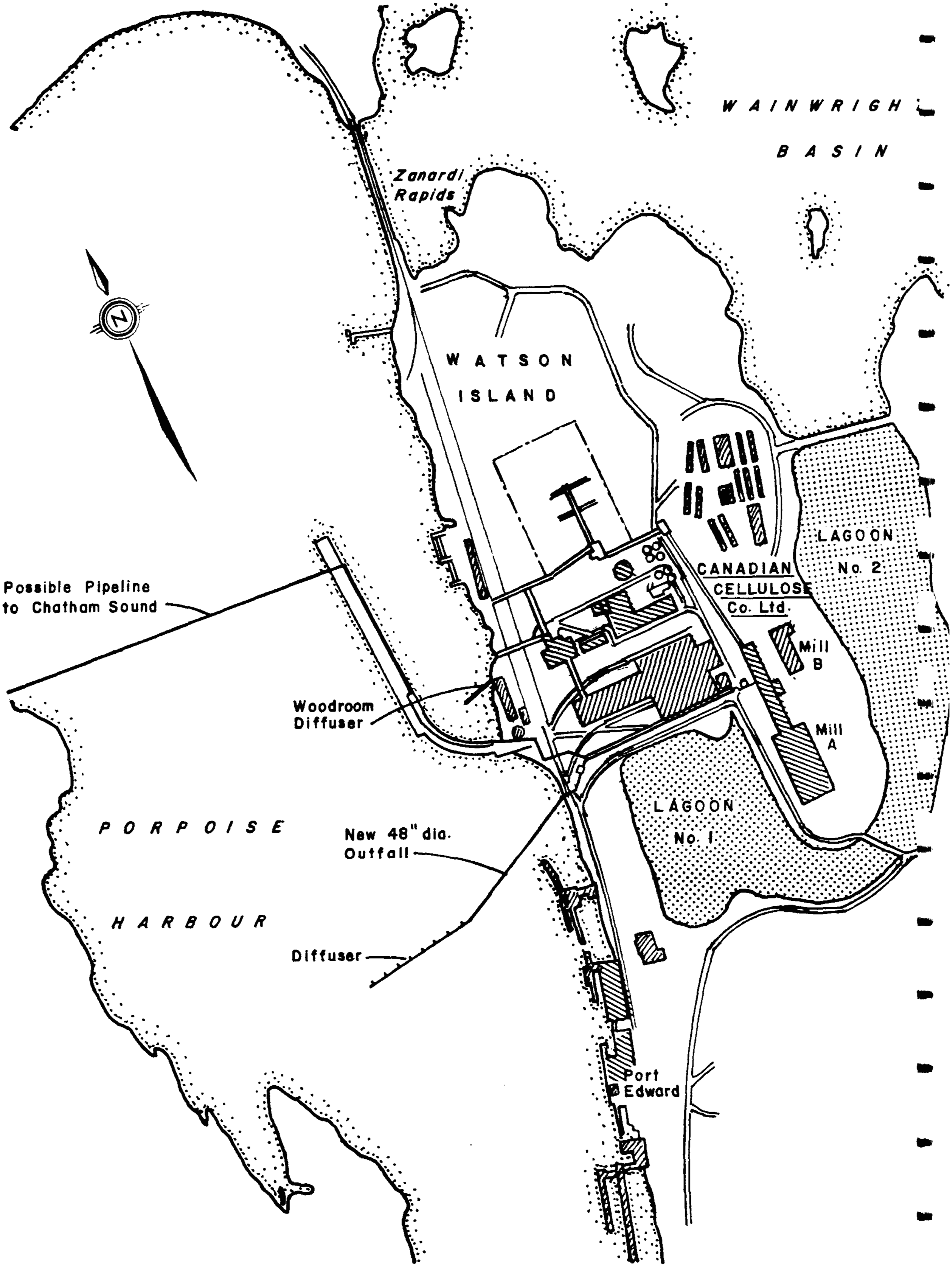

FIGURE 3 EFFLUENT DISCHARGE IN NEW MILL COMPLEX

2.2.4 Woodrooms. In 1970, two woodrooms were in operation. No. 1 woodroom used two hydraulic barkers while No. 2 woodroom utilized four mechanical barkers. The bark and coarse material was removed to hogfuel piles while the waste water from the No. 1 woodroom was discharged via a flume and thence to the sulphite main mill sewer. No. 1 woodroom was shutdown in the early 1970's. No. 3 woodroom possessing one hydraulic barker was constructed in 1975. At this time a diffuser was installed to handle all woodroom effluents (Figure 2). When this line was inspected by Environmental Protection Service personnel using SCUBA gear in January 1977, it was discovered that a diffuser was not in fact present on the end of this line. The diffuser line has recently had to be extended to accommodate hogfuel cover material used in an operation to contain spilled polychlorinated biphenyls. There are no plans to change this diffuser line to accommodate mill modifications.

2.2.5 Sanitary Wastes. The sanitary sewer system as it existed in 1970 is presented in Figure 4 (Ker et al, 1970). At that time the Kraft mill, No. 2 woodroom, booming office and chemical unloading area all had independent sanitary sewerage utilizing septic tanks for treatment prior to discharge. The garage and yard office each had a single facility discharging to Lagoon #1. Sanitary wastes from the Sulphite Mill were discharged through the Mill Main Sewer and a separate sanitary sewer directly into Lagoon #1. The sanitary discharge volumes at that time are given below:

(a) Kraft Mill	2300 g/d
(b) Yard Office	350 g/d
(c) Garage	300 g/d

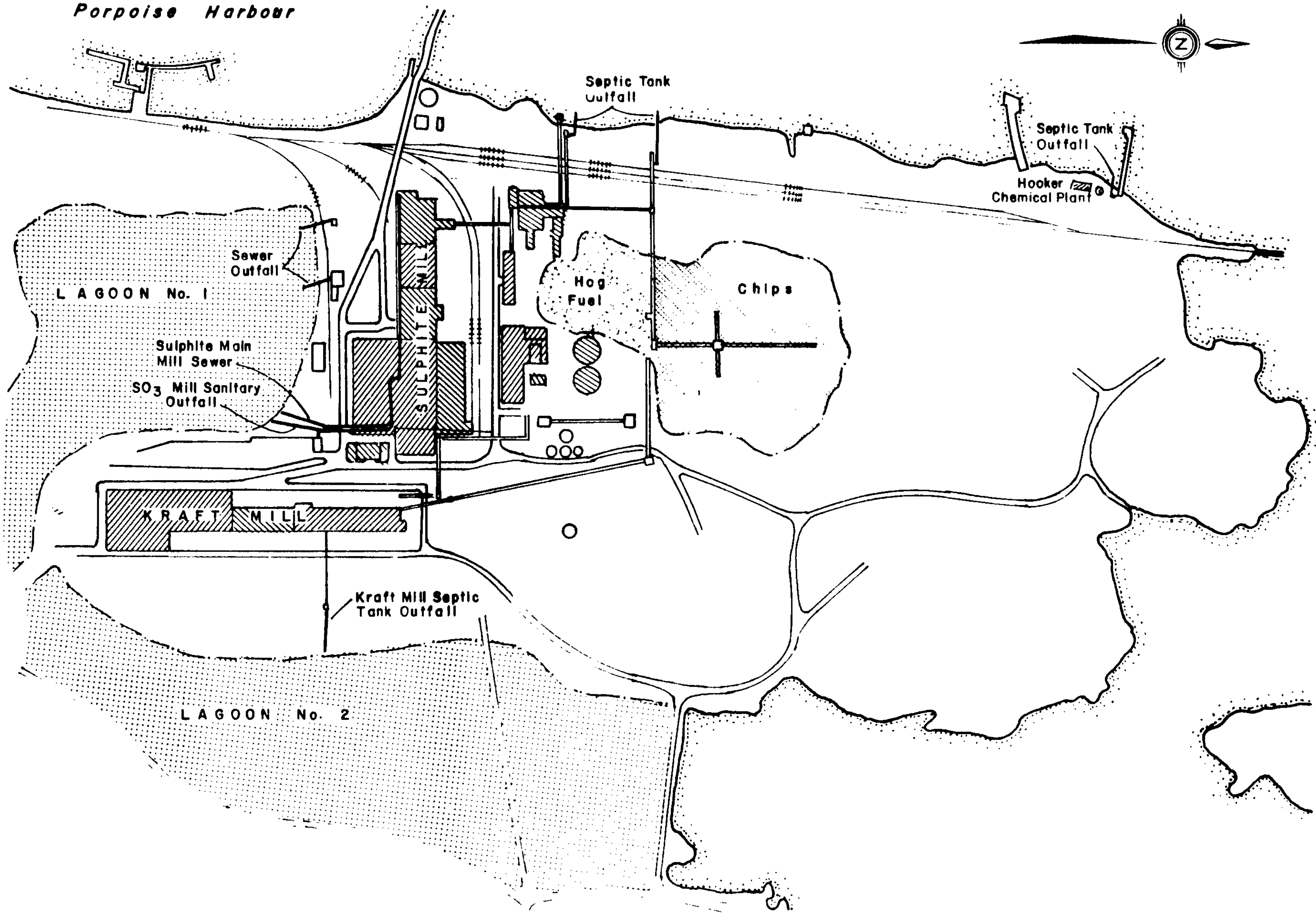

FIGURE 4 SANITARY SEWAGE SYSTEM (Ker et al, 1970)

3 EFFLUENT QUALITY

3.1 Government Requirements

Tables 1 and 2 show the BOD_5 and Suspended Solids results of the effluent monitoring program carried out by the mill for the years 1976 and 1977. Tables 3 and 4 show the Federal and Provincial Requirements which the CanCel Mill will be required to comply with as an Existing Kraft Mill. A program is contained in the amended Pollution Control Branch Permit (PE-1157) which is intended to bring the combined mill complex in line with the conditions outlined in Tables 3 and 4. Table 5 includes the toxicity results obtained during a two year study conducted by the Environmental Protection Service in conjunction with the mill.

3.2 Pollution Abatement Programs Underway

At the present time the Canadian Cellulose mill is undergoing a great deal of change directed towards pollution abatement (CanCel, 1976). The most important and costly measure which the company has adopted has been the shutdown of the old Sulphite Mill and the installation of an additional Kraft process mill. Concurrent with the construction of Mill B a number of changes have been incorporated into Mill A such that it now has recycling and spill control systems compatible with those of the new mill. Therefore, process lines can be run between the two mills to keep up production and prevent spills in one or other mill if one mill has mechanical problems. The recycling systems include the recycling of everything possible from the knotting, cleaning and screening of the fibre, such that the discharge from these areas is reduced to two TPD. Contaminated condensate from the digesters is stripped of up to 90% of their methanol content, and recycled back to the recausticizing department. Wastes from the flyash disposal are dried, and from the recausticizing dreg recovery concentrated, and both disposed of as landfill.

Spill control is also an important aspect of the mill's pollution control program. All operating areas in both mills are provided with slab floors and drains. The drains collect any spilled

TABLE 1 1976 EFFLUENT QUALITY RESULTS

Month	Flow x 10^6IG/D	BOD_5 LB/ADT	BOD_5 Tons	Suspended Solids LB/ADT	Suspended Solids Tons
January	30.4	85.0	32.90	47.8	18.50
February	27.7	67.1	24.32	64.3	23.31
March	23.6	112.9	45.55	154.4	62.30
1st Quarter	47.2	88.3	34.26	88.8	34.70
April	19.8	131.1	31.46	40.6	9.75
May	28.6	84.3	28.74	37.6	12.83
June	29.5	56.6	20.11	66.2	23.54
2nd Quarter	26.0	90.7	26.77	48.1	15.37
July	29.1	64.2	20.59	37.1	11.91
August	29.2	94.0	33.06	50.7	17.83
September	29.8	73.2	23.36	113.7	36.28
3rd Quarter	29.4	77.1	25.67	67.2	22.01
October	28.8	63.5	21.89	46.2	15.93
November	26.3	76.4	24.02	119.6	37.62
December	25.3	84.4	28.44	87.4	29.46
4th Quarter	26.8	74.8	24.78	84.4	27.67
Yearly Average	27.4	82.7	27.87	72.1	24.94

TABLE 2 1977 EFFLUENT QUALITY RESULTS

Month	Flow x 10^6 IG/D	BOD_5 LB/ADT	BOD_5 Tons	Suspended Solids LB/ADT	Suspended Solids Tons
January	28.5	82.7	24.76	98.9	29.63
February	27.5	56.3	19.68	67.7	23.67
March	31.4	110.3	29.49	115.5	30.91
1st Quarter	29.1	83.1	24.64	93.9	28.07
April	25.6	88.9	29.25	78.6	25.86
May	30.9	91.2	32.30	79.4	28.12
June	32.0	88.2	32.74	96.5	36.79
2nd Quarter	29.5	89.4	31.43	84.8	29.92
July	32.1	109.5	38.53	119.7	42.14
August	34.1	108.8	41.60	107.6	37.81
September	- - - - - - - - - - Mill Down - - - - - - - - - - - -				
3rd Quarter					
October	- - - - - - - - - - Mill Down - - - - - - - - - - - -				
November					
December	19.9	79.9	22.55	69.5	19.60
4th Quarter	19.9	79.9	22.55	69.5	19.60
Yearly Average	26.17	84.13	26.21	82.73	25.86

TABLE 3 FEDERAL REGULATIONS

BOD_5 (lb/ADT)	Suspended Solids (lb/ADT)	Toxicity
Pulping - 64 Bleaching - 27	Pulping - 7 (Brownstock) Bleaching - 6 (Bleached Pulp) Sheet Formation - 2 (Product)	80% Survival in 65% (V/V) Effluent over 96 hours

TABLE 4 POLLUTION CONTROL BRANCH PERMIT REQUIREMENTS

	Woodmill Hydraulic Barker	Two Bleached Kraft Pulp Mills
Effluent Volume - Weekly Avg. (IGPD) Daily Max. (IGPD)	2 300 000 (10 500 m /d) 3 500 000 (15 900 m /d)	40 000 000 (182 000 m /d) 48 000 000 (218 000 m /d)
Total Suspended Solids (lbs/day)	5120 (2320 kg/d)	37 110 (16 800 kg/d)
Settleable Solids (ml/l)	2.5	2.5
BOD_5 (lbs/day)	5120 (2320 kg/d)	74 220 (33 500 kg/d)
pH Range (within 4.6 m of outfall)	6.5-8.5	6.5-8.5
Temperature Maximum (°C)		35°C
Toxicity (TLM 96)	50% survival in a 12.5% effluent concentration over a 96 hour exposure time	50% suvival in a 12.5% effluent concentration over a 96 hour exposure time
Floatable Solids	Negligible	Negligible
Treatment		- in plant chemical fibre recovery facilities - primary out plant treatment facilities as resources - submerged outfall and diffuser (maximum 2) and related apurtenances

TABLE 5 RESULTS OF E.P.S. BIOASSAY PROGRAM

Sample Date	Type of Effluent	% Mortality Over 96 Hours, Static Test Concentration % (V/V) Effluent (Neutralized)						Sample pH
		49	42	37	30	24	18	
Dec. 21, 1977	Kraft	100	100	100	100	100	0*	7.0
Nov. 23, 1977	Kraft	100	70	60	10	0	0	8.0
Aug. 2, 1977	Kraft	100	100	100	100	0	0	6.9
May 24, 1977	Kraft	100	100	100	100	100	80	6.9
May 5, 1977	Kraft	100	80	50	10	0	0	6.9
Feb. 23, 1977	Kraft	100	100	80	20	0	0	6.7
		Concentration % (V/V) Effluent (Neutralized)						
		100	65	45	32	12.5	5.6	
Nov. 26, 1976	Kraft				100	100	100	2.9
Oct. 20, 1976	Kraft	100	100	100	100	0	0	5.5
Sept. 13, 1976	Kraft	100	100	100	20	0	0	7.0
June 13, 1976	Sulphite					100	100	3.9
June 13, 1976	Kraft	100	100	100	100	0	0	6.4
Apr. 7, 1976	Sulphite	100	100	100	100	100	100	4.2
Apr. 7, 1976	Kraft	100	100	100	100	0	0	5.6
Mar. 3, 1976	Sulphite	100	100	100	100	100	100	3.5
Feb. 27, 1976	Kraft	100	100	100	100	100	100	3.2

*11.5% concentration

material and return it to the process where possible. Dilute spilled material is discharged through the Porpoise Harbour diffuser. A more complete breakdown of the in-plant pollution abatement facilities installed is contained in a Progress Report from Canadian Cellulose to the Pollution Control Branch dated October 1976. This report was compiled as a partial fulfillment of the requirements of the mill's Pollution Control Branch Permit.

3.3 Out-of-Plant Effluent Treatment

The company anticipates that the new in-plant effluent treatment measures which they are installing will be sufficient to bring the effluent within the terms of their Pollution Control Branch Permit and compliance with Federal Regulations respecting an altered mill as well. Therefore, their out-of-plant treatment is currently limited to the Porpoise Harbour diffuser which handles all of the main mill effluent. Discharges which are not included in the Porpoise Harbour diffuser discharge include: the effluent from the three woodrooms, which will continue to be discharged through a diffuser laid under the log pond, and discharges from the Flyash Disposal and Recaust Dreg Disposal, which are both disposed of as landfill.

4 RECEIVING ENVIRONMENT

4.1 Oceanography

The Canadian Cellulose pulp mill is located on Watson Island which is midway along a series of partially enclosed marine embayments connected by a series of constricted turbulent passages (Figure 1). Although the tidal range in the Prince Rupert area is relatively large (up to 25 feet [7.5 m] on spring tides) the narrow channels leading to these embayments tend to dampen the tidal amplitude such that the tidal range in Morse Basin is only slightly greater than 0.7 of the amplitude in Prince Rupert Harbour (Waldichuk and Bousefield, 1962). Although large volumes of water do pass through Wainwright and Morse basins via Zanardi, Galloway and Butze rapids the actual flushing rates of the bottom water in these basins is very slow, due primarily to the sill formations at the entrances to the basins.

4.1.1 Wainwright Basin. The water column in Wainwright Basin is somewhat stratified due to the input of freshwater from Wolf Creek and the discharge of the pulp mill effluent, which has a lower specific gravity than that of seawater (Waldichuk, 1962). Any influence of fresh water from the Skeena River upon the stratification of this basin would be negated by the turbulence generated in Zanardi Rapids, where the water column is virtually homogeneous. Wainwright Basin has had a continuing problem of dissolved oxygen depletion since the establishment of the mill. Over the period of time since the start-up of the sulphite mill until its closure, the dissolved oxygen values steadily declined down to or near zero throughout the water column (Stokes, 1953; Waldichuk, 1962; Waldichuk *et al*, 1968; Kussat, 1968; Brothers, 1970; Goyette *et al*, 1970; Packman, 1977). Since the shutdown of the sulphite mill, however, the mill has reported rapid recovery of the dissolved oxygen concentrations in this area to near normal levels (Doug Ho pers. comm.). These relatively normal levels of dissolved oxygen were verified by data obtained in Environmental Protection Service surveys in June of 1977 and July 1978. The data from these surveys are presented in Appendix I.

4.1.2 Porpoise Harbour. The water column in Porpoise Harbour is stratified to a limited degree with respect to temperature, salinity and dissolved oxygen (Waldichuk, 1962; Packman, 1977). This stratification is affected somewhat by the seasonal fluctuations in the flow rates of the Skeena River. The water column in the vicinity of Porpoise Channel, being closest to the Skeena River mouth is affected to a greater degree by freshwater intrusions from that river, than the water column towards the head of Porpoise Harbour.

Dissolved oxygen concentrations in Porpoise Harbour declined continually from the time the Sulphite Mill was built until the red liquor line was moved to discharge into Chatham Sound. Stokes (1953) noted depressed dissolved oxygen concentrations as a result of mill activities. Waldichuk's observations of low dissolved oxygen concentrations in Porpoise Harbour in 1961, are presented in Figure 5 (Waldichuk, 1962). After the red liquor line was moved to discharge into Chatham Sound in February 1968, the dissolved oxygen levels in Porpoise Harbour improved markedly. Numerous breaks, however, occurred in the red liquor line releasing liquor to Porpoise Harbour with the result that fish kills occurred. One such break occurred in July 1968 (Kussat, 1968). As a result effluent was being discharged into Porpoise Harbour at the rate of 2500 gpm. In responding to a resultant fish kill in September 1968, an oceanographic survey was conducted in October. The results of this survey are presented in Table 6 where the exceptionally low dissolved oxygen values are apparent.

TABLE 6 DISSOLVED OXYGEN DATA (Kussat, 1968)

Location	Number of measurements	Depth range D (m)	DO range (ppm)	DO $\bar{X}$ (ppm)
Morse Basin	4	0-12.5	0-1.3	0.52
Wainwright Basin	14	0-42	0-1.0	0.24
Porpoise Harbour	36	0-25	0-6.1	2.04
Porpoise Harbour	6	0-32	5.3-7.3	6.56

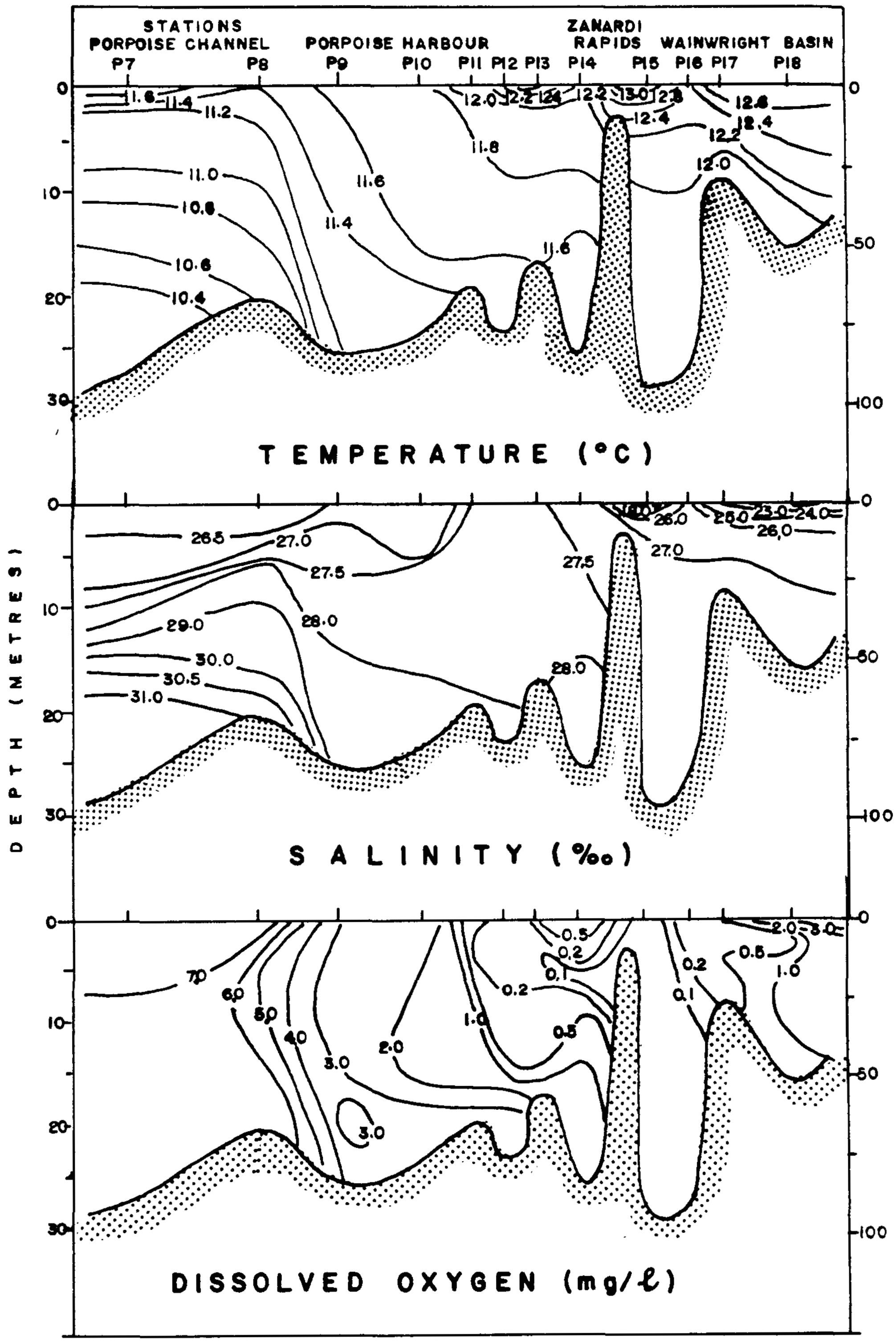

FIGURE 5 WATER COLUMN PROFILES (PORPOISE HARBOUR - WAINWRIGHT BASIN) (Waldichuk, 1962)

In 1974, dissolved oxygen concentrations were found to be somewhat depressed ranging as low as 4.0 mg/l in mid-water at the upper end of Porpoise Harbour (Packman, 1977). At that time the spent sulphite liquor was being discharged into Chatham Sound.

Since the shutdown of the Sulphite Mill in 1976, the dissolved oxygen concentrations in Porpoise Harbour have also reportedly risen to "normal" levels (Ho pers. comm.). This information has also been verified by the Environmental Protection Service surveys conducted in 1977 and 1978 (Appendix I).

Current studies have been conducted in Porpoise Harbour to determine its flushing characteristics (Ker et al, 1970; H.A. Simons, 1977). The Ker et al (1970) study determined that the net flow of water through Wainwright Basin and Porpoise Harbour, is out through Porpoise Channel and Chatham Sound. Approximations of flushing rates were also calculated in this report.

The H.A. Simons (1977) study was directed towards the design of the new effluent diffuser for the entire mill. In this study the intial plume dilution, using the recommended diffuser was calculated at 50:1-60:1 during the winter months; and 13:1 to 17:1 during the summer months. The total dilution would, however, be much greater than the initial dilution due to the great amount of water movement adjacent to the diffuser. The effluent plume trapping depth was estimated to range from 3.4 m during the winter months to 13.7 m during the summer. It was also estimated that at a rate of discharge of 13 300 lb/day of BOD_5 the dissolved oxygen concentrations would be depressed by only 0.5 mg/l, due to the fact that the discharge was located in mid-channel and at the bottom of Porpoise Harbour. These predictions remain subject to field confirmation.

The waters of Chatham Sound are well stratified, but more sensitive to the effects of changing flow rates in the Skeena River than the waters of Porpoise Harbour (Packman, 1977). Water column profiles presented in that report appear in Figure 6.

Oceanographic data dealing with Chatham Sound have been gathered on three occasions by Federal agencies (Waldichuk et al, 1968; Brothers, 1970; Packman, 1977). None of these surveys revealed a significant reduction in dissolved oxygen concentrations attributable to

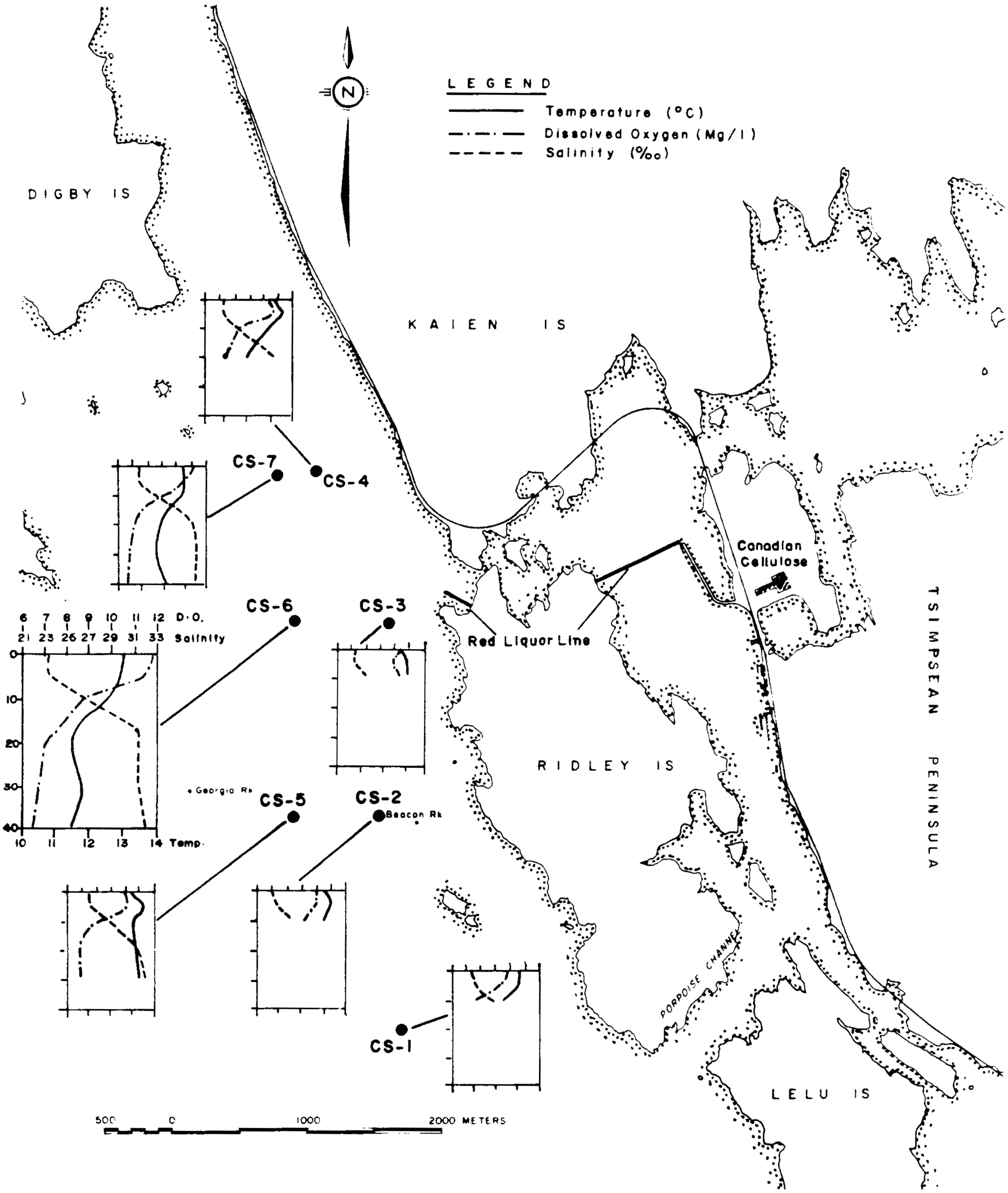

FIGURE 6 WATERCOLUMN PROFILES FLOOD TIDE
(Chatham Sound) - (Packman, 1977)

the spent sulphite liquor discharge. The most reasonable explanation for this is the rapid dilution of the effluent by the large moving water mass in Chatham Sound.

Current studies in Chatham Sound have also been conducted by Waldichuk (1968) and H.A. Simons Engineering (Ker et al, 1970). Waldichuk using current meters determined that the current direction and peak flow were 0°-30° T and 1.217 knots during the flood tide and 190°-200°T at 1.283 knots on the ebb (Holman, 1974). H.A. Simons Engineering conducted float and dye tracer studies in Chatham Sound. It was concluded from this work that a substantial accumulation of effluent could occur in the vicinity of Barrett Rock due to eddying, on a flood tide. It was also determined that on a flood tide some effluent could move into Prince Rupert Harbour. A strong southward movement of water from the northwest corner of Ridley Island was noted at the five meter depth which was hypothesized might mitigate the concentration of effluent from around Barrett Rock.

Packman (1977) reported that in 1974 the spent sulphite liquor which was being discharged at the surface from shore at the time was observed to spread as far north towards Prince Rupert Harbour as Casey Point on a flood tide and as far south as Coast Island on an ebb tide.

4.2 Biology

Prior to the establishment of the CanCel pulp mill on Watson Island the waters of Porpoise Harbour, Wainwright Basin and Morse Basin were reported to have been extremely productive. The area was primarily noted for its productive capacity with respect to herring. Even in the 1960-1961 herring season after the mill had been operating for 10 years, Morse Basin provided almost 18% of the total British Columbia catch (Fisheries Service Draft Submission to Pulp and Paper Review, 1977) which gives some idea of the potential productive capacity of this area.

Stokes (1953) made the first biological observations in the area after the establishment of the pulp mill. He observed plankton mussels, barnacles, hermit crabs and fish in Porpoise Harbour adjacent to the mill.

Biological observations were next recorded from a survey in 1961 by Waldichuk (1962) and Waldichuk and Bousefield (1962). During the survey small crabs, limpets and other forms of gastropods were observed (Holman, 1974). It was judged from the high numbers and diversity of the shell remains obtained in both benthic and intertidal samples that at one time this area had a high capacity for bivalve productivity. Also noted was the predominance of polychaetes in samples from Porpoise Harbour. One outstanding observation made at the time was the high numbers of amphipods obtained in most benthic samples from Porpoise Harbour. Amphipods were also noted swimming near the surface of the water in such numbers that a single dip with a bucket yielded as many as 40 specimens. It was hypothesized that the pelagic amphipods were driven to the surface seeking higher oxygen concentrations in view of the depressed oxygen conditions in Porpoise Harbour at that time (0.1-3 mg/l) (Waldichuk and Bousefield, 1962).

Goyette *et al* (1970) examined the marine life in the intertidal zone of Wainwright Basin and Porpoise Harbour. The life forms noted at that time included large numbers of nematodes and amphipods along with scattered clumps of poorly formed *Fucus* sp. Similar conditions persisted throughout Porpoise Harbour and well out into Porpoise Channel (Holman, 1974). Extensive fibre deposits on the bottom in Wainwright Basin and portions of Porpoise Harbour were also noted in the Goyette *et al* (1970) report. Also included in this report is a qualitative documentation of biological recovery after a 26 day mill shutdown. The observed recovery included a substantial growth of *Enteromorpha* sp. and the return of a variety of fish species. Goyette *et al* (1970) also conducted some *in situ* bioassay tests in the vicinity of the mill using staghorn sculpins. The results are detailed in Table 7.

Laboratory toxicity tests utilizing coho salmon fry were conducted on the discharge from the lime mud flyash sewer and leachate from the limestone pile. Extremely high toxicities were recorded in both cases, with the fish succumbing to death in 5 minutes and 10 minutes repectively. The pH of approximately 13.0 in both samples was adjusted to 6.9 prior to running the bioassays.

TABLE 7 *IN SITU* BIOASSAY RESULTS (Goyette *et al*, 1970)

Location	% Mortality	Time
Morse Basin	0	2300 hours
Wainwright Basin	100	0045 hours
"Pulp Mill Inlet"	100	0040 hours
Porpoise Harbour	0	0230 hours

In 1974 the intertidal marine life in Wainwright Basin was observed to have changed little from the observations of Goyette *et al* (1970) (Packman, 1977). Packman (1977) also subjectively delineated the extent of biological damage to the intertidal biota in the vicinity of the red liquor discharge into Chatham Sound. It was noted that the area of "Discharge Cove" had been totally denuded of intertidal life. The discharge area was so sterile that the extended siphons on dead bivalves in the beach had not decomposed. An orange slime was observed coating the rocks of the cove. At the seaward extremities of the cove this orange slime gradually transformed into a green algal slime of unidentified chlorophyta. Biological communities were reported to have returned to some semblance of normality at 0.25 n mi (.46 km) on either side of the cove along the coastline with apparently complete recovery existing at the 0.5 n mi (.93 km) mark. Studies of the benthos in Chatham Sound were also described in Packman (1977) where it was reported that the only discernable reduction in species diversity related to the spent sulphite liquor discharge was in the actual "Discharge Cove". No fibre deposits were reported in Chatham Sound other than in the immediate vicinity of the cove.

A study of intertidal macro-algae was conducted by the Water Investigations Branch of the Provincial Government in 1974 and 1975 (Water Investigations Branch, 1977). Some interesting observations were made in the course of this study. Intertidal algal communities in Morse Basin did not appear to have been affected by the discharge of pulp mill effluent into Wainwright Basin. From this information and data from Waldichuk (1966) and Drinnan and Webster (1974) the author concluded that little exchange of water occurred between Wainwright Basin and Morse Basin. An increase in quantities of wood and fibre debris was observed in the intertidal areas of Galloway Rapids; however, algal populations flourished there. Most of the intertidal areas of Wainwright Basin were covered with heavy deposits of fibre and slime. The intertidal algae in this area consisted of scattered patches of very few species. The intertidal zone in the upper portions of Porpoise Harbour was observed to be similar to Wainwright Basin. This situation changed for the better, however, as the mouth of Porpoise Channel was approached. The observations in the intertidal zone of Chatham Sound closely paralleled those of Packman (1977) in that the degradation caused by the sulphite discharge was intense, but essentially confined to the area of "Discharge Cove".

A qualitative biological survey was undertaken in June 1977, by the Environmental Protection Service in both Porpoise Harbour and Chatham Sound the results of which have not been reported as yet. It was, however, observed that in several beach seines conducted in Porpoise Harbour and Channel hundreds of juvenile and/or adult herring were obtained. In addition a large herring spawn had occurred on the rocks and seaweed near the seaward end of Porpoise Channel. This gave a good indication of how quickly herring moved back into Porpoise Harbour after the shutdown of the sulphite mill in October 1976 and is demonstrative of the importance of this area for herring production. Dungeness crabs (Cancer magister) have been caught regularly and in abundance by EPS personnel in Porpoise Harbour.

5 NATURAL RESOURCES

5.1 Fishery Resources

A summary of information regarding the commercial and recreational fishery resource of the Prince Rupert area has been compiled for the Pulp and Paper Review by Fisheries and Marine Service and is contained in Appendix I.

5.2 Migratory Birds

According to the submission of the Canadian Wildlife Service to the Pulp and Paper Review very little data exist dealing with avian utilization of the areas around Watson Island. It was stated, however, that "it is generally agreed that the extensive tide flats of the estuary of the Skeena River provide valuable wintering habitat for waterbirds (particularly diving ducks, gulls, grebes and loons) and shorebirds. Hoos (1975) states that waterfowl breeding in the area include: Canada geese, mallards, mergansers, black turnstones, rock sandpipers, dunlin, and glaucous winged gulls. It is apparent that the areas of prime importance with regard to avian utilization are the tide flats of the Skeena River estuary including such areas as Flora Bank and these areas should remain inviolate with respect to pulp mill pollution.

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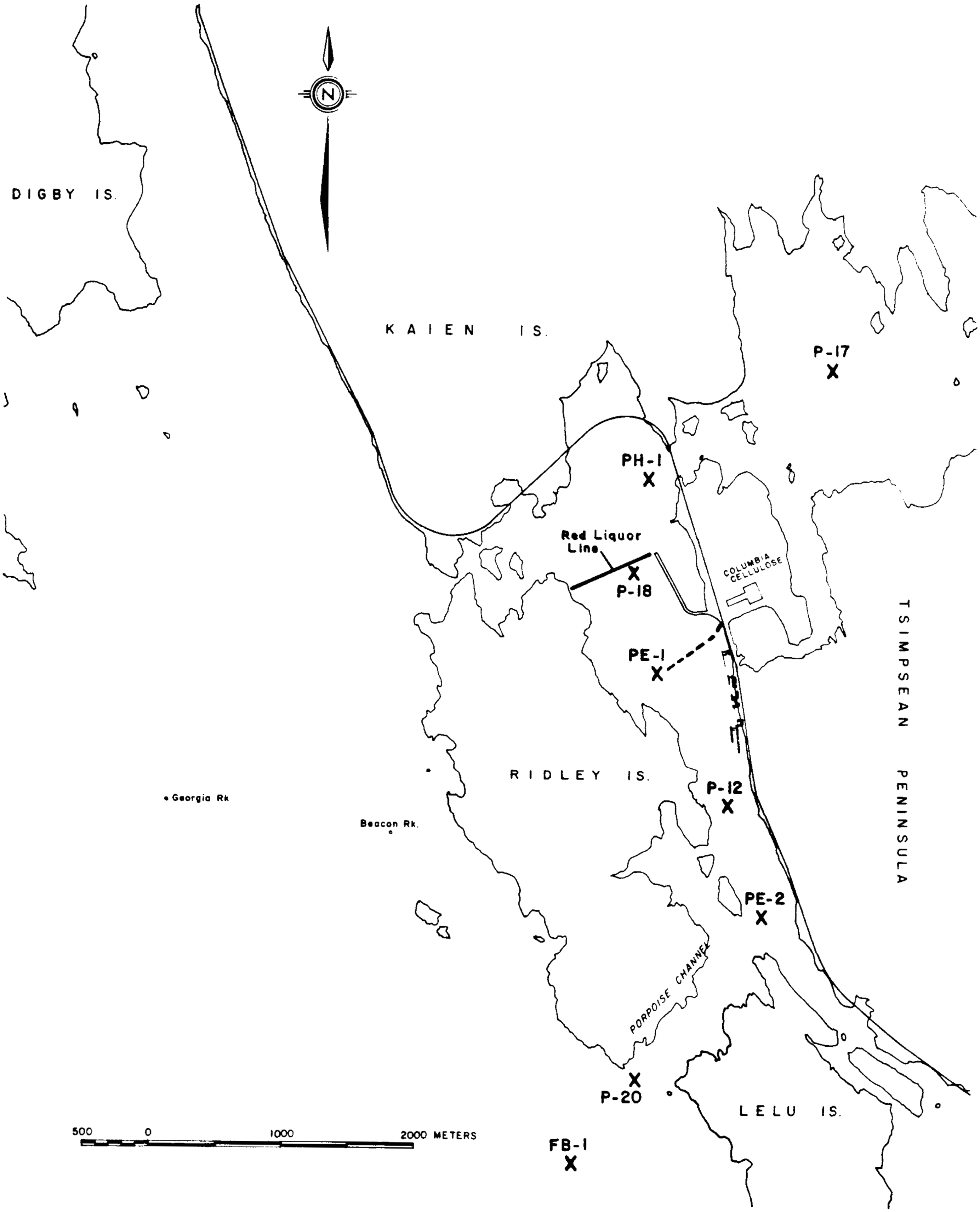
APPENDICES

APPENDIX I

EPS WATER QUALITY DATA 1977 AND 1978 (Unpublished)

(a) Water Quality Results - Porpoise Harbour - June 1977

(b) Water Quality Results - Porpoise Harbour - Wainwright Basin - July 13, 1978



E.P.S. OCEANOGRAPHIC SAMPLE STATIONS

APPENDIX I EPS WATER QUALITY DATA 1977 AND 1978 (unpublished)

(a) Water Quality Results - Porpoise Harbour - June 1977

Station	Depth (m)	Temperature (°C)	Salinity $^{0}/oo$	Dissolved Oxygen (mg/l)	% Saturation
P-20	0	10.66	20.78	9.05	95.18
	2	10.26	21.69	9.00	94.33
	5	10.05	25.92	8.10	86.81
	10	9.65	28.28	8.30	89.52
	25	9.24	31.00	9.00	97.92
P-12	0	10.89	23.47	8.70	93.55
	2	10.50	23.93	8.60	91.94
	5	10.28	24.57	8.35	89.19
	10	10.04	26.40	7.75	83.31
	17	9.91	27.33	7.90	85.19
P-18	0	11.13	25.21	8.10	88.56
	2	10.51	26.25	7.65	83.03
	5	10.18	27.04	7.55	81.76
	10	10.06	27.60	7.65	82.92
	14	9.87	28.27	7.65	82.93
PH-1	0	10.67	26.14	7.75	84.37
	2	10.62	26.10	7.55	82.09
	5	10.55	26.17	7.45	80.91
	10	10.29	27.24	7.35	79.91
	20	9.54	27.96	8.15	87.50

APPENDIX I EPS WATER QUALITY DATA 1977 AND 1978 (unpublished)
(b) Water Quality Results - Porpoise Harbour - Wainwright Basin - July 13, 1978

Station	Depth (m)	Temperature (°C)	Salinity °/oo	Dissolved Oxygen (mg/l)	% Saturation
FB-1	0	10.77	23.74	8.15	87.55
	2	10.68	24.46	8.20	88.32
	5	10.55	25.93	7.50	81.31
	10	9.09	29.65	6.60	70.91
	12	8.56	30.35	7.70	82.08
P-20	0	11.03	24.65	8.15	88.59
	2	10.81	24.85	8.10	87.73
	5	10.79	26.04	7.00	76.36
	10	10.23	27.66	6.40	69.67
	15	8.24	30.62	6.75	71.54
	20	8.05	31.06	6.55	69.31
PE-2	0	11.15	24.53	8.20	89.31
	2	10.95	25.28	7.80	84.98
	5	10.95	25.95	7.20	78.78
	10	10.78	26.53	6.80	74.40
	15	10.36	27.34	6.55	71.37
	20	8.61	30.05	6.65	70.83
P-12	0	11.38	24.83	8.20	89.94
	2	11.03	25.56	7.60	83.09
	5	10.99	25.93	7.10	77.74
	10	10.66	26.68	6.80	74.28
	15	10.31	27.30	6.70	72.90
	18	9.16	28.51	6.10	65.14
PE-1	0	11.38	25.65	7.65	84.35
	2	11.09	26.21	7.05	77.52
	5	10.99	26.51	6.70	73.64
	10	10.79	26.98	6.50	71.34
	15	9.65	28.70	6.20	67.06
P-18	0	11.30	26.14	7.25	80.05
	2	11.26	26.32	6.95	76.76
	5	11.22	26.44	7.10	78.40
	10	10.83	26.70	6.75	74.02
	15	10.66	27.13	6.60	72.30
PH-1	0	11.24	26.23	7.10	78.35
	2	11.04	24.42	6.80	73.82
	5	10.89	26.68	6.40	70.26
	10	10.71	26.98	6.90	75.60
	15	10.28	27.70	6.15	67.05
P-17	0	11.59	26.40	6.90	76.81
	2	11.16	26.51	6.76	74.59
	5	11.19	26.53	6.80	75.10
	10	11.18	26.57	6.80	75.10
	15	11.23	26.66	7.30	80.76
	20	11.44	26.68	7.30	81.14
	25	11.40	26.72	7.30	81.10

APPENDIX II

CANADIAN CELLULOSE PULP MILL, PORT EDWARD, B.C.,
FISHERIES RESOURCES OF FISHERIES AND MARINE SERVICE
STATISTICAL AREA 4

The information presented in this document was collated solely for use within the Pacific Region (DFE) "Pulp Mill Review Process": a process designed to determine effluent characteristics, degree of treatment, and effects upon the receiving environment. This task was carried out to identify current and potential conflicts between aquatic resources and effluent disposal in order to priorize pollution abatement efforts.

Opinions expressed in the text reflect the judgement of the authors and contributing personnel.

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DEPARTMENT OF FISHERIES AND THE ENVIRONMENT
FISHERIES AND MARINE SERVICE

Canadian Cellulose Pulp Mill - Port Edward, B.C. Fisheries Resources of Fisheries and Marine Service Statistical Area 4

by
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Resource Services Branch
1978

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CANADIAN CELLULOSE PULP MILL - PORT EDWARD, B.C.
FISHERIES RESOURCES OF
FISHERIES AND MARINE SERVICE STATISTICAL AREA 4

I INTRODUCTION

Fisheries Statistical Area 4, in which the Canadian Cellulose pulp mill is situated, is located between Dundas and Porcher Islands on the north coast of British Columbia (Figure 1). Most of the salmon in the area are produced by the Skeena-Ecstall River systems, however smaller coastal streams (Figure 2) support fair runs of most salmon species. The coastal region of Area 4 is also an important herring spawning and rearing area that has been adversely affected by the effluent from the Canadian Cellulose mill on Watson Island.

II SALMON

A. Commercial Fishery

The most important commercial salmon species of Area 4 is sockeye, with an average harvest of 822,000 pieces, (1966-1975, Table I). Sockeye harvests have increased over the years, due to enhancement facilities at Fulton River and Pinkut Creek on Babine Lake. The majority of gill-net fishing for sockeye occurs in the mouth of the Skeena River; Inverness Passage west of Smith Island, in Edye Passage, off Finlayson Island and in Chatham Sound.(1)

Pink salmon stocks provide equally good harvests with the even and odd year runs providing mean (1966-1975) harvests of 654,000 and 556,000 pieces respectively (Table I). The mean (1966-1975) harvests of other salmon species are much lower (Table I); 120,000 coho, 43,000 chinook and 49,000 chum. The only major fishing location in Area 4, other than those noted for sockeye is a concentrated fishery for chinook and chum in the Skeena River tidal area.

It is not known what proportion of salmon stocks caught in Dixon Entrance and Hecate Strait originate in Area 4 streams. However, it has been calculated that there are as many Skeena River sockeye caught by the commercial fishery as there are sockeye taken by the Area 4 fishery.(2) It was estimated that the average commercial harvest (1951-1963) of Skeena River sockeye was 485,500 pieces while the mean Area 4 commercial sockeye catch for 1956 to 1964 was 411,400 fish. This does not mean however, that all Skeena River sockeye are necessarily caught in Area 4.

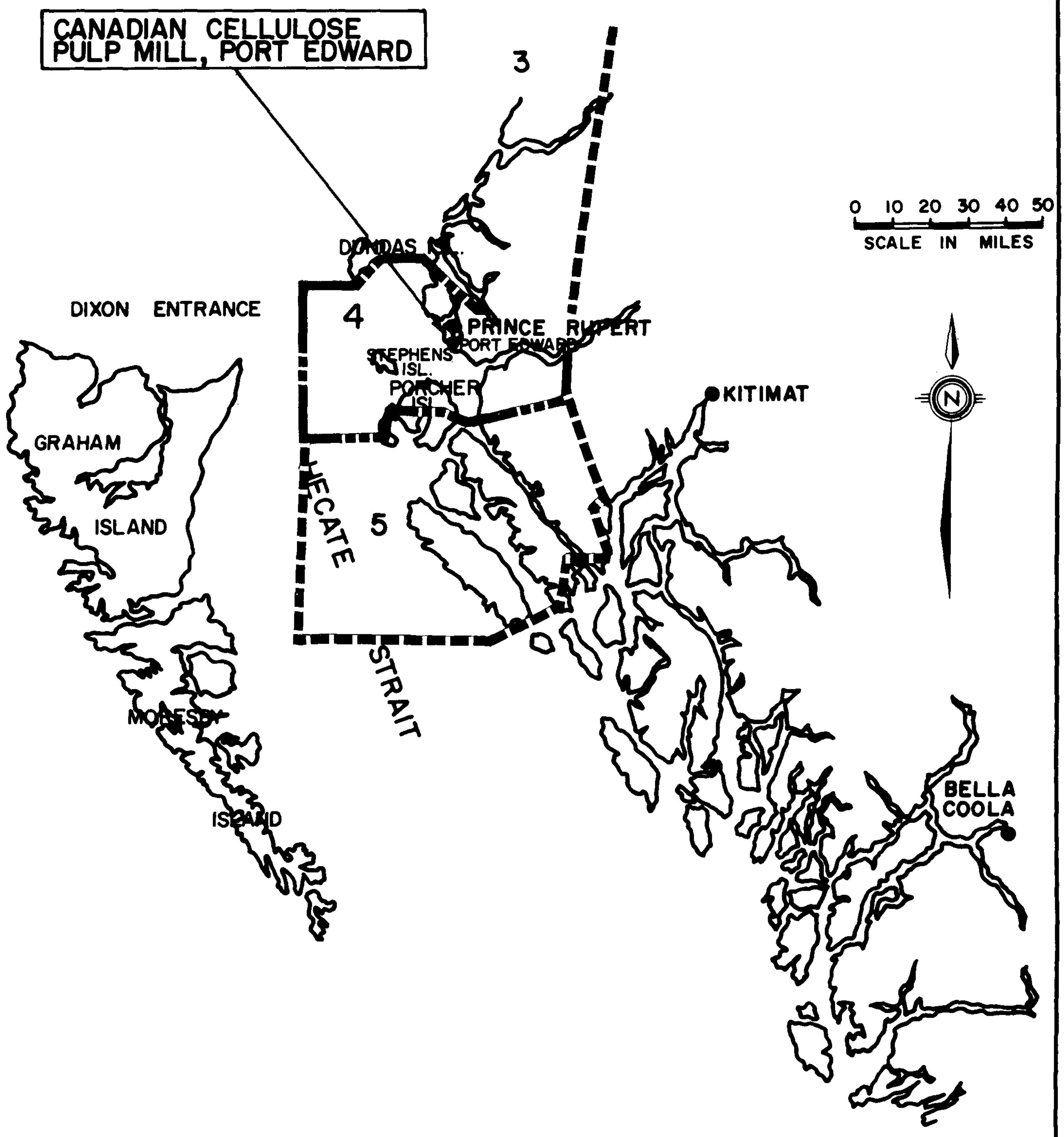

FIGURE 1 – LOCATION OF CANADIAN CELLULOSE PULP MILL (PORT EDWARD) IN STATISTICAL AREA 4

TABLE I

Commercial Catch (Pieces) of Area 4 Salmonids, 1956-75(3)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd Year	CHUM	STEELHEAD
1956-69	307,254	78,463	98,339	658,862/1,459,384	40,622	3,660
1960-64	494,750	33,219	114,688	771,649/722,043	26,937	5,644
1965-69	650,299	47,345	163,695	745,019/313,858	26,776	8,180
1970	546,244	30,427	86,035	788,599	33,522	4,752
1971	858,237	39,558	114,290	860,554	39,022	8,425
1972	674,599	52,259	148,985	689,477	119,923	7,737
1973	1,308,986	42,747	73,030	606,371	89,406	4,443
1974	1,381,745	33,069	45,347	301,607	61,091	4,137
1975	488,513	35,969	51,143	520,322	22,761	3,166
10 YEAR AVERAGE (1966-75)	822,000	43,000	120,000	654,000/556,000	49,000	7,000

TABLE II

Salmonid Escapements to all Area 4 Streams and River Systems(4)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd Year	CHUM
1956-59	601,300	89,500	140,600	381,800/1,250,000	5,700
1960-64	593,400	25,100	69,000	886,600/1,080,000	14,600
1965-69	558,700	23,900	108,000	1,175,000/945,000	13,000
1970	790,000	23,000	80,800	964,600	10,800
1971	868,200	22,200	69,600	1,172,000	4,800
1972	721,200	18,200	55,400	1,784,700	41,200
1973	820,200	39,700	32,900	1,256,100	24,700
1974	740,900	31,601	32,400	366,200	18,400
1975	808,900	16,400	20,900	1,867,500	9,500
1970-75	791,000	25,200	48,700	1,038,500/1,431,800	18,300
10 YEAR AVERAGE (1966-75)	697,000	25,000	69,300	1,093,000/1,164,500 (Average of Even and Odd Years)	16,800

TABLE III

Salmonid Escapements (pieces) to Skeena & Ecstall River Systems, 1956-75(4)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd	CHUM
1956-59	593,000	89,100	121,200	300,000/1,151,000	5,200
1960-64	584,000	24,500	65,800	789,000/982,200	14,300
1965-69	553,000	23,300	97,000	1,035,800/925,700	12,900
1970	785,000	22,700	77,600	916,000	10,800
1971	864,200	21,800	65,700	1,069,100	4,800
1972	719,200	17,900	53,500	1,683,900	41,100
1973	818,400	39,400	30,200	1,244,000	24,700
1974	739,800	31,400	30,800	310,700	18,800
1975	806,900	16,200	20,100	1,818,600	9,500
1970-75	788,900	24,900	46,300	1,173,700	18,300
10 YEAR AVERAGE (1966-75)	693,800	24,700	62,400	996,400/1,123,000	16,700
% of Area 4 Escapement	99.5	98.8	90.0	91.2/96.4	99.4

B. Escapements

i) Skeena-Ecstall

Area 4 escapements are dominated by the Skeena-Ecstall River systems (Tables II, III) which produce 99.5% of the sockeye, 98.8% of the chinook, 90.0% of the coho, 91.2/96.4% of the even/odd year pinks and 99.4% of the chum spawning in Area 4 (1966-75). The remaining salmon are produced by small coastal streams.

The Skeena River ranks second only to the Fraser River as a salmon producer in British Columbia and as such is the major single source of income to the residents of the Prince Rupert area.(5) Total salmon escapements to this system averaged two million fish during the period 1970-1975. This included an annual average of 1,173,700 pink salmon, 788,900 sockeye, 46,300 coho, 24,900 chinook and 18,300 chum (Table III). The single most productive area of the Skeena River drainage is the Babine River system. A rock slide in 1951, substantially reduced the salmon stocks from this area. In 1960, the Fisheries Service, overtook an intensive program to restore the salmon resources to their previous levels. This involved the installation of spawning channels at Fulton River and Pinkut Creek and the enforcement of stringent management regulations. The returns from these enhancement facilities is expected to increase the annual landed value of Skeena River salmon by 2.5 million dollars.(5)

Migration Timing

Sockeye salmon usually spawn from late summer through autumn, with two main peaks. The first occurs from late July to early August, and the second from September through October. Emergence occurs in early spring (April to May), and the fry move up or downstream to lake systems where they are resident for one to three years before migrating downstream to the sea. Seaward migration takes place from April to June, the peak occurring in mid-May.(5) Upon reaching the Skeena estuary, the majority of juvenile sockeye stay in the river mouth or on Flora Bank near Kitson Island. Some, however move out along the mainland beach or beaches among the islands to the west of the estuary. They are resident in these areas for no more than a few weeks to a month (until mid-July) before moving out to sea.(5)

The migration of adult pink salmon begins in mid-July with spawning occurring in late August through late October. The fry emerge from the gravel from April to early May, and immediately migrate downstream to the sea. The peak of the downstream is in mid-May and the end occurs by mid-June.(5)

Unlike sockeye, pink salmon juveniles do not remain at the mouth of the Skeena River. They move out into the shallow estuary channels, along the beaches and shores of the Western Chatham Sound Islands and sand banks of the mainland (particularly Flora banks, and to a lesser degree De Horsey Bank. Their residence here is short-lived. Within a month they move out to sea.(5)

Coho salmon spawning occurs in October or early November, with emergence occurring the following spring. A few fry move directly to the sea, but the majority remain in tributary streams and lakes for at least one year before migrating seaward. One report (5) indicated that coho do not have a major seaward migration peak. Instead, they have several smaller peaks, the largest of which coincided, in 1972, with a very high discharge period in the Skeena River in early June.(5) Coho salmon are known to have a relatively longer estuary residence than either sockeye or pink salmon. Juveniles reach the estuary in early June and remain in the shallow waters of the sand banks, particularly of Inverness Passage, for several weeks to several months before moving out to sea.(5)

Adult chinook salmon migrate upstream during the summer, with spawning occurring in September. The fry emerge the following spring and migrate to the sea after spending from a few days to a year in their natal streams. Once in the estuary, fry tend to delay movement to the sea. Like coho, chinook take up residence in the estuary shallows of Inverness Passage for the summer, and do not leave until September. Chinook juveniles are evident from early May until late August, with peak numbers occurring in mid-June, coincidental to the peak discharge of the Skeena River.(5)

Adult chum salmon move upstream during mid-summer with spawning occurring in August and early September. The fry emerge in the spring, and move directly to the sea without stopping to feed until they reach the estuary.(5) Like coho, chum salmon have a relatively long estuarine residence, utilizing mainly Inverness Passage. One report (5) mentioned the presence of chum juveniles in the Skeena River estuary as early as May, with peak numbers being recorded in mid-July; fry were still abundant in August. Chum fry, from the Skeena estuary did not migrate out to sea until late August or early September.(6)

ii) <u>Coastal Stream Escapements</u>

The coastal streams of Area 4 (Figure 2) are utilized annually (1966-1975) by a mean of 3,700 sockeye,

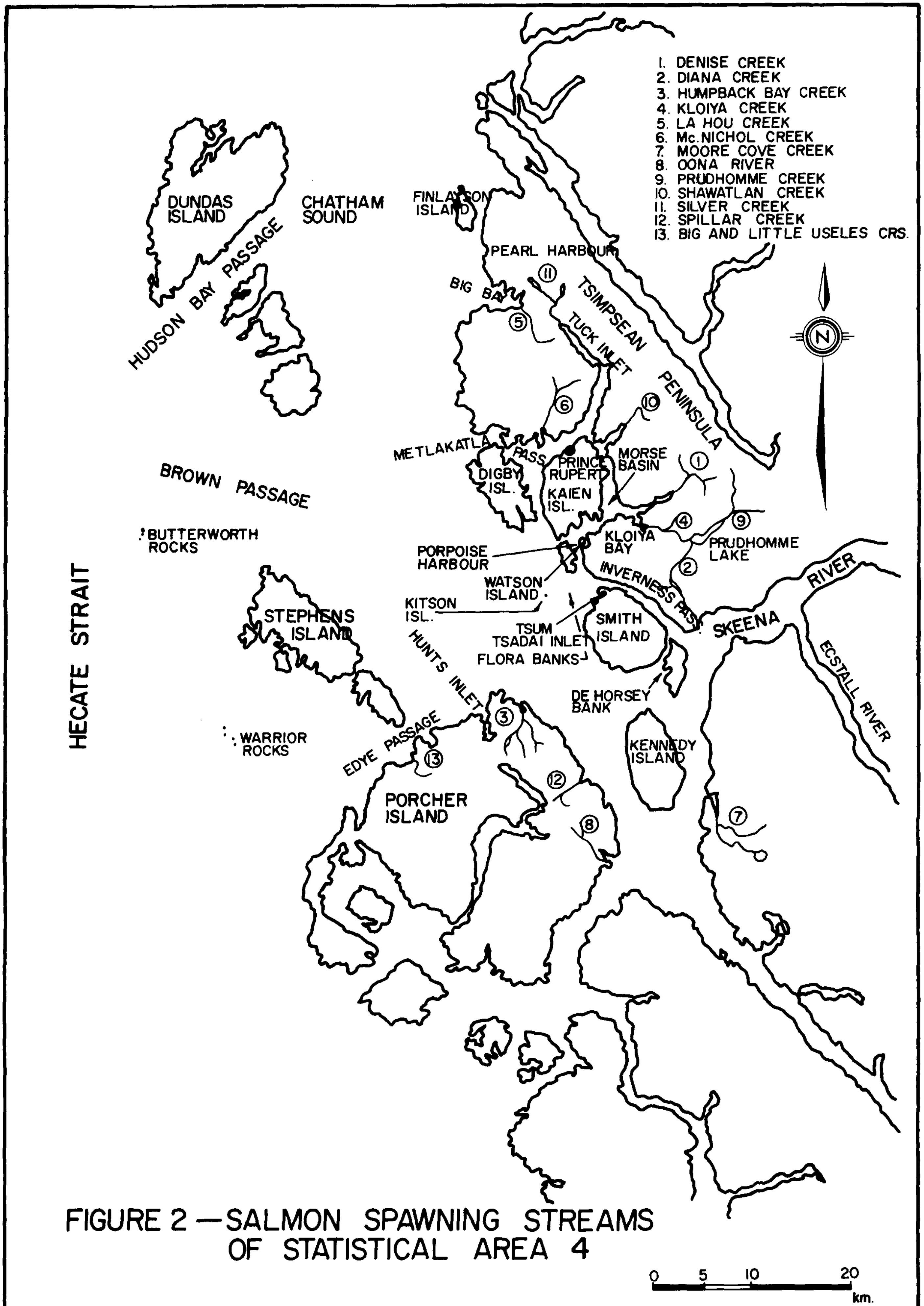

FIGURE 2 — SALMON SPAWNING STREAMS OF STATISTICAL AREA 4

TABLE IV

Salmon Escapements to all Area 4 Coastal Streams
(Excluding the Skeena and Ecstall Systems(4)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd	CHUM
1950-54	9,400	100	2,600		
1955-59	8,300	400	3,500		2,900
1950-59				139,200/67,000	400
1960-64	9,300	600	8,400		300
1965-69	5,700	650	13,000	114,200/100	50
1970	5,000	400	4,600	48,700	0
1971	4,000	350	4,100	102,800	0
1972	2,000	250	2,400	100,700	25
1973	1,800	250	2,800	12,000	25
1974	1,100	200	1,900	55,500	25
1975	2,000	200	1,000	48,800	0
1966-75	3,700	450	7,500	96,600/41,600	25

TABLE V

Salmon Escapements to Morse Basin Streams
(Denise, Diana, Kloiya, Prudhomme and Shawatlan)(4)

1950-54	9,400	100	2,300		900
1955-59	8,300	400	2,200		350
1950-59				2,200/2,000	
1960-64	9,350	600	1,900		200
1965-69	5,700	650	3,300		25
1970	5,000	400	3,900	0	0
1971	4,000	350	700	6	0
1972	2,000	250	1,200	0	25
1973	1,800	250	1,700	0	25
1974	1,100	200	1,000	0	25
1975	2,000	200	700	0	0
1966-75	3,740	450	2,400	200/25	25

TABLE VI

Salmon Escapements to Prince Rupert Harbour - Tuck Inlet Streams (McNicol and Silver Creeks)(4)

YEAR	COHO	PINK Even/Odd	CHUM
1950-54	0		2,000
1955-59	25		25
1950-59	0	4,800/1,000	
1960-64	0		100
1965-69	420		25
1960-69	0	4,800/2,100	
1970	0	1,000	0
1971	0	2,000	0
1972	0	1,200	0
1973	0	400	0
1974	0	500	0
1975	0	400	0
1966-75	210	4,700/1,500	10

TABLE VII

Salmon Escapements to Porcher Island and Tsimpsian Peninsula Streams(4)

1950-54	275	
1955-59	550	
1950-59		132,150/000
1960-64	6,500	
1965-69	8,700	
1960-69		109,250/48,350
1970	750	47,600
1971	3,400	100,800
1972	1,175	99,500
1973	1,150	11,625
1974	900	55,000
1975	300	48,400
1966-75	4,700	91,800/40,150

450 chinook, 7,500 coho, 96,600/41,600 even/odd year pink and 25 chum salmon adults (Table IV). These coastal streams were divided into three groups with reference to the Canadian Cellulose pulp mill; the streams of Morse Basin (Denise, Diana, Kloiya, Prudhomme and Shawatlan Creeks, Table V), the streams of Prince Rupert Harbour-Tuck Inlet (McNichol and Silver Creeks, Table VI) and the streams of Porcher Island and the Tsimpsean Peninsula (Humpback Bay Cr., La Hou Cr., Moore Cove Cr., Donn R., Spillar R., Big and Little Useless Cr., Table VII).

In Area 4, salmon adults returning to the streams of Morse Basin would probably be exposed to the most severe pollution from the Canadian Cellulose pulp mill. These streams produce all the sockeye and chinook originating from Area 4's small coastal streams. Sockeye numbers have declined since the 1960-1964 period to about one third of their former levels (Table V). Chinook stocks have increased from their 1950-1959 levels, but the 1970 to 1975 returns indicate a trend of diminishing stocks. Coho stocks have fluctuated over the years. Chum and pink stocks have dwindled from thousands in 1948-1949 to almost zero since 1970. In 1950-1951, Canadian Cellulose built a dam and fish-way between Kloiya Creek and Prudhomme Lake in order to provide a supply of fresh water to the mill.(7) This, however, is not thought to be responsible for salmon declines because the fish in Denise and Shawatlan Creeks have also declined.(4)

Salmon adults returning to the streams of Prince Rupert Harbour - Tuck Inlet would be exposed to less severe pollution conditions than would be encountered by the Morse Basin salmon. Coho production in this area has been variable with no escapements since 1975 (Table VI). Chum levels have decreased from 2,500 in 1948-1949, to nil since 1970. These streams were formerly utilized by even/odd year pink runs of 30,000/10,000 (1948-1949), but since 1950-1959, have produced 5,000/1,500 even/odd year pink. Since 1970, pink stocks seem to have declined even further.

The streams of Porcher Island and the Tsimpsean Peninsula, which are well removed from major influence of the Canadian Cellulose pulp mill, are utilized by most (1966-1975) of the pink (95.0/96.5% even/odd years, Table VII) and coho (62.1%) salmon returning to Area 4 coastal streams. They are not utilized by any other species of salmon.

C. Sport Fishery

The mean sport harvest (1966-1975) of salmonids in Area 4 is: 1,000 chinook, 450 coho and 100/20 even/odd year pink (Table VIII). The harvest is concentrated in Prince Rupert Harbour, Metlakatla Passage, Hunts Inlet and

TABLE VIII

Area 4 Sport Fishery Harvest(8)

YEAR	CHINOOK	COHO	PINK Even/Odd
1960-64	200	60	0/0
1965-69	1,120	620	240/20
1970	925	350	0
1971	750	450	0
1972	650	170	20
1973	925	470	30
1974	750	150	0
1975	1,050	175	5
10 YEAR AVERAGE (1966-75)	1,000	450	100/20

Tsum Tsadai Inlet (Figure 2). A small sport coho fishery is carried out in Kloiya Bay. (8)

D. Indian Food Fishery

Most of the Indian food fishery occurs above the tidal influence of the Skeena River (Tables IX, X). The lower Skeena River - Chatham Sound fishery (Table X) produces 8,400 sockeye, 150 chinook, 400 coho, 1,100/1,800 even/odd year pink, 150 chum and 50 steelhead (1966-1975). Limited numbers of sockeye are also harvested in the Shawatlan Creek area. (7)

III HERRING

Populations of herring in the Skeena area are highly variable from year to year (Table XI). Herring stocks in the northern subdistrict (Areas 3, 4 and 5 - Figure 1) yielded a mean of 22,000 tons/year to the commercial fishery from 1940 to 1964. (10) Sixty percent of the stock in the northern subdistrict spawn along the eastern shore of Chatham Sound, between Pearl Harbour and Metlakatla Village (Figure 3). (7)

Juvenile herring rearing habitat is provided by highly productive inlets and bays which are sheltered and allow good survival during the critical larval and juvenile stages. In the past this type of environment was provided by the waters enclosed by Digby, Kaien and Ridley Islands and the Tsimpean Peninsula, Prince Rupert Harbour, Tuck Inlet, Morse and Wainwright Basins and Porpoise Harbour. (10) However, effluent from the Canadian Cellulose mill has caused the deterioration of the aquatic environment of Porpoise Harbour and Wainwright Basin to the point where these areas are no longer capable of supporting viable herring populations. (10) Even in Morse Basin, pre-spawning adult herring have been observed to be under stress. (10)

Pulp mill effluent can lower herring survival directly, by causing large-scale mortality of larval and juvenile stages. This may be due to low dissolved oxygen levels and effluent toxicity. It can also affect productivity indirectly, by decreasing the abundance of food organisms in areas where dissolved oxygen levels are high enough to support herring populations. (10)

Herring distribution was examined in six areas in 1972: south of Digby Island (northwest Ridley Island, south of Kinahan Island, Flora Bank, DeHorsey Bank, Inverness Passage and Telegraph Passage. (5) It was determined that most of the adult herring were caught northwest of Ridley Island and south of Kinahan Island. The abundance of herring spawn in the Skeena estuary area was much lower than historical levels that particular year. (5)

TABLE IX

Area 4 Indian Food Fishery(7)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd	CHUM	STEELHEAD
1956-59	54,000	6,500	8,800	6,600/11,300	700	1,300
1960-64	41,600	2,600	3,850	4,900/9,500	325	900
1965-69	41,200	2,500	5,600	4,000/5,800	425	1,000
1970	54,250	3,400	2,600	22,500	400	1,200
1971	91,700	1,225	5,450	14,000	850	1,200
1972	59,575	2,650	3,000	8,500	700	1,200
1973	82,000	2,075	2,600	10,500	750	0
1974	82,800	2,250	2,200	3,900	500	1,000
1975	85,950	3,500	5,250	6,700	650	1,000
10 YEAR AVERAGE (1966-75)	62,100	2,500	3,900	8,600/8,500	550	1,000

TABLE X

Indian Food Fishery of Chatham Sound and the Tidal Portion of the Skeena River(7)

YEAR	SOCKEYE	CHINOOK	COHO	PINK Even/Odd	CHUM	STEELHEAD
1956-59	620	25	275	150/325	0	0
1960-64	2,550	75	400	1,425/2,875	50	50
1965-69	3,800	75	750	1,000/1,925	150	100
1970	4,150	50	75	400	50	25
1971	11,950	50	50	800	25	150
1972	7,725	500	725	1,790	150	75
1973	12,325	225	475	2,425	225	0
1974	19,825	175	450	1,300	200	0
1975	12,000	200	500	1,500	250	0
10 YEAR AVERAGE (1966-75)	8,400	150	400	1,100/1,800	150	50

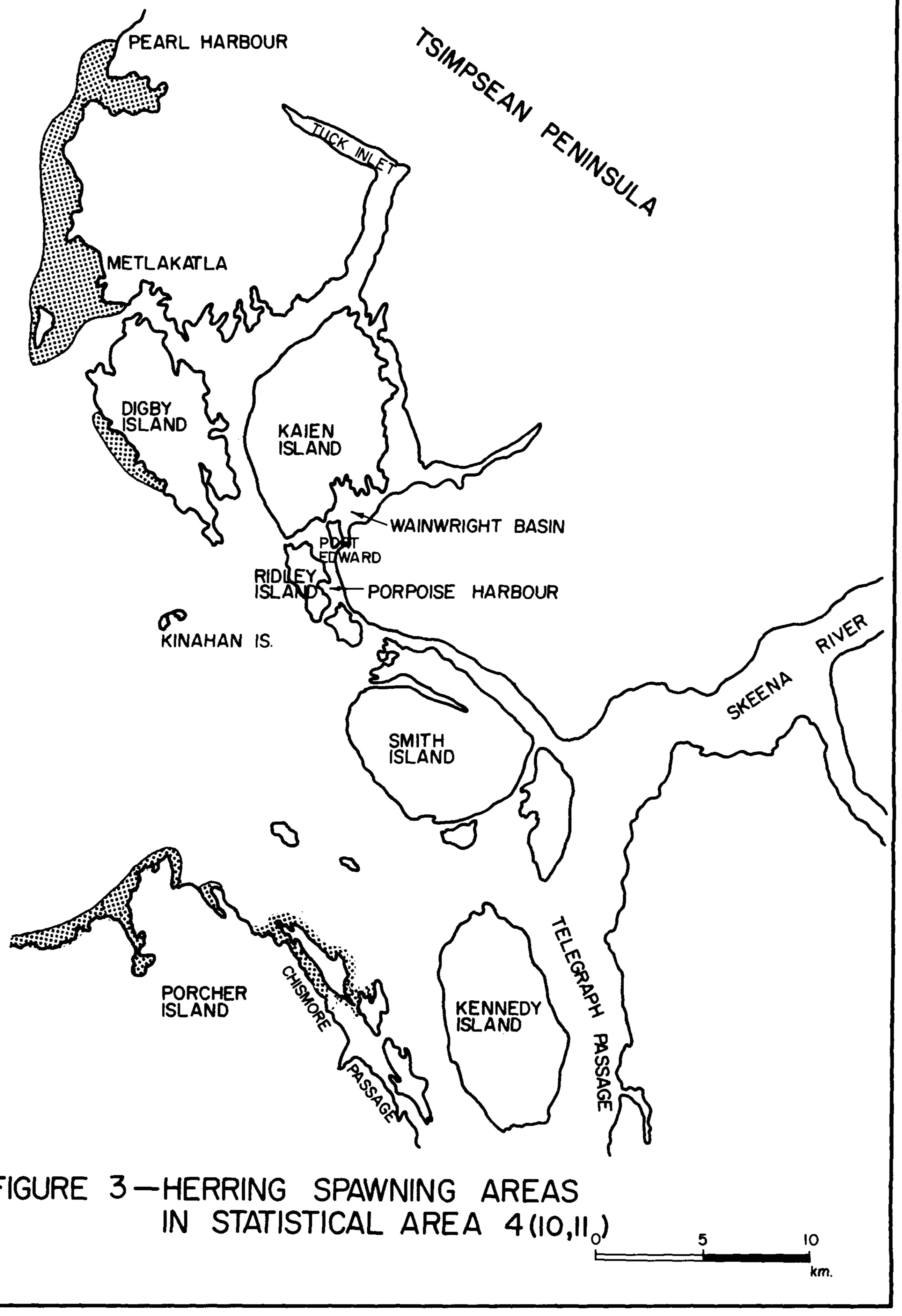

FIGURE 3—HERRING SPAWNING AREAS IN STATISTICAL AREA 4 (10,11)

Commercial herring catches are made in Hunt's Inlet, Butler Cove, Edye Passage, Prince Rupert Harbour and Chismore Passage (Figure 3).(7) The area around Prince Rupert and Port Edward is important to the commercial fishery.(11) Before 1961, Morse Basin was a productive area for the herring fishery. In the 1960-1961 season, Morse Basin yielded the greater part of the 31,000 tons of herring harvested from Area 4 (18% of the total B.C. catch).(13) A small amount of herring was also taken in Wainwright Basin which at that time was favourable for the commercial herring fishery because of its proximity to the Port Edward reduction plant.(13) In addition to the herring reduction fishery, in the early 1960's the Prince Rupert area also provided most of the herring bait for the Canadian halibut fishery in the Bering Sea and Hecate Straits.(10) In 1963 and 1964, herring did not enter Prince Rupert Harbour or Morse-Wainwright Basins in any quantity.(7) The herring reduction fishery was closed in 1968 due to declining stocks. Presently the herring roe and bait fisheries are lucrative.(11) In the 1975-1976 season, 67% of the catch was taken for food and bait and the remainder was taken for roe.(14)

A single haul of herring for food was taken in Morse Basin in the 1975-1976 season. This produced 3 to 4% of the total food and bait catch, although it consisted of smaller sized fish.(14)

With an improvement in water quality, as a result of the conversion of the pulp mill from a sulfite to a kraft process, herring appear to be moving back into Porpoise Harbour and Wainwright Basin. Similar occurrances have been noted in the past whenever the mill shut down for short periods of time. However, in these cases fish kills resulted with the subsequent start-up of the mill.(15) With long term improvements in water quality, herring are expected to again utilize the formerly alienated waters of Wainwright Basin and Porpoise Harbour.

IV HALIBUT AND GROUNDFISH

The Area 4 halibut fishery is carried out by small, gill-net boats.(7) At the opening of the sockeye season these boats convert to salmon gear. Thus some low catches can be attributed to a delay in the opening of the halibut season and the shift of effort to salmon fishing when that season opens. Most of the halibut are taken in Hecate Strait, with only small numbers taken inshore by small boats.(7)

Other groundfish in Area 4 are taken in Hecate Strait from Butterworth to Warrior Rocks, the most productive trawl fishing area in B.C. Groundfish harvest data is given in Table XII.

TABLE XI

Herring Catch, Spawners and Stock
and Miles of Herring Spawn Found in Area 4, 1956-75(3,11)

YEAR	CATCH	SPAWNERS	STOCK	STATUTE MILES OF SPAWN AT MEDIUM INTENSITY
	Millions of Fish			
1956-59	62.6	265.3	327.9	9.94
1960-64	162.4	332.2	494.6	23.51
1965-69	43.4	147.5	190.9	10.52
1970	3.5	63.8	67.3	3.12
1971	1.5	31.8	33.2	5.44
1972	.84	52.1	52.9	7.64
1973	1.8	222.0	223.8	18.41
1974*	12.9	51.8	64.7	3.79
1975*	4.6	221.2	225.7	16.17
10 YEAR AVERAGE (1966-75)	21.7	131.5	153.2	9.62

* Catch extrapolated from tons caught,(3) assuming there is 7,000 fish/ton.(11) Spawners extrapolated from statute miles of spawn, assuming 13.68 million spawners/mile of spawn (from 1966 to 1973 data).(11)

TABLE XII

Groundfish Harvests (CWT) of Area 4, 1956-75(3)

YEAR	HALIBUT	FLOUNDER & SOLE	COD	SKATE	NON-FOOD & OTHER
1956-59	24,240	19,610	9,645	64	2,739
1960-64	18,845	20,446	16,972	96	7,098
1965-69	8,309	32,238	37,625	115	11,205
1970	7,397	53,249	16,266	290	6,276
1971	6,084	52,244	17,236	307	1,258
1972	6,697	31,398	27,051	654	4,904
1973	3,710	30,700	27,190	640	8,550
1974	1,820	23,300	30,070	250	5,900
1975	2,410	41,160	33,590	1,370	8,850
10 YEAR AVERAGE (1966-75)	5,784	37,978	27,837	396	8,619

TABLE XIII

Mean Annual Shellfish Harvests (CWT) of Area 4, 1965-75(3)

YEAR	SHRIMP	CRABS	BUTTER CLAMS	SHUCKED OYSTERS (U.S. GAL.)	ABALONE
1956-59	444	2,800	2,578	42	0
1960-64	1,719	1,638	1,911	55	32
1965-69	1,963	1,353	0	0	1
1970	1,968	279	0	0	0
1971	759	732	0	0	0
1972	9	30	0	0	0
1973	70	920	0	0	0
1974	120	920	1,800	0	0
1975	0	910	520	0	50
10 YEAR AVERAGE (1966-75)	1,143	899	232	0	14

V CRUSTACEANS

Current fisheries for shrimp and prawns occur in Chatham Sound. Earlier shrimp fisheries were carried out in the vicinity of Prince Rupert Harbour (1957) and behind Kaien Island (1948).(1)

Crabs are taken commercially in the vicinity of Kitson Island, Tuck Inlet, and Venn Passage.(1) Small numbers of crabs are also taken by local residents in these areas and in Porpoise Harbour. The annual shellfish harvest is presented in Table XIII.

VI MOLLUSCS

A small oyster lease operated from 1958 to 1962 on Melville Arm (Figure 2) near McNicol Creek.(7)

Butterclams have been harvested from beaches at Kitkatla, Metlakatla, Dundas Island, Stephen's Island and Prescott Passage (Figure 2).(1) No harvests were allowed from 1964-1973 due to high toxicities from paralytic shellfish poisoning. However, harvests were permitted in 1974 and 1975 (Table XIII).

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