"A BIOLOGICAL ASSESSMENT OF FISH UTILIZATION OF THE SKEENA RIVER ESTUARY, WITH SPECIAL REFERENCE TO PORT DEVELOPMENT IN PRINCE RUPERT"

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I. INTRODUCTION

Prince Rupert is Canada's western-most deep sea port and is serviced by the Canadian National Railway and the Yellowhead Highway. These factors coupled with the continually expanding Japanese demand for Western Canadian raw materials and the industrial growth now taking place in northern British Columbia have resulted in considerable attention being given to the development of Prince Rupert as a major port for the handling of both general and bulk cargoes. While most of this interest has been expressed in the form of reports, there now have been two firm proposals advanced for the actual construction of major port facilities in the Prince Rupert area. The first of these originated with Maui Enterprises Ltd., (later known as Kitson Harbour Developments Ltd.) and entailed the construction of a bulk loading terminal in the Kitson Island-Flora Bank area which ultimately would have encompassed in excess of 3,000 acres within that section of the Skeena River estuary. During 1972, Prince Rupert was declared a national port and was placed under the jurisdiction of the National Harbours Board. The boundaries of the port were defined in such a way that the Kitson Island - Flora Bank site could not be developed without National Harbours Board concurrence and participation. Wright Engineers Limited was subsequently commissioned by the National Harbours Board to review and up-date the appropriate earlier studies for the purpose of establishing relevant-to-the-need recommendations for development of port facilities at Prince Rupert, their optimum timing and capacity. Their report concluded that:

1) the Fairview site was suitable for the general purpose terminal;
2) there was no need for a bulk loading terminal until about 1980; and that
3) Ridley Island was the most suitable site for a bulk terminal.

Tenders have now been called for site preparation at Fairview.

In view of the extensive site development work in the form of estuarine filling and dredging entailed with the original Kitson Island - Flora Bank proposal, the Fisheries Service, in 1971, initiated a cursory investigation into the biological significance of Flora Bank. The results of this study indicated that Flora Bank was of significance to the maintenance of local fisheries resources. In 1972, the study was expanded to augment the information obtained in the previous year and to answer the question of where a super port capable of handling bulk commodities such as coal might be located with a minimum of impact on the fisheries resource.

To those not familiar with the west coast fishing industry and the fisheries resource maintenance requirements in general, two principal questions can logically be asked. These are: "What is the significance of the fishing industry to the community of Prince Rupert?" and "What destructive consequences could be imparted on the fisheries resource by superport construction?"

The answer to the first question is that: fishing is of overwhelming importance to the people of Prince Rupert. Prince Rupert has long been the centre of northern British Columbia's commercial fishing industry, and it is expected that much of the north coast's tidal sport fishing activity will take place in the Prince Rupert area in the future.

A socio-economic study conducted in 1971 by William F. Sinclair of the Fisheries Service, showed that commercial fishing provided approximately 42 percent of Prince Rupert's basic employment and about 36 percent of its basic income during 1970. Subsequent development of the fishing industry in the Prince Rupert area and of the fishing industry within British Columbia probably has increased the importance of commercial fishing to the residents of Prince Rupert. Not only have the returns from the halibut fishery increased substantially during this period, but also a very lucrative and promising herring roe fishery has developed.

Aside from the fact that commercial fishing and its related activities creates a substantial amount of income and employment for the people of Prince Rupert, fishing is important as a way of life for many of Prince Rupert's residents. The job opportunities provided by the commercial fishing industry complement very nicely the manpower requirements of the Prince Rupert region. Persons employed in logging operations or in pulp mills often work in the commercial fishing industry when forest closures or labour disputes occur. Further, the skill requirements and experience of the Prince Rupert labour force is well suited to the needs and requirements of the commercial fishing industry. Thus, commercial fishing is a very important employment and income stabilizer in this area of the province where the main economic activities are based on the natural resources of the area.

Income from salmon fishing and processing is the prime contributor to the total income from the fisheries resource. The Skeena River ranks second only to the Fraser River as a salmon producer and as such is the major single source of fishing income to residents of Prince Rupert employed in the fishing industry.

It is noteworthy that the Fisheries Service upon examination of the Skeena River sockeye salmon spawning and rearing areas concluded that these very large natural salmon stocks could be expanded through the provision of artificial spawning channels. To that end, the Fisheries Service has, since 1965, expended 10 million dollars on the construction of spawning channels at Fulton River and Pinkut Creek on Babine Lake. In the next few years, the returns from these enhancement facilities will increase the annual landed value of Skeena River salmon by 2.5 million dollars.

In addition to its commercial importance, fishing provides many hours of enjoyment for residents living along the Skeena River. The amount of fishing activity which takes place in this area of the province will likely increase substantially in the future. As sport fishing develops and highways and other transportation systems expand and improve, it can be expected that recreational fishing will add to the employment and income base of the area.

Turning now to the question "What destructive consequences could be imparted on the fisheries resource by superport construction?", this is extremely complex and is to a very large degree dependent upon the site chosen for superport construction. In the case of Prince Rupert, all the potential sites are in or adjacent to the Skeena River estuary which is one of the two largest estuarine areas in British Columbia.

Pritchard (1967) has defined an estuary as "A semi-enclosed body of water which has a free connection with the open sea and within sea water is measurably diluted with fresh water derived from land drainage". Estuaries are a combined interacting system of land, air, water, plants, animals, minerals and energy resources. They are among the most fertile areas in the world.

This fertility is due to the trapping of nutrients, which is manifested in three ways. Vertical and horizontal circulation patterns, driven by the mixing of waters of differing densities in concert with tidal forces, entrain nutrients within the water column. Secondly, estuarine sediments have high sorptive qualities owing to their fine composition. The sediments act as a buffer allowing desorption of nutrients into the water as they are lost to phytoplankton (Odum, 1970). The third mechanism for nutrient enrichment of the sediments is biodeposition of faecal materials by benthic invertebrates.

The food web in an estuary is unsophisticated and of low diversity , thus extremely susceptible to subtle alteration. Primary production in terms of phytoplankton and detritus is based on availability of sunlight and an abundant supply of nutrients. If these are available primary production may be optimal and thus primary consumers (zooplankton) will be able to thrive. These in turn are consumed by secondary consumers (larval fish). Destruction of a single component in a specific trophic level will imperil its related consumer in the next level due to the low number of key organisms available for consumption.

Kinne (1967) has stated that a few organisms find optimum conditions in estuarines during their life cycles. It is not a single environmental factor which governs physiological responses but a combination of factors impinging one upon another. The result is that degradation of a single environmental factor may allow another factors' effect to become disproportionate and perhaps lethal. Generally, these factors are self-moderating.

As a final comment, estuaries provide nursery areas for rearing salmonids not only in terms of "super-market" potential but also as a "halfway-house" for physiological adaptation. Juvenile salmonids are provided an opportunity to adapt to a hypertonic environment from their hypotonic natal stream life. The varied salinity regime in an estuary allows this. It provides the buffer against physiological shock.

We can also be certain that not all areas within an estuary have the same fish productive capacity or biological significance. Thus, before the prime question can be answered, studies must be undertaken to determine the biological significance of various sub areas within an estuary. When that information has been obtained, it becomes possible not only to determine the potential destructive impacts superport construction will have on the fisheries resource, but to demonstrate which area could be developed with a minimum of biological degradation. The Fisheries Service investigations in the Skeena River estuary were designed to provide this necessary information.

The 1972 study was initiated and designed to:

a) demonstrate the fish distribution and utilization patterns within the estuary;

b) relate the fish distribution and utilization patterns with fish diet and food availability, and to,

c) obtain, within available resource and time constraints, some insights into the relationship between the physical and chemical water characteristics and the distribution of fish and fish food organisms.

The on-site investigations commenced in early April and were terminated in late August, 1972.

II METHODS AND MATERIALS

Basic modifications to the 1971 cursory study were indicated for the 1972 investigations. The initial program had failed to demonstrate significant estuarine presence on the part of juvenile salmonids and the scope of sampling was too limited to facilitate alternative site selection. Consequently, both the type of gear used and the number of stations were modified in 1972 and emphasis was placed on fish distribution especially as related to juvenile salmon.

Initially, eighteen stations were established and seining began April 16 utilizing a 10' outboard craft and a 54 fathom x 6 fathom purse seine. On May 15, the number of capture sites was increased to 28 with two of the original stations (Stations 4 and 16) being deleted. To maintain continuity with existing maps and charts the two deleted station numbers were not relocated. Thus, as seen in Figure 1 the stations number up to 30 and are in a scattered numerical order. On May 18 a local gillnetter, the M.V. "BREEZEWAY" was chartered and equipped with a 71 fathom x 7 fathom purse seine (constructed with a 35 fathom lead of 1" mesh, and a purse consisting of 23 fathoms of 1" mesh, 8 fathoms of ½" mesh and 5 fathoms of ¼" mesh) and commenced sampling. On June 15, the M.V. "SILVER TOKEN" of similar size and like equipped was chartered and began sampling. Purse seining continued until July 30 with all stations being sampled twice weekly. This schedule could not be strictly adhered to due to weather conditions, break-

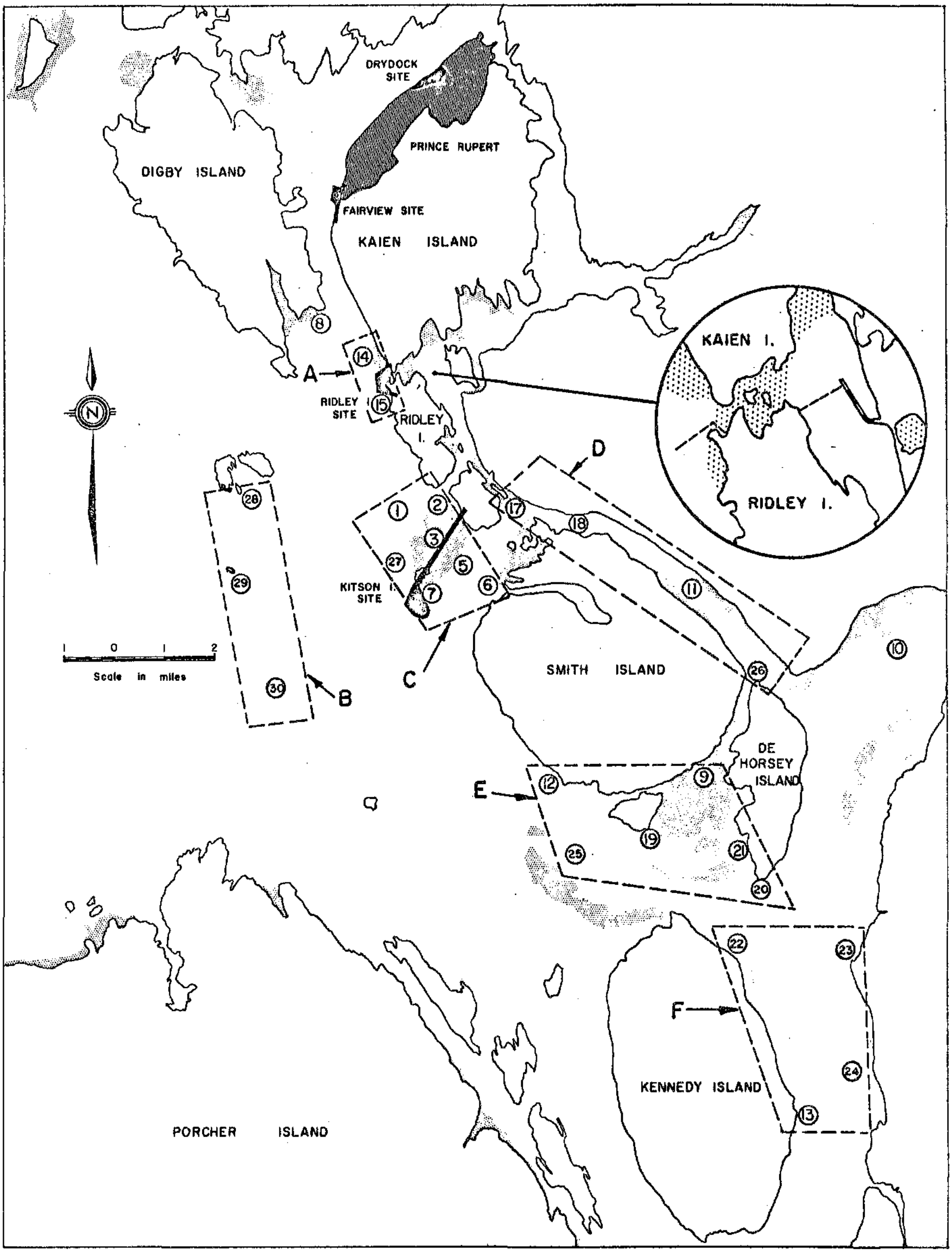

Figure 1. Purse seining stations in the Skeena River estuary.

downs or utilization of the vessels in the commercial fishing industry during the regulated salmon fishing openings.

On August 3 the M.V. "THRASHER ROCK" began surface trawling using a net 30' long having a 10' x 11' mouth opening. This method of capture continued until August 13. From April 16 to August 13, 1972 over 9,000 juvenile salmon, herring, needelfish and smelt were captured and identified using both types of fishing gear. Of this total, 1,133 fish were retained for analysis. These samples were obtained from every set. If less than 10 specimens of each species were caught in any set, all were retained. If more than 10 fish of each species were caught in any particular set, 10 were selected at random and the remainder were released. The blotted weight and the fork length of each of these specimens was measured and recorded. The whole fish was then preserved in formalin. At a later date, the stomachs were removed and their contents were analyzed for food species composition and abundance.

To enable a cursory evaluation of the benthic biota in the estuary, bottom samples were taken by Ponar dredge at 13 of the seine stations in the estuary during April. The species present and their relative abundance was recorded. Time and resource constraints did not permit a repitition of sampling.

Plankton samples were gathered at 10 locations in the estuary from August 10-13. The plankton was collected by vertical tows using a 50 cm. diameter simple oceanographic plankton net with a mesh aperture of 180 microns. The plankton samples were analyzed for species composition and relative abundance. Resource constraints did not permit a more frequent sampling of plankton.

In order to quantify the distribution and abundance of eelgrass, aerial photographs were taken on May 16 and August 26 of Flora Bank. Also of Inverness Passage and of the bank between De Horsey and Smith Islands, hereafter referred to as De Horsey Bank. The photographs were taken using Kodak false colour infra-red and Kodachrome-X colour film. Both films were exposed simultaneously from two 35 mm. cameras equipped with 50 mm. lenses and polarizers. The film was exposed at an altitude of 1000' from a De Haviland Beaver flying a pre-determined course.

Nansen bottle casts were made at 26 stations on various tides and at 0, 2, 5, 10, 15, 25 metre depths from August 15-21. The specific gravity and temperature at each depth was measured and the salinity value was determined by cross comparison in a sigma-T table. This provided a qualitative estimation of the salinity regime within the estuary during the period of sampling. Resource constraints did not permit more frequent sampling for salinity.

III RESULTS AND DISCUSSION

Inasmuch as it is almost impossible to deal with the results of the 1972 investigations as they relate to each of the 28 sampling stations, the data collected from stations within certain geographical zones was pooled. Thus, the following presentation and discussion of results relates to the six geographical zones at Ridley Island (Area A), the offshore zone (Area B), Flora Bank (Area C), Inverness Passage (Area D), De Horsey Bank (Area E), Telegraph Passage-Kennedy Island (Area F) as well as two "controls" at Digby Island (Station 8) and the Skeena River (Station 10) as illustrated in Figure 1.

a) Fish Distribution, Abundance and Timing

Totals of 1950 juvenile salmon (5 species *Onchorhynchus*), 5861 herring (*Clupea pallasi*), 806 needlefish (*Ammodytes hexapterus*), and 1087 surf and longfin smelts (*Hypomesus pretiosus* and *Spirinchus dilatus*) were captured by purse seining and surface trawling. Incidental catches of small numbers of other species (see list in Appendix A) were made but are not dealt with in this discussion.

Unlike the previous year's experience (Fisheries Service Report; A Cursory Investigation of the Productivity of the Skeena River Estuary, 1972), little difficulty was encountered in capturing substantial numbers of juvenile salmon once the commercial fishing vessels were chartered and equipped with as large a seine as the vessels could physically accommodate. Juvenile salmon were captured in the estuary from April 23, though known to be present earlier, until August 11. Thus, in terms of demonstrated juvenile salmon utilization in the estuarine area, the results of the Skeena River study are not different from the results obtained in other areas of the North American Pacific Coast (Goodman and Vroom, 1972; Reimers, 1971; Sims, 1970; Parker, 1970; Smith, 1972).

Catch per unit of effort calculations were made utilizing the purse seine catches only. Aside from the fact that the trawling method of fish capture and the purse seining method cannot be validly compared, the trawl was only used to test whether it may be a viable method for fish captures for studies to be conducted at a later date.

The downstream migration of pink salmon fry (O. gorbuscha) into the estuary was underway when sampling commenced at Station 10 in the Skeena River on May 3rd. The out-migration peaked in the third week of May and was over by mid-June. Peak of abundance in Inverness Passage coincided with that at Station 10. This abundance was reflected at Flora Bank and De Horsey Bank (Areas C and E) during the following week. Pink salmon abundance by area, as indicated by catch per unit of effort is shown in Figures 2A and B.

The initial downstream migration of sockeye salmon smolts (O.nerka) and the peak of migration as measured at Station 10 occurred in the last week of May. Abundance at virtually all sub-areas closely coincided with out-migration from the river. As of the first week in July virtually all sockeye had left

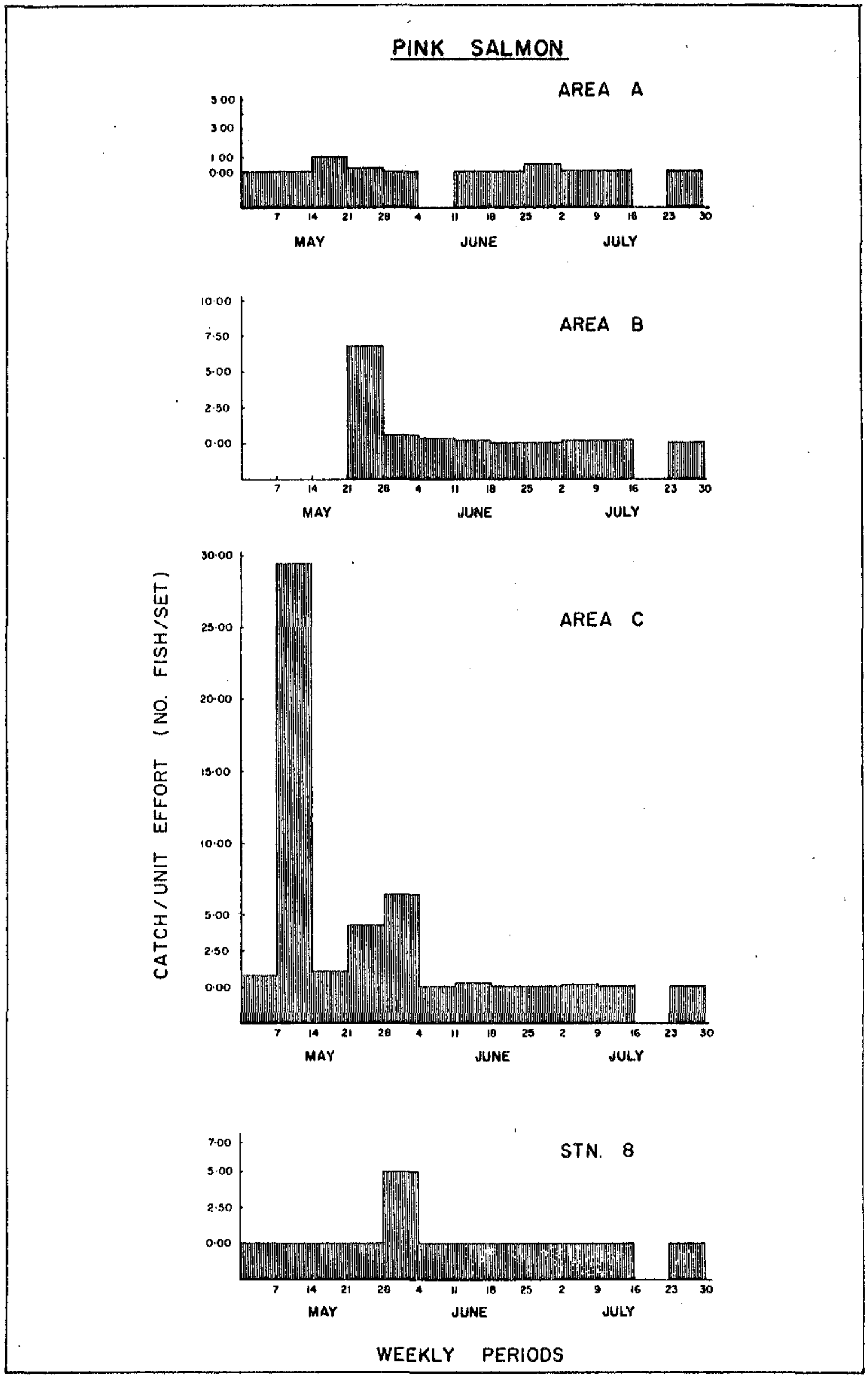

Figure 2A. Average weekly captures of pink salmon juveniles.

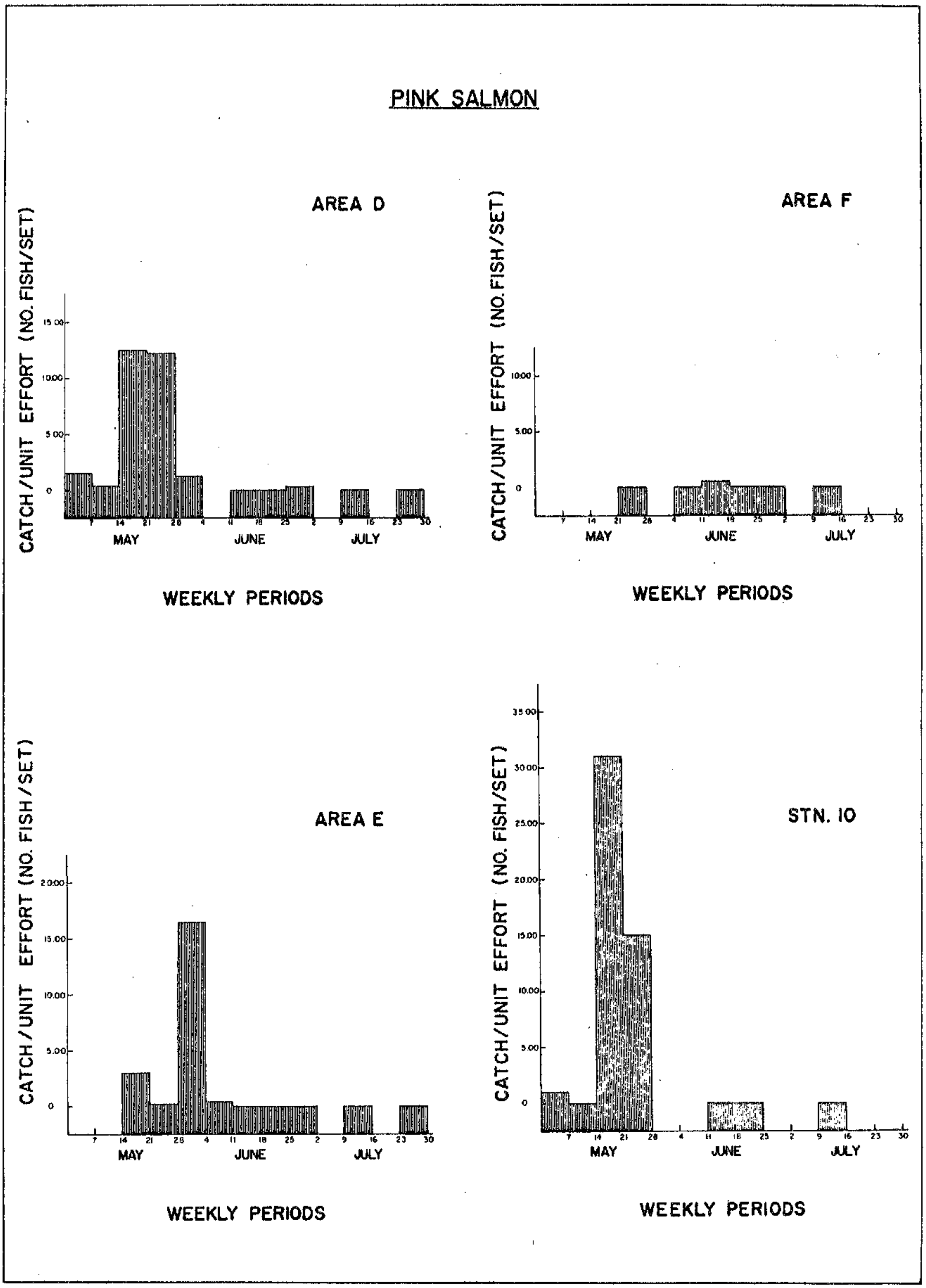

Figure 2B. Average weekly captures of pink salmon juveniles.

the estuary. Sockeye salmon abundance by area, as indicated by catch per unit of effort is shown in Figures 3A and B.

The data obtained on pink and sockeye salmon show a major peak of capture and then a drastic decline. This strongly suggests that these species move into and out of the estuary in a very short time span. Due to the frequency of sampling, (twice a week), it is not possible to demonstrate this time span is less than three or four days, although a cross comparison between adjacent stations within each area suggests this is the case. The peak of sockeye abundance in the estuary, coincidental with initial presence indicates movement of a major population into the estuary at that time. On June 6 a sockeye smolt tagged at Babine Lake was captured in the Offshore zone (Area B). This would suggest that the major influx of sockeye into the estuary during the previous week originated in Babine Lake which is the main sockeye producer in the Skeena River system.

The small captures of sockeye smolts and pink fry long after the pronounced peaks, could either be non-Skeena stocks migrating through the estuary or progeny from very minor salmon producers within the Skeena River system.

The downstream migration of coho salmon smolts (O. kisutch) as indicated by seine catches at Station 10, commenced in the third week of June and peaked immediately.

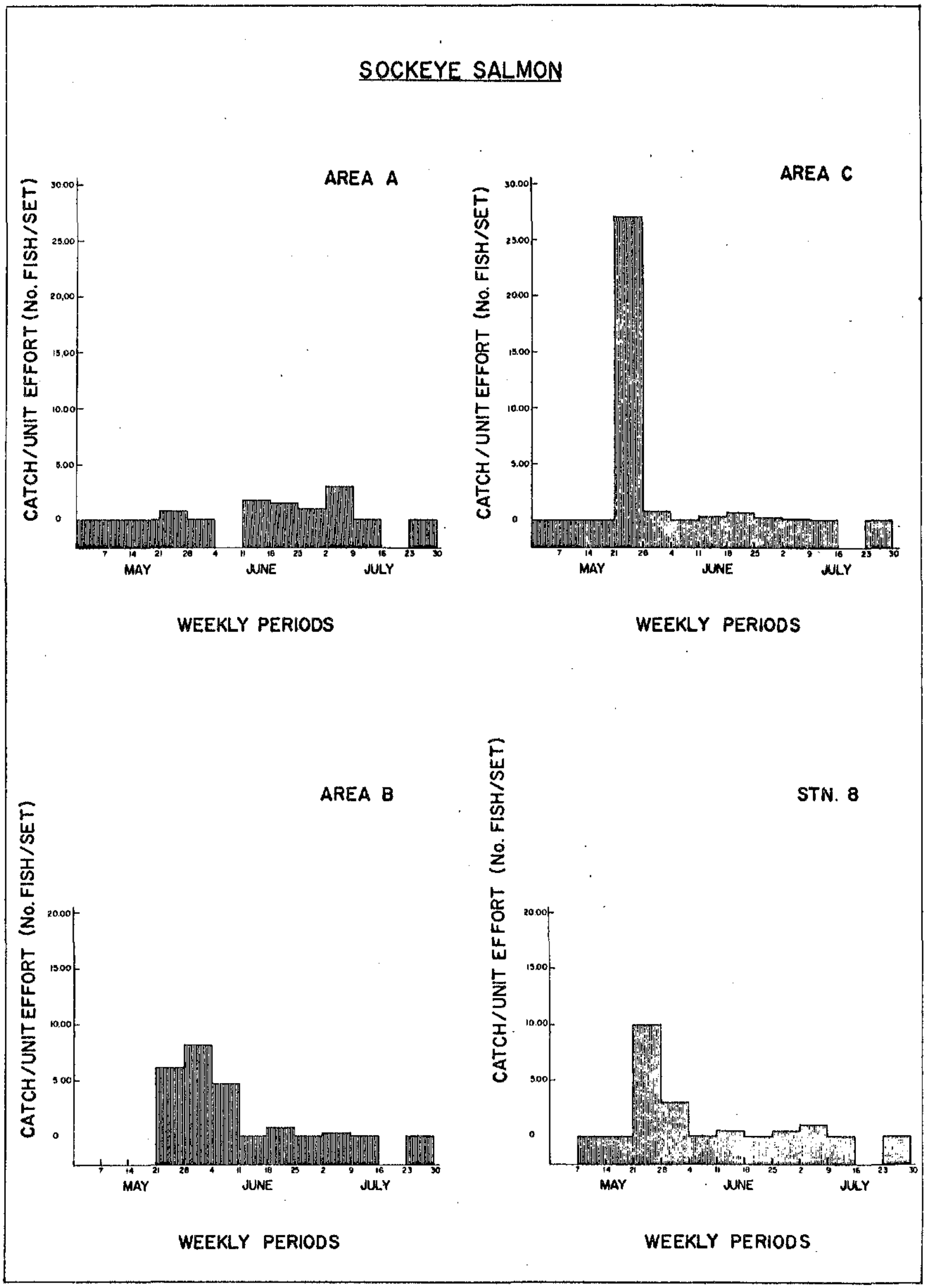

Figure 3A. Average weekly captures of sockeye salmon juveniles.

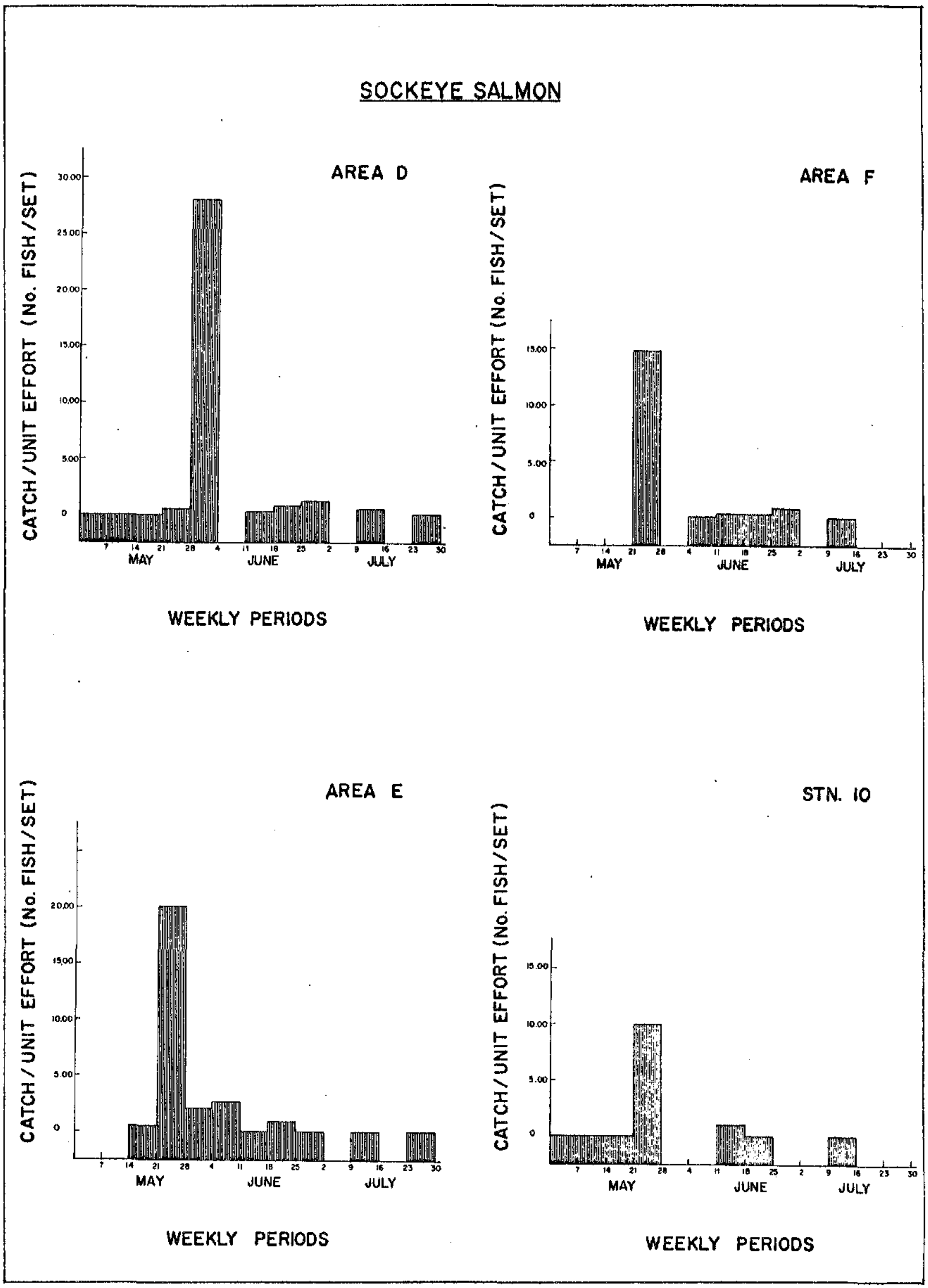

Figure 3B. Average weekly captures of sockeye salmon juveniles.

A second, less dramatic peak occurred two weeks later. Coho were within the estuary until purse seining was discontinued on July 30. This species was not taken in the surface trawl which operated during the first two weeks of August. Coho salmon abundance as indicated by catch per unit of effort is shown in Figures 4A and B.

Chinook salmon juveniles, (O. tshawytscha) were present in the estuary from the third week in May until sampling was discontinued in mid-August. The timing of abundance peaks varied in the different estuarine areas, but the overall peak abundance occurred in mid-June. Catch per unit of effort by area for chinook salmon is shown in Figures 5A and B.

Chum salmon fry (O. keta) were not abundant in the estuary which is not surprising since the Skeena River is not noted for its chum salmon production. Sparse captures were made in May and the largest captures were made in the second week of July. Chum salmon were still in the estuary in very small numbers in the second week of August as evidenced by trawl captures.

Catch per unit of effort by area for this species is illustrated in Figures 6A and B.

It is clear that coho, chinook and chum salmon juveniles did not exhibit dramatic peaks of abundance. They exhibited a major peak and several lesser peaks of abundance which was not the case for the other two salmon species. The peak of migration for chinook and coho coincided with the very high discharge period in the Skeena River (Figure 7). However,

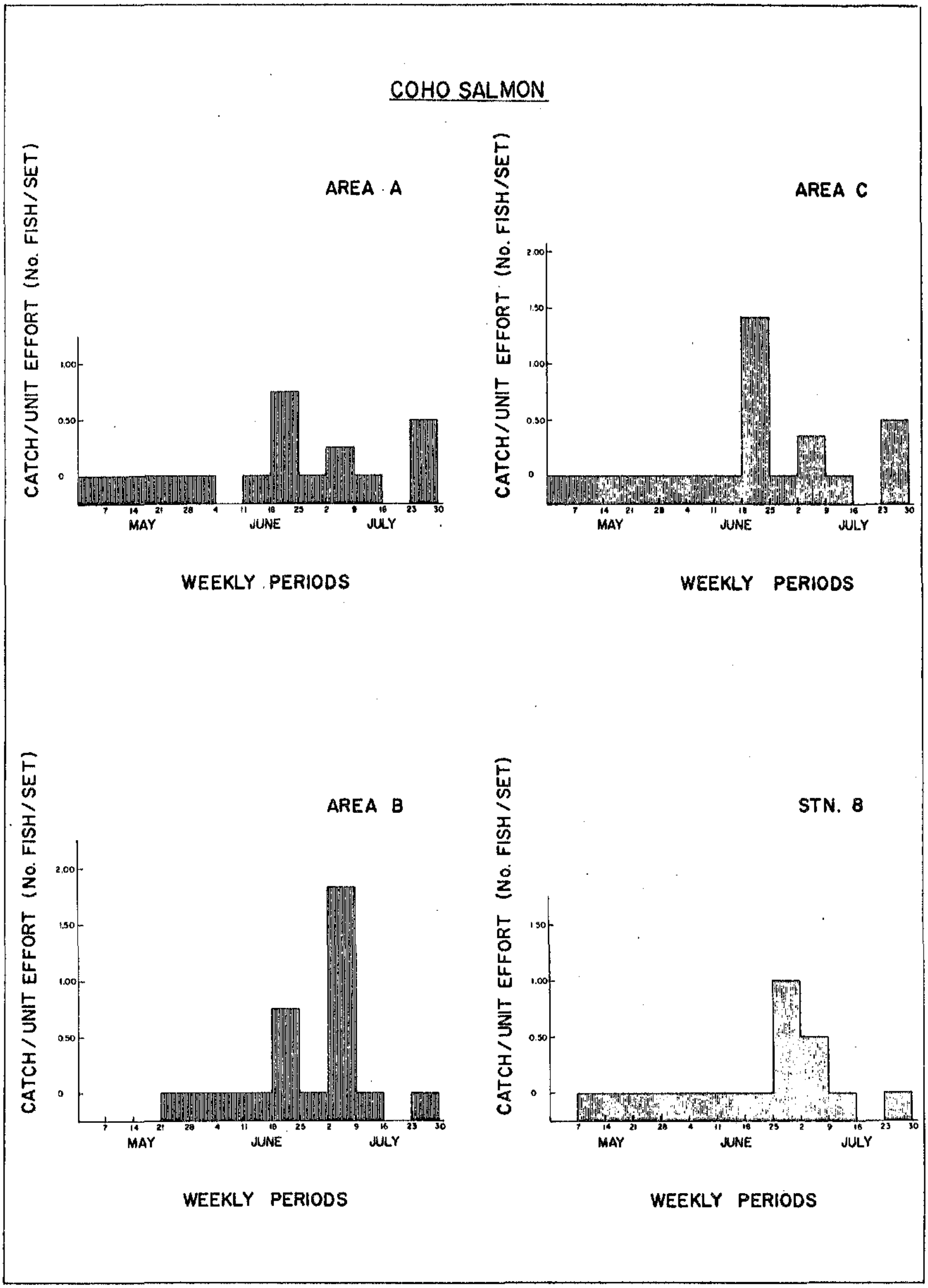

Figure 4A. Average weekly captures of coho salmon juveniles.

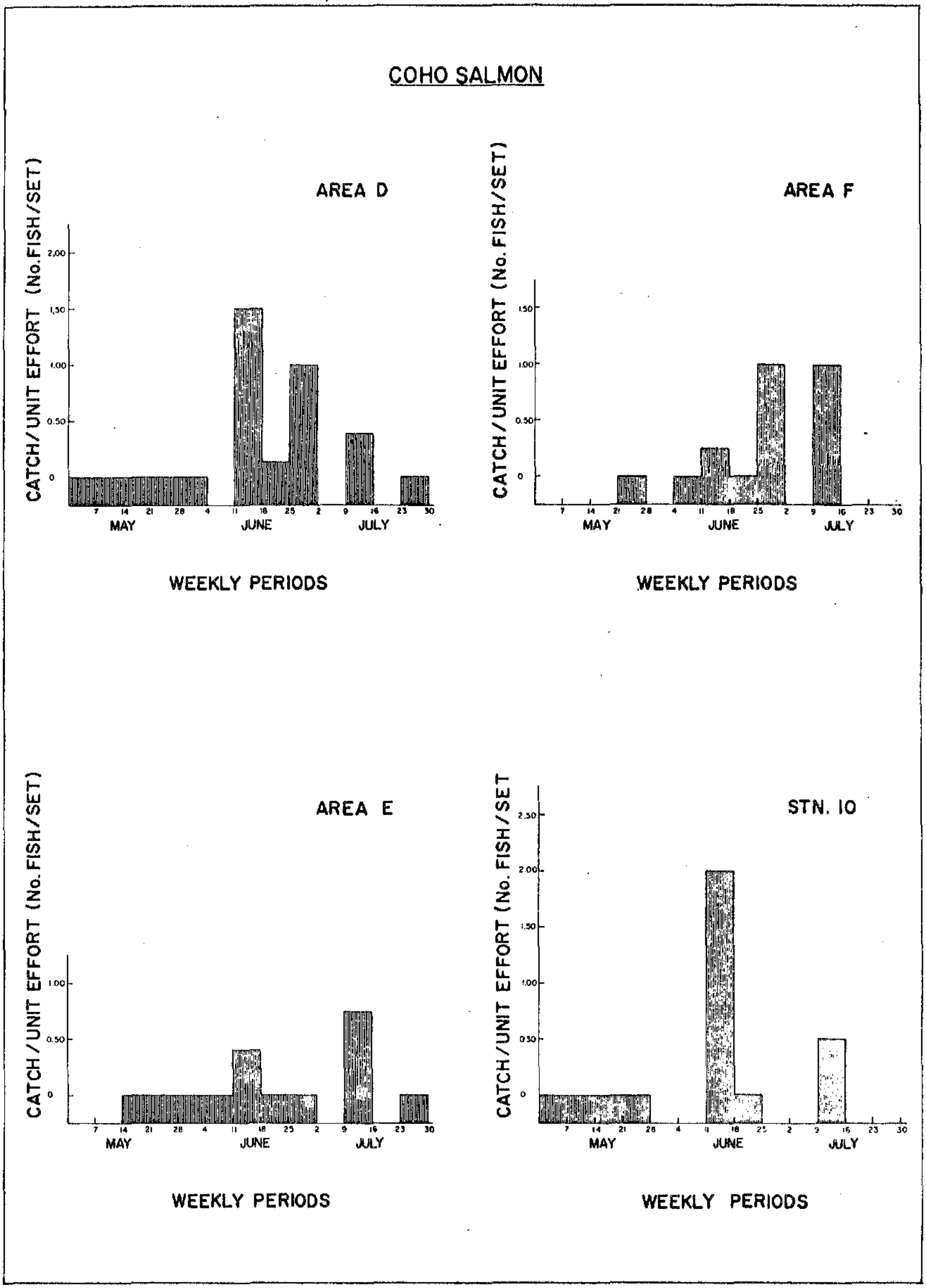

Figure 4B. Average weekly captures of coho salmon juveniles.

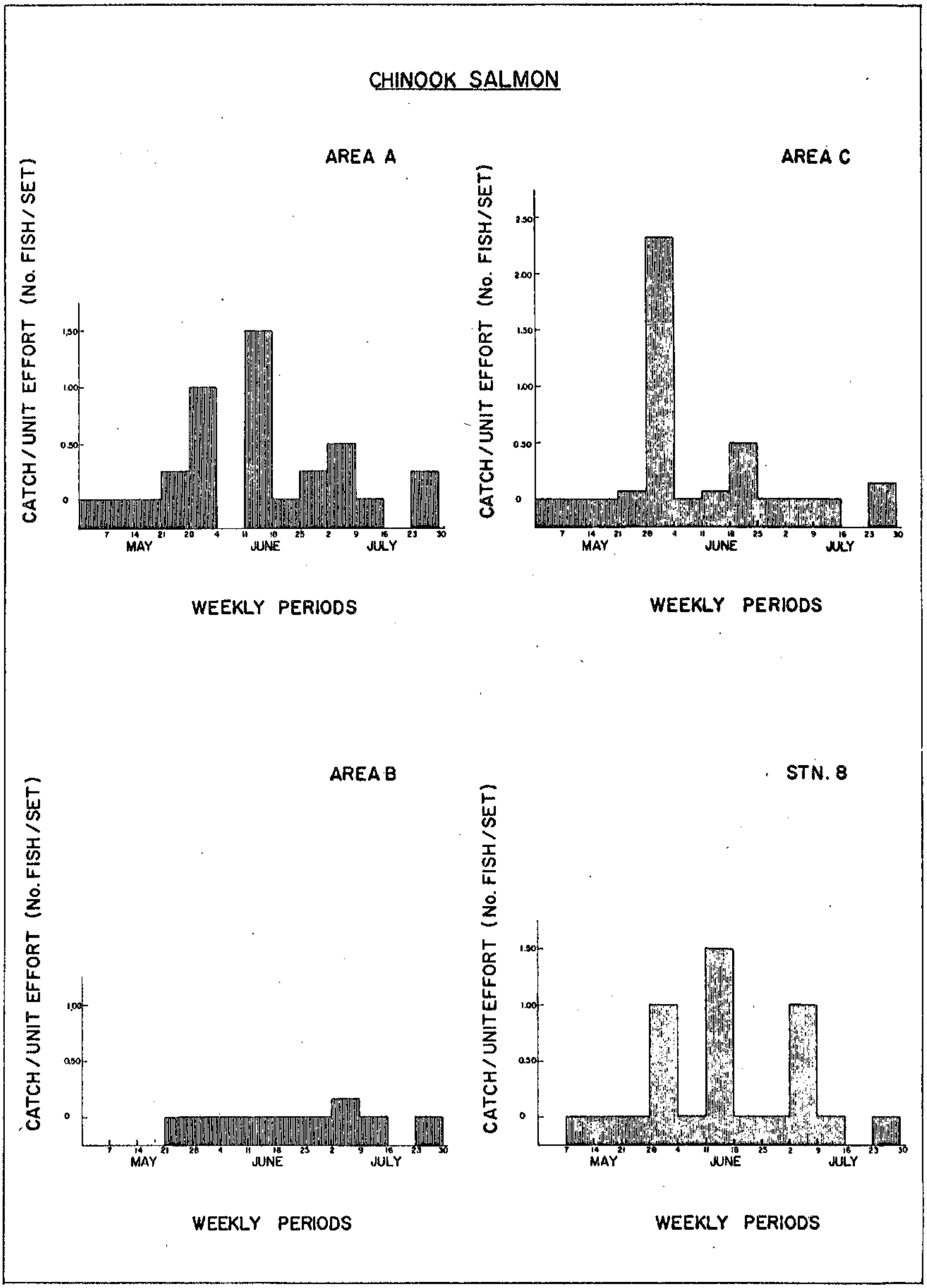

Figure 5A. Average weekly captures of chinook salmon juveniles.

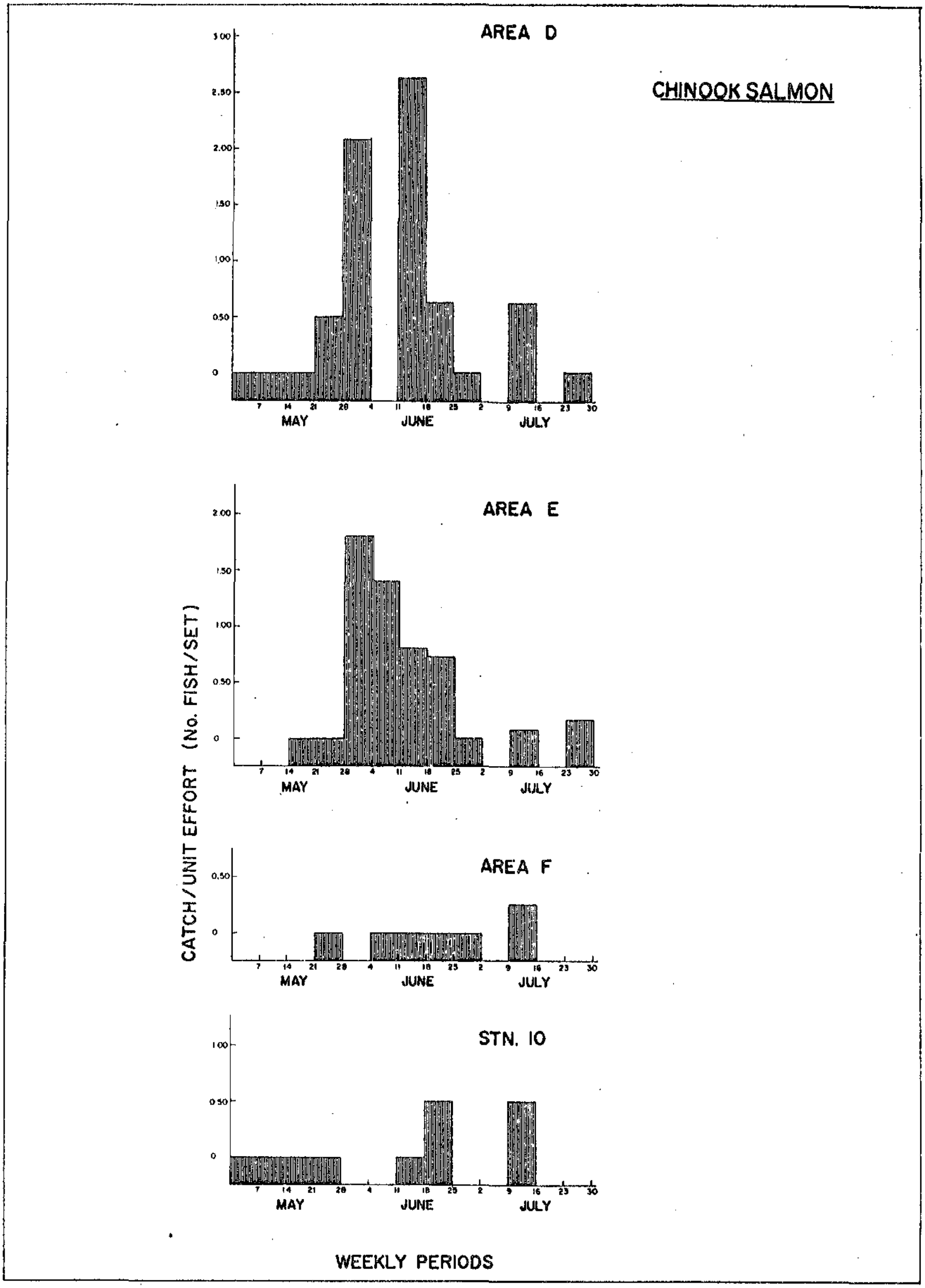

Figure 5B. Average weekly captures of chinook salmon juveniles.

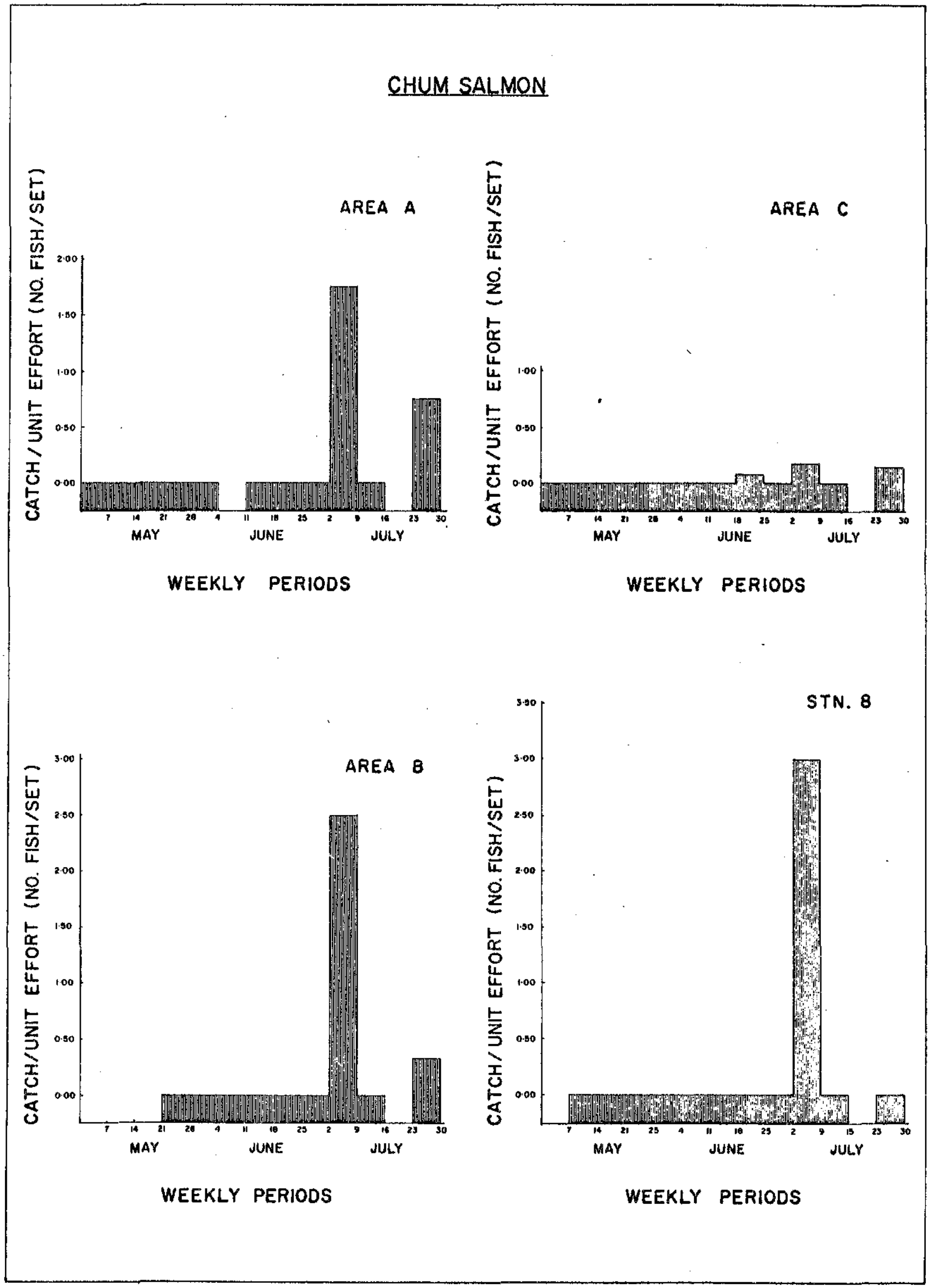

Figure 6A. Average weekly captures of chum salmon juveniles.

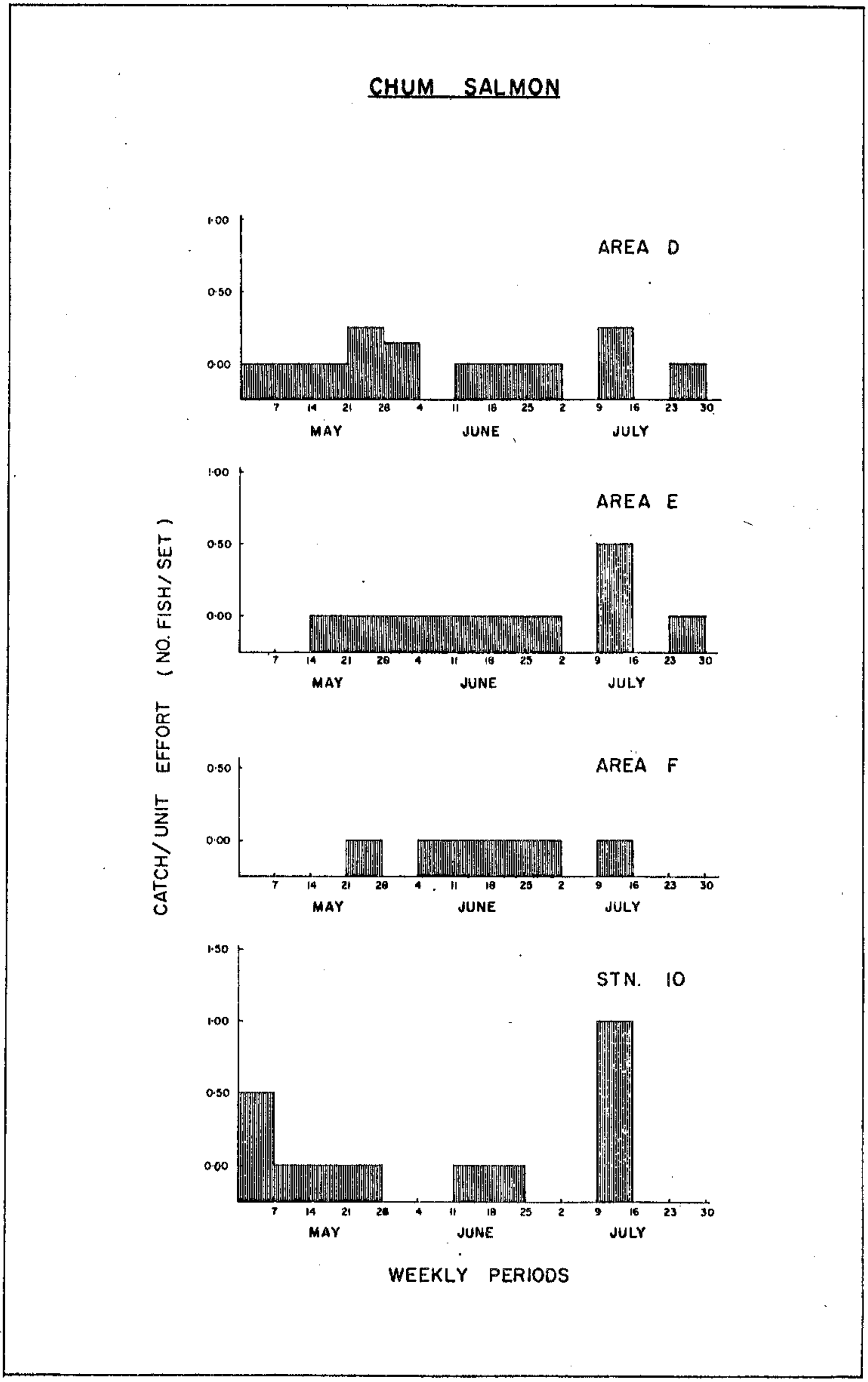

Figure 6B. Average weekly captures of chum salmon juveniles.

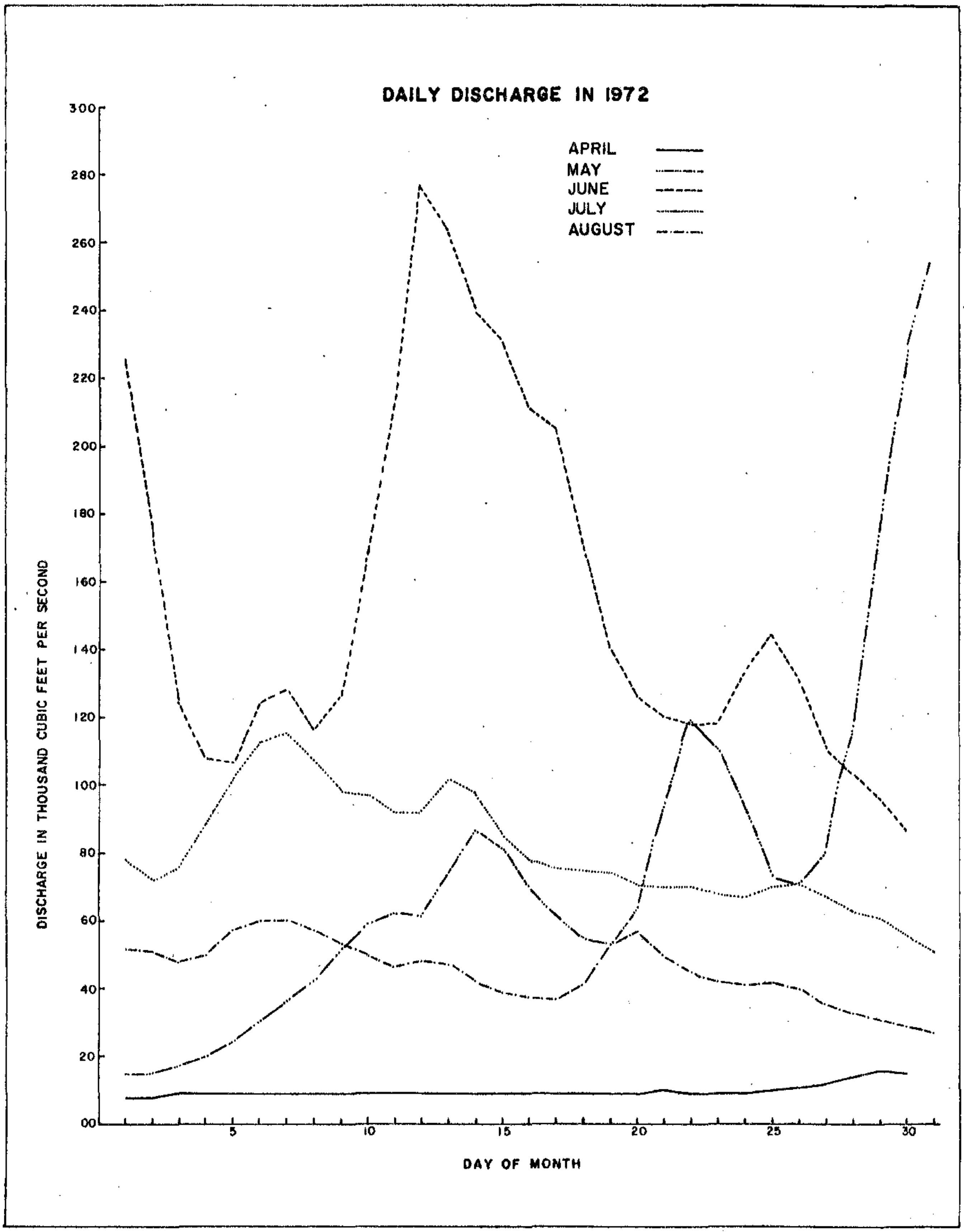

Figure 7. Daily discharge for April - August 1973 recorded at Usk.

the scattered peaks of abundance are most probably a reflection of the combined factors of a natural scattering of downstream migrations out of the natal streams in the Skeena River system and a longer residency within the estuarine zone. Sims (1970) and Reimers (1971) have noted lengthy residence periods for chinook and coho juveniles in the Columbia River estuary and the Sixes River estuary in Oregon. In the case of the Skeena River, it was not possible, because of resource constraints, to establish downstream migrant traps several miles upstream of the estuary. This would have enabled us to define downstream migrations more precisely and as consequence to determine positively if the coho and chinook captures were evidence of back-and-forth estuarine movements. Such movements are known to occur with chinook salmon juveniles in the Fraser River, (K.R. Pitre, personal communication).

The frequency distributions for the juvenile salmon captures by species and area are shown in TABLES I-V. Due to the multiplicity of distributions and varied numbers of species captured, each of the species distributions have differing results in terms of major areas of residency. However, the general statement can be made that Inverness Passage (Area D) yielded the greatest mean captures for all species except chum salmon.

When all salmon catches were combined (or pooled) the number of fish caught in a set radically increased and the number of zero counts diminished (See TABLE VI). This enables a better understanding of the relative salmon utilization

TABLE I. Catch frequency distribution of pink salmon juveniles.

Area "A"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	32	91	0.171	0.381	0.618
1.0	1	3			
2.0	1	3			
3.0	1	3			

Area "B"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	37	86	0.605	9.340	3.056
1.0	4	9			
2.0	1	2			
20.0	1	2			

Area "C"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	105	82	3.016	459.548	21.437
1.0	9	7			
2.0	1	1			
3.0	3	3			
5.0	2	2			
7.0	1	1			
11.0	1	1			
44.0	1	1			
55.0	1	1			
230.0	1	1			

Area "D"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	41	75	2.036	28.665	5.354
1.0	3	5			
2.0	3	5			
3.0	1	2			
4.0	1	2			
8.0	1	2			
13.0	2	4			

TABLE I cont'd. Catch frequency distrubution of pink salmon juveniles.

Area "D" cont'd.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
15.0	1	2			
22.0	1	2			
25.0	1	2			

Area "E"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	48	86	1.643	50.634	7.116
1.0	2	4			
2.0	1	2			
5.0	1	2			
6.0	1	2			
12.0	1	2			
15.0	1	2			
50.0	1	2			

Area "F"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	26	93	0.071	0.069	0.262
1.0	2	7			

TABLE II. Catch frequency distribution of sockeye salmon juveniles.

Area "A"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	27	77	0.914	5.140	2.267
1.0	2	6			
2.0	1	3			
3.0	1	3			
4.0	2	6			
6.0	1	3			
11.0	1	3			

Area "B"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	36	84	1.512	25.065	5.007
1.0	1	2			
2.0	2	5			
3.0	1	2			
14.0	1	2			
19.0	1	2			
24.0	1	2			

Area "C"

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
0.0	103	82	3.272	553.732	23.532
1.0	12	9			
2.0	5	4			
4.0	1	1			
6.0	1	1			
27.0	1	1			
112.0	1	1			
238.0	1	1			

TABLE II cont'd. Catch frequency distribution of sockeye salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "D"						
	0.0	36	62	3.891	440.506	20.988
	1.0	10	17			
	2.0	5	9			
	3.0	1	3			
	4.0	1	3			
	34.0	1	3			
	153.0	1	3			
Area "E"						
	0.0	39	69	3.214	270.062	16.434
	1.0	6	10			
	2.0	4	7			
	3.0	1	2			
	4.0	2	4			
	6.0	1	2			
	7.0	1	2			
	20.0	1	2			
	122.0	1	2			
Area "F"						
	0.0	22	79	2.286	58.508	7.649
	1.0	3	11			
	3.0	1	4			
	25.0	1	4			
	33.0	1	4			

TABLE III. Catch frequency distribution of coho salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "A"						
	0.0	30	86	0.171	0.205	0.543
	1.0	4	11			
	2.0	1	3			
Area "B"						
	0.0	41	95	0.326	2.987	1.728
	3.0	1	2			
	11.0	1	2			
Area "C"						
	0.0	108	86	0.232	0.567	0.753
	1.0	12	10			
	2.0	2	2			
	4.0	2	2			
	5.0	1	1			
Area "D"						
	0.0	45	82	0.364	1.051	1.025
	1.0	6	11			
	2.0	2	4			
	5.0	2	4			
Area "E"						
	0.0	53	95	0.196	1.215	1.102
	1.0	1	2			
	2.0	1	2			
	8.0	1	2			
Area "F"						
	0.0	21	75	0.321	0.347	0.612
	1.0	5	18			
	2.0	2	7			

TABLE IV. Catch frequency distribution of chinook salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
<u>Area "A"</u>						
	0.0	27	77	0.371	0.652	0.808
	1.0	5	14			
	2.0	1	3			
	3.0	2	6			
<u>Area "B"</u>						
	0.0	42	98	0.023	0.023	0.153
	1.0	1	2			
<u>Area "C"</u>						
	0.0	115	92	0.240	2.087	1.445
	1.0	7	6			
	3.0	1	1			
	5.0	1	1			
	15.0	1	1			
<u>Area "D"</u>						
	0.0	41	75	0.855	4.090	2.022
	1.0	4	7			
	2.0	4	7			
	4.0	3	5			
	6.0	2	4			
	11.0	1	2			

TABLE IV. cont'd. Catch frequency distribution of chinook salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "E"						
	0.0	42	75	0.536	1.235	1.111
	1.0	5	9			
	2.0	5	9			
	3.0	2	4			
	4.0	1	2			
	5.0	1	2			
Area "F"						
	0.0	27	96	0.071	0.143	0.378
	2.0	1	4			

TABLE V. Catch frequency distribution of chum salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "A"						
	0.0	32	91	0.286	1.269	1.127
	1.0	1	3			
	3.0	1	3			
	6.0	1	3			
Area "B"						
	0.0	39	91	0.395	3.054	1.748
	1.0	1	2			
	2.0	1	2			
	3.0	1	2			
	11.0	1	2			
Area "C"						
	0.0	120	96	0.048	0.062	0.249
	1.0	4	3			
	2.0	1	1			
Area "D"						
	0.0	51	93	0.073	0.069	0.262
	1.0	4	7			
Area "E"						
	0.0	53	95	0.107	0.243	0.493
	1.0	1	2			
	2.0	1	2			
	3.0	1	2			
Area "F"						
	None captured					

TABLE VI. Catch frequency distribution all salmon juveniles.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "A"						
	0.0	19	54	1.914	11.198	3.346
	1.0	1	3			
	2.0	5	14			
	3.0	5	4			
	4.0	1	3			
	5.0	1	3			
	7.0	1	3			
	8.0	1	3			
	17.0	1	3			
Area "B"						
	0.0	31	72	2.861	60.552	7.782
	1.0	2	5			
	2.0	2	5			
	3.0	2	5			
	5.0	1	2			
	6.0	1	2			
	15.0	1	2			
	22.0	1	2			
	24.0	1	2			
	39.0	1	2			
Area "C"						
	0.0	66	52	6.808	1162.317	34.093
	1.0	30	23			
	2.0	9	7			
	3.0	5	4			
	4.0	4	3			
	5.0	1	1			
	7.0	2	2			
	11.0	1	1			
	14.0	1	1			
	17.0	1	1			

TABLE VI. cont'd. Catch frequency distribution all salmon juveniles.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "C" cont'd.					
32.0	1	1			
55.0	1	1			
112.0	1	1			
230.0	1	1			
238.0	1	1			
Area "D"					
0.0	21	36	7.118	488.544	22.103
1.0	4	7			
2.0	8	14			
3.0	5	9			
4.0	2	4			
5.0	1	2			
6.0	2	4			
7.0	1	2			
9.0	1	2			
10.0	1	2			
11.0	2	4			
13.0	1	2			
14.0	1	2			
15.0	1	2			
25.0	2	4			
38.0	1	2			
153.0	1	2			

TABLE VI. cont'd. Catch frequency distribution all salmon juveniles.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "E"					
0.0	29	51	5.696	322.724	17.965
1.0	5	8			
2.0	5	8			
3.0	2	4			
4.0	3	5			
5.0	1	2			
6.0	2	4			
7.0	1	2			
8.0	1	2			
10.0	1	2			
11.0	1	2			
15.0	1	2			
20.0	2	4			
56.0	1	2			
122.0	1	2			
Area "F"					
0.0	15	54	2.750	57.380	7.575
1.0	7	25			
2.0	2	7			
4.0	2	7			
25.0	1	4			
33.0	1	4			

of different areas within the estuary. It is apparent that, when all species of salmon are considered together, Inverness Passage, Flora Bank and De Horsey Bank (Areas D,C, and E), in that order, produced the greatest mean captures per set. These areas also have the largest variances with the Flora Bank area showing the greatest variation in size of captures. The Ridley Island zone (Area A), on the other hand, produced the smallest mean captures per set and yielded the lowest variance. A higher variance is indicative of captures of "groups" of fish which are either schooled populations or fractions of schooled populations. Inverness Passage, Flora Bank and De Horsey Bank yielded captures of these "groups" whereas the Ridley area tended to produce only individual fish or at best very small groups of fish in a single set. Manzer (1966) has reported that juvenile salmon entering the sea move along the coast in schools during their early sea life prior to offshore movement. Consequently, the non-schooling distribution at Ridley Island suggests that these fish are either preparing for offshore migration in the higher salinity waters or are displaying, at the very least, an atypical ethological trait. Possible reasons for such a behavioural response will be discussed later when the aquatic environment adjacent to Ridley Island is discussed.

The frequency distribution for herring (Clupea pallasii) TABLE VII, illustrates that Areas B and A produce the largest mean captures. Sporadic captures of "Groups" of herring are shown. There appear to be large captures

TABLE VII. Catch frequency distribution of herring.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "A"					
0.0	8	22	35.171	5964.309	77.229
1.0	7	19			
2.0	1	3			
3.0	1	3			
8.0	2	6			
11.0	1	3			
17.0	1	3			
20.0	1	3			
25.0	3	8			
30.0	2	6			
35.0	1	3			
50.0	2	6			
100.0	2	6			
110.0	1	3			
150.0	1	3			
425.0	1	3			
Area "B"					
0.0	11	27	44.372	11,527.383	107.366
1.0	5	14			
2.0	2	6			
3.0	3	7			
4.0	1	2			
5.0	2	5			
6.0	1	2			
7.0	1	2			
9.0	1	2			
10.0	1	2			
20.0	4	9			
23.0	1	2			
25.0	1	2			
45.0	1	2			
50.0	1	2			

TABLE VII. cont'd. Catch frequency distribution of herring.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "B" Cont.					
56.0	1	2			
90.0	1	2			
120.0	1	2			
128.0	1	2			
225.0	1	2			
450.C	1	2			
500.0	1	2			
Area "C"					
0.0	51	40	9.584	608.115	24.660
1.0	15	11			
2.0	6	5			
3.0	9	6			
4.0	5	4			
5.0	4	3			
6.0	6	5			
7.0	2	2			
8.0	3	2			
10.0	2	2			
11.0	1	1			
12.0	1	1			
15.0	2	2			
19.0	1	1			
20.0	1	1			
25.0	5	4			
30.0	3	2			
49.0	1	1			
55.0	1	1			
60.0	1	1			
63.0	1	1			
81.0	1	1			
95.0	1	1			
100.0	1	1			
200.0	1	1			

TABLE VII. cont'd. Catch frequency distribution of herring.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "D"					
0.0	52	95	0.309	2.069	1.439
2.0	1	2			
7.0	1	2			
8.0	1	2			
Area "E"					
0.0	45	80	1.179	50.004	7.071
1.0	7	13			
2.0	3	5			
53.0	1	2			
Area "F"					
0.0	25	88	0.357	1.868	1.367
1.0	1	4			
2.0	1	4			
7.0	1	4			

relative to salmon captures but they are not significantly large herring captures.

The abundance of herring spawn in the general study area is much lower than historical levels. The only area immediately adjacent to the study area where spawn was located in 1972, was the west side of Digby Island, (F. Dickson, personal communication). Given a varied salinity regime herring preferentially avoid low salinity regions (D. Outram, personal communication).

Thus, the larger populations of fish at Ridley Island and the offshore area, indicate moving schools of fish seeking a spawning area, yet avoiding low salinity areas in the estuary, during their meandering.

The frequency distribution of needlefish (Ammodytes hexapterus), as shown in TABLE VIII, indicates that Flora Bank (Area C) produced the greatest mean captures of this particular species. They were not as generally abundant as herring, which is indicated by the high frequency of zero captures.

b) Benthic organisms

The small number of samples collected afford only a coarse assessment of the epifaunal and infaunal community structure of the estuarine benthos. The locations where samples were taken are shown in Figure 8. As seen in TABLE IX the largest number of organisms and greatest number of taxonomic groups were collected from Stations 1 and 3, both located on Flora Bank. Polychaetes, both motile and sedentary forms, were represented by the largest

TABLE VIII. Catch frequency distribution of needlefish.

Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "A"					
0.0	32	91	0.186	.080	0.284
1.C	3	9			
Area "B"					
None captured					
Area "C"					
0.0	99	77	5.364	533.102	23.089
1.0	6	4			
2.0	3	2			
3.0	1	1			
4.0	1	1			
5.0	2	2			
6.0	1	1			
8.0	1	1			
10.0	2	2			
15.0	1	1			
25.C	2	2			
35.0	1	1			
40.C	1	1			
45.0	1	1			
85.0	1	1			
125.0	1	1			
200.0	1	1			

TABLE VIII. cont'd. Catch frequency distribution of needlefish.

	Catch	Frequency	Percentage	Mean	Variance	Standard Deviation
Area "D"						
	0.0	54	98	0.018	0.018	0.135
	1.0000	1	2			
Area "E"						
	0.0	49	88	1.804	103.034	10.151
	1.0	3	5			
	4.0	1	2			
	6.0	1	2			
	13.0	1	2			
	75.0	1	2			
Area "F"						
	0.0	24	86	0.464	3.0000	1.732
	1.0	2	7			
	2.0	1	4			
	9.0	1	4			

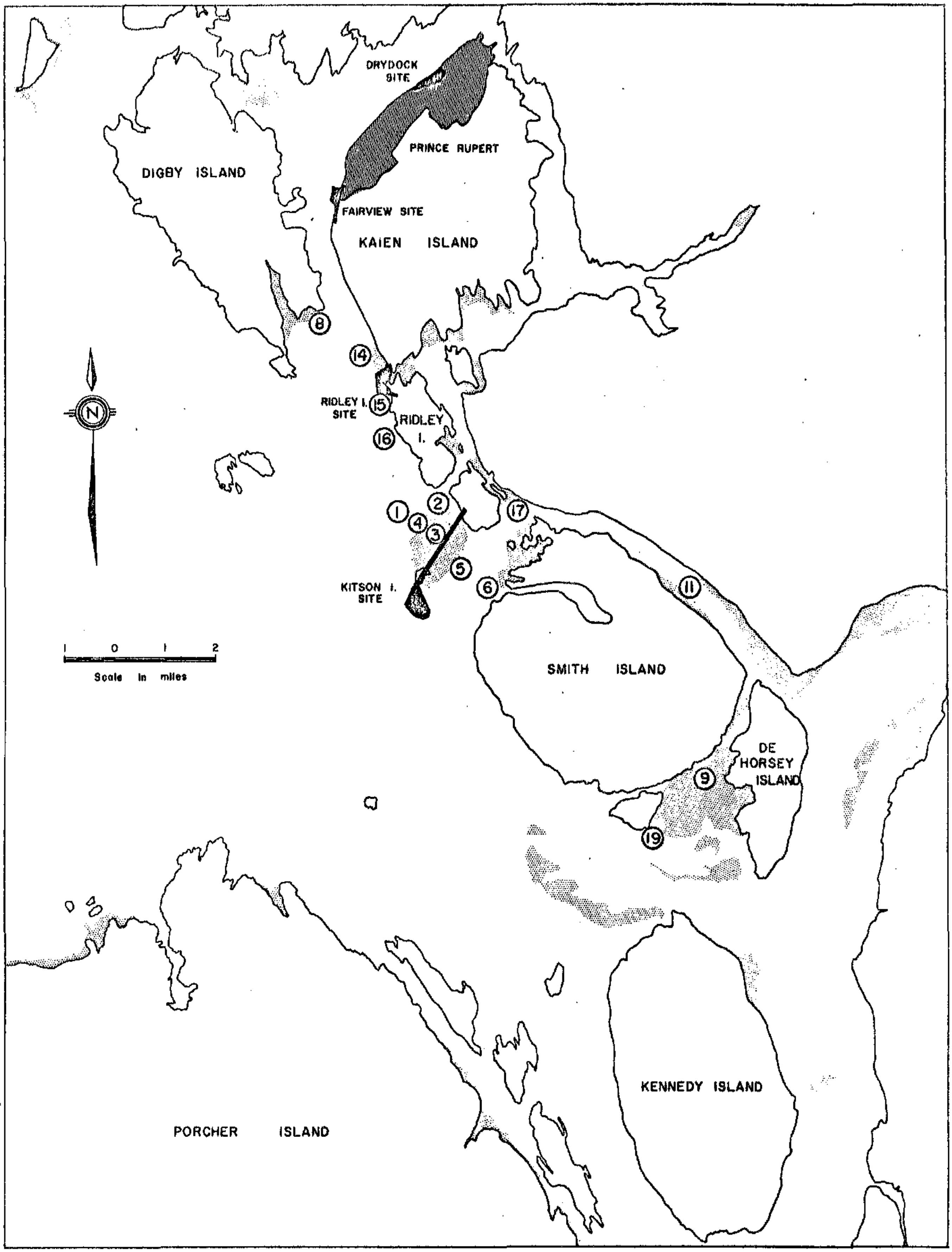

Figure 8. Dredge sampling sites in the Skeena River estuary.

TABLE IX. Distribution and abundance of benthic invertebrates.

STATION	1	2	3	4	5	6	8	9	11	14	15	16	17
Pelecypoda													
Veneridae	23	2	10	5	2	5	4			3	2	15	
Ungulinidae	2	2	1							1		1	1
Cardiidae	1		1	2	1		2			3		1	1
Tellinidae		2	1							2		2	
Nuculanidae	1		2				3		2			4	
Gastropoda													
Acmaeidae				1									
Amphipoda													
Vedicerotidae		1									1		
Corophidae	2	1		1	3								
Isaeidae	24	1	5	1			1					1	1
Isopoda													
Idoteidae	2		1		3								
Cumacea	1		3									1	
Cirripedia													
Holothuroidea												1	
Ophiuroidae		1	1	1	1		1						
Nemertea	1	1	1				1						
Oligochaeta	1	2	1	1					1	2			

TABLE IX cont'd. Distribution and abundance of benthic invertebrates.

STATION	1	2	3	4	5	6	8	9	11	14	15	16	17
Polychaeta													
Errantia													
Polynoidae													
Glyceridae	1	1	4							1			
Phyllodocidae											1	1	
Nephthydidae		2	4	1	2						1	1	
Nereidae										1			
Syllidae										2			
Eunicidae	7	1	15							1		1	
Polychaeta													
Sedentaria													
Spionidae	1	1	3		3			35		3			
Cirratulidae		1	1	5						2			
Maldanidae	6		9		7		2			7		4	
Scalibregmidae													
Sternaspidae						8	1			5			
Ampharetidae			3		1					1			
Terebellidae	1									5			
Ophelidae	1	1	1	1						1			
Ariciidae	1	2	1										
Capitellidae			1										
Sabellariidae							1						
Sabellidae	1	1											
Serpulidae							10						
Pectinariidae													
Number of Organisms	76	23	70	21	24	13	27	35	3	41	4	33	3
Number of Tax Groups	17	17	23	11	10	2	11	1	2	17	3	12	3

number of taxa. They were most abundant at Stations 1 and 3 (Area C) and Station 14(Area A). Pelecypods were present in greatest numbers at Stations 1 and 3 and at Station 16 (middle of Ridley Island shoreline). Echinoderms, although low in number in Area C, were represented nowhere else.

Amphipods and isopods were found only in Area C. The presence of these species on Flora Bank may be related to the flourishing eelgrass beds on the bank. Goodman and Vroom (1972) and Gerke and Kaczynski (1972) have reported amphipods as an important dietary component in the early sea life of salmon.

c) Planktonic organisms

Plankton samples were gathered by vertical tows at the sites shown in Figure 9. The species composition, vertical distribution and abundance of the zooplankton collected by the tows is illustrated in TABLE X. No apparent difference between stations, in terms of species composition or abundance, exists. Generally, copepods, specifically calanoid copepods, are extant in the largest numbers. They also display the greatest species diversity. The juvenile calanoid stages (nauplius and copepodite) are the most abundant components of the planktonic community.

Stations 26, 20 and 10, located nearest the mouth of the Skeena River, reflect the lowest number of organisms and the smallest species diversity. This is attributed to the strong flushing influence of the river and a lower salinity regime at these particular stations.

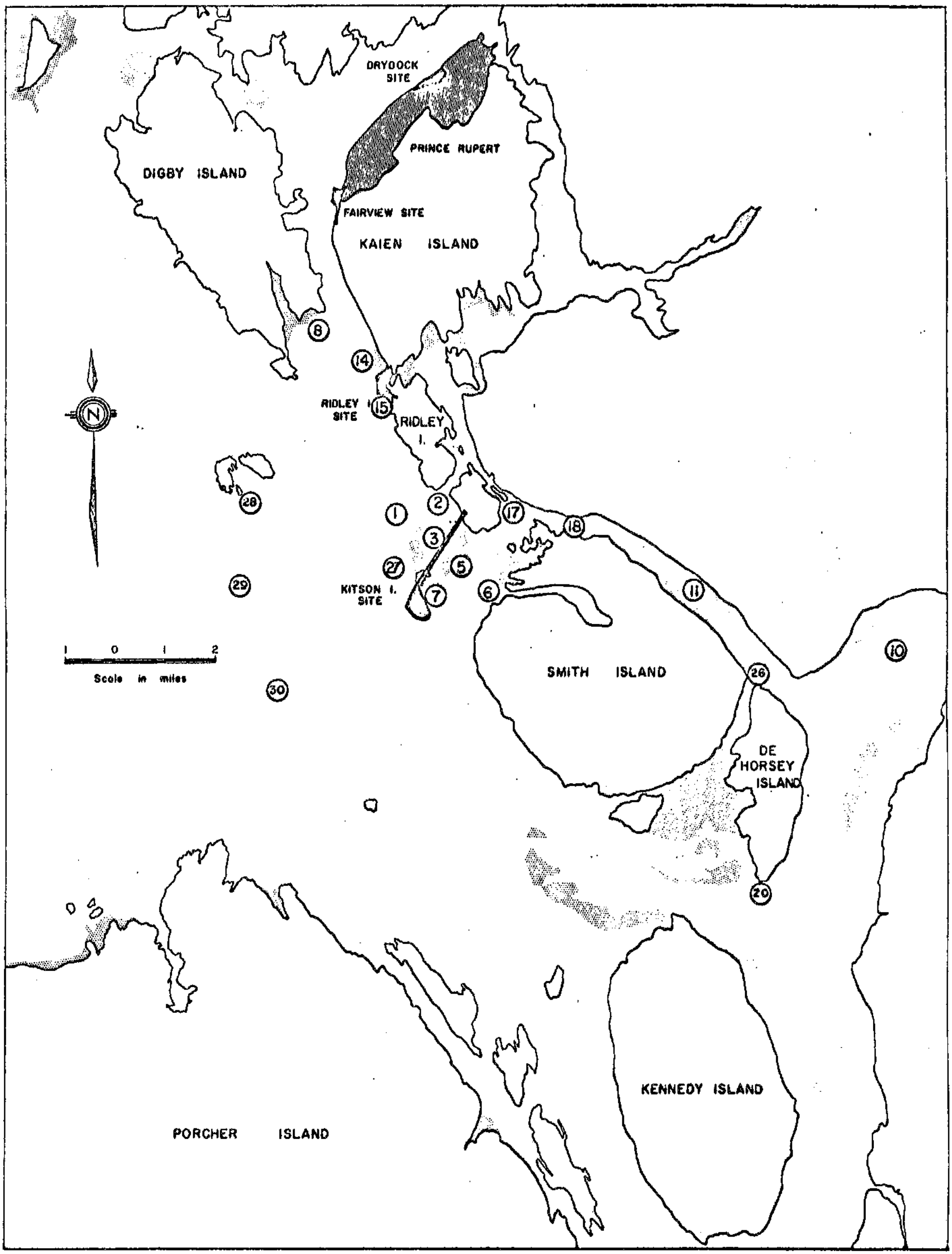

Figure 9. Plankton sampling sites (vertical tows) in the Skeena River estuary.

TABLE X. Species composition of vertical plankton hauls (No. captured/cubic metre x 10^6).

Station	Depth (metres)	Calanoid nauplii	Calanoid copepodites	Acartia longeremis	Pseudocalanus minutus	Centropage abdominalis	Tortanus discaudatus	Calanus sp.	Eurytemora pacifica	Oithona sp.	Harpacticoid copepods	Podon sp.	Evadne sp.	Noctiluca sp.	Oikopleura sp.	Cirripedia nauplii	Cirripedia cypris	Euphausid nauplii	Pulmonata	Pelecypoda	Hydrozoa	Chaetognath	Polychaete	Fish Larvae
8	2	3.8	4.6	1.1	0.8					1.1		0.6		0.4	1.5	1.3		0.2	0.2	0.4	0.2			0.2
	5	5.7	5.3	1.5	0.7	0.1		0.3		2.0		0.8		0.1	2.2	0.7	0.4				0.3			
	10	1.7	2.8	0.7	0.3	0.3				1.3		0.9	0.1		1.4	0.4								
14	2	8.1	8.1	2.5	0.6					1.9		2.7		0.8	2.1	1.5			0.2	0.4				0.4
	5	4.5	4.6	0.8	0.2					1.0		1.5	0.1		1.0	0.6								
	15	0.7	2.2	0.4	2.0		0.3	0.3		0.3		0.2			0.5				0.2	0.1				
15	2	8.7	1.2	1.9						1.1		17.8	0.4		1.1	1.3	1.9							
	5	10.3	7.7	1.9	0.1				0.1	1.3		9.0	0.2		0.8	0.2	0.2		0.1					
	10	6.5	4.8	1.9	0.1					0.5		3.6	0.1		0.5	0.2								
28	2	0.4	2.4	0.7						0.8		0.6		0.2		0.3			0.2			0.2		
	5	0.6	4.4	1.2						0.6		0.6	0.2			0.3	0.2							
29	2	278.2	20.6	3.8	0.2					1.7		3.6	0.4		0.4	3.2	0.4			0.2				
	5	32.9	13.7	3.3	0.3					0.8		0.5	0.2	0.1	2.2				0.1	0.1				
	10	13.1	10.8	1.0	2.5					1.4		0.3			1.3	0.1								
30	2	34.8	36.1	25.3	0.2					5.1		2.5			3.6		0.2					0.6		
	5	8.8	17.0	5.4	0.3	0.1		0.1		2.1		0.3			2.0				0.1	0.1				
	10	1.5	15.7	2.2	3.1			0.2		1.8					2.5				0.1			0.1		
1	2	0.8	14.2	4.3						1.3		3.6		0.2		0.2			0.6		0.2			
	5	0.4	11.2	0.7	1.2	0.2				2.2		1.2			0.7	0.3								
	10	0.5	6.8	1.2	0.7					1.5		0.7			0.2	0.2								

TABLE X cont'd. Species composition of vertical plankton hauls. (No. captured/cubic metre x 10^6).

Station	Depth (metres)	Calanoid nauplii	Calanoid copepodites	Acartia longeremis	Pseudocalanus minutus	Centropage abdominalis	Tortanus discaudatus	Calanus sp.	Eurytemora pacifica	Oithona sp.	Harpacticoid copepods	Podon sp.	Evadne sp.	Noctiluca sp.	Oikopleura sp.	Cirripedia nauplii	Cirripedia cypris	Euphausid nauplii	Pulmonata	Pelecypoda	Hydrozoa	Chaetognath	Polychaete	Fish Larvae
3	2	0.4	3.9	1.6						0.8		0.1		0.1	0.1			0.4						
	5	0.5	3.9	4.4	0.4					2.3						0.3			0.1			0.1		
5	2		1.0							0.6														
	5	1.5	4.6	2.2	0.3	0.2				3.0		0.1				0.5			0.2	0.2				
	8		3.8	1.3	0.5	0.1				0.4						0.1		0.1						
6	2	0.6	5.3	1.7	0.6					4.0				0.4						0.4		0.2		
	5	0.1	4.4	3.1	1.5	0.3		0.5		2.4		0.3		0.2	0.5	0.3	0.1		0.1			0.2		
	10	0.3	5.0	1.0	2.3	0.2		0.2		1.8					0.5					0.1				
	15	0.2	5.2	0.5	4.6		0.1	0.6		0.8					0.3									
7	2	0.4	6.6	2.1						0.2		0.6				0.2								
27	2		2.7	1.5						0.6		0.4												
	5	1.7	3.6	1.0	0.3			0.1		1.1	0.1	0.2		0.1	0.2		0.3				0.1	0.3		0.3
	10		0.9	0.7	0.3						1.0	0.1				0.1				0.8		0.1	0.5	
17	2	0.4	7.0	1.3	0.6							0.6			1.5	0.4	0.2							
	5	0.5	2.5	0.9	0.3	0.3		0.2		1.0		0.3		0.2	0.3	0.3	0.1		0.1					
	10	0.2	4.4	0.4	2.4		0.3	0.2		1.1		0.1												
	15		3.6	0.5	2.0					1.0		0.1												

TABLE X cont'd. Species composition of vertical plankton hauls (No. captured/cubic metre x 10^6).

Station	Depth (metres)	Calanoid nauplii	Calanoid copepodites	Acartia longeremis	Pseudocalanus minutus	Centropage abdominalis	Tortanus discaudatus	Calanus sp.	Eurytemora pacifica	Oithona sp.	Harpacticoid copepods	Podon sp.	Evadne sp.	Noctiluca sp.	Oikopleura sp.	Cirripedia nauplii	Cirripedia cypris	Euphausid nauplii	Pulmonata	Pelecypoda	Hydrozoa	Chaetognath	Polychaete	Fish Larvae
18	2		3.2	0.6	0.4					1.3		0.6		0.2	0.2									
	5	0.4	4.1	1.9	0.5			0.3		1.8		0.3		0.3	0.1	0.3								
	10	0.2	3.9	0.8	1.1		0.1	0.2		1.3		0.1			0.4									
	15		3.6	0.6	1.5		0.1	0.1		1.0					0.1									
11	2		24.8	5.9	2.54	0.4		0.2		1.1		0.2		0.2		0.8								
	5	0.3	9.8	1.9	3.1	0.1	0.1	0.5		1.0				0.1	0.2	0.3	0.2		0.1		0.1			
	10	0.1	6.5	0.9	4.3		0.1	0.3		1.1											0.1			
	15		4.2	0.7	2.5		0.1	0.4		0.4														
26	2	1.1			0.4				0.8															
	5	0.3			0.2				1.3		0.3													
	10								0.4															
	15								0.7															
20	2		6.4	0.2	8.1					1.1					0.2									
10	2		6.2						28.5		0.8													
	5		0.9						19	0.1	0.4													
2	2		2.0	0.4	1.0					0.1		0.4												
	5		1.7	0.5	1.6					0.1					0.1									
	10	0.2	4.6	1.2	7.0		0.1	0.3		0.7		0.1				0.1						0.1		
	15		2.7	0.2	6.1		0.2	1.1		0.3					0.2	0.1								

d) Eelgrass distribution and abundance

The two aerial photographic surveys made of the major bank areas in the estuary illustrated that Flora Bank supports the largest eelgrass bed in the estuary. This is in agreement with the 1971 Fisheries Service study of the area. Infrequent measurements were taken of plant length in a quadrat situated on Flora Bank, during the months from May to August and plant growth, in one instance, from 17 cm. to a length of 31 cm. was recorded during this period. Burkholder and Doheny (1968) have reported a vegetative phase for eelgrass during the winter, with growth occurring during the summer as water temperatures increase.

The study area is located within the "extended range" for eelgrass distribution (Burkholder and Doheny, 1968) and as a result the biomass in this region will be less than in regions located within the area of principal abundance which would include the Fraser River estuary. Although the eelgrass population in the study area is not as significant as in southern areas, it is still beneficial to the food chain. Decaying plants form a detritus base for consumption by benthic and planktonic invertebrates. It acts a sediment stabilizer preventing drifting of sediments and it often provides a suitable environment for browsing invertebrates by virtue of its associated epiphytes.

e) Salinity and temperature

The large tidal fluctuations in the Prince Rupert area and the high discharge of the Skeena River result in a dynamic salinity regime within the estuary. The surface salinity values in TABLE XI represent relative differences between areas under a single set of physical conditions. Areas D, E and F yielded the lowest mean salinity values and D, E and C had the greatest of salinities.

When salinity values were averaged for 0, 2, 5 and 10 meter depths by area, the range of salinities naturally increased (TABLE XII). Area D still produces the lowest salinity value and the greatest range. Areas C and E are identical in salinity value and range.

Massman (1963) has described the "critical zone" of an estuary as occurring below salinity values of 18‰, rich in adults, but especially in young of many species and with abundant plankton populations. Low salinity areas with a wide range of salinity values will allow juvenile salmonids a chance for physiological adaptation by active and passive movements to and from differing regions of salinity concentration.

The temperature regimes differed very little by areas but varied greatly with depth. There was no definite thermocline within the estuarine confines, due to the mixing of tide and river waters. At a depth of 25 metres there is a sharp temperature change indicative of a thermocline, but this was not true in all areas. Average surface temperatures, rose from 6.7°C. in the first week of May to 12.5°C. in the second week of August.

TABLE XI. Surface salinities by area.

AREA	SALINITY ($^o/oo$)	RANGE($^o/oo$)
A	21.0	0.8
B	23.3	4.4
C	21.0	5.0
D	7.9	6.4
E	18.0	6.2
F	19.1	4.3

TABLE XII. Depth average salinities for 0,2,5,10 metre depths.

AREA	AVER. SALINITY ($^o/oo$)	RANGE ($^o/oo$)
A	25.0	8.9
B	26.4	7.4
C	22.4	8.6
D	17.5	10.6
E	22.5	8.9
F	20.2	9.3

f) Dietary components

At this writing, the stomach content analysis of the 1,133 fish retained for examination, has not been completed. Preliminary results indicate that sockeye, coho, and chinook are utilizing amphipods and insect remains as a food source. Copepods are also major components in the gut contents of chinook and sockeye. Amphipods were not utilized by herring and needlefish as a food source. The major source of food for these species are P. minutus and Cirripedia cypris.

g) Aquatic environment in the Ridley Island Region

Unlike all the other areas of sampling, the aquatic environment in waters surrounding Ridley Island is subject to the severe pollutional effects of effluents being discharged from the pulpmill complex on Watson Island. Untreated sulfite and kraft pulping and bleaching effluents have been discharged to the Wainwright Basin-Porpoise Harbour system on the east side of Ridley Island for many years. In the past several years, frequent large fish kills have occurred as a direct result of these discharges and the associated de-oxygenation of the receiving waters. In order to improve the water quality in Porpoise Harbour and Wainwright Basin, a pipeline was constructed from the sulfite mill across Porpoise Harbour and Ridley Island to carry the very high oxygen demanding sulfite red liquor to Chatham Sound for disposal. As a consequence of this action, conditions within Porpoise Harbour and Wainwright Basin improved slightly so that a lethal environment no longer exists as long as pipeline ruptures or pump failures do not occur. This does not imply that a viable, fish producing environment has ensured but, rather, that fish may now migrate through the area successfully. At the same time, a very localized zone of severe pollution has been created in Chatham Sound immediately adjacent to the northern end of Ridley Island. Because the outfall discharges into an eddy area, the bulk of the effluent is dispersed into Chatham Sound instead of being swept by tidal currents into Prince Rupert Harbour. In short, the red liquor outfall location is of strategic importance. The company has now embarked on a very long term effluent treatment program which will reduce the red liquor oxygen demand by approximately 75 percent and initially they requested that the red liquor outfall be relocated in Porpoise Harbour. The Fisheries Service has objected to the outfall relocation on the grounds that conditions in Porpoise Harbour could once again become lethal to fish despite effluent treatment, and, that effluents so released could potentially have a detrimental effect on Flora Bank as a juvenile salmon habitat.

The realization that the aquatic environment adjacent to Ridley Island is already severely disrupted and affords only marginal opportunity for improvement is a factor which cannot be ignored when consideration is being given to siting industrial complexes which will result in disruption of the aquatic environment.

IV CONCLUSIONS

It can be concluded that, when the factors of fish distribution, food availability, presence of aquatic vegetation and highly variable salinities are considered in combination, the shallow estuarine areas between Porpoise Channel and the mouth of the Skeena River are of high biological significance as a fish (especially juvenile salmon) rearing habitat. Inverness Passage, Flora Bank and De Horsey Bank, in that order, are habitats of critical importance for the rearing of juvenile salmon. The construction of a superport at the Kitson Island - Flora Bank site would destroy much of this critical salmon habitat.

The Ridley Island area does not have any significant biological life or importance to the Fisheries resource because it lies within a zone of industrial pollution which in the long term can only be moderately improved through the application of currently available waste treatment technology. Thus, from a Fisheries resource maintenance stand point, the selection of the Ridley Island site for development as a superport would bring about the least increment of environmental degradation. It would also tend to ensure that the zone of industrially oriented environmental degradation is concentrated in one relatively small area within the Prince Rupert district.

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APPENDIX A

A LIST OF FISH SPECIES
CAPTURED IN ESTUARY
BY
PURSE SEINES

TABLE A-I List of fish species captured in purse seine.

1.	Pacific lamprey	- Entosphenus tridentatus
2.	Eulachon	- Thaleicthys pacificus
3.	Capelin	- Mallotus villosus
4.	Sand sole	- Psettichthys melanostictus
5.	Lemon sole	- Parophrys vetulus
6.	Butter sole	- Isopsetta isolepis
7.	Starry flounder	- Platichthys stellatus
8.	Sandfish	- Trichodon trichodon
9.	Spinynose sculpin	- Radulinus taylori
10.	Padded sculpin	- Artedius fenestralis
11.	Buffalo sculpin	- Enophrys bison
12.	Staghorn sculpin	- Leptocottus armatus
13.	Grunt sculpin	- Rhamphocottus richardsoni
14.	Deep pitted poacher	- Bothragomus swanii
15.	Sturgeon poacher	- Agonus acipenserinus
16.	Spiny lumpsucker	- Eumicrotremus orbis
17.	Tadpole snailfish	- Nectoliparis pelagicus
18.	Threespin stickleback	- Gasterosteus aculeatus
19.	Whitebarred prickleback	- Poroclinus rothrocki
20.	Red brotula	- Brosmophycis marginata
21.	Flathead clingfish	- Gobiesox masandricus