A REVIEW OF SALMON ENHANCEMENT OPPORTUNITIES IN THE NISGA'A LAND CLAIM AREA

By

R.N. Palmer

Prepared for the
Department of Fisheries and Oceans

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1.0 INTRODUCTION

The purpose of this report is to provide a review of information in preparation for enhancement activities to be initiated within the Nass River drainage and adjacent coastal streams, with the direct involvment of the Nisga'a Tribal Council. The report includes information necessary to develop a reconnaissance plan which will lead to project concepts, initial design and subsequent development. The information review includes: a description of the Nisga'a Land Claim Area; an outline of salmon distribution and abundance; available information on timing of salmon migration and spawning; an overview of fisheries harvesting claim area salmon stocks; a summary of salmon studies and enhancement projects in the claim area; an overview of enhancement opportunities; and a list of opportunities developed from previous reconnaissance. The report also includes some recommendations for future reconnaissance and feasibility studies.

To prepare this report the author first consulted with Department of Fisheries and Oceans (DFO) personnel in Vancouver and Prince Rupert to identify information sources and then reviewed relevant information available in published literature and DFO files. Some historical background information was taken from other publications and archival sources. A list of references is included. Some information and conclusions result from the authors own observations within the Nass River watershed.

It may be useful to define the terms stock, run and escapement as used in describing salmon populations in this report. The term stock refers to a group of fish of a species which reproduces at a particular time of year in a particular area such as a tributary stream, with little or no interbreeding with other groups. For example, the populations of each of the five species of salmon indigenous to the Nass River consist of numerous stocks which spawn at different times and/or in different areas of the watershed. The term run, used in reference to salmon, is more general and refers to one or more stocks or species migrating through an area or to a particular timing segment of a population. The term escapement as used in this report, refers to that segment of a stock or group of stocks which remains after exploitation in the various fisheries. Escapement records for individual areas identify the numbers of fish available for reproduction.

2.0 DESCRIPTION OF THE AREA

The Nisga'a Land Claim Area encompasses approximately 2,375,000 ha. including the Nass River watershed and the adjacent coastal areas of Observatory Inlet, Portland Canal, Pearce Canal and much of Portland Inlet (Figures 1,2 & 3). Originating in the Skeena Mountains, the Nass River flows generally south and southwest and cuts through the Coast Mountains, entering the sea at Portland Canal near the southern boundary of Southeast Alaska.

Tributaries drain the Coast Mountains from the west and the Skeena and Hazleton Mountains from the east.

The Nisga'a people currently live mainly in four communities on the lower 60 miles of the Nass River: Kincolith, Greenville, Canyon City and Aiyansh. The Nisga'a have strong ties to the fish resources of the Nass River area, traditionally harvesting the stocks of salmon, eulachons and other freshwater and marine species. The Nass River is well known for the annual eulachon run which has long supported a major fishery and eulachon oil trade. When the commercial salmon fishery began on the lower Nass in 1878 the industry was dependent on the Nisga'a for supplies of fish (Report of Inspector of Fisheries, 1878).

Although the resources of the area have been of interest to non-Indians since the early fur trade era there was little impact on the salmon habitat of the claim area until relatively recently. The earliest non-Indian visitors were interested mainly in furs and used salmon only as a local food supply. They did not venture far inland. Visits from fur trading ships began in the 1780's and from 1831-34 the Hudson's Bay Company operated Fort Simpson which was located near present day Kincolith. This fort was later moved to the site of present day Port Simpson near the entrance to Portland Inlet (Akrigg and Akrigg, 1975).

Missionary activity began in the 1860's when the Nisga'a invited William Duncan of the Church Missionary Society to visit the Nass Valley. A mission was established at Kincolith in 1867 and missionary efforts were extended to other areas of the Nass Valley during the 1880's (Patterson, 1982). Access to the Nass Valley during that period was by canoe or shallow draft launch to the upper limit of navigation about 60-70 miles up the river.

The commercial salmon industry developed around the estuary beginning in 1878. The abundant sockeye salmon runs resulted in early development of this fishery and by 1918 six canneries were in operation (Todd and Dickson, 1970). In later years, the number of canneries declined and by the mid-1940's all the Nass catch was transported to centralized canneries for processing. There was also a commercial eulachon oil factory near the Nass estuary for a few years beginning in 1878 (Report of Inspector of Fisheries, 1879).

Bonney (1913), in his report of a forestry reconnaissance of the Nass River in 1913, summarized the status of white settlement and development in the Nass River watershed. He reported that while occasional white trappers, prospectors and land stakers visited the country there had been no permanent settlers prior to 1912. Settlement of the Nass Valley generally began after the construction of the railway along the Skeena River to Prince Rupert. Pre-emption Reserves were established along the

Kitsumkalum River and on the Nass River from Aiyansh to the Cranberry River and Bonney reported that 60 pre-emptors had taken up land in the Nass Valley during 1913. By the 1950's, all but one homestead site had been abandoned.

The upper Nass River watershed and routes to the railway along the Skeena were accessible by trails. Initially, trails were established by Indians to reach fishing and hunting areas and facilitate trade. Perhaps the most famous of these trails on the Nass were the "grease trails" from Kispiox and Kitwanga on the Skeena River to the Nass via the Cranberry River. The grease trails served as Indian trade routes and were so named because of the boxes of eulachon oil packed out by the Indians of the upper Skeena. Other trails extended along the Kitsumkalum and Tseax valleys and up the Nass River to Meziadin River.

In 1875, J.A. Gardiner was assigned by the Provincial government to search for a route to drive cattle and move supplies through the upper Nass River to the Cassiar mining areas. The journal of this survey provides what may be the earliest written record of observations on the upper Nass watershed (Gardiner,1875). Although his attempt to find a suitable route to the Cassiar country was unsuccessful, Gardiner traversed much of the upper Nass using Indian trails in many cases. He visited the falls on the Meziadin River in August, when the salmon were running and described this Indian fishing site as one of the finest salmon fisheries seen in British Columbia.

The Yukon Telegraph line was constructed through the upper Nass River by the Dominion government in 1901 (Richeson, 1982). The line from Hazelton followed the Damdochax River, crossed the Nass River, went overland to the upper Bell-Irving River and then north to Telegraph Creek on the Stikine River. A trail and cabins maintained along the line provided a communication route through the area. The line was closed down in 1936 and the trail soon deteriorated.

The Dominion government also built a telegraph line from the Skeena River along the Kitsumkalum and Tseax Rivers to Aiyansh and on to Stewart. By the early 1900's, a good trail was also available from Stewart to Meziadin Lake. The main trails were improved and maintained by the Provincial government during the early 1900's but deteriorated during the depression years of the 1930's and by the 1950's most had virtually disappeared.

While proposals for railways and roads (Bonney, 1913) and even an airport at Meziadin Lake (The Northern Argonaut, Stewart, B.C. April 7, 1938) were developed from time to time, the upper portions of the Nass River above Aiyansh remained almost a complete wilderness until road construction began in the 1950's. Initial forest surveys were carried out in 1913 and the watershed was periodically examined for hydro-electric development, eg. 1913 (Bonney, 1913), 1927 (Kewstubb, 1929), 1955 (Anon., 1958a). Other than some minor placer activity on the Nass tributaries there has been virtually no mineral extraction in the watershed. The first logging road reached Lava Lake on the Tseax River in 1956 and the road was soon extended to Aiyansh and beyond. The Stewart-Cassiar highway and connecting roads from Kitwanga and Terrace were constructed during the 1960's opening up much of the upper Nass River area. Since that time, there has been considerable logging activity and an increase in recreational fishing and tourist travel.

Mineral discoveries at the head of Portland Canal in the early 1900's led to establishment of the town of Stewart which has survived the ups and downs of the mining industry since that time. Mines were also operated periodically in the Kitsault River area in Alice Arm during the 1930's, 40's and 50's and again in the early 1980's. Anyox, a mining community on Observatory Inlet has been abandoned. These developments may have had some localized impact on salmon stocks.

3.0 SALMON DISTRIBUTION AND ABUNDANCE

The Nisga'a Land Claim Area provides extensive freshwater and inshore marine habitat for all species of Pacific salmon and steelhead (<u>Oncorhynchus spp</u>.) indigenous to British Columbia. As illustrated in Figures 2 and 3, salmon are widely distributed throughout the Nass River watershed and in coastal streams of the claim area.

Government fisheries personnel have inspected some of the spawning grounds of the claim area since the early 1900's. The early inspection reports provide only subjective assessments of relative abundance. Spawning populations were defined in terms of "light", "medium" and "heavy", or general comparisons were made with observations in previous seasons.

Beginning in the mid-1930's, fishery officers began, in some cases, to provide numerical estimates of fish usually within a range such as 1,000 to 2,000 or 10,000 to 20,000. These estimates are generally based on visual observations made by fishery officers and guardians who carry out surveys on foot, by boat and by fixed wing aircraft and helicopters. The level of accuracy is highly variable and dependent on many factors such as frequency and timing of surveys, variability of observation conditions between streams and years, observation methods, and changes in access to streams over time. Argue (1984) reviewed many of the problems with spawning estimates and provided information which demonstrated the tendency of visual surveys to significantly underestimate spawners.

Since 1957, population estimates of the major sockeye salmon stocks and some stocks of other species in the Nass River have been improved through use of fence and fishway counts, tag and recapture assessments, and analysis of stock characteristics (Anon, 1957, 1958a, 1958b, 1959a, 1959b, Todd and Dickson, 1970). Efforts have also been made to apply more consistent observation methods for visual observation and to record actual estimates rather than a range.

The absence of numerical information for early years and the variability in methods and survey effort precludes any review of long term trends for many stocks. In particular, improvements of access within the claim area have resulted in more regular and better surveys of spawning grounds.

These changes are most evident in the Nass River watershed where road construction since the 1950's has greatly improved access to the spawning areas. Argue (1984) has examined this factor for the Nass River pointing out, for example, that chinook salmon were reported for only four systems prior to 1950, whereas after 1970 spawning populations were reported for 15 streams. Currently, chinook salmon are recorded in 23 Nass River streams (Jantz et.al., 1989). Argue (1984) concluded that with the exception of sockeye the index value of escapement data for the Nass River system prior to 1970 is poor. Department of Fisheries and Oceans biologists consider even recent escapement records for Nass River chinook and coho to be poor (Kadowaki et.al., 1984).

In general, spawning escapement records for salmon stocks within the claim area have been relatively good for sockeye since 1966; fairly reliable for pinks, chums and chinook in recent years and poor for coho. The wide distribution and extended spawning season of coho salmon precludes any accurate visual estimation of spawning abundance and it is likely that escapements are seriously underestimated.

A "Key Stream" program has recently been developed for North Coast fisheries (Jantz et al, 1989). Key streams are described as generally the major salmon (primarily sockeye, pink and chum) producers most important for in-season management of the North Coast net fisheries. These streams have usually been used as indicators of in-season management and post-season indicators of management success since the 1950's. Key streams are usually major producers in the area and as a result have received better coverage over the years. Key streams in the claim area are listed in Table 1.

TABLE 1

Key Streams Located in the Nisga'a Land Claim Area

Stream	Location	Species Managed
Meziadin River	Nass River	Sockeye and Chinook
Gingit Creek	Nass River	Sockeye
Kwinageese River	Nass River	Sockeye
Cranberry River	Nass River	Coho and Chinook
Ishkeenickh River	Nass River	Coho, Pink and Chinook
Tseax River	Nass River	Chum
Iknouk River	Nass River	Pink
Bear River	Portland Canal	Coho and Chum
Dogfish Bay Creek	Portland Canal	Pink
Alliance River	Observatory Inlet	Coho
Kshwan River	Observatory Inlet	Chum
Stagoo Creek	Observatory Inlet	Chum
Kwinamass River	Portland Inlet	Pink and Chum

(Source: Jantz et al, 1989)

Despite the many problems associated with enumeration of salmon spawning populations, the available data provide an essential basis for evaluation of the relative importance of claim area salmon to the fisheries of British Columbia. Recent escapements and DFO escapement targets are summarized in Table 2. Target escapements are defined in Appendix 1 (from Jantz et.al., 1989). Additional information is provided for some streams in later sections of this report outlining enhancement opportunities. Spawning distribution by species is summarized below.

3.1 Sockeye Salmon

The sockeye salmon return to the Nass River is dominated by the Meziadin run which in recent years has constituted about 80 percent of the escapement. Other sockeye producing areas in the Nass watershed include Bowser Lake, Damdochax River, Kwinageese River and Gingit Creek. A few hundred spawners are distributed in nine other Nass River tributaries. The Bear River at the head of the Portland Canal also supports a minor sockeye run.

3.2 Chinook Salmon

Chinook salmon are widely distributed in the Nass River system. Major spawning areas include the Cranberry River, Damdochax River, Ishkeenickh River, Kwinageese River, Meziadin River, Tseax River and the Nass mainstem. Smaller populations are found in at least 16 other Nass tributaries. Chinook salmon are also found in four claim area streams outside of the Nass River.

3.3 Coho Salmon

Coho salmon are found in most accessible Nass River tributaries and in many coastal streams in the claim area. Currently, coho salmon escapement targets are recorded for 36 Nass River tributaries and 17 coastal streams and Coho are probably present in several other streams. Major Nass River spawning areas include the Cranberry River, Damdochax River, Iknouk River, Ishkeenickh River, Kincolith River, Kiteen River, Kwinageese River, Meziadin River and the Tseax River. Outside the Nass River, substantial escapements are found in the Bear River, Kitsault River and the Kwinamass River.

3.4 Pink Salmon

The major pink salmon stocks in the claim area spawn in two Nass River tributaries, the Iknouk River and Ishkeenickh River, and in the Kwinamass River which drains into Portland Inlet. These rivers support both even and odd year stocks but the Iknouk and Ishkeenickh are dominant in the odd years and the Kwinamass is greater in the even years. Minor populations of pink salmon spawn in 26 other Nass tributaries as well as in the Nass River mainstem. Although a few pinks migrate as far upstream as the Meziadin River, most spawning areas are in the lower river below Aiyansh. Minor pink salmon stocks also spawn in Portland Canal (6 streams), Observatory Inlet (9 streams) and Portland Inlet (2 streams).

3.5 Chum Salmon

The most abundant chum salmon stocks in the claim area spawn in streams tributary to Observatory inlet. Major streams include the Illiance River, Kitsault River, Kshwan River and Stagoo Creek. Although chum salmon escapements are recorded for the Nass River mainstem and 21 lower Nass tributaries, all are relatively minor with the current total escapement averaging about 4,000 fish. Five minor and severely depressed stocks spawn in Portland Canal and a few chums spawn in two Portland Inlet tributaries, the Kwinamass river and Lizard Creek.

3.6 Steelhead

Although no estimates of abundance are available, steelhead have been reported in 12 Nass River tributaries and in the Kwinamass River.

TABLE 2

Target and 1980-89 average escapements of salmon to streams in the Nisga'a Land Claim Area

STREAM	Sockeye		Chinook		Coho		Pink			Chum		Steelhead
	Target	Average	Target	Average	Target	Average	Target	Av Even	Av Odd	Target	Average	
Nass River Sub-Area												
Anliyen Creek					500	414						
Ansedagan Creek					600	210	2,000	274	308	500	4	
Bowser R. & Lake	30,000	26,190			UNK	N/R						Present
Brown Bear Creek	500	245	25	3	300	150	500	500	N/R			Present
Burton Creek							3,500	188	7,940	250	N/R	
Chambers Creek			500	N/R	500	150	10,000	12,100	13,500	500	20	Present
Cranberry River	250	75	7,500	2,700	6,000	2,213	2,000	283	650			Present
Damdochax R. & Lake	20,000	4,300	7,500	1,550	2,500	850						Present
Diskangieg Creek					1,500	700	100	56	313			
Flewin Creek							1,000	750	1,170			
Gingit Creek	7,500	2,450			750	100	1,000	175	N/R	500	N/R	
Ginlulak Creek					1,500	855	50	N/R	N/R	50	N/R	
Gitzyon Creek	100	55	300	N/R	300	34	500	35	290	400	10	
Hodder Creek			100	15								Present
Iknouk River			1,000	263	5,000	1,892	60,000	1,920	123,000	500	534	
Ishkeenickh River	100	N/R	4,000	459	6,000	1,838	30,000	18,700	74,000	2,000	144	Present
Kincolith River			2,000	320	5,000	1,978	10,000	7,100	9,100	500	109	
Kinskuch R.			50	N/R	100	32	200	83	250			Present
Kiteen River			2,000	220	3,000	230						Present
Ksedin Creek					400	34	2,000	186	1,115	250	33	
Kwinageese R.	20,000	10,080	3,000	1,383	2,000	1,760						Present
Kwinyarh Creek					250	150	50	N/R	500	50	N/R	
Kwinylak River					250	269	2,000	500	N/R	500	N/R	
McKnight Creek					400	276						
Meziadin R. & Lake	160,000	163,271	1,500	797	5,000	2,725	100	745	610			
Nass Mainstem			1,000	560	1,000	920	5,000	7,000	10,000	10,000	2,575	
Oweegie Cr. & L.	500	100	400	228	500	469						
Quilgauw Creek					100	43				100	N/R	
Saladamis Creek			25	N/R								
Seaskinnish Creek	500	109	1,000	355	1,500	311	2,000	67	267	500	50	Present
Shumal Creek							25	23	50			
Snowbank Creek			50	50	100	367						
Tchitin River			50	22	100	63						
Teigen Creek			30	101	100	50						
Tseax River	2,500	326	2,500	935	5,000	4,889	5,000	3,440	8,900	3,000	657	Present
Tseax Slough			500	275	500	594	2,000	940	2,500	3,000	1,467	
Van Dyke Creek					100	89						
Vetter Cr. & Slough					500	22	500	258	230	2,000	355	
Wegiladap Creek					100	50	500	20	23	50	N/R	
Welda Creek							1,000	238	4,880			
Wilyayanooth Creek					50	121	500	233	290	25	105	
Zolzap Creek	1,000	N/R	25	N/R	1,000	581	200	175	200	200	126	
Zolzap Slough	100	N/R			1,000	430	250	200	283	500	83	
Sub-Area Total	243,050	206,747	35,055	8,953	53,500	19,659	141,975	48,270	250,630	25,375	4,172	

TABLE 2 (cont'd)

STREAM	Sockeye		Chinook		Coho		Pink			Chum		Steelhead	
	Target	Average	Target	Average	Target	Average	Target	Av Even	Av Odd	Target	Average		
Portland Canal Sub-Area													
Bear River	2,500	100			5,000	2,417	3,500	167	125	7,500	86		
Belle Bay Creek					100	100	2,000	3,103	4,328				
Dogfish Bay Creek					500	127	12,000	17,450	30,800	50	27		
Donahue Creek			100	N/R	100	N/R	1,000	644	3,510	1,000	202		
Georgie River			500	N/R	1,000	N/R	5,000	4,750	4,333	2,000	700		
Rainy Creek					500	356							
Roberson Creek					100	N/R	500	25	1,967	1,000	N/R		
Sub-Area Total	**2,500**	**100**			**600**	**N/R**	**7,300**	**2,020**	**24,000**	**22,452**	**40,875**	**11,550**	**264**
Observatory Inlet Sub-Area													
Cascade Creek					200	N/R	500	25	10	500	N/R		
Illiance River					1,000	550	1,000	390	2,263	5,000	1,775		
Kitsault River			600	120	2,500	1,350	1,000	410	470	7,000	3,565		
Kshwan River					1,000	652	1,000	425	217	15,000	13,200		
Olh Creek					100	50	50	N/R	20	200	48		
Perry Bay Creek							25	25	3	100	78		
Salmon Cove Creek					100	49	3,000	3,500	4,500				
Stagoo Creek					2,000	300	10,000	7,580	11,500	15,000	4,960		
Wilauks Creek					500	813	3,000	1,510	3,320	1,000	416		
Sub-Area Total			**600**	**120**	**7,400**	**2,171**	**19,575**	**13,740**	**20,837**	**43,800**	**23,894**		
Portland Inlet Sub-Area													
Kwinamass River			3,000	315	5,000	3,605	100,000	132,000	114,000	3,500	311	Present	
Lizard Creek					50	N/R	2,000	2,670	925	500	10		
Nasoga Gulf Creek							1,000	450	250				
Sub-Area Total			**3,000**	**315**	**5,050**	**3,606**	**103,000**	**135,120**	**115,175**	**4,000**	**321**		

Data Source: Unpublished records from Department of Fisheries and Oceans, Prince Rupert

4.0 TIMING OF MIGRATION AND SPAWNING

Timing information is available for migration through the commercial fishing grounds of the claim area as well as for arrival in the spawning tributaries and the spawning period. Detailed timing information for spawning areas is presented by species in Appendix 1, taken from Jantz et.al. (1989).

4.1 Sockeye Salmon

Sockeye appear in the Nass River area in mid-May and reach a peak of abundance in late June or early July. The run is usually through the lower river by late July or early August. Stocks are intermingled in the commercial fishing area and, with the exception of the Gingit Creek stock which is normally through by early July, there are no evident timing differences in the lower river. There are, however, some significant differences in the time of arrival and spawning in the tributary streams (Appendix 1). First arrival dates vary from early July to mid-September and spawning peaks occur as early as late July in lower river tributaries and as late as mid-September to mid-October in the up-river tributaries. Sockeye arrive in the Bear River at the head of Portland Canal in mid-June and spawning peaks in mid-August.

4.2 Chinook Salmon

Chinook salmon migrate through the lower river from April through July and arrive as early as mid-June in some tributaries and as late as mid-August in others. Spawning peaks during the mid-August to mid-September period in most streams but is later (early October peak) in the Tseax River and Slough.

4.3 Coho Salmon

The timing of coho migration through the lower river is poorly defined but the migration probably peaks during August and September. Most stocks first appear in the spawning streams in early September but appear about a month earlier in the Kwinamass River. Spawning peaks from mid-October to mid-November in most streams.

4.4 Pink Salmon

Claim area pink stocks arrive in Area 3 in significant numbers in mid-July, peak in early to mid-August and the run generally ends by early September. Pinks first arrive in some lower Nass streams and the Kwinamass River in early July but appear in mid-July or early August in most streams. Spawning generally peaks in the mid-August to early September period.

4.5 Chum Salmon

Most claim area chum stocks are present in Area 3 during June and July with a peak of abundance in early July. Although Observatory Inlet chums are considered early stocks, entering Area 3 in June, the Kshwan River in Observatory Inlet also has a major late run component which is in the area from early July to the end of August with a peak in early August (Charles and Henderson, 1985). Timing of entry to the spawning streams and peak spawning periods are variable. Earliest arrival in the streams varies from late July to mid-September in Nass River, Portland Canal and Portland Inlet streams and is as early as the beginning of July in some Observatory Inlet streams. Peak spawning periods vary from mid-August to mid-October.

5.0 EXPLOITATION OF CLAIM AREA SALMON STOCKS

Salmon stocks originating in the claim area are harvested in commercial fisheries in Canadian and United States tidal waters, in sport fisheries in both tidal and non-tidal waters, and in Indian fisheries within the claim area. A method of analysis known as run reconstruction has been developed for assessment of fisheries on sockeye, pink and chum salmon stocks. This method as described by Starr et.al., (1984) calculates the allocation of the catch in each fishery between stocks. The analysis which takes into account such factors as escapement levels, run timing and migration routes makes it possible to track each fish stock throughout the fisheries on a week-to-week basis. While the data for run reconstruction is by no means complete and precise, the analysis provides the best current information on exploitation of stocks.

The nature of fisheries for chinook, coho and steelhead precludes application of run reconstruction methodology to those species. A brief outline of available information is presented for fisheries impacting on chinook, coho and steelhead stocks.

5.1 Sockeye Salmon

The report on reconstruction of British Columbia sockeye salmon stocks (Starr et.al., 1984) breaks out a number of stock groups. The claim area sockeye are included in two stock groups: Meziadin sockeye and Non-Meziadin sockeye. During the period 1970-82, Meziadin sockeye comprised, on average, approximately 80 percent of both the total run and total escapement of claim area stocks. During that period, the total run of Meziadin sockeye averaged 334,000 fish and the catch averaged 171,000 for a mean exploitation rate of 51 percent. Most of the commercial catch is taken in Statistical Area 3, including the Nass River estuary and nearby migration routes. Some fish are intercepted in the Noyes Island and Cape Fox areas of Southeast Alaska. During the 1970-82 period, interception rates ranged from about 4-14 percent in most years but reached 34 percent in 1980. In that year, the Area 3 fishery was restricted and total exploitation was below average. Approximately 2-18 percent of the catch was taken in Indian fisheries during that period.

The total run of non-Meziadin sockeye averaged 89,000 with a catch averaging 48,000. Since there are no apparent differences in timing between Meziadin and non-Meziadin stocks exploitation and U.S. interception rates are assumed to be the same for both groups.

Management of the Nass River sockeye fishery is actively directed to the dominant Meziadin stock and the other stocks, Bowser, Damdochax, Kwinageese, Gingit and several minor stocks, are managed passively, ie. they are harvested at about the same rate as Meziadin stocks. Meziadin sockeye escapements have increased since construction of a fishway in 1966 but other stocks have remained stable or declined (Pacific Region salmon stock management plan - Anon, 1986).

5.2 Pink Salmon

Claim area pink salmon are harvested primarily in the Area 3 commercial net fishery, although some are taken in Area 1 (North Queen Charlotte Islands) troll and net fisheries and up to 10 percent of the catch is taken in Southeast Alaska. In most years, less than one percent of the catch is taken in the Indian fishery. Harvest rates during the 1970-82 period averaged 62 percent for even years and 55 percent for odd years (Henderson and Charles, 1984). The Area 3 net fishery is regulated in response to the abundance of returning major stocks including the Iknouk, Ishkeenickh, Dogfish Bay, Khutzeymateen and Kwinamass stocks.

5.3 Chum Salmon

Stock reconstruction data for Area 3 chum salmon (Charles and Henderson, 1985) illustrate that claim area chums are harvested mainly in the commercial net fisheries of Areas 3 and 4 but significant numbers are intercepted in Southeast Alaska. During the 1970-82 period, the portion of the catch taken in Southeast Alaska varied from 8-24 percent. The Indian fishery takes less than three percent of the catch in most years. Based on the exploitation rates calculated for the stock reconstruction analysis and recent escapement levels, total annual harvest of claim area chum salmon is in the order of 90,000 fish. Chum salmon are currently harvested incidentally during the sockeye and pink salmon fisheries but specific fisheries could be implemented in Portland Canal and Observatory Inlet if stocks returned in sufficient abundance.

5.4 Chinook Salmon

Claim area chinook salmon are harvested commercially in Canadian and Alaskan troll fisheries and in Canadian net fisheries. They are also taken in both tidal and freshwater sport fisheries and in Indian fisheries both in the Nass River and tidal water portions of the claim area.

Catch distribution data for north coast chinook stocks, based on coded wire tag recoveries (Starr and Pitre, 1984), indicate that approximately 30 percent of the catch during the 1977-82 period was taken in Alaskan troll fisheries and about 20 percent in Canadian troll fisheries. Approximately 25 percent were attributed to Canadian net fisheries and 25 percent to sport fisheries. These estimates were based on a general analysis of all north coast stocks and may not be entirely representative of claim area stocks. The data, however, indicate the probability of a high rate of interception in U.S. fisheries. The net catch is taken incidentally in fisheries for other species. This data is somewhat biased because Indian food catches are not sampled for coded wire tags. Based on recorded catches for the 1979-84 period (Jantz, 1985), the Indian food fishery would have taken about five percent of the total harvest.

5.5 Coho Salmon

The distribution of northern British Columbia coho stocks in the fisheries is poorly documented. The limited data based on recoveries of coded wire tags from north coast hatcheries indicate that these coho are harvested primarily in northern British Columbia and Alaska troll fisheries with 20-30 percent being taken in Alaska (Canada/U.S. Technical Committee on Coho Salmon - Report C 1985). Significant numbers are also taken incidentally in northern British Columbia commercial net fisheries and in Indian fisheries in the lower Nass River (Jantz, 1985). Coho salmon are also taken in sport fisheries both in tidal waters and in the Nass River system.

6.0 SALMON STUDIES AND ENHANCEMENT PROJECTS IN THE CLAIM AREA

The importance of the Nass River as the fourth ranking sockeye producer in British Columbia resulted in relatively early fisheries surveys of the watershed. The salmon and steelhead stocks were first described in the report of the Inspector of Fisheries in 1878, the year the commercial fishery began. Although seasonal fisheries guardians were assigned to the Nass beginning in the early years of the fishery, there is no record of inspections of spawning streams before the early 1900's. In 1898, however, a prospector reported observations made at Meziadin Falls which led him to conclude that the upper falls was a major obstruction to salmon (Todd, 1899). The Indians had spoken of this obstruction in past years. The same report mentioned an obstruction on the Tseax River.

Fisheries management activity increased in north coast areas in 1904 when the Department of Marine and Fisheries split the Province into two districts and appointed a separate Inspector for the north with headquarters at Port Essington on the Skeena River. In that year the Inspector discussed the possibility of removing an obstruction on the Tseax river but no action was taken (Williams, 1905)

In 1905, Rev James B. McCullagh, a missionary with the Church Missionary Society at Aiyansh, was appointed to make an inspection of the falls on the Meziadin River. Rev. McCullagh, who had served at Aiyansh since 1883, was generally familiar with the lower Nass and was able to recruit local Indian people to help him on the survey. During this six week trip he examined the falls, took photographs, made sketches and developed a proposal to reduce the obstruction (McCullagh, 1905). Although his report was forwarded to Ottawa with the support of the Inspector of Fisheries, no immediate action was taken.

McCullagh also examined the Cranberry River (he called it Salmon River) and recommended remedial work on two falls. His report included a sketch map providing details about several streams in the vicinity of Aiyansh.

In 1908, McCullagh carried out surveys of the Tseax and Seaskinnish systems for the Department of Marine and Fisheries

(McCullagh, 1908). He provided detailed descriptions of obstructions and spawning distribution and recommended remedial measures. McCullagh was particularly impressed with the sockeye spawning grounds on Gingit Creek, an area he described as a "perfect natural hatchery." He noted that, because of the spring fed water supply, the volume of water and temperature were constant and the stream never freezes. He recommended an enhancement project for the site. The 1908 report included a sketch map of salmon streams in the Aiyansh area.

In the same report, McCullagh noted that in the autumn, large numbers of dead unspawned sockeye were washed up the banks of the Nass River. This apparently was a common occurrence and he concluded that these were probably fish that were unable to ascend the Meziadin River Falls.

During the same period, fisheries surveys were increased on the upper Skeena River watershed and fishery officers from the Skeena began to include the Damdochax system in their inspections. By the 1920's, the upper Skeena fishery officer also began to make periodic surveys of the Kwinageese River and parts of the upper Nass River.

In the early 1900's, there was period of time when fishery officers of both the Dominion and Provincial governments carried out inspections of salmon streams. Between 1908 and 1931, Provincial Fisheries Overseer, C.P. Hickman made annual inspections of the Meziadin system (Annual reports of the B.C. Commissioner of Fisheries). Initially, he walked in from the head of navigation on the Nass River but beginning in 1911, he packed in over the Bear River Glacier from Stewart. In 1908, after observing the sockeye migration at Meziadin Falls he recommended remedial work. No action was taken until 1912 when John Pease Babcock, Assistant to the B.C. Commissioner of Fisheries, visited the falls along with Hickman. Babcock designed a fishway and a proposal was submitted to the Dominion Minister of fisheries. It was agreed that the Department of Marine and Fisheries would provide funds for a fishway to be constructed by the Provincial Road Superintendent from Stewart. A rock-cut fishway with concrete steps was built in 1913 on the left bank of the upper falls. The fishway was 126 feet long and 20 to 30 feet wide with five pools divided by concrete barriers. Several tons of materials and supplies were packed in from Stewart for the project. The fishway was maintained periodically during the 1920's and 30's and when this writer first visited the site in 1956 the fishway was still in good working order.

In 1912, Hickman travelled from Meziadin Lake overland via Hanna Creek and located Bowser Lake which he named after the B.C. Commissioner of Fisheries (and later Premier), W.J. Bowser. He built a raft and navigated the shoreline, observing sockeye throughout the lake.

In later years, Hickman usually made his inspections in company with his federal counterpart and they continued to gather information on the sockeye stocks. Trips were made into Bowser Lake in 1922 and 1923 at which time gillnetting was carried out to obtain scale samples. Scale samples were also taken at Meziadin Falls and in the Nass River above Meziadin River throughout the 1922-34 period. Interpretation of these scale samples was included in the annual publication of "Contributions to the Life-History of the Sockeye Salmon" by Dr. C.H. Gilbert and later by Drs. W.A. and L.S. Clemens. (Reports of the B.C. Commissioner of Fisheries, 1922-34). Although very few samples were available, especially for the Bowser Lake stock, the scientists were able to identify specific scale characteristics for each of the two stocks. In recent years, scale characteristics have been used in conjunction with size composition to identify Nass River stocks and facilitate population estimates for the Bowser Lake stock (Todd and Dickson, 1970).

Although the Provincial inspections were discontinued after 1931, the federal government continued to carry out annual inspections of the Meziadin system and occasional inspections of other areas. By 1935, surveys were somewhat curtailed because of budget restrictions, and later because of shortage of staff and resources during World War II. By 1930, fisheries officers had concluded that Bowser Lake was not an important sockeye producer and the system received very little attention until the late 1950's.

Most of the early fisheries work on the Nass River system was directed to the major sockeye stocks but some inspections were made of lower Nass tributaries. For example, in 1914 a Provincial fisheries overseer examined several tributaries from the mouth of the Nass River to 27 miles above Aiyansh. A similar survey was reported in 1919 (Annual Reports of B.C. Commissioner of Fisheries). As early as 1909, work was carried out to remove minor obstructions on lower Nass River tributaries (Williams, 1910) and in 1931, a channel was opened around a falls on the Cranberry River (McHugh, 1932).

Annual spawning ground inspections were continued on the Meziadin system and some other tributaries throughout the 1940's and early 1950's but no new studies were initiated until the mid-1950's. In 1955, engineering surveys were initiated on the Nass River watershed to assess hydro-electric potential for the system (Anon., 1958a). An earlier proposal, developed in 1929 (Knewstubb, 1929), had been abandoned but the Nass was again being considered for hydro-electric development. Studies were initiated by the Department of Fisheries in 1956 to assess the implications of the proposed development. These studies, carried out during the 1956-59 period, were designed to assess salmon abundance, timing and distribution in the upper Nass River watershed. The results of the studies provided the first actual estimates of abundance of sockeye and chinook salmon in the upper Nass watershed and also provided basic timing information for Nass River sockeye salmon.

During the same period, a thorough assessment was made of sockeye migration at Meziadin Falls. Although the original fishway facilitated migration of large numbers of sockeye over the falls, the studies revealed that there was a substantial loss of spawners in some years. Annual mortality rates ranged from a low of 4 percent to high of 38 percent over the period of the study (Anon., 1957, 1958b and 1959b). In 1965, when the Stewart-Cassiar highway facilitated access to Meziadin Lake, a modern vertical slot fishway was constructed over both falls. This fishway which was in place for the 1966 migration has virtually eliminated sockeye mortality at the falls.

Further biological investigations were carried out beginning in 1963 to obtain information for management of Nass River sockeye salmon. Gillnet test-fishing was initiated on the lower Nass River in 1963 to obtain a day-to-day index of sockeye escapement into the river. Also, studies on the up-river tributaries have produced reliable estimates of sockeye escapement since 1964. Since 1966, a total count of the Meziadin River sockeye escapement has been obtained as the fish pass through the fishway and annual assessments and sampling programs are carried out on the other major sockeye spawning areas. The increased surveillance on the

Nass River in recent years has also resulted in improved information on the abundance of other species.

Other than construction of the Meziadin Fishway in 1966 there has been relatively little salmon enhancement activity in the Claim Area in recent years and only a few small projects have been implemented.

1. Kincolith Hatchery - The Nisga'a of Kincolith have operated a small hatchery on the Kincolith River since 1979. This hatchery, a Community Economic Development Project, has produced both chinook and coho salmon which are harvested in commercial and sport fisheries in northern British Columbia and Alaska and in the claim area Indian fisheries. Recent releases included 36,329 coho and 33,105 chinook in 1988 and 52,306 chinook in 1989 (SEP Updates 1988-89 and 1989-90).

2. Cranberry River - Remedial work was carried out in 1973 to improve access to the river above Cranberry Falls. This work has apparently improved access over the falls.

3. Kiteen River - Remedial work was carried out in 1970 at a falls 8 Km. above the river mouth to alleviate a low

water obstruction. There is no reference to the effectiveness of this project.

4. <u>Gingit Creek</u> - In 1986 enhancement work was carried out on a sockeye spawning area in Gingit Creek. A 200 Metre section of the creek, beginning at the headwater springs, was improved by removal of debri and poor spawning gravel and placement of graded spawning gravel. There is no record of followup assessment.

5. <u>Tseax River</u> - An incubation box for coho has been operated through the SEP Public Involvement Program for several years.

6. <u>Bear River</u> - A small chum salmon spawning channel was constructed on the Bear River (Connex Creek) in 1986. This project also involved transfer of adult chums from Fish Creek in Alaska. It was reported that spawning success was unknown and many fish died before spawning (Anon, 1988).

7. <u>Minor stream clearance</u> - Minor obstructions such as beaver dams are removed from time to time eg. Seaskinnish Creek, Illiance River, Zolzap Creek.

7.0 OVERVIEW OF ENHANCEMENT OPPORTUNITIES

Although there is significant enhancement potential in the Nisga'a land Claim Area, the opportunities are constrained by mixed stock fisheries in north coastal British Columbia and interceptions in Alaska. All species of salmon arrive in the area over a relatively short time period and there is little opportunity for selective harvest or conservation of individual stocks.

Regulation of the commercial fishery is governed primarily by the strength of the Meziadin sockeye run in the early season and a few major pink salmon stocks e.g.Iknouk, Ishkeenickh and Kwinamass, in the latter part of the fishing season. Other stocks of sockeye and pink salmon are subjected to the same harvest rate as the major stocks despite potential differences in productivity. Other species are taken incidentally in the north coast net fisheries and chinook and coho salmon are also caught in substantial numbers in mixed stock commercial troll fisheries and sport fisheries in northern B.C. and Alaska.

All species of claim area salmon are intercepted to some extent in Alaska thereby reducing direct benefits to fisheries in the north coastal area. Although, under the terms of the Canada-U.S. salmon agreement, each country is to benefit from the production of fish originating within its boundaries, interceptions may be balanced on a region-wide basis and credit for Alaskan catches of claim area stocks would not necessarily result in local benefits. Despite the fact that the Alaskan fishery will have to be taken into account in the evaluation of potential projects, current interception rates will not necessarily preclude otherwise viable projects.

In a mixed stock fishery, such as the Nass River, successful enhancement has the potential to create serious management problems. When enhancement technology results in increased productivity of the enhanced stocks fishery managers are faced with some difficult choices. Exploitation in the fishery can be increased to harvest the additional production but this will result in over-fishing of unenhanced stocks. Another option is to hold the fishery at a level that will sustain all stocks. This will result in some increase in average production but more than the required number of spawners will return to the enhanced system resulting in lost benefits. A third option is to develop new terminal fisheries which will target on the enhanced stock. This option may require new approaches for harvest outside the traditional fishing areas and, in some cases, virtually a "hatchery rack" fishery may be necessary. Negative aspects of this option may include poor quality fish because of advanced maturity and exclusion of user groups from some of the benefits of enhancement.

Enhancement can be used effectively in mixed stock fisheries to rebuild and maintain stocks that are depressed or declining because of excess harvest by fisheries regulated for other stocks. Initially, enhancement methods can be directed to rebuilding stocks without any change to harvest rates or pattern but eventually, as the depressed system is brought up to capacity the options described above will come into play.

Enhancement projects which increase numbers of fish but do not significantly increase production rates are less disruptive to existing management regimes and can be used effectively in mixed stock situations. Projects such as removal of obstructions on streams to increase spawning and rearing area and colonization of unutilized habitat fall into this category. Some potential projects of this type have been identified in the claim area. An overview of enhancement potential for the claim area is presented below.

7.1 Sockeye Salmon

Sockeye salmon spawn in 14 Nass River tributary systems and in the Bear River at the head of Portland Canal but the fishery is dominated by the Meziadin River run which constitutes about 80 per cent of the total. Since 1966, counts of fish passing through the Meziadin fishway have facilitated an accurate assessment of sockeye escapement to the Meziadin River system. Although average escapements have been near management target levels in recent years and illustrate no upward or downward trend, both escapements and total run size have been highly variable (Table 2 and Starr et.al, 1984). The available data also illustrate a 50 percent average exploitation rate for an implied ratio of return of about 2:1. These data suggest relatively low average productivity for Meziadin sockeye with very poor returns in some years.

Since they exhibit the same migration timing it is assumed that other Nass River sockeye stocks are subject to the same rate of exploitation as Meziadin stocks. Analyses in 1986 indicated that non-Meziadin stocks had lower productivity than Meziadin stocks and a declining trend was illustrated. Based on recorded escapements to 1990 however, there is now less indication of a downward trend. Escapement levels have fluctuated widely for non-Meziadin stocks but most have shown no obvious increase or decrease in escapement levels in recent years. Escapements to nearly all tributaries other than Meziadin are, however, well below management target levels. The data suggest that, under the current management regime, non-Meziadin stocks are being maintained but at a level below the capacity of the systems.

Any major enhancement of Nass River sockeye has the potential to increase mixed stock fishery problems and would require careful examination of the implications. Also, studies of the sockeye producing systems are required to assess productivity and spawning and rearing capacities. In the short term, however, there may be opportunities for enhancement of some minor stocks, especially ones which are far below management targets.

7.2 Pink Salmon

Claim area pink salmon are harvested in mixed stock fisheries and offer little opportunity for major enhancement of individual stocks. There may be some opportunities to increase production through removal of obstructions and minor stream improvement.

7.3 Chum Salmon

While most of the chum salmon catch is currently taken incidentally during the sockeye and pink salmon fisheries there is potential for terminal chum fisheries in Observatory Inlet and Portland Canal. If all stocks in either area were enhanced concurrently the increased production could be harvested in controlled terminal fisheries. Any project in Portland Canal, however, would require an enhancement and management agreement with the U.S.

7.4 Chinook Salmon

Chinook salmon escapements are currently below the capacity of the streams in the claim area, averaging about 25 percent of management targets. Although harvest of chinook has been better controlled in recent years under the Canada-U.S. agreement there has been no obvious increase in escapement levels in claim area streams. The structure of the current commercial fishery precludes any opportunities for directed fisheries on specific chinook stocks but any successful chinook enhancement project would benefit all fisheries through increased production and could benefit terminal Indian and sport fisheries. There would also be potential for benefits from "hatchery rack" harvest of surplus fish.

Enhancement planning for the area is handicapped by lack of information on chinook life history, migration characteristics and exploitation in Canadian and U.S. fisheries. Also, there is relatively little data on the application of chinook enhancement technology in northern B.C. rivers. Implementation of small projects with concurrent field studies of natural production could provide the information needed for longer term enhancement planning.

7.5 Coho Salmon

The situation for coho salmon is generally the same as described above for chinook salmon. Coho are widely distributed throughout the claim area but very little is known about their life history and production potential. While it assummed that claim area stocks are caught in fisheries in northern B.C. and Alaska there is virtually no specific information on exploitation.

Escapement data for coho salmon is generally poor and current escapement targets are based on very limited information. Fishery managers have concluded, however, that recent coho escapement levels in the claim area are below capacity, averaging about 40 percent of target levels during the 1980-89 period. As with chinook salmon, implementation of small scale coho enhancement projects could provide valuable information for future fishery management and enhancement while, at the same time, providing some direct production benefits.

8.0 SUMMARY OF POTENTIAL ENHANCEMENT PROJECTS

Enhancement projects have been proposed for the claim area from time to time since the late 1800's and, as described previously some work has been completed in the past. A number of potential projects which have been identified in various DFO reports are reviewed below along with a general overview of enhancement potential in some other major tributaries. Opportunities are presented for three segments of the claim area: the upper Nass River, upstream from the junction of the Nass and Cranberry Rivers; the lower Nass River, from the Cranberry River to the estuary; and coastal streams outside the Nass River.

8.1 Upper Nass River

8.1.1 Damdochax River

This system was examined during the 1979 reconnaissance (Ginetz and Neilsen, 1980). There is some potential for a hatchery site with good groundwater at the outlet of Damdochax Lake. Potential for side channel or semi-natural spawning channel development was also identified. Sockeye production is probably inhibited by the rearing capacity of the small lakes on this system. There could be some potential for lake enrichment. Because of the isolated location and lack of access to this system construction and operation of enhancement facilities may be impractical at this time. (Lill et. al., 1985).

8.1.2 Upper Nass River Log Jams

Major log jams have been reported from time to time on the Nass River near Vile Creek since 1928. Since these jams have the potential to block access of salmon to the Damdochax River, consideration was given to removal many years ago eg. Boyd (1935) and Warne(1945) but no action was taken. The jams were examined periodically over the years but most observers considered removal impractical. Neilsen (1980) inspected the two log jams in

October, 1980 and concluded that salmon migration would not be obstructed at the low water level at the time of inspection. Conditions at higher water levels were not determined. Neilsen concluded that the jams could be removed by burning in the autumn. He recommended inspection during salmon migration to assess the extent of blockage or delay of salmon. There is no record of any followup action.

8.1.3 Bowser Lake

Bowser Lake was identified for potential lake enrichment (Lill et.al.1985) but was deemed technically and economically impractical. Bowser Lake is extremely glaciated and visibility is limited to a few inches. The lake is a significant producer of lake spawning sockeye but the implications of enrichment are unknown.

8.1.4 Bell-Irving River System

Some enhancement potential has been identified in Oweegee Creek and Teigen Creek, tributaries to the Bell-Irving River.(Ginetz and Neilsen, 1980). Oweegee Creek was identified for potential natural or semi-natural chinook enhancement. Teigen Creek was identified as a possible site for a chinook facility. Although road access is available from the Stewart-Cassiar highway these sites were rated as impractical at the present time (Lill et.al 1985).

8.1.5 Meziadin River System

The Meziadin River was identified as a possible site for a pilot hatchery or a major facility for chinook, coho and steelhead but more research would be needed to determine feasibility. Concerns were expressed about access, groundwater supply and disease potential. Meziadin Lake was identified for possible lake enrichment but was rejected in 1985 because of anticipated stock management problems. (Lill et.al. 1985)

8.1.6 Kwinageese River System

The Kwinageese River (Figure 4) is fed by a network of small lakes and tributary streams and is a significant producer of sockeye, chinook and coho. Chinook spawn in the Kwinageese River below Fred Wright Lake and the system was identified as a possible site for a chinook facility (Ginetz and Neilsen, 1980) but no suitable site has been found.

Bonney Creek, a sockeye spawning stream tributary to Fred Wright Lake is obstructed by an impassable falls about 1 kilometre upstream. Fishery Officers have recommended removal to open up additional spawning area. This project was also identified by Lill et.al.,1985. Studies are required to determine potential for obstruction removal and to assess sockeye spawning and rearing potential above the falls. Other connected lakes should be assessed for sockeye rearing potential and possible lake enrichment feasibility.

This system may have some unique possibilities for sockeye enhancement . Road access is available to parts of the watershed.

8.1.7 Brown Bear Creek

This system which drains several lakes supports minor populations of sockeye and coho salmon. The stream is blocked by an impassable falls less than 1 kilometre from the mouth. The possibility of colonization of coho into the upper river has been identified (Lill et.al. 1985).

8.1.8 Cranberry River

The Cranberry River (Figure 5) is a major producer of chinook, coho and steelhead with at least 80 kilometres of spawning and rearing area. A falls 16 kilometres from the river mouth presents a partial barrier to salmon migration. Remedial measures were recommended as early as 1905 (McCullagh, 1905) and some blasting was done in 1931 and additional work in 1973 improved access to the upper river. Further surveys have been recommended to determine requirements for additional work to alleviate the obstruction.

Ginetz and Nielsen,(1980) reported good enhancement potential on the Cranberry River due to good quantities of surface groundwater outflows. Potential for gravity water supply was identified on the upper river above Weber Creek. The Cranberry River was not suggested as a potential hatchery site in subsequent SEP lists of opportunities i.e. 1983 and 1985. The Cranberry is accessible from Highway 37 and connecting logging roads.

8.1.9 Kiteen River

The Kiteen River is a tributary to the Cranberry River. Some remedial work was carried out at fall 8 kilometres from the mouth in 1970. Ginetz and Nielson,(1980) reported that the river was glacial with a steep gradient and did not appear to have much potential for enhancement.

8.2 Lower Nass River

8.2.1 Seaskinnish and North Seaskinnish Creek (Figure 6)

Seaskinnish Creek was surveyed by McCullagh,(1908) who recommended alleviation of a falls on the North Seaskinnish Creek below Dragon Lake. No action was taken at that time but more recent reconnaissnace has led to similar suggestions. The available records are inconclusive as to the extent of obstructions and the available area upstream. Some minor obstructions were alleviated in 1984 but the current Stream Information Summary (Demarco, 1988) indicated an impassable falls at 5.9 kilometres.

The system has been identified as a potential location for a chinook and coho facility but further reconnaissance is required (Lill et. al. 1985). Potential for access and power supply is good.

8.2.2 Tseax River System

The Tseax River which enters the Nass River near the community of Aiyansh has unique characteristics dominated by a large and geographically recent lava outflow from a now-extinct volcano at the headwaters of a tributary stream (Figure 7). According to Sutherland Brown,(1969) eruption occurred c.1750, spreading lava over most of the Tseax River valley and adjacent Nass River. The eruption had major impact on the river channel and the system has probably been undergoing a long period of change and recolonization of fish stocks. For example, McCullagh,(1908) described the system and produced sketch maps showing two sets of falls. The lower falls, below the small lake,(Spencer Lake) near the confluence of Gitzyon Creek he referred to as "little falls". He noted that salmon had only been able to ascend these falls within the past 30 years (c.1880), the obstructing wall of lava having succumbed to the action of the water. Shepard and Neilsen,(1985) described this section in 1985 as "three passable chutes as the Tseax exits the lava bed". A second falls further upstream, referred to as "big falls" by McCullagh, remains as an obstruction to chinook and pink salmon but some coho salmon and steelhead ascend to the upper river.

The lava disrupts the flow of the river creating small lakes, diversions and subterranean channels and, in some sections, the river runs entirely underground. The lava provides filtration and a degree of temperature control which prevents significant freezing in the winter.

Several enhancement opportunities have been identified and the most current proposals are summarized in a DFO salmon stock management plan, discussion document produced in 1986. (Anon,1986).

Tseax River Chinook Hatchery - A central chinook hatchery has been proposed for the Tseax River. Eggs taken from the Tseax, Cranberry and Ishkeenickh rivers would be incubated in the hatchery and after a period of rearing the juvenile fish would be planted in the donor streams. Fish produced in this fishery would be harvested in commercial fisheries in B.C. and Alaska and in local Indian and sport fisheries. Groundwater sites have been identified but further feasibiltiy studies are required. Earlier proposals (Lill et.al, 1985) included the alternative of a pilot facility before construction of a major hatchery. A pilot operation would provide an opportunity for more thorough feasibility assessment and release of marked fish would provide valuable information on migration and exploitation.

Tseax River Falls - Alleviation of falls on the upper Tseax River is proposed to aid the upstream migration of chinook and pink salmon. Some alternative approaches have been identified but additional surveys are required to determine the best approach.

Vetter River - The Vetter River separates from the Tseax below the falls, drops over a 3-4m falls and, further downstream becomes sub-surface flowing under the lava bed towards the Nass River. There is concern that juvenile salmon may be lost in this channel and proposals have been developed to either divert the surface flow back into the Tseax or open a channel to the Nass River. Further studies are needed to assess the need for and the implications of this project.

Gingit Creek - This small tributary to the Tseax River is the major producer of stream type sockeye on the Nass River system. The stream also supports small populations of coho and pink salmon and the 1986 planning report recommended annual control of obstructions caused by beaver. As previously described, improvements to the sockeye spawning area were completed in 1986. Although this project is considered completed the effectiveness of the work should be assessed and the area should be studied for other sockeye enhancement opportunities.

Enhancement plans for the Tseax River will have to take into account the historical and recreational importance of the lava beds and the surrounding area. The area has special significance to the Nisga'a and consultation will be essential as plans are developed.

8.2.3 Ishkeenickh River

The Ishkeenickh River, an important producer of chinook, coho and pink salmon joins the lower Nass River on the south bank between Kincolith and Greenville. This system is considered to have some potential for a hatchery or channel site but there is uncertainty about a suitable water supply and system productivity. Also, there is no road access or hydro power in the area. The Tseax is considered a more suitable system for developemnt and the Ishkeenickh River was not included in the 1986 list of enhancement opportunities.

8.2.4. Zolzap Creek

Opportunities have been identified to improve and increase spawning habitat for pink salmon in Zolzap Creek. The stream, a minor producer of sockeye, pink, coho and chum salmon, flows into the Nass River from the south about 20 kilometres below Aiyansh. There is road access.

8.2.5. Diskangieg Creek

Diskangieg Creek enters the Nass River on the north side near Greenville. Stream debri clearance has been proposed to improve coho salmon production.

8.2.6. Anliyen Creek

Anliyen Creek, a small coho producing stream, joins the Nass River on the north side near Greenville. Some potential for stream improvement or rehabilitation has been identified. Further reconnaissance is required.

8.2.7 Kwinyarh Creek

Kwinyarh Creek supports minor populations of coho, pink and chum salmon. Annual beaver control has been recommended to maintain access to the stream. This creek enters the Nass River on the south side about 20 kilometres below Aiyansh and is accessible by road.

8.2.8. Ansedagan Creek

Ansedagan Creek is a minor producer of coho, pink and chum salmon. Some potential for stream improvement or rehabilitation has been identified. This tributary is located on the south side of the Nass River about 25 kilometres below Aiyansh.

8.2.9 Ginlulak Creek

Ginlulak Creek supports significant numbers of coho salmon and a few pinks and chums. Coho spawn in heavily silted gravel and addition of suitable spawning gravel has been recommended. The stream enters the Nass River on the south side nearly opposite Greenville. Road access is available.

8.3 Coastal Streams

8.3.1 Kitsault River

A preliminary proposal has been developed to locate a central chum salmon hatchery on the Kitsault River, at the head of Alice Arm. The facility would be used as a central site for incubation of eggs from four streams in Observatory Inlet and Alice Arm; Illiance River, Kshwan River, Stagoo Creek and Kitsault River. These stocks are heavily exploited as incidental catch during the area 3 pink salmon fishery and escapements are below target levels. If enhancement rebuilt the stock, surplus fish could be harvested in terminal fisheries in Observatory Inlet. There is some potential for an agreement with the U.S. for co-ordinated enhancement of both Portland Canal (mainly U.S. Stocks) and Observatory Inlet chums. There is also some potential for hatchery production of chinook and coho salmon in the Kitsault River.

8.3.2. Bear River

The Bear River supports a major coho salmon population and minor stocks of sockeye, pinks and chums. Sockeye, pink and chum salmon escapements are far below target levels. Some potential for a pilot scale facility was identified during initial reconnaissance but no good sites were found. (Lill et.al. 1985). Two minor projects were proposed in 1986. Rehabilitation of sockeye spawning grounds in Clement Creek, tributary to Bear River, was recommended to increase sockeye production. Also, chum salmon incubation boxes were proposed for small feeder streams in the Bear River estuary, near Stewart. This latter project requires further investigation since it would require transplant of eggs from Fish Creek in Alaska. The Bear River is accessible from the Stewart-Cassiar highway near Stewart.

8.3.3. Kwinamass River

The Kwinamass River was included on the 1985 list of enhancement opportunities (Lill et al, 1985) as a potential site for chinook and coho enhancement but no details were provided. Further reconnaisance would be needed to identify opportunities.

9.0 RECOMMENDED RECONNAISSANCE AND FEASIBILITY STUDIES

A number of potential enhancement opportunities have already been identified within the Nisga'a area but further reconnaissance is needed to determine project feasibility and establish priorities. Since there has been no complete overview of the area for enhancement opportunities for several years a general reconnaissance of at least the main spawning areas is recommended. Inspection of the claim area is difficult and costly and advantage should be taken of an available helicopter and reconnaissance team, which should include the local fishery officer and a representative of the Nisga'a Tribal Council to carry out a thorough inspection. Helicopter surveys should cover at least the streams identified in the summary of potential enhancement projects in the previous section of this report.

Development of enhancement opportunities is hampered by a lack of basic life history information on claim area stocks. In particular, little is known about distribution and migration routes of chinook and coho in Canadian and Alaskan waters. At this time there are no reliable estimates of exploitation rates or U.S. interception rates for stocks of these species originating in the claim area. Initial feasibility studies and pilot projects should give high priority to marking of juvenile chinook and coho. Also, little is known about the rearing capacity of the sockeye salmon producing systems. A better understanding of juvenile distribution, growth rates and migration timing could facilitate development of future enhancement strategy for sockeye salmon.

Some of the projects identified in the 1986 salmon stock management plan could be initiated in the near future. While the more major and complex projects such as the developments proposed for the Tseax River and Observatory Inlet chum salmon will require additional bio-engineering field work, several minor stream improvement projects could proceed in the short term. Some minor projects which are reasonably accessible from the Nisga'a communities include alleviation of the obstruction at Cranberry River Falls and stream improvement projects in Zolzap Creek, Diskangieg Creek, Anliyen Creek, Ansedagan Creek and Ginlulak Creek. These streams should be examined to verify that remedial work is needed. Other opportunities for projects which could be initiated in the short term may be identified during further reconnaissance of the area.

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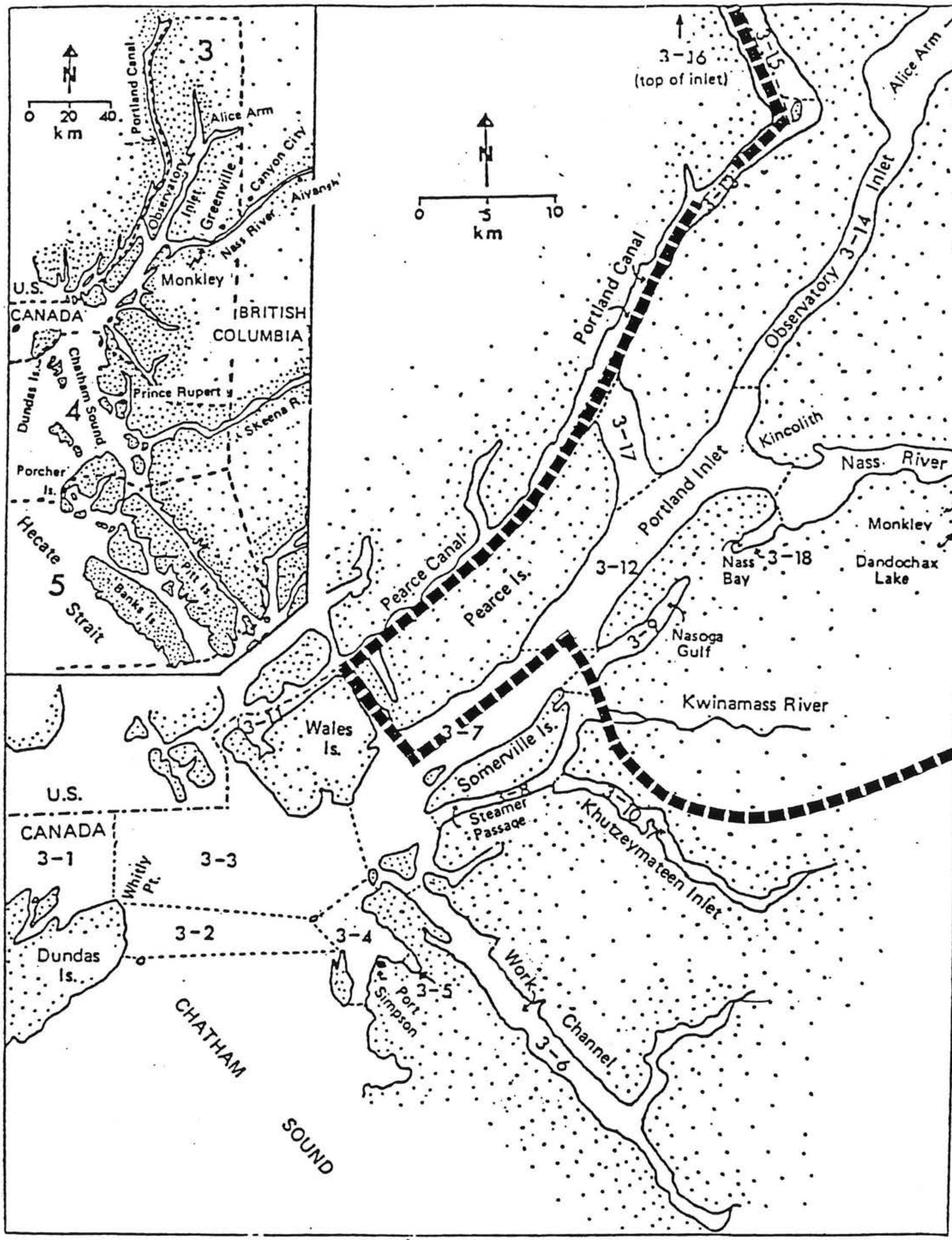

Figure 1. Approximate seaward boundaries of the Nisga'a Land Claim Area. Source: Argue (1984).

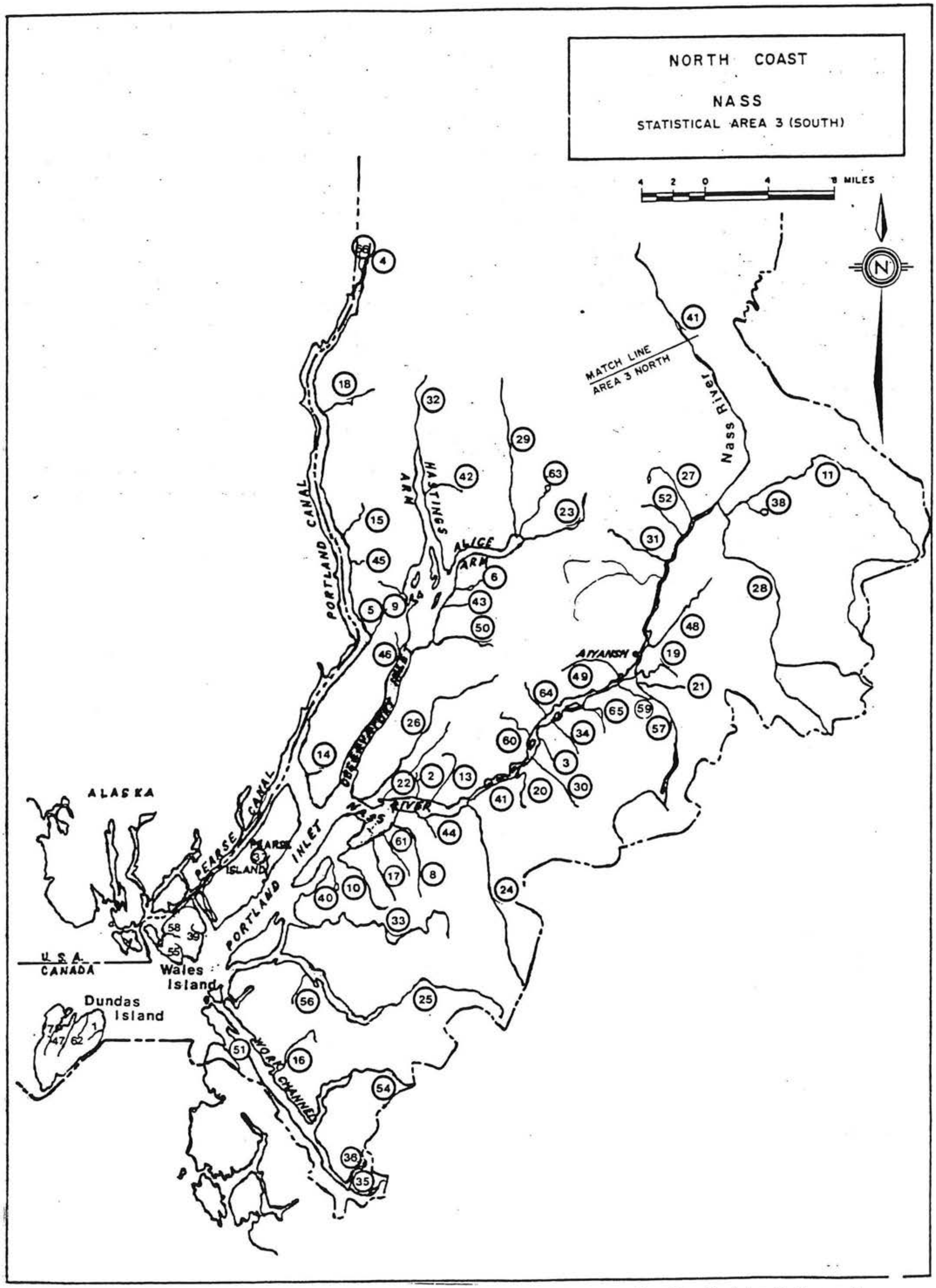

Figure 2. Map showing location of salmon streams in Statistical Area 3 (south) and index to the map.
Source: Hancock and Marshall (1984). Streams outside the claim area indicated by an asterisk on the index.

INDEX TO MAP OF SPAWNING STREAMS OF STATISTICAL AREA 3
NASS RIVER (SOUTH)

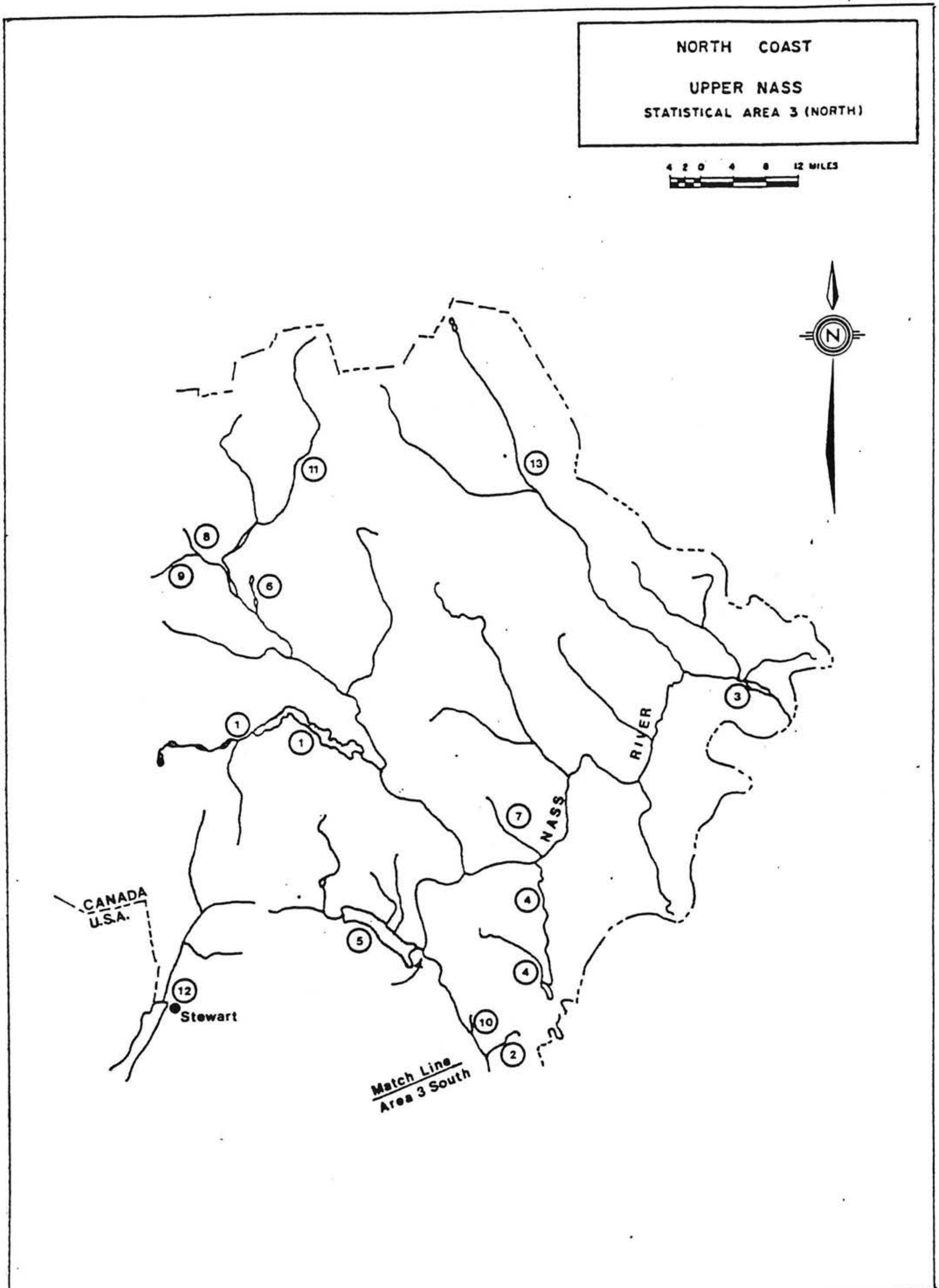

Figure 3. Map showing location of salmon streams in Statistical Area 3 (north) and index to the map. Source: Hancock and Marshall (1984)

INDEX TO MAP OF SPAWNING STREAMS OF STATISTICAL AREA 3
NASS RIVER (NORTH)

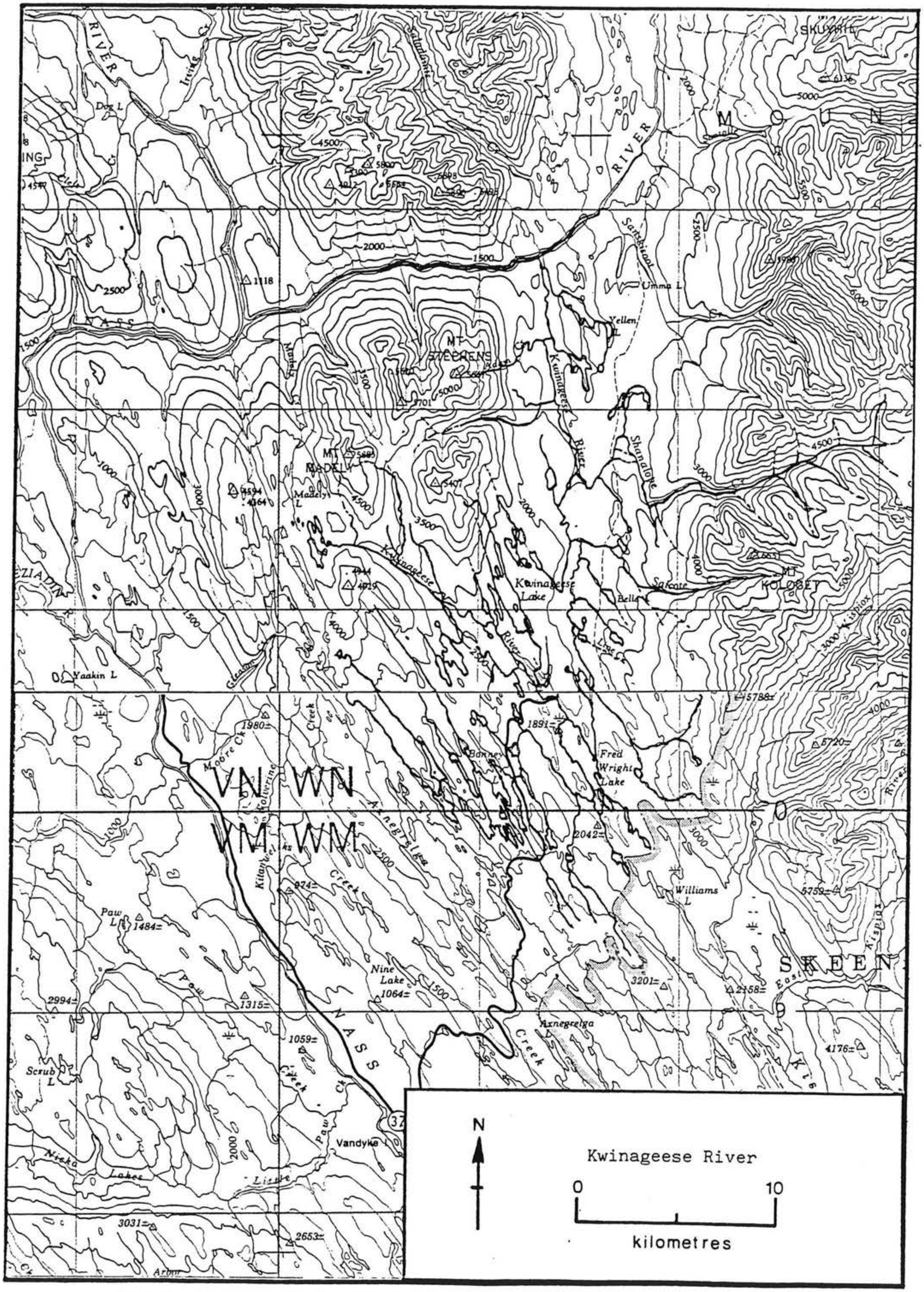

Figure 4. Map of the Kwinageese River system.
Source: Hancock and Marshall (1984)

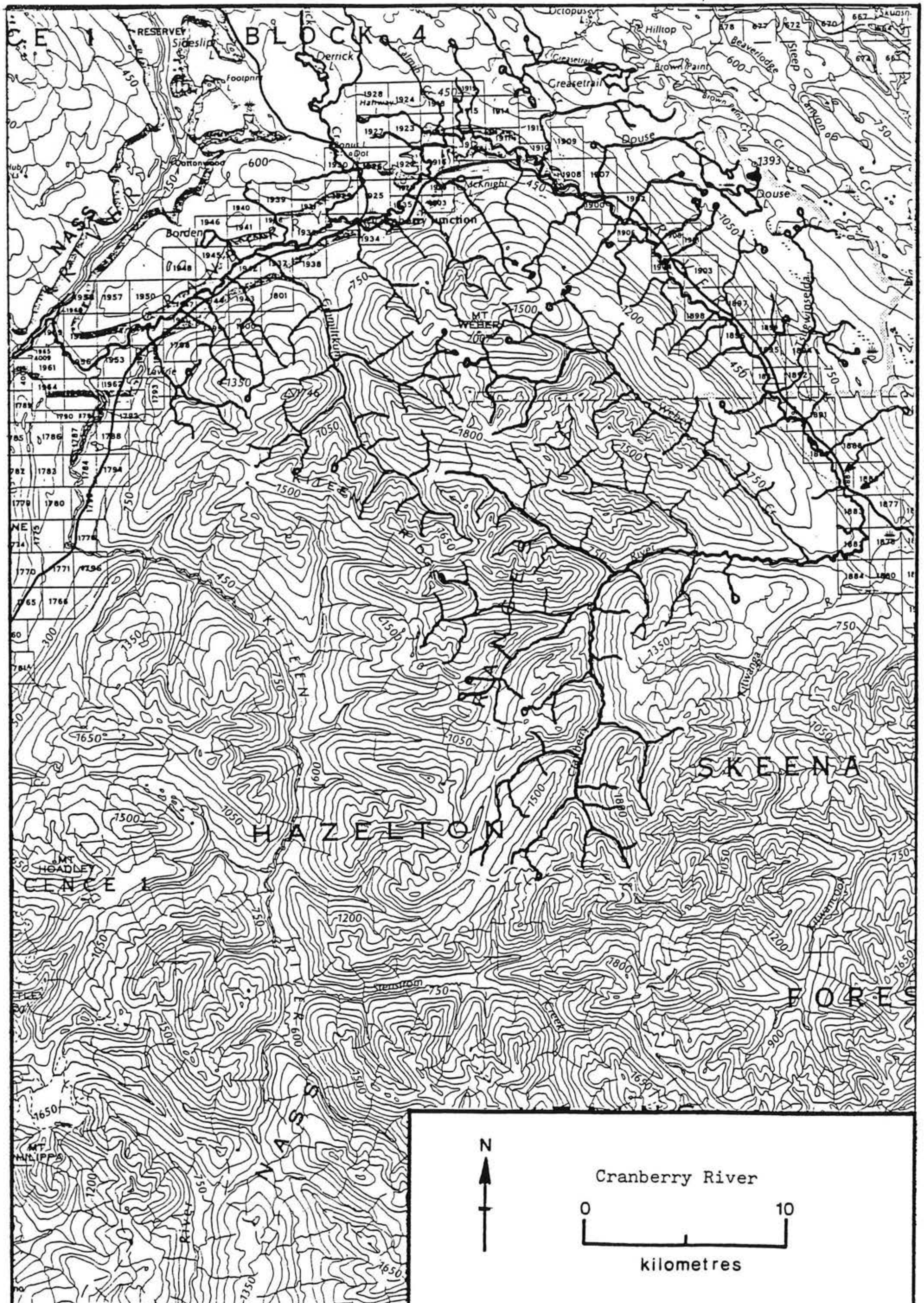

Figure 5. Map of the Cranberry River system.
Source: Hancock and Marshall (1984)

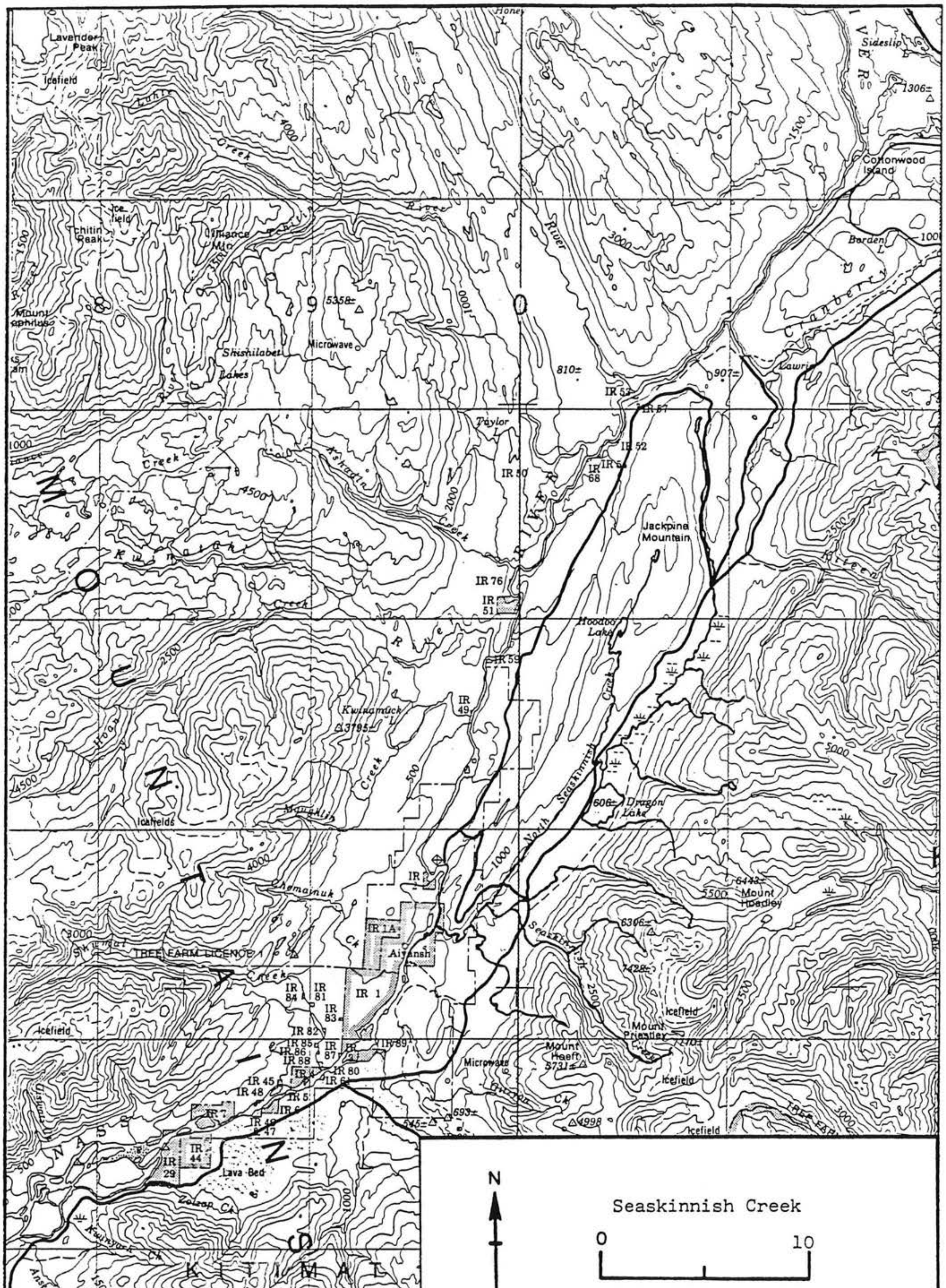

Figure 6. Map of the Seaskinnish River system.
Source: Hancock and Marshall (1984)

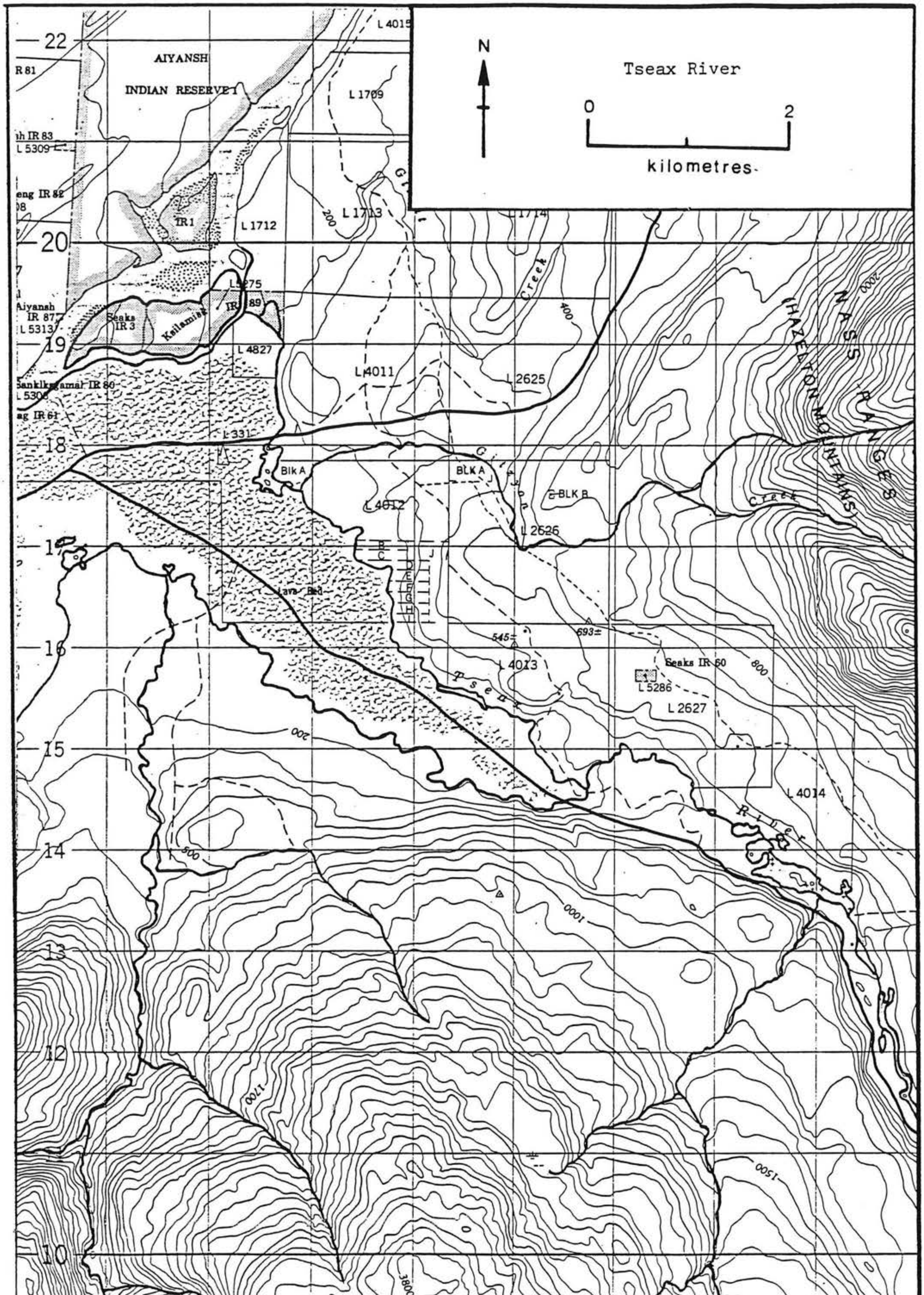

Figure 7. Map of the Tseax River system.
Source: Hancock and Marshall (1984)

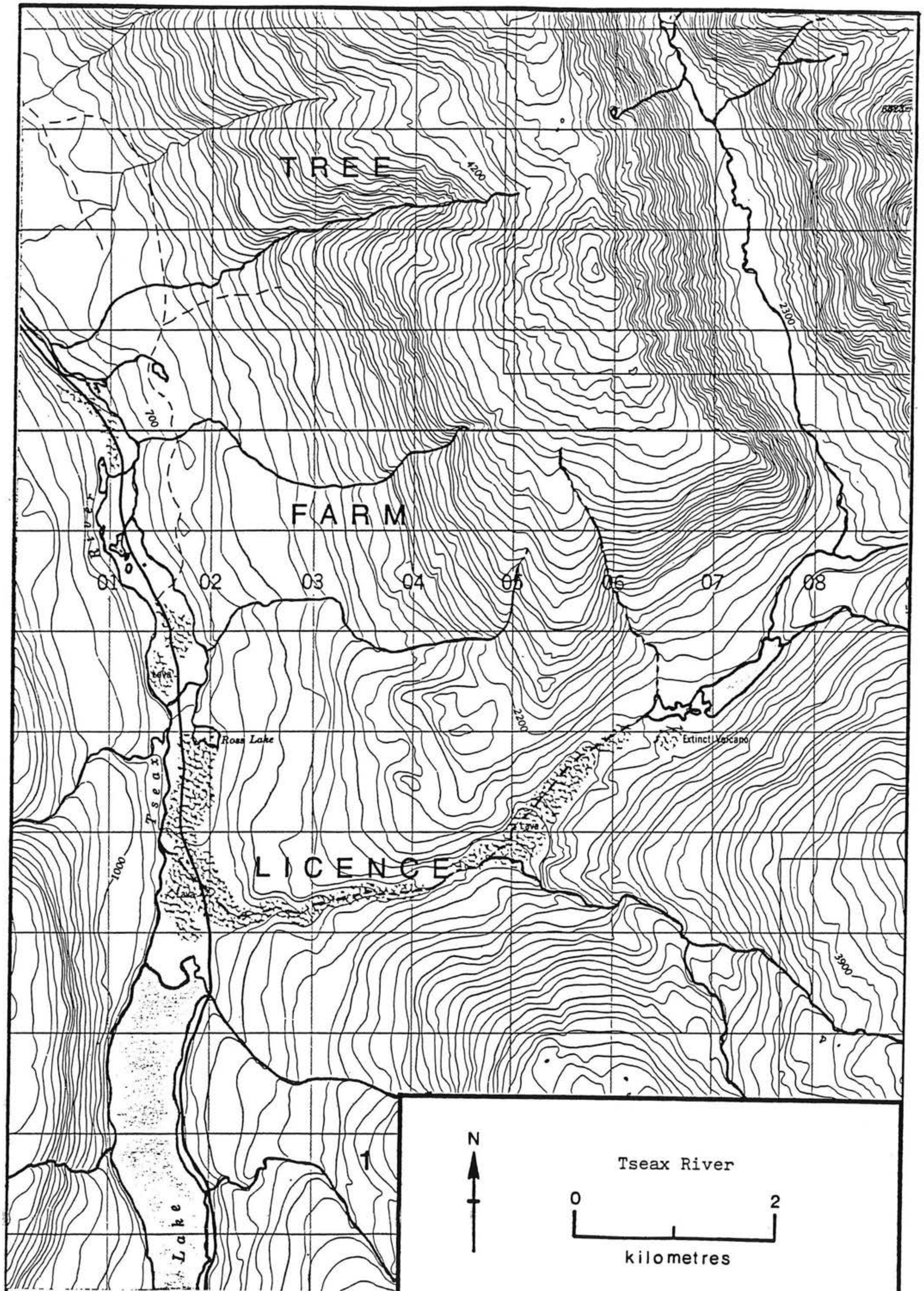

Figure 7. (Cont.)

APPENDIX 1

Timing of spawning by species for streams in Statistical Area 3 and a description of the basis for establishing escapement targets.

Timing of Spawning

This section consists of figures outlining the timing of spawning by salmon species for each stream, grouped by sub-area (Fig. I - VII). The arrival, start, peak and end of spawning are indicated using the following abbreviations from the Catalogue of Spawning Streams and Spawning Escapements:

ARR = date salmon arrive in stream
ST and S = begin to spawn
PK and P = reach peak in spawn
END = finish spawning
MA, JU, JL, A, S, O, N, D, J = standard abbreviations for the months
E = early
M = mid (11th to 20th of month)
L = late (21st to end of month)

The abbreviations to the right of the stream name indicate the month (JU, A, S) or part of the month (ES, MO, LO) when each of the four spawning periods (either ARR, ST, PK or END) occur. To the right of this the spawning period is illustrated. The x's represent the arriving (ARR) period and appear until the start of the active spawning (S). Once spawning has started the following x's represent the same condition and continue until the peak (P) is reached. The remainder of the spawning period, including the end, is represented by x's.

Each month is represented by nine spaces indicated by x's or S and P as described above. Three x's represent either the E, M or L period of the month; nine x's represent an entire month. An S was placed at the beginning of any time period to indicate start and a P was always placed in the middle of the appropriate time period to indicate the peak. If arrival and start were represented by the same time period, the x would be the first character and S would follow in the next space in the time period.

Timing for the Key Streams were derived from information from the local Fishery Officer and from historical records. Information on data sources is available in the introduction to the Key Stream section. Timing for other streams was taken from information in the Catalogue Of Salmon Streams and Spawning Escapements.

The second section consists of figures outlining the timing of spawning of all salmon species for each stream, by sub-area (Fig. VIII-X). The start, peak and end of spawning are indicated. Timing for the Key Streams was derived from information from the local Fishery Officer and from historical records (see Key Streams). Timing for other streams was taken from information in the Catalogue of Salmon Streams and Spawning Escapements.

Fig. I. Sockeye timing of spawning in Portland Canal and Nass River sub-areas, Area 3.

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STREAM                    |ARR ST  PK END |  MAY   |  JUNE  |  JULY  |  AUG.  | SEPT.  |  OCT.  |  NOV.  |  DEC.  |
--------------------------|------------------------|--------|--------|--------|--------|--------|--------|--------|
Portland Canal Subarea    |               |        |        |        |        |        |        |        |        |
                          |               |        |        |        |        |        |        |        |        |
BEAR RIVER                |MJU MJL MA  MS |        |    XXXXXXXXSXXXXXXXXPXXXXXXXXX    |        |        |        |
                          |               |        |        |        |        |        |        |        |        |
                          |               |        |        |        |        |        |        |        |        |
Nass River Subarea        |               |        |        |        |        |        |        |        |        |
                          |               |        |        |        |        |        |        |        |        |
BOWSER RIVER & LAKE       |MA  LA  MS  LO |        |        |        |    XXXSXXXXPXXXXXXXXXXXXX|        |        |
BROWN BEAR CREEK          |MS  LS  MO  EN |        |        |        |        |   XXXXSXXXXPXXXXXX       |        |
DAMDOCHAX RIVER & LAKE    |LJL ES  MS  LS |        |        |       XXXXXXXXXXXSXXXPXXX|        |        |        |
GINGIT CREEK              |MJL MJL LJL LA |        |        |    XSXPXXXXXXXXX|        |        |        |        |
GITZYON CREEK             |MJL LJL EA  ES |        |        |    XXXSXPXXXXXXXXX       |        |        |        |
ISHKHEENICKH R.           |               |        |        |        |        |        |        |        |        |
KWINAGEESE RIVER          |EA  LA  ES  LS |        |        |        |XXXXXXXSXXPXXXXXX|        |        |        |
MEZIADIN RIVER & LAKE     |EJL MJL EO  MN |        |        |XXXSXXXXXXXXXXXXXXXXXXXXXXPXXXXXXXXXXXXX    |        |
SEASKINNISH CREEK         |EJL MJL LJL MA |        |        |XXXSXXXPXXXXX    |        |        |        |        |
TSEAX RIVER               |EJL MJL LJL LA |        |        |XXXSXXXPXXXXXXXXX|        |        |        |        |
ZOLZAP CREEK              |               |        |        |        |        |        |        |        |        |
ZOLZAP SLOUGH             |               |        |        |        |        |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|
```

Fig. II Coho timing of spawning in Portland Canal, Observatory Inlet and Nass River sub-areas, Area 3.

```
STREAM                    |ARR ST  PK  END |  JUNE  |  JULY  |  AUG.  | SEPT.  |  OCT.  |  NOV.  |  DEC.  |  JAN.  |
--------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|
Portland Canal Subarea    |                |        |        |        |        |        |        |        |        |
                          |                |        |        |        |        |        |        |        |        |
BEAR RIVER                |MS  EO  MO  LD  |        |        |        |     XXXXXSXXPXXXXXXXXXXXXXXXXXXXXX|        |
BELLE BAY CREEK           |ES  LS  MO  MN  |        |        |        |XXXXXXXSXXXXPXXXXXXXXX    |        |        |
DOGFISH BAY CREEK         |                |        |        |        |        |        |        |        |        |
DONAHUE CREEK             |                |        |        |        |        |        |        |        |        |
GEORGIE RIVER             |LA  LS  EO  LO  |        |        |       XXXXXXXXXSXXPXXXXXX|        |        |        |
RAINEY CREEK              |MS  MO  LO  MD  |        |        |        |    XXXXXXXXSXXXPXXXXXXXXXXXXXX    |        |
ROBERSON CREEK            |ES  ES  LS  LO  |        |        |        |XSXXXXXPXXXXXXXXX|        |        |        |
                          |                |        |        |        |        |        |        |        |        |
Nass River Subarea        |                |        |        |        |        |        |        |        |        |
( Upper )                 |                |        |        |        |        |        |        |        |        |
                          |                |        |        |        |        |        |        |        |        |
ANLIYEN CREEK             |LS  EO  MO  LN  |        |        |        |       XXXSXPXXXXXXXXXXXXX|        |        |
ANSEDAGAN CREEK           |EO  MO  LO  MN  |        |        |        |        |XXXSXXXPXXXXX    |        |        |
BOWSER RIVER & LAKE       |MS  LS  MO  MD  |        |        |        |    XXXSXXXXXPXXXXXXXXXXXXXXXX     |        |
BROWN BEAR CREEK          |MS  MS  MO  LN  |        |        |        |    XSXXXXXXXPXXXXXXXXXXXX|        |        |
CRANBERRY RIVER           |MA  MS  EO  MN  |        |        |    XXXXXXXXSXXXXXXXXXXXXPXXXXX    |        |        |
DAMDOCHAX RIVER & LAKE    |LA  LS  MO  EN  |        |        |       XXXXXXXXXSXXXXPXXXXXX       |        |        |
DISKANGIEG CREEK          |MS  EO  MO  LN  |        |        |        |    XXXXXXSXPXXXXXXXXXXXXX|        |        |
GINGIT CREEK              |MS  LS  MO  MN  |        |        |        |    XXXSXXXXPXXXXXXXXX    |        |        |
GINLULAK CREEK            |ES  LS  MO  LN  |        |        |        |XXXXXXXSXXXXPXXXXXXXXXXXXX|        |        |
GITZYON CREEK             |MS  LO  MN  MJA |        |        |        |    XXXXXXXXXXXXSXXXXPXXXXXXXXXXXXXXXXXX    |
ISHKHEENICKH RIVER        |ES  MO  EN  ED  |        |        |        |XXXXXXXXXXXXSXXXXXXPXXXXXXXX       |        |
KINSKUTCH RIVER           |LA  LS  EO  EN  |        |        |       XXXXXXXXXSXXPXXXXXXXXX      |        |        |
KITEEN RIVER              |LA  EO  MO  MN  |        |        |       XXXXXXXXXXXXSXPXXXXXXXXX    |        |        |
KSEDIN CREEK              |MS  EO  MO  EN  |        |        |        |    XXXXXXSXPXXXXXXX      |        |        |
KWINAGEESE RIVER          |MS  MO  LO  LD  |        |        |        |    XXXXXXXXSXXXPXXXXXXXXXXXXXXXXXX|        |
KWINYARH CREEK            |LS  EO  MO  EN  |        |        |        |       XXXSXPXXXXXXX      |        |        |
KWINIAK RIVER             |EO  MO  EN  ED  |        |        |        |        |XXXSXXXXXXPXXXXXXXX       |        |
MCKNIGHT CREEK            |MS  MO  LO  LN  |        |        |        |    XXXXXXXXSXXXPXXX      |        |        |
MEZIADIN RIVER & LAKE     |LA  LS  MO  MD  |        |        |       XXXXXXXXXSXXXXPXXXXXXXXXXXXXXXXXX    |        |
NASS MAINSTEM             |EO  EN  MN  MD  |        |        |        |        |XXXXXXXXXXSXPXXXXXXXXX    |        |
OWEGIE CREEK & LAKE       |MS  LS  MO  LN  |        |        |        |    XXXSXXXXPXXXXXXXXXXXXX|        |        |
QUILGAUW CREEK            |MS  MO  EN  ED  |        |        |        |    XXXXXXXXSXXXXXXPXXXXXXXX       |        |
SEASKINNISH CREEK         |LA  LO  EN  LN  |        |        |       XXXXXXXXXXXXXXXXXXSXXPXXXXXX|        |        |
SNOWBANK  CREEK           |EO  LO  EN  ED  |        |        |        |        |XXXXXXXSXXPXXXXXXXX       |        |
TCHITIN RIVER             |                |        |        |        |        |        |        |        |        |
TEIGEN CREEK              |MS  MO  LO  EN  |        |        |        |    XXXXXXXXSXXXPXX       |        |        |
TSEAX RIVER               |LA  LO  EN  MJA |        |        |       XXXXXXXXXXXXXXXXXXSXXPXXXXXXXXXXXXXXXXXXXX    |
TSEAX SLOUGH              |MS  MO  LO  MJA |        |        |        |    XXXXXXXXSXXXPXXXXXXXXXXXXXXXXXXXXXXX    |
VAN DYKE CREEK            |MS  LS  EO  LN  |        |        |        |    XXXSXXPXXXXXXXXXXXXXXX|        |        |
VETTER CREEK & SLOUGH     |EO  MO  LO  MN  |        |        |        |        |XXXSXXXPXXXXX    |        |        |
WEGILADAP CREEK           |LA  MS  LS  LO  |        |        |       XXXXXSXXXPXXXXXXXXX|        |        |        |
WILYAYANOOTH CREEK        |EO  MO  LO  MN  |        |        |        |        |XXXSXXXPXXXXX    |        |        |
ZOLZAP CREEK              |MS  EO  LO  LN  |        |        |        |    XXXXXXSXXXXXPXXXXXXXXX|        |        |
ZOLZAP SLOUGH             |MS  MO  EN  LN  |        |        |        |    XXXXXXXXSXXXXXXPXXXXXX|        |        |
                          |                |        |        |        |        |        |        |        |        |
( Lower )                 |                |        |        |        |        |        |        |        |        |
                          |                |        |        |        |        |        |        |        |        |
CHAMBERS CREEK            |LS  LO  MN  LN  |        |        |        |       XXXXXXXXXSXXXXPXXXX|        |        |
IKNOUK RIVER              |ES  EN  MN  ED  |        |        |        |XXXXXXXXXXXXXXXXXXXSXPXXXXXX       |        |
KINCOLITH RIVER           |ES  MO  MN  ED  |        |        |        |XXXXXXXXXXXXSXXXXXXXXPXXXXXX       |        |
--------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|
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Fig. III   Coho timing of spawning in Portland Inlet, Work Channel and Coastal sub-areas, Area 3.

```
STREAM                     |ARR ST  PK  END  |  JUNE   |  JULY   |  AUG.   |  SEPT.  |  OCT.   |  NOV.   |  DEC.   |  JAN.   |
---------------------------|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|
Portland Inlet Subarea     |                 |         |         |         |         |         |         |         |         |
                           |                 |         |         |         |         |         |         |         |         |
KHUTZEYMATEEN RIVER        |LA  LO  MN  ED   |         |         |        XXXXXXXXXXXXXXXXXXXSXXXXPXXXXXX          |         |
KWINAMASS RIVER            |LJL LO  MN  LN   |         |       XXXXXXXXXXXXXXXXXXXXXXXXXXXXSXXXXPXXXXX|            |         |
LIZARD CREEK               |LS  MO  LO  LN   |         |         |         |        XXXXXSXXXPXXXXXXXXXX|          |         |
MANZANITA COVE CREEK       |EO  MO  LO  LN   |         |         |         |         |XXXSXXXPXXXXXXXXXX|          |         |
TSAMPANAKNOK BAY C.        |                 |         |         |         |         |         |         |         |         |
                           |                 |         |         |         |         |         |         |         |         |
Observatory Inlet Subarea  |                 |         |         |         |         |         |         |         |         |
                           |                 |         |         |         |         |         |         |         |         |
CASCADE CREEK              |                 |         |         |         |         |         |         |         |         |
ILLIANCE RIVER             |MS  MO  EN  MD   |         |         |         |    XXXXXXXXSXXXXXPXXXXXXXXXXXXX       |         |
KITSAULT RIVER             |ES  MO  MN  ED   |         |         |         |XXXXXXXXXXXXSXXXXXXXXPXXXXXX           |         |
KSHWAN RIVER               |ES  LS  MO  ED   |         |         |         |XXXXXXXSXXXXPXXXXXXXXXXXXXXXX          |         |
OLH CREEK                  |ES  EO  MO  MN   |         |         |         |XXXXXXXXXSXXPXXXXXXXXXX      |         |         |
SALMON COVE CREEK          |MS  EO  MO  MN   |         |         |         |    XXXXXSXXPXXXXXXXXXX      |         |         |
STAGOO CREEK               |LS  MO  MN  ED   |         |         |         |       XXXXXSXXXXXXXXPXXXXXX           |         |
WILAUKS CREEK              |ES  MO  MN  LN   |         |         |         |XXXXXXXXXXXXSXXXXXXXXPXXXX|            |         |
                           |                 |         |         |         |         |         |         |         |         |
Work Channel Subarea       |                 |         |         |         |         |         |         |         |         |
                           |                 |         |         |         |         |         |         |         |         |
ENSHESHESE RIVER           |ES  EN  LN  MD   |         |         |         |XXXXXXXXXXXXXXXXXXSXXXXXXPXXXXX        |         |
LACHMACH RIVER             |ES  EN  MN  ED   |         |         |         |XXXXXXXXXXXXXXXXXXSXXPXXXXXX           |         |
LEVERSON LAKE SYSTEM       |ES  LO  MN  ED   |         |         |         |XXXXXXXXXXXXXXXXSXXXXPXXXXXX           |         |
TOON RIVER                 |LA  MO  MN  ED   |         |         |        XXXXXXXXXXXXXXSXXXXXXXXPXXXXXX           |         |
                           |                 |         |         |         |         |         |         |         |         |
Coastal Subarea            |                 |         |         |         |         |         |         |         |         |
                           |                 |         |         |         |         |         |         |         |         |
BRUNDIGE CREEK             |LS  EO  MO  LN   |         |         |         |       XXSXXPXXXXXXXXXXXXX|            |         |
SANDY BAY CREEK            |LS  EO  MO  LN   |         |         |         |       XXSXXPXXXXXXXXXXXXX|            |         |
STUMAUN CREEK              |                 |         |         |         |         |         |         |         |         |
TRACY CREEK                |                 |         |         |         |         |         |         |         |         |
TURK CREEK                 |                 |         |         |         |         |         |         |         |         |
---------------------------|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|
```

Fig. IV Pink timing of spawning in Portland Canal, Observatory Inlet and Nass River sub-areas, Area 3.

```
STREAM                       |ARR ST  PK END  |   MAY   |  JUNE   |  JULY   |  AUG.   |  SEPT.  |  OCT.   |
-----------------------------|----------------|---------|---------|---------|---------|---------|---------|
Nass River Subarea           |                |         |         |         |         |         |         |
( Upper )                    |                |         |         |         |         |         |         |
                             |                |         |         |         |         |         |         |
ANSEDAGAM CREEK              |MA  MA  LA  ES  |         |         |         |     SPXXXXXXXXXXXX|         |
BROWN BEAR CREEK             |                |         |         |         |         |         |         |
CRANBERRY RIVER              |ES  MS  MS  LS  |         |         |         |         |XXXSPXXXX|         |
DISKANGIEG CREEK             |LA  ES  MS  LS  |         |         |         |         XXSXXPXXXX|         |
GINGIT CREEK                 |                |         |         |         |         |         |         |
GINLULAK CREEK               |                |         |         |         |         |         |         |
GITZYON CREEK                |                |         |         |         |         |         |         |
ISHKHEENICKH RIVER           |LJL MA  LA  ES  |         |         |        XXXXXSXXXPXX         |         |
KINSKUTCH RIVER              |                |         |         |         |         |         |         |
KSEDIN CREEK                 |EA  MA  MA  MS  |         |         |         |XXXSPXXXXXXXXX     |         |
KWINYARH CREEK               |                |         |         |         |         |         |         |
KWINYIAK RIVER               |                |         |         |         |         |         |         |
KITEEN RIVER                 |                |         |         |         |         |         |         |
MEZIADIN RIVER               |MA  LA  MS  EO  |         |         |         |     XXXSXXXXPXXXXXX         |
NASS MAINSTEM                |EJL EA  MA  ES  |         |         |XXXXXXXXXSXXPXXXXXX          |         |
SEASKINNISH CREEK            |EA  MA  LA  ES  |         |         |         |XXXSXXXPXX         |         |
SHUMAL CREEK                 |EA  LA  MS  EO  |         |         |         |XXXXXXXSXXXXPXXXXXXX         |
TSEAX RIVER                  |EA  LA  MS  EO  |         |         |         |XXXXXXXSXXXXPXXXXXXX         |
TSEAX SLOUGH                 |EA  MA  LA  ES  |         |         |         |XXXSXXXPXX         |         |
VETTER CREEK & SLOUGH        |MA  LA  ES  LS  |         |         |         |     XXXSXPXXXXXXXX|         |
WEGILADAP CREEK              |MA  LA  ES  MS  |         |         |         |     XSXPXXXXX     |         |
WILYAYAMOOTH CREEK           |MA  MA  LA  MS  |         |         |         |     SXXPXXXXX     |         |
ZOLZAP CREEK                 |MA  LA  ES  MS  |         |         |         |     XXXSXPXXX     |         |
ZOLZAP SLOUGH                |EA  MA  LA  ES  |         |         |         |XXXSXXXPXX         |         |
                             |                |         |         |         |         |         |         |
( Lower )                    |                |         |         |         |         |         |         |
                             |                |         |         |         |         |         |         |
BURTON CREEK                 |EA  EA  MA  MS  |         |         |         |XSXXPXXXXXXXXX     |         |
CHAMBERS CREEK               |LJL EA  LA  MS  |         |         |        XXSXXXXXXPXXXXX      |         |
PLEWIN CREEK                 |LJL EA  LA  ES  |         |         |        XXSXXXXXXPXX         |         |
IKNOUK RIVER                 |MJL EA  MA  MS  |         |         |     XXXXXSXXXPXXXXXXXX      |         |
KINCOLITH RIVER              |EJL EA  MA  MS  |         |         |XXXXXXXXXSXXXPXXXXXXXX       |         |
WELDA CREEK                  |EA  MA  LA  ES  |         |         |         |XXXXSXXPXX         |         |
                             |                |         |         |         |         |         |         |
Portland Canal Subarea       |                |         |         |         |         |         |         |
                             |                |         |         |         |         |         |         |
BEAR RIVER                   |EA  MA  ES  LS  |         |         |         |XXXSXXXXXPXXXXXXXXX|         |
BELLE BAY CREEK              |EA  MA  LA  MS  |         |         |         |XXXXSXXPXXXXX      |         |
DOGFISH BAY CREEK            |LJL EA  LA  MS  |         |         |        XXSXXXXXXPXXXXX      |         |
DONAHUE CREEK                |EA  EA  LA  MS  |         |         |         |SXXXXXXPXXXXX      |         |
GEORGIE RIVER                |EA  MA  LA  LS  |         |         |         |XXXXSXXPXXXXXXXXXXX|         |
ROBERSON CREEK               |EA  MA  LA  MS  |         |         |         |XXXXSXXPXXXXX      |         |
                             |                |         |         |         |         |         |         |
Portland Inlet Subarea       |                |         |         |         |         |         |         |
                             |                |         |         |         |         |         |         |
KHUTZEYMATEEN RIVER          |MJL EA  LA  MS  |         |         |     XXXXXSXXXXXXPXXXXX      |         |
KWINAMASS RIVER              |EJL LJL LA  LS  |         |         |XXXXXXXSXXXXXXXXPXXXXXXXXXXXX|         |
LIZARD CREEK                 |EA  MA  ES  MS  |         |         |         |XXXXSXXXXPXXX      |         |
MANZANITA COVE CREEK         |EA  MA  LA  ES  |         |         |         |XXXXSXXPXX         |         |
NASOGA GULF CREEK            |EA  MA  LA  ES  |         |         |         |XXXXSXXPXX         |         |
TSAMPANAKNOK BAY C.          |                |         |         |         |         |         |         |
-----------------------------|----------------|---------|---------|---------|---------|---------|---------|
```

Fig. V   Pink timing of spawning in Portland Inlet, Work Channel and Coastal sub-areas, Area 3.

```
STREAM                     |ARR ST  PK END|  MAY   |  JUNE  |  JULY  |  AUG.  |  SEPT. |  OCT.  |
---------------------------|--------------|--------|--------|--------|--------|--------|--------|
Observatory Inlet Subarea  |              |        |        |        |        |        |        |
                           |              |        |        |        |        |        |        |
CASCADE CREEK              |              |        |        |        |        |        |        |
ILLIANCE RIVER             |EA  MA  LA  MS|        |        |        |XXXXSXXPXXXXX    |        |
KITSAULT RIVER             |EA  MA  LA  LS|        |        |        |XXXXSXXPXXXXXXXXX|        |
KSHWAN RIVER               |EA  MA  LA  LS|        |        |        |XXXXSXXPXXXXXXXXX|        |
OLH CREEK                  |              |        |        |        |        |        |        |
PERRY BAY CREEK            |              |        |        |        |        |        |        |
SALMON COVE CREEK          |EA  MA  LA  MS|        |        |        |XXXXSXXPXXXXX    |        |
STAGOO CREEK               |EA  MA  LA  MS|        |        |        |XXXXSXXPXXXXX    |        |
WILAUKS CREEK              |EA  MA  LA  MS|        |        |        |XXXXSXXPXXXXX    |        |
                           |              |        |        |        |        |        |        |
Work Channel Subarea       |              |        |        |        |        |        |        |
                           |              |        |        |        |        |        |        |
ENSHESHESE RIVER           |LJL MA  LA  LS|        |        |       XXXXXXSXXPXXXXXXXXX|        |
LACHMACH RIVER             |LJL MA  LA  MS|        |        |       XXXXXXSXXPXXXXX    |        |
LEVERSON LAKE SYSTEM       |EA  EA  LA  MS|        |        |        |SXXXXXXPXXXXX    |        |
TOON RIVER                 |LJL MA  LA  MS|        |        |       XXXXXXSXXPXXXXX    |        |
                           |              |        |        |        |        |        |        |
Coastal Subarea            |              |        |        |        |        |        |        |
                           |              |        |        |        |        |        |        |
BRUNDIGE CREEK             |LA  LA  LA  LS|        |        |        |      SPXXXXXXXXX|        |
SANDY BAY CREEK            |LA  LA  LA  LS|        |        |        |      SPXXXXXXXXX|        |
STUMAUN BAY CREEK          |MA  MA  ES  LS|        |        |        |   XSXXXXPXXXXXXX|        |
TRACY CREEK                |LA  LA  MS  LS|        |        |        |       SXXXXXPXXX|        |
TURK CREEK                 |LA  LA  LA  LS|        |        |        |      SPXXXXXXXXX|        |
WHITLEY POINT CR.          |LA  LA  LA  LS|        |        |        |      SPXXXXXXXXX|        |
---------------------------|--------------|--------|--------|--------|--------|--------|--------|
```

Fig. VI Chum timing of spawning in Portland Canal, Observatory Inlet, Nass River, Portland Inlet, Work Channel and Coastal sub-areas, Area 3.

STREAM	ARR	ST	PK	END	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Nass River Subarea										
(Upper)										
ANSEDAGAN CREEK										
GINGIT CREEK										
GINLULAK CREEK										
GITZYON CREEK										
ISHKHEENICKH RIVER	EA	MA	LA	ES				XXXSXXXP	XX	
KSEDIN CREEK	EA	MA	LA	MS				XXXSXXXP	XXXXX	
KWINYARH CREEK										
KWINIAK RIVER										
NASS MAINSTEM	MS	LS	MO	LO					XXXXS	XXXXPXXXX
QUILGAUW CREEK										
SEASKINNISH CREEK										
TSEAX RIVER	ES	MS	LS	LO					XXXSXXXP	XXXXXXXXX
TSEAX SLOUGH	MS	LS	EO	LO					XXXXS	XPXXXXXXX
VETTER CREEK & SLOUGH	LA	LS	EO	LO				X	XXXXXXXXS	XPXXXXXXX
WEGILADAP CREEK										
WILYAYANOOTH CREEK	MA	LA	ES	LS				XXXS	XPXXXXXXX	
ZOLZAP CREEK	MA	LA	ES	MS				XXXS	XPXXX	
ZOLZAP SLOUGH	EA	LA	ES	LS				XXXXXXXS	XPXXXXXXX	
(Lower)										
BURTON CREEK	MA	MA	LA	ES				SPXX	XX	
CHAMBERS CREEK	LA	LA	MS	LS				S	XXXXPXXXX	
IKNOUK RIVER	MA	MA	MA	LS				SPXX	XXXXXXXXX	
KINCOLITH RIVER	LJL	EA	MA	MS			X	XSXXXPXXX	XXXXX	
Portland Canal Subarea										
BEAR RIVER	EA	ES	MS	LO				XXXXXXXX	XSXXPXXXX	
DOGFISH BAY CREEK										
DONAHUE CREEK	EA	MA	ES	LS				XXXSXXXX	XPXXXXXXX	
GEORGIE RIVER	LJL	LJL	MA	ES			XS	XXXXXPXXX	XX	
ROBERSON CREEK	EA	MA	MA	ES				XXXXSPXX	XX	
Portland Inlet Subarea										
KHUTZEYMATEEN R. {EARLY}	MJL	LJL	EA	MA			XXXS	XPXXXX		
{LATE}	MA	LA	ES	LS				XXXS	XPXXXXXXX	
KWINAMASS RIVER	EA	EA	MA	MS				SXXXPXXX	XXXXXX	
LIZARD CREEK										

Fig. VI cont. Chum timing of spawning in Portland Canal, Observatory Inlet, Nass River, Portland Inlet, Work Channel and Coastal sub-areas, Area 3.

STREAM	ARR	ST	PK	END	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Observatory Inlet Subarea										
CASCADE CREEK										
ILLIANCE RIVER	MJL	EA	MA	MS			XXXXXSXXXPXXXXXXXXX			
KITSAULT RIVER	EJL	EA	MA	MS			XXXXXXXXXSXXXPXXXXXXXXX			
KSHWAN RIVER	EA	MA	MS	LO				XXXXSXXXXXXXXPXXXXXXXXXXX		
OLH CREEK	MJL	LJL	MA	LA			XXXSXXXXXPXXX			
PERRY BAY CREEK	EA	MA	LA	ES				XXXXSXXPXX		
STAGOO CREEK	EJL	MA	LA	MS			XXXXXXXXXXXXXSXXPXXXXXX			
WILAUKS CREEK	LJL	EA	LA	EO			XXSXXXXXXPXXXXXXXXXXX			
Work Channel Subarea										
ENSHESHESE RIVER	MJL	EA	LA	MS			XXXXXSXXXXXXPXXXXXX			
LACHMACH RIVER	MA	LA	MS	LS				XXXSXXXXXPXXX		
LEVERSON LAKE SYSTEM	EA	MA	LA	MS				XXXXSXXPXXXXXX		
TOON RIVER	LJL	MA	LA	MS			XXXXXXSXXPXXXXXX			

Fig. VII Chinook timing of spawning in Portland Canal, Observatory Inlet, Nass River and Portland Inlet sub-areas, Area 3.

```
STREAM                     |ARR ST  PK END |  MAY   |  JUNE  |  JULY  |  AUG.  | SEPT.  |  OCT.  |  NOV.  |
---------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|
Nass River Subarea         |               |        |        |        |        |        |        |        |
( Upper )                  |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
BROWN BEAR CREEK           |               |        |        |        |        |        |        |        |
CRANBERRY RIVER            |MJU EA  MA  MS |        |   XXXXXXXXXXXXXXSXXXPXXXXXXXX     |        |        |
DAMDOCHAX RIVER            |EJL LA  ES  LS |        |        |XXXXXXXXXXXXXXXXSXPXXXXXXL|        |        |
GITZYON CREEK              |               |        |        |        |        |        |        |        |
HODDER CREEK               |               |        |        |        |        |        |        |        |
ISHKHEENICKH RIVER         |MJU LJL LAU LS |        |   XXXXXXXXXXXXSXXXXXXXXPXXXXXXXXX |        |        |
KINSKUTCH RIVER            |               |        |        |        |        |        |        |        |
KITEEN RIVER               |LJU EA  MA  ES |        |   XXXXXXXXXXXXXXSXXXPXXXXX        |        |        |
KWINAGEESE RIVER           |EA  LA  ES  LS |        |        |        |XXXXXXXSXPXXXXXXX|        |        |
MEZIADIN RIVER             |MJU LJL ES  MO |        |   XXXXXXXXXXXXSXXXXXXXXXXPXXXXXXXXXXXX     |        |
NASS RIVER                 |MJL EA  LA  LS |        |        |    XXXXXSXXXXXXPXXXXXXXXX|        |        |
OWEEGIE RIVER              |MA  ES  MS  LS |        |        |        |    XXXXXSXXXPXXX|        |        |
SALADAMIS CREEK            |EA  LA  ES  LS |        |        |        |XXXXXXXSXPXXXXXXX|        |        |
SEASKINNISH CREEK          |LJU LJL MA  MS |        |  XXXXXXXXXXXXXSXXXXXPXXXXXXXXXX   |        |        |
SNOWBANK CREEK             |EA  LA  ES  LS |        |        |        |XXXXXXXSXPXXXXXXX|        |        |
TCHITIN RIVER              |EA  LA  ES  LS |        |        |        |XXXXXXXSXPXXXXXXX|        |        |
TEIGEN CREEK               |MA  LA  ES  LS |        |        |        |    XXXSXPXXXXXXX|        |        |
TSEAX RIVER                |MJL ES  EO  MN |        |        |    XXXXXXXXXXXXXXSXXXXXXXXXPXXXXXXXXXXXXX  |
TSEAX SLOUGH               |ES  LS  EO  EN |        |        |        |        |XXXXXXXSXPXXXXXXXXX       |
ZOLZAP CREEK               |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
Nass River Subarea         |               |        |        |        |        |        |        |        |
( Lower )                  |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
CHAMBERS CREEK             |LJU  MJL EA LA |        |   XXXXXXXXXSXXXXPXXXXXXX |        |        |        |
IKNOUK RIVER               |               |        |        |        |        |        |        |        |
KINCOLITH RIVER            |EA  EA  MA  LA |        |        |        |SXXXPXXX|        |        |        |
                           |               |        |        |        |        |        |        |        |
Portland Canal Subarea     |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
DONAHUE CREEK              |LJU  MJL MA LA |        |   XXXXXXXXXSXXXXXXXXPXXX |        |        |        |
GEORGIE RIVER              |EJL  LJL MA LA |        |        |XXXXXXXSXXXXXPXXX|        |        |        |
                           |               |        |        |        |        |        |        |        |
Portland Inlet Subarea     |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
KHUTZEYMATEEN RIVER        |LJL MA  LA  MS |        |        |    XXXXXXXXXSXXPXXXXX    |        |        |
KWINAMASS RIVER            |MJU MA  LA  LS |        |   XXXXXXXXXXXXXXXXXSXXPXXXXXXXXX  |        |        |
                           |               |        |        |        |        |        |        |        |
Observatory Inlet          |               |        |        |        |        |        |        |        |
                           |               |        |        |        |        |        |        |        |
KITSAULT RIVER             |MJL LJL EA  LA |        |        |     XXSXPXXXXXXX|        |        |        |
---------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|
```

Fig. VIII   Salmon escapement timing by stream in Portland Canal and Observatory Inlet sub-areas, Area 3.

```
STREAM                     |ARR ST  PK  END |  MAY   |  JUNE  |  JULY  |  AUG.  | SEPT.  |  OCT.  |  NOV.  |  DEC.  |  JAN.  |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
Portland Canal Subarea     |                |        |        |        |        |        |        |        |        |        |
                           |                |        |        |        |        |        |        |        |        |        |
BEAR RIVER            COHO |MS  EO  MO  LD  |        |        |        |        |     XXXXXSXXPXXXXXXXXXXXXXXXXXXXXX|        |
                      PINK |EA  MA  ES  LS  |        |        |        |XXXSXXXXXPXXXXXXX|        |        |        |        |
                      CHUM |EA  ES  MS  LO  |        |        |        |XXXXXXXXXSXXPXXXXXXXXXXXXX|        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
BELLE BAY CREEK       COHO |ES  LS  MO  MN  |        |        |        |        |XXXXXXXSXXXXPXXXXXXXXX    |        |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXXSXXPXXXXX    |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
DOGFISH CREEK         PINK |LJL EA  LA  MS  |        |        |       XXSXXXXXXPXXXXX    |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
DONAHUE CREEK         PINK |EA  EA  LA  MS  |        |        |        |SXXXXXXPXXXXX    |        |        |        |        |
                      CHUM |EA  MA  ES  LS  |        |        |        |XXXSXXXXXPXXXXXXX|        |        |        |        |
                   CHINOOK |LJU MJL MA  LA  |        |        |       XXXXXSXXXXXXXXPXXXX|        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
GEORGIE RIVER         COHO |LA  LS  EO  LO  |        |        |        |       XXXXXXXXXSXPXXXXXXX|        |        |        |
                      PINK |EA  MA  LA  LS  |        |        |        |XXXXSXXPXXXXXXXXX|        |        |        |        |
                      CHUM |LJL LJL MA  ES  |        |        |       SXXXXXPXXXXX       |        |        |        |        |
                   CHINOOK |EJL LJL MA  LA  |        |        |        |XXXXXXXSXXXXPXXXX|        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
RAINEY CREEK          COHO |MS  MO  LO  MD  |        |        |        |        |    XXXXXXXXSXXXPXXXXXXXXXXXXXX    |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
ROBERSON CREEK        COHO |ES  ES  LS  LO  |        |        |        |        |XSXXXXXPXXXXXXXXX|        |        |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXXSXXPXXXXX    |        |        |        |        |
                      CHUM |EA  MA  MA  ES  |        |        |        |XXXSPXXXXX       |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
Observatory Inlet Subarea  |                |        |        |        |        |        |        |        |        |        |
                           |                |        |        |        |        |        |        |        |        |        |
ILLIANCE RIVER        COHO |MS  MO  EN  MD  |        |        |        |        |    XXXXXXXXSXXXXXPXXXXXXXXXXXX    |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXSXXXPXXXXX    |        |        |        |        |
                      CHUM |MJL EA  MA  MS  |        |        |   XXXXXSXXPXXXXXXXXXX    |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
KITSAULT RIVER        COHO |ES  MO  MN  ED  |        |        |        |        |XXXXXXXXXXXXSXXXXXXXXPXXXXXX       |        |
                      PINK |EA  MA  LA  LS  |        |        |        |XXXSXXXPXXXXXXXXX|        |        |        |        |
                      CHUM |EJL EA  MA  MS  |        |        |XXXXXXXXXSXXPXXXXXXXXXX   |        |        |        |        |
                   CHINOOK |MJL LJL EA  LA  |        |        |   XXXXSPXXXXXXXX|        |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
KSHWAN RIVER          COHO |ES  LS  MO  ED  |        |        |        |        |XXXXXXXXSXXXXPXXXXXXXXXXXXXX       |        |
                      PINK |EA  MA  LA  LS  |        |        |        |XXXSXXXPXXXXXXXXX|        |        |        |        |
                      CHUM |EA  MA  MS  LO  |        |        |        |XXXSXXXXXXXXXPXXXXXXXXXXXX|        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
OLH CREEK             COHO |ES  EO  MO  MN  |        |        |        |        |XXXXXXXXXSXXPXXXXXXXXX    |        |        |
                      CHUM |MJL LJL MA  LA  |        |        |    XXXSXXXXPXXXX|        |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
PERRY BAY CREEK       CHUM |EA  MA  LA  MS  |        |        |        |XXXSXXXPXXXXX    |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
SALMON COVE CREEK     COHO |MS  EO  MO  MN  |        |        |        |        |    XXXXXSXXPXXXXXXXXX    |        |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXSXXXPXXXXX    |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
STAGOO CREEK          COHO |LS  MO  MN  ED  |        |        |        |        |      XXXXXSXXXXXXXXXPXXXXXX       |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXSXXXPXXXXX    |        |        |        |        |
                      CHUM |EJL MA  LA  MS  |        |        |XXXXXXXXXXXXXSXXPXXXXXX   |        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
WILAUKS CREEK         COHO |ES  MO  MN  LN  |        |        |        |        |XXXXXXXXXXXXSXXXXXXXXPXXXX|        |        |
                      PINK |EA  MA  LA  MS  |        |        |        |XXXSXXXPXXXXX    |        |        |        |        |
                      CHUM |LJL EA  LA  EO  |        |        |       XXSXXXXXXPXXXXXXXXXX        |        |        |        |
---------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
```

Fig. II Salmon escapement timing by stream in Nass River sub-area, Area 3.

STREAM		ARR	ST	PK	END	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
Nass River Subarea (Upper)														
ANLIYEN CREEK	COHO	LS	EO	MO	LN					XXXSXPXXXXXXXXXXXX				
ANSEDAGAN CREEK	COHO	EO	MO	LO	MN						XXXSXXXPXXXXX			
	PINK	MA	MA	LA	ES				SPXXXXXXXXXX					
BOWSER RIVER & LAKE	SOC	MA	LA	MS	LO				XXXSXXXXPXXXXXXXXXXXX					
	COHO	MS	LS	MO	MD					XXXSXXXXXPXXXXXXXXXXXXXXX				
BROWN BEAR CREEK	SOC	MS	LS	MO	EN					XXXXSXXXXPXXXXXX				
	COHO	MS	MS	MO	LN					XSXXXXXXXPXXXXXXXXXXX				
CRANBERRY RIVER	COHO	MA	MS	EO	MN				XXXXXXXXSXXXXXXXXXXXXPXXXXX					
	PINK	ES	MS	MS	LS					XXXSPXXX				
	CHINOOK	MJU	EA	MA	MS		XXXXXXXXXXXXXSXXXPXXXXXXXX							
DAMDOCHAX RIVER & LAKE	SOC	LJL	ES	MS	LS			XXXXXXXXXXSXXXPXXX						
	COHO	LA	LS	MO	EN				XXXXXXXXXSXXXXPXXXXXX					
	CHINOOK	EJL	LA	ES	LS			XXXXXXXXXXXXXXXXSXPXXXXXXL						
DISKANGIEG CREEK	COHO	MS	EO	MO	LN					XXXXXSXPXXXXXXXXXXXX				
	PINK	LA	ES	MS	LS				XXSXXPXXXX					
GINGIT CREEK	SOCKEYE	MJL	MJL	LJL	LA			XSXPXXXXXXXXX						
	COHO	MS	LS	MO	MN					XXXSXXXXPXXXXXXXX				
GINLULAK CREEK	COHO	ES	LS	MO	LN					XXXXXXXSXXXXPXXXXXXXXXXX				
GITZYON CREEK	SOCKEYE	MJL	LJL	EA	ES			XXXSXPXXXXXXXXX						
	COHO	MS	LO	MN	MJA					XXXXXXXXXXXXSXXXXPXXXXXXXXXXXXXXXXX				
ISHKHEENICKH R.	COHO	ES	MO	EN	ED					XXXXXXXXXXXXSXXXXXXPXXXXXXXX				
	PINK	LJL	MA	LA	ES			XXXXXSXXXPXX						
	CHUM	EA	MA	LA	ES				XXXSXXXPXX					
	CHINOOK	MJU	LJL	LAU	LS		XXXXXXXXXXXSXXXXXXXXPXXXXXXXXX							
KINSKUTCH RIVER	COHO	LA	LS	EO	EN				XXXXXXXXXSXXPXXXXXXXXX					
KITEEN RIVER	COHO	LA	EO	MO	MN				XXXXXXXXXXXXSXPXXXXXXXXX					
	CHINOOK	LJU	EA	MA	ES		XXXXXXXXXXXXXXSXXXPXXXXX							
KSEDIN CREEK	COHO	MS	EO	MO	EN					XXXXXXSXPXXXXXXX				
	PINK	EA	MA	MA	MS				XXXSPXXXXXXXX					
	CHUM	EA	MA	LA	MS				XXXSXXXPXXXXX					
KWINAGEESE R.	SOCKEYE	EA	LA	ES	LS				XXXXXXXSXXPXXXXXXX					
	COHO	MS	MO	LO	LD					XXXXXXXXSXXXPXXXXXXXXXXXXXXXX				
	CHINOOK	EA	LA	ES	LS				XXXXXXXSXPXXXXXXX					
KWINYARH CREEK	COHO	LS	EO	MO	EN					XXSXXPXXXXXXX				

Fig. IX cont. Salmon escapement timing by stream in Nass River sub-area, Area 3.

STREAM		ARR	ST	PK	END	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
Nass River Subarea (Upper)														
KWINYIAK RIVER	COHO	EO	MO	EN	ED						XXXSXXXXXPXXXXXXXXX			
MCKNIGHT CREEK	COHO	MS	MO	LO	LN					XXXXXXXXSXXXPXXXXXXXXX				
MEZIADIN RIVER & LAKE	SOCKEYE	EJL	MJL	EO	MN			XXXSXXXXXXXXXXXXXXXXXXXXXXXXPXXXXXXXXXXX						
	COHO	LA	LS	MO	MD				XXXXXXXXXSXXXXPXXXXXXXXXXXXXXXXXX					
	PINK	MA	LA	MS	EO				XXXSXXXXPXXXXXX					
	CHINOOK	MJU	LJL	ES	MO		XXXXXXXXXXXSXXXXXXXXXPXXXXXXXXXXX							
NASS MAINSTEM	COHO	EO	EN	MN	MD						XXXXXXXXXSXXXPXXXXXXXX			
	PINK	EJL	EA	MA	ES			XXXXXXXXXSXXPXXXXXX						
	CHUM	MS	LS	MO	LO					XXXXSXXXXPXXXX				
	CHINOOK	MJL	EA	LA	LS			XXXXXSXXXXXXPXXXXXXXXX						
OWEGIE CREEK & LAKE	COHO	MS	LS	MO	LN					XXXSXXXXPXXXXXXXXXXXXX				
	CHINOOK	MA	ES	MS	LS				XXXXXSXXXPXXX					
QUILGAUW CREEK	COHO	MS	MO	EN	ED					XXXXXXXXSXXXXXPXXXXXXXXX				
SALADAMIS	CHINOOK	EA	LA	ES	LS				XXXXXXXSXPXXXXXXX					
SEASKINNISH CK.	SOCKEYE	EJL	MJL	LJL	MA			XXXSXXXPXXXXX						
	COHO	LA	LO	EN	LN				XXXXXXXXXXXXXXXXXXSXXPXXXXXX					
	PINK	EA	MA	LA	ES				XXXSXXXPXX					
	CHINOOK	LJU	LJL	MA	MS		XXXXXXXXXSXXXXXPXXXXXXXXXX							
SHUMAL CREEK	PINK	EA	LA	MS	EO				XXXXXXXSXXXXPXXXXXX					
SNOWBANK CREEK	COHO	EO	LO	EN	ED						XXXXXXXSXPXXXXXXXXX			
	CHINOOK	EA	LA	ES	LS				XXXXXXXSXPXXXXXXX					
TCHITIN CREEK	CHINOOK	EA	LA	ES	LS				XXXXXXXSXPXXXXXXX					
TEIGEN CREEK	COHO	MS	MO	LO	EN					XXXXXXXXSXXXPXX				
	CHINOOK	MA	LA	ES	LS				XXXSXPXXXXXXX					
TSEAX RIVER	SOCKEYE	EJL	MJL	LJL	LA			XXXSXXXPXXXXXXXXX						
	COHO	LA	LO	EN	MJA				XXXXXXXXXXXXXXXXXXSXXPXXXXXXXXXXXXXXXXXXX					
	PINK	EA	LA	MS	EO				XXXXXXXSXXXXPXXXXXX					
	CHUM	ES	MS	LS	LO				XXXSXXXPXXXXXXXXX					
	CHINOOK	MJL	ES	EO	MN			XXXXXXXXXXXXXSXXXXXXXPXXXXXXXXXXXX						
TSEAX SLOUGH	COHO	MS	MO	LO	MJA					XXXXXXXXSXXXPXXXXXXXXXXXXXXXXXXXXX				
	PINK	EA	MA	LA	ES				XXXSXXXPXX					
	CHUM	MS	LS	EO	LO					XXXXSXPXXXXXXX				
	CHINOOK	ES	LS	EO	EN				XXXXXXXSXPXXXXXXXXX					
VAN DYKE CREEK	COHO	MS	LS	EO	LN					XXXSXPXXXXXXXXXXXXXXX				

Fig. II cont.   Salmon escapement timing by stream in Nass River sub-area, Area 3.

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STREAM                    |ARR ST  PK END |  MAY   | JUNE   | JULY   | AUG.   | SEPT.  | OCT.   | NOV.   | DEC.   | JAN.   |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
Nass River Subarea        |               |        |        |        |        |        |        |        |        |        |
( Upper )                 |               |        |        |        |        |        |        |        |        |        |
                          |               |        |        |        |        |        |        |        |        |        |
VETTER CK & SLOUGH   COHO |EO  MO  LO  MN |        |        |        |        |        |XXXSXXXPXXXXX    |        |        |
                     PINK |MA  LA  ES  LS |        |        |        |    XXXSXPXXXXXXX|        |        |        |        |
                     CHUM |LA  LS  EO  LO |        |        |        |       XXXXXXXXXSXPXXXXXXX|        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
VEGILADAP CREEK      COHO |LA  MS  LS  LO |        |        |        |        XXXXXSXXXPXXXXXXXX|        |        |        |
                     PINK |MA  LA  ES  MS |        |        |        |    XXXSXPXXX    |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
VILYAYANOCTH CREEK   COHO |EO  MO  LO  MN |        |        |        |        |        |XXXSXXXPXXXXX    |        |        |
                     PINK |MA  MA  LA  MS |        |        |        |    SXXPXXXXX    |        |        |        |        |
                     CHUM |MA  LA  ES  LS |        |        |        |    XXXSXPXXXXXXX|        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
ZOLZAP CREEK         COHO |MS  EO  LO  LN |        |        |        |        |    XXXXXXSXXXXXPXXXXXXXXX|        |        |
                     PINK |MA  LA  ES  MS |        |        |        |    XXXSXPXXX    |        |        |        |        |
                     CHUM |MA  LA  ES  MS |        |        |        |    XXXSXPXXX    |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
ZOLZAP SLOUGH        COHO |MS  MO  EN  LN |        |        |        |        |    XXXXXXXXSXXXXXXPXXXXXX|        |        |
                     PINK |EA  MA  LA  ES |        |        |        |XXXSXXXPXX       |        |        |        |        |
                     CHUM |EA  LA  ES  LS |        |        |        |XXXXXXXSXPXXXXXXX|        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
                          |               |        |        |        |        |        |        |        |        |        |
Nass River Subarea        |               |        |        |        |        |        |        |        |        |        |
( Lower )                 |               |        |        |        |        |        |        |        |        |        |
                          |               |        |        |        |        |        |        |        |        |        |
BURTON CREEK         PINK |EA  EA  MA  MS |        |        |        |XXSXXPXXXXXXX    |        |        |        |        |
                     CHUM |MA  MA  LA  ES |        |        |        |    SXXPXX       |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
CHAMBERS CREEK       COHO |LS  LO  MN  LN |        |        |        |        |      XXXXXXXXXSXXXXPXXXX|        |        |
                     PINK |LJL EA  LA  MS |        |        |       XXSXXXXXXPXXXXX    |        |        |        |        |
                     CHUM |LA  LA  MS  LS |        |        |        |       SXXXXPXXXX|        |        |        |        |
                  CHINOOK |LJU MJL EA  LA |        |        |XXXXSXXXXPXXXXXXX|        |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
FLEVIN CREEK         PINK |LJL  EA  LA ES |        |        |       XXSXXXXXXPXX       |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
IKNOUK RIVER         COHO |ES  EN  MN  ED |        |        |        |        |XXXXXXXXXXXXXXXXXXXSXPXXXXXX       |        |
                     PINK |MJL EA  MA  MS |        |        |    XXXXXSXXXPXXXXXXXX    |        |        |        |        |
                     CHUM |MA  MA  MA  LS |        |        |        |     SPXXXXXXXXXX|        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
KINCOLITH RIVER      COHO |ES  MO  MN  ED |        |        |        |        |XXXXXXXXXXXXSXXXXXXXXPXXXXXX       |        |
                     PINK |EJL EA  MA  MS |        |        |XXXXXXXXXSXXXPXXXXXXXX    |        |        |        |        |
                     CHUM |LJL EA  MA  MS |        |        |       XXSXXXPXXXXXXXX    |        |        |        |        |
                  CHINOOK |EA  EA  MA  LA |        |        |         SXXXPXXX|        |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
VELDA CREEK          PINK |EA  MA  LA  ES |        |        |        |XXXXSXXPXX       |        |        |        |        |
--------------------------|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
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Fig. I Salmon escapement timing by stream in Portland Inlet, Work Channel and Coastal sub-areas, Area 3.

STREAM		ARR	ST	PK	END	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
Portland Inlet Subarea														
KHUTZEYMATEEN R.	COHO	LA	LO	MN	ED				IIIIIIIIIIIIIIIIISIIIIPIIIIII					
	PINK	MJL	EA	LA	MS			IIIIISIIIIIIPIIIII						
	EARLY CHUM	MJL	LJL	EA	MA			IIISIPIIII						
	LATE CHUM	MA	LA	ES	LS				IIISIPIIIIIIII					
	CHINOOK	LJL	MA	LA	MS			IIIIIISIIPIIIII						
KWINAMASS RIVER	COHO	LJL	LO	MN	LN			IIIIIIIIIIIIIIIIIIIIIIIIIIISIIIIPIIII						
	PINK	EJL	LJL	LA	LS			IIIIIIISIIIIIIIPIIIIIIIII						
	CHUM	EA	EA	MA	MS				SIIIPIIIIIIIII					
	CHINOOK	MJU	MA	LA	LS		IIIIIIIIIIIIIIIIIISIIPIIIIIIIIII							
LIZARD CREEK	COHO	LS	MO	LO	LN					IIIIISIIIPIIIIIIIII				
	PINK	EA	MA	ES	MS				IIIISIIIIPIII					
MANZANITA COVE CREEK	COHO	EO	MO	LO	LN						IIISIIIPIIIIIIIII			
	PINK	EA	MA	LA	ES				IIIISIIPII					
NASOGA GULF CREEK	PINK	EA	MA	LA	ES				IIIISIIPII					
Work Channel Subarea														
ENSHESHESE RIVER	COHO	ES	EN	LN	MD					IIIIIIIIIIIIIIIIIISIIIIIIPIIIII				
	PINK	LJL	MA	LA	LS			IIIIISIIIPIIIIIIIII						
	CHUM	MJL	EA	LA	MS			IIIIISIIIIIIPIIIIII						
LACHMACH RIVER	COHO	ES	EN	MN	ED					IIIIIIIIIIIIIIIIIISIIPIIIIIII				
	PINK	LJL	MA	LA	MS			IIIIISIIIPIIIII						
	CHUM	MA	LA	MS	LS				IIISIIIIIPIII					
LEVERSON LAKE SYS.	CO	ES	LO	MN	ED					IIIIIIIIIIIIIIIISIIIIPIIIIIII				
	PINK	EA	EA	LA	MS				SIIIIIIPIIIII					
	CHUM	EA	MA	LA	MS				IIIISIIPIIIIII					
TOON RIVER	COHO	LA	MO	MN	ED				IIIIIIIIIIIIISIIIIIIIIPIIIIII					
	PINK	LJL	MA	LA	MS			IIIIIISIIPIIIII						
	CHUM	LJL	MA	LA	MS			IIIIIISIIPIIIIII						
Coastal Subarea														
BRUNDIGE CREEK	COHO	LS	EO	MO	LN					IISIIPIIIIIIIIIIIIII				
	PINK	LA	LA	LA	LS				PIIIIIIIII					
SANDY BAY CREEK	COHO	LS	EO	MO	LN					IISIIPIIIIIIIIIIIII				
	PINK	LA	LA	LA	LS				PIIIIIIIII					
STUMAUN BAY CREEK	PINK	MA	MA	ES	LS				SIIIIIPIIIIIIII					
TRACY CREEK	PINK	LA	LA	MS	LS				SIIIIIPIII					
TURK CREEK	PINK	LA	LA	LA	MS				PIIIII					
WHITLEY POINT CR.	PINK	LA	LA	LA	MS				ISIIPIIIII					

Target Escapements

What are Target Escapements?

Target escapements are based on subjective evaluation of spawning capacity. In the case of sockeye, coho and chinook, rearing capacity may also have to be considered. Escapement targets can be established by considering:

1. long term escapements
2. escapement extremes
3. distribution and density for specific years, especially extremes. (This often involves contacting predecessors).
4. habitat capacity (from habitat inventories).

Optimum escapement is a term that has a very rigid biological definition. Optimums have not been defined for any stock, although they have been estimated in some cases where enough research has been carried out to be able to identify a range within which the optimum likely lies. Target escapements on the other hand can be identified and agreed upon subjectively, without any prejudice about optimum escapement. In many cases, the target escapement may in fact be an approximation of the optimum, but should never be construed as or confused with the optimum escapement.

An escapement target should infer an acceptable range from slightly over to slightly under the target. If the target is viewed as a top-end number, chances of hitting below target will always be greater. This can only lead to a long, slow downward trend.

Why do we have Target Escapements?

Escapement targets are a necessary component of salmon management, especially where that salmon management is governed by the philosophy of the Adaptive Management System (AMS). The target serves as the goal for managing the fishery. Without a firm target to serve as something to strive for, the whole concept of AMS (do it, evaluate it and fix it) breaks down, because there is nothing to evaluate.

There is little point in discussing why we need fish to escape, but it is important to remember the basic concepts of Stock and Recruitment. At low escapement levels, there are a number of factors that contribute to low average production (in returning adults in the next generation) from each pair of spawners. At some high level of escapement, there are a different set of factors that act to reduce the average production from each spawning pair. Somewhere in between, there is a point where production per spawner is at its maximum. One of the principle objectives in setting targets is to try to approximate the escapement that most often will maximize production. There are other factors that can intercede in setting targets, such as social requirements and mixed stock fishery implications, but, maximizing production should be foremost.

Altering or Adjusting Escapement Targets

It is most probable, and indeed desireable, that escapement targets will undergo some adjustments over time. They will have to remain flexible to accomodate improved knowledge (especially habitat capacities or productivity rates) or changes in priorities, etc.. This is the heart of the Adaptive Management System. However, there must be a formal mechanism developed in order to initiate change (consultative process with Fishery Officer, Supervisor, and Management Biologist). In other words, haphazard changes are not acceptable within the AMS.

One idea that may have some merit as a formal mechanism to initiate and manage the setting of escapement targets is to treat the entire process as an experiment. Following prescribed scientific procedure, the process of changing targets would be carried out to test the hypothesis that escapements at the new level will produce at a higher rate than at the old level. This process can work both to raise and lower targets, with the principle objective always being to increase average production per spawner. If the hypothesis is shown to be false (ie. there is no evidence that the average production has decreased since the change), then the previous target should be restored or a new one chosen, with the same hypothesis in place. Because such experiments may take some time to show results, it is essential that they be documented clearly and thoroughly in the Records of Management Strategies.

HRMCN
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