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A Preliminary Assessment of Canadian Enhanced Salmon Production,
1974 - 1990

by

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Introduction

The existing salmon enhancement projects in British Columbia began with spawning channels in the 1960's and the first routine hatchery operation in 1971. The Salmonid Enhancement Program (SEP) was started in 1977 with the intent of rebuilding stocks and increasing catch through the expanded use of enhancement technology. Today SEP operates approximately 281 projects including hatcheries, spawning and rearing channels, fishways, flow control works and lake fertilization.

The projects range widely in their production capacity and in the way in which they are run. Many of the smaller projects are operated by public volunteers under the direction of SEP staff, whereas large projects are operated by SEP staff. Methods used to assess projects vary by species of salmon, technology, and size.

Biological assessment of SEP production includes survival during spawning, incubation and rearing, and the survival of juvenile fish released measured as their contribution to the catch and the spawning escapement. This report describes methods used in British Columbia to estimate catch and escapement of enhanced stocks. Data are provided for the enhancement program as a whole and for one stock (Quinsam hatchery chinook, Oncorhynchus tshawytscha) in more detail. This paper provides one possible format for further exchange of enhancement information under NPAFC. It is hoped that more detailed exchanges will occur in the future.

Methods Used to Estimate Catch and Spawning Escapement

The current methods of choice for estimating the production (catch and escapement) of enhanced salmon stocks are juvenile mark/adult recovery studies for chinook, coho (O. kisutch), pink (O. gorbuscha) and chum (O. keta), and stock reconstruction analyses for sockeye (O. nerka). Mark recovery studies are often designed to permit comparison of different rearing or experimental strategies as well as to estimate production (for examples see Cross and Perry, 1985). Attempts are made to assess all major stocks routinely using the method of choice, but some enhancement projects are rarely or never assessed using these methods. In these cases, indirect methods are used. Production estimates are made for all projects. The estimates are of variable reliability as described below.

Chinook and Coho

For chinook and coho, a portion of the juveniles from each major group of fish is marked for later identification and recovery as adults in the catch and escapement. The marked fish are assumed to represent the unmarked fish from these large production groups. Smaller experimental groups may also be marked to assess various rearing strategies within a project. The mark consists of a uniquely coded wire tag introduced internally and an external (visible) fin clip. A proportion of all chinook and coho fisheries is then sampled for marked fish as part of the Mark Recovery Sampling Program, a rigorous coast-wide sampling program with Canada - U.S. data exchange agreements. Data quality are discussed by Cross et al., (1991). The resultant data allow calculation of catch for individual groups of fish in specific fisheries (ocean and fresh water), by gear type, date, and country (Kuhn, 1988;

Kuhn et al., 1988). The escapement of hatchery fish is estimated through counting and sampling returning fish with fences and extensive mark-recapture studies or during brood stock capture (Cross et al., 1991).

Most chinook released are represented by a marked group while for coho, marking at some of the smaller hatcheries or channels has never been done or done only infrequently. As well, some stages of release are typically not marked. In these instances, catch and escapement are estimated from data generated by marked groups from nearby facilities.

Chum and Pink

Major hatchery adult chum production is also determined from recovery of fish marked as fry in the catch and in the escapement. Marks, however, can either be fin clips or coded-wire tags. For chum marked with coded-wire tags, the mark recovery process and data outputs described for chinook and coho are generally applicable. Assessments based on finclip marks are similar in principle to coded-wire tag studies but usually require an independent age estimate based on scale reading. Adult production estimates for projects not assessed by mark recovery are based on the major hatchery mark recovery information.

For pink salmon, a portion of the release for select stocks may be finclipped for recovery in the fishery and the escapement or in some cases, for recovery in only the escapement because the large number of unmarked adults in the catch renders catch sampling impractical. Generally pink fry are too small to be coded-wire tagged. Sampling considerations are similar to chum. For finclipped groups, stock reconstruction techniques are similar to chum but with no requirement for an independent estimate of age (since all pinks are age 2). The survival and exploitation rates for total Fraser pink production have been used to estimate enhanced production of Fraser channels. Because consistent marking has been confined to only two facilities, pink salmon adult production for other unmarked facilities is calculated using long-term survival rates and estimated exploitation rates.

Sockeye

Production of sockeye is enhanced through the use of lake enrichment and spawning channels. The assessment strategy to quantify the incremental benefits from lake enrichment involves intensive monitoring of size and abundance of juveniles, catch, and escapement for selected index lakes. Production increases result from improved in-lake survival of juvenile sockeye, and from improved marine survival due to increased juvenile size.

Assessment of spawning channels involves partitioning total adult returns into returns from sockeye that spawn naturally in the stream system and returns from sockeye that spawn in the channel. Coded-wire tags and fin clips are used in a few instances to evaluate rearing and release strategies and the effects of time and size at release of juveniles on marine survival, but marking is not used as a routine assessment technique.

Assessment Data Quality

Type 1.

Assessment data for chinook, coho, pink, and chum salmon facilities which have good quality catch and escapement data are classified as Type 1, the highest quality data. These are typically facilities where groups of fish have been consistently marked as juveniles so that they can be identified as adults. For these sites, we have also estimated the escapement of hatchery fish by counting and sampling most of the returning fish for marks with fences or extensive mark-recapture studies. Marked fish in both the catch and escapement are then used to indicate the survival and distribution of unmarked fish from the same group released from the same site.

Selected sites with good quality catch and escapement data are designated as "look-up" facilities. Their data are used as-is or with site-specific fisheries removed to represent facilities or areas in the same production region with less complete data.

For pink salmon, fry releases from Fraser River channels have been enumerated but not marked. Studies on chum have shown channel fry to have equal survivals to wild fry and this is assumed to also apply to pink salmon. Because good fry release, catch, and escapement data are available for the total Fraser pink stock, these data were used to estimate pink channel contribution, and quality of the data is considered to be Type 1 quality.

There are no Type 1 data for sockeye salmon because there are no production releases of sockeye fry marked with coded wire tags or finclips.

Type 2.

These are production estimates for chinook and coho facilities where groups of fish have been marked and for which we have good catch data, but incomplete or inconsistent escapement data. We use catch rate data from the "look-up" facility (Type 1) for the area to estimate the escapement and then combine the result with actual catch data to obtain the total production rate and related parameters.

Assessments of some sockeye salmon spawning channels and index systems for the lake enrichment program are also classed as Type 2 quality. For spawning channels with estimates of fry production, natural spawners, and adult returns, regression analysis is used to calculate the contributions to total adult returns from the natural and enhanced components. Annual stock-specific exploitation rates are used to calculate catches and escapement. Estimates of enhanced production are considered conservative. Sockeye production estimates for lake enrichment index systems are based on accurate catch and escapement data collected using standardized procedures.

There are no Type 2 facilities for chum and pink because the terminal nature of their fisheries makes it difficult for one facility to represent another.

Type 3.

These represent estimates for facilities where the number of fish released is known but where fish are not normally marked, including releases from facilities where fish are seldom marked, and unmarked releases from facilities where marking is done but not representative of some unmarked fish. There are

Type 3 facilities for all five of the enhanced species. For such facilities, all unmarked releases from a geographic area are summed by release stage and then multiplied by an average survival rate from "look-up facility(s)" in the same region to generate a total number of expected adults. This expected number of adults is then divided into fisheries and escapement based on data from the "look-up" facility for that area. Where no suitable "look-up" facility exists, long term survival rates and overall fishery or stock-specific exploitation rate data are used.

Type 4.

Sockeye spawning channel projects which only have data on abundance of adult spawners are classed Type 4. Average egg-to-fry, and fry-to-adult survival rates are used to estimate returns from spawner counts. Annual stock-specific or average production area age composition and exploitation rates are used to calculate catches and escapement.

All sockeye lake enrichment projects which are not index systems are considered Type 4. These are systems for which catch and escapement are not accurately assessed. Total returns are estimated by multiplying pre-smolt abundance estimates by average smolt to adult survival, and net production due to enrichment is calculated as 50% of the total returns. Average age composition and exploitation rates for each production area are used to calculate catches and escapements.

Preliminary Assessment Results

Assessment of enhanced projects involves the evaluation of survival and production for each species and release stage by brood year or catch year. Data outputs for assessment include survival rates by mark group; by brood year and release stage within a facility; and by brood year and release stage for the program overall. Also included is production of enhanced fish to the catch (by gear) and escapement for each facility and the program, and comparative data for enhanced and total catch.

Release data are utilized as a component of survival assessment and on their own to show program development and trends. Data are typically summarized by species and release stage for each brood year and can be presented for the program as a whole (Table 1) or for individual facilities. Total juvenile salmon released doubled from 341 million to 681 million from the 1977 to the 1990 brood year. Chum salmon accounted for the largest increase.

Table 2 summarizes enhanced production by catch year and species. The data represent the number of fish of enhanced origin which were recovered in each stratum. In 1990, the production of enhanced salmon was 7.4 million fish of which 3.8 million were taken in Canadian commercial fisheries, 0.30 million in Canadian sport fisheries, 0.24 million in U.S. fisheries, while 3.0 million escaped. Pink and chum were numerically dominant in 1990. Table 3 provides a comparison of the total and the enhanced catch for one example species, chum. Enhanced chum now comprise about one-third of the total catch of chum salmon in British Columbia.

Survival rates are assessed from release to recovery. They are calculated for each marked release group and then extrapolated to unmarked groups or unsampled recovery strata using the methods described in the methods section. Results can be presented for the program overall (Table 4), by facility (Table 5, chinook at Quinsam hatchery, located near Campbell River on the east coast of Vancouver Island) or by release group. For brood years 1978 through 1986/87 survival of chinook juveniles has decreased while survival of coho juveniles has been fairly stable or decreased slightly. For the same period, chum survival increased then decreased but remained high compared to the 1978 to 1980 broods, and pink salmon survival has increased (Table 4). Survival of Quinsam hatchery chinook declined steeply from the mid 1970's to the mid 1980's (Table 5).

Table 5 provides a format that is useful for summarizing production results for individual facilities. It identifies, by brood year, the number of fish released, the catch in major fishery sectors, the escapement for all age classes and the survival rates. Table 6 offers a more detailed production summary format than Table 5, with more information on recoveries and age composition.

SEP undertakes a broad range of roles associated with the collection and evaluation of information on enhanced salmon production in British Columbia. A variety of assessments are currently underway to evaluate trends in these facilities. Results will be made available in future years.

Table 1. Releases of juveniles from SEP facilities in British Columbia, Canada.

Brood Year	Chinook	Socketeye *	Pink Unfed	Pink Fed	Chum Unfed	Chum Fed	Coho Fry	Coho Smolts	Total
1977	13,583,185	237,762,000	31,029,220	0	52,127,027	1,904,625	2,073,819	2,908,832	341,388,708
1978	14,253,404	188,431,000	0	0	48,958,030	5,535,566	1,046,721	3,510,051	261,734,772
1979	16,379,080	258,121,521	26,145,904	358,639	73,460,748	9,191,947	3,755,519	4,980,454	392,393,812
1980	19,846,183	236,318,400	4,705,834	1,859,631	76,642,961	29,684,300	2,449,038	5,270,862	376,777,209
1981	17,564,755	293,409,370	33,113,088	492,440	60,912,404	68,980,710	7,310,922	4,949,674	486,733,363
1982	24,841,721	278,236,919	2,510,301	423,038	97,034,872	69,365,130	10,811,938	6,944,312	490,168,231
1983	29,374,066	182,830,333	27,341,916	1,521,896	92,812,067	85,579,589	8,973,671	13,627,953	442,061,491
1984	34,864,768	294,796,975	3,783,368	2,296,285	63,995,445	103,779,630	13,208,001	12,103,672	528,828,144
1985	42,736,623	225,980,555	26,182,597	5,057,021	55,769,394	102,049,394	9,292,291	9,854,521	476,922,396
1986	53,815,001	253,106,498	17,026,335	4,509,098	107,035,482	85,842,800	11,904,360	10,206,414	543,445,988
1987	63,693,726	163,009,013	44,781,230	4,807,689	120,697,363	75,979,591	8,145,251	9,663,322	490,777,185
1988	64,553,624	261,766,751	34,245,812	2,827,349	137,717,352	87,928,664	8,523,144	11,319,111	608,881,807
1989	63,543,105	257,749,211	49,796,430	2,797,031	105,888,519	92,855,759	10,710,097	11,908,918	595,249,070
1990	66,555,822	285,719,149	91,606,634	927,396	119,816,231	94,759,699	9,246,335	12,408,103	681,039,369

Data for 1991 and 1992 brood years are not included as releases are not yet complete.

* includes lake enrichment projects

Table 2. Recovery components of SEP production in British Columbia, Canada.

Catch Year	Coho				Chinook				Chum			
	Commercial	Sport	Escapement	U.S.	Commercial	Sport	Escapement	U.S.	Commercial	Sport	Escapement	U.S.
82	170,531	110,284	123,731	16,404	103,916	28,492	25,918	53,478	255,354	0	313,933	0
83	241,175	104,204	152,058	9,396	93,544	32,175	24,611	57,421	135,357	0	407,723	0
84	207,752	91,029	173,970	10,156	90,581	40,532	38,899	46,214	415,771	0	476,991	0
85	280,176	246,390	218,977	34,899	56,169	29,658	74,763	35,243	1,892,829	0	1,384,648	0
86	572,930	216,702	297,604	60,081	49,625	37,091	56,367	23,197	1,328,907	0	893,761	0
87	397,380	319,639	436,956	56,708	46,595	31,164	82,286	29,992	839,894	0	600,108	0
88	324,950	400,958	303,088	34,404	56,153	32,674	128,201	46,818	2,385,804	0	830,038	0
89	363,991	226,414	301,006	65,725	102,580	57,372	163,483	64,539	655,584	0	915,541	0
90	533,838	245,382	399,359	48,822	135,163	57,008	211,982	100,237	1,028,577	0	997,858	0

Year	Pink				Sockeye				All Species			
	Commercial	Sport	Escapement	U.S.	Commercial	Sport	Escapement	U.S.	Commercial	Sport	Escapement	U.S.
82	45,931	0	31,141	0	827,688	0	685,119	128,459	1,403,420	138,776	1,179,842	198,341
83	438,811	0	236,172	78,913	826,928	0	694,166	133,554	1,735,815	136,379	1,514,730	279,284
84	50,304	0	20,957	0	948,507	0	602,823	159,673	1,712,915	131,561	1,313,640	216,043
85	378,113	0	262,114	138,365	819,148	0	661,376	130,501	3,426,435	276,048	2,601,878	339,008
86	292,780	0	236,606	0	902,255	0	710,352	145,799	3,146,497	253,793	2,194,690	229,077
87	616,560	0	382,565	92,757	825,983	0	747,646	133,586	2,726,412	350,803	2,249,561	313,043
88	345,313	0	332,018	0	899,527	0	760,879	130,363	4,011,747	433,632	2,354,224	211,585
89	1,735,978	0	662,945	165,117	508,628	0	681,871	99,471	3,366,761	283,786	2,724,846	394,852
90	1,697,837	0	911,547	0	452,213	0	514,061	90,423	3,847,628	302,390	3,034,807	239,482

Table 3. Total chum commercial and enhanced catch in British Columbia, Canada.

Catch Year	Total Catch	Enhanced Catch	Percent Enhanced
1982	2,974,848	255,354	8.58
1983	1,005,661	135,357	13.46
1984	1,850,797	415,771	22.46
1985	5,492,723	1,892,829	34.46
1986	5,580,498	1,328,907	23.81
1987	2,298,501	839,894	36.54
1988	6,189,340	2,385,804	38.55
1989	1,820,522	655,584	36.01
1990	3,221,341	1,028,577	31.93

Table 4. Average percent release to recovery survival by species and release stage for projects in British Columbia, Canada.

Brood Year	Pink	Chinook	Chum	Coho	
				Smolts	Fed Fry
1978	1.5	1.5	.7	10.4	2.2
1979	5.2	1.3	.7	8.2	3.0
1980	1.2	1.0	.5	8.6	1.9
1981	2.3	1.2	2.4	8.0	1.2
1982	2.4	.8	1.6	9.3	1.0
1983	2.7	.5	.7	6.5	1.0
1984	8.7	1.0	1.9	8.0	.9
1985	3.5	.7	.9	9.8	1.2
1986	3.6	.9	.8	7.6	1.0
1987	5.2	N/A	N/A	8.0	1.2

N/A - not available as recoveries are not yet complete for 5 year old fish

Table 5. Assessment data summary for Quinsam chinook, British Columbia, Canada.

Brood Year	Number Released	Canadian Comm. Catch	Canadian Sport Catch	Canadian Escapement	Total Canadian	U.S. Catch	Total Overall	Average Survival (%)
1974	162516	2184	418	1383	3985	622	4607	2.8
1975	424567	1525	174	1094	2793	74	2867	.7
1976	376480	5763	1359	2169	9291	1774	11065	2.9
1977	776387	3432	832	922	5186	2144	7330	.9
1978	849226	6962	1173	2215	10350	2230	12580	1.5
1979	1081433	3575	492	1434	5501	2502	8003	.7
1980	1136778	4370	1466	3023	8859	2103	10962	1.0
1981	765464	5385	1068	4159	10612	4502	15114	2.0
1982	1093278	4963	1227	3766	9956	2857	12813	1.2
1983	1446870	6371	1477	4747	12595	1907	14502	1.0
1984	3156571	14027	3364	17675	35066	6838	41904	1.3
1985	2987456	3007	1235	4548	8790	1709	10499	.4
1986	3309673	7763	2589	9771	20123	4295	24418	.7

Table 6. Mean brood year survival weighted by number tagged for Quinsam chinook.
 (Abbreviations: IFF = Indian Food Fish, FW = Fresh Water, Hatch = Hatchery, Nat = Natural)

QUINSAM RIVER		CHINOOK				STOCK: ALL												TOTAL	% SURV
RELEASE INFORMATION	RECOV AGE	WEST COAST		NORTH CENTRAL		INSIDE		WASH ORG	ALASKA	TOTAL MARINE CATCH	FRESH SPORT	IFF	TOTAL FW CATCH	ESCAPEMENT					
		VAN	ISLAND	COMM	SPT	COMM	SPT	COMM	SPT					HATCH	NAT	TOTAL			
Brood Year 1974																			
		2	0	0	156	0	23	158	0	0	337	0	0	0	0	0	337	0.2	
Tagged:	65683	3	0	0	1022	0	135	103	0	64	1324	0	0	0	32	0	32	1356	0.8
Total:	162516	4	12	0	281	0	112	51	0	324	781	0	0	0	45	237	281	1062	0.7
		5	0	0	328	30	78	76	0	194	706	0	0	0	140	916	1056	1762	1.1
		6	0	0	21	0	17	0	0	39	76	0	0	0	8	6	14	91	0.1
		Tot	12	0	1807	30	365	388	0	622	3225	0	0	0	224	1160	1383	4608	2.8
Brood Year 1975																			
		2	0	0	191	0	15	17	0	0	223	0	0	0	0	0	0	223	0.1
Tagged:	99167	3	0	0	552	0	122	35	0	0	708	0	0	0	0	0	0	708	0.2
Total:	424567	4	0	0	288	17	9	19	0	34	367	0	0	0	35	835	870	1237	0.3
		5	0	0	220	0	121	69	0	40	451	0	0	0	61	162	223	674	0.2
		6	0	0	7	17	0	0	0	0	24	0	0	0	0	0	0	24	0.0
		Tot	0	0	1258	34	267	140	0	74	1773	0	0	0	96	997	1094	2867	0.7
Brood Year 1976																			
		2	31	0	640	16	349	113	0	0	1148	0	0	0	0	0	0	1148	0.3
Tagged:	97123	3	0	0	1486	155	291	100	0	432	2465	0	0	0	48	12	59	2524	0.7
Total:	376480	4	0	0	1537	211	346	260	0	918	3271	0	0	0	320	487	807	4079	1.1
		5	34	19	716	31	311	455	0	394	1960	0	0	0	255	1017	1272	3232	0.9
		6	0	0	13	0	9	0	0	30	52	0	0	0	7	23	30	82	0.0
		Tot	65	19	4392	412	1306	928	0	1774	8896	0	0	0	630	1539	2169	11065	2.9
Brood Year 1977																			
		2	0	0	482	19	166	111	0	0	778	0	0	0	0	0	0	778	0.1
Tagged:	152518	3	13	0	851	32	154	72	0	1364	2485	0	0	0	37	0	37	2522	0.3
Total:	776387	4	0	0	842	40	214	194	0	509	1799	0	0	0	39	156	195	1994	0.3
		5	23	0	446	116	229	248	0	271	1332	0	0	0	121	569	690	2022	0.3
		6	0	0	13	0	0	0	0	0	13	0	0	0	0	0	0	13	0.0
		Tot	36	0	2634	207	762	625	0	2144	6407	0	0	0	197	725	922	7329	0.9
Brood Year 1978																			
		2	0	0	1016	117	119	37	0	0	1289	0	0	0	10	0	10	1298	0.2
Tagged:	97316	3	0	0	2556	175	159	50	0	67	3006	0	0	0	27	0	27	3033	0.4
Total:	849226	4	37	0	1203	35	210	237	0	1285	3006	0	0	0	331	542	874	3880	0.5
		5	69	0	1206	140	321	384	0	807	2927	0	0	0	285	891	1176	4102	0.5
		6	0	0	55	0	12	0	0	71	137	0	0	0	25	104	130	267	0.0
		Tot	106	0	6036	466	820	707	0	2230	10365	0	0	0	677	1538	2215	12580	1.5
Brood Year 1979																			
		2	52	0	153	0	0	0	0	8	213	0	0	0	11	0	11	224	0.0
Tagged:	102844	3	0	0	1175	45	81	0	0	596	1897	0	0	0	30	60	90	1987	0.2
Total:	1081433	4	0	0	1254	126	218	120	0	1417	3136	0	0	0	198	198	396	3532	0.3
		5	36	0	429	40	142	99	0	482	1229	0	0	0	295	506	801	2030	0.2
		6	0	0	0	0	35	61	0	0	96	0	0	0	31	106	136	233	0.0
		Tot	88	0	3011	212	476	280	0	2502	6571	0	0	0	565	869	1434	8005	0.7
Brood Year 1980																			
		2	0	0	991	30	90	148	0	154	1413	0	0	0	41	0	41	1454	0.1
Tagged:	156121	3	0	0	1372	211	292	208	0	322	2404	0	0	0	59	33	92	2496	0.2
Total:	1136778	4	14	19	827	200	253	448	0	1343	3104	0	0	0	809	643	1453	4556	0.4
		5	0	0	268	61	264	141	0	285	1019	0	0	0	520	891	1410	2429	0.2
		6	0	0	0	0	0	0	0	0	0	0	0	0	16	11	27	27	0.0
		Tot	14	19	3458	502	898	945	0	2103	7939	0	0	0	1445	1578	3023	10962	1.0

Table 6. Mean brood year survival weighted by number tagged for Quinsam chinook (cont.).

QUINSAM CHINOOK

QUINSAM RIVER		CHINOOK		STOCK: ALL														TOTAL	% SURV	
RELEASE INFORMATION	RECOV AGE	WEST COAST VAN ISLAND		NORTH CENTRAL		INSIDE		WASH ORG	ALASKA	TOTAL MARINE CATCH	FRESH SPORT	IFF	TOTAL FW CATCH		ESCAPEMENT					
		COMM	SPT	COMM	SPT	COMM	SPT						HATCH	NAT	TOTAL					
Brood Year 1981																				
	2	7	0	1165	4	152	102	0	32	1461	0	0	0	0	0	0	1461	0.2		
Tagged:	415741	3	31	0	985	126	259	86	0	825	2313	0	0	0	143	62	204	2517	0.3	
Total:	765464	4	0	0	876	80	433	164	0	2513	4066	0	0	0	804	769	1572	5639	0.7	
	5	12	4	1028	160	303	294	6	978	2785	0	0	0	339	1725	2064	4849	0.6		
	6	0	0	72	29	60	19	0	148	329	0	0	0	55	264	319	647	0.1		
	Tot	50	4	4127	400	1208	664	6	4496	10954	0	0	0	1340	2819	4159	15114	2.0		
Brood Year 1982																				
	2	0	0	811	64	78	62	4	271	1290	0	0	0	99	37	136	1426	0.1		
Tagged:	566368	3	26	0	1142	56	223	216	5	811	2481	32	0	32	321	67	389	2901	0.3	
Total:	1093278	4	0	0	1233	225	277	325	0	1241	3301	0	0	0	865	583	1448	4749	0.4	
	5	0	7	893	134	266	104	0	506	1910	0	0	0	789	881	1670	3580	0.3		
	6	0	0	14	0	2	0	0	18	34	0	0	0	39	84	124	157	0.0		
	Tot	26	7	4092	480	845	708	9	2848	9015	32	0	32	2114	1652	3766	12812	1.2		
Brood Year 1983																				
	2	0	0	1479	0	97	71	0	75	1722	0	0	0	112	2	114	1836	0.1		
Tagged:	237392	3	56	0	2643	120	319	403	0	580	4121	0	0	0	312	92	404	4524	0.3	
Total:	1446870	4	73	0	1021	269	253	200	0	1160	2976	0	0	0	668	1003	1671	4646	0.3	
	5	0	0	258	211	172	199	0	93	932	0	0	0	435	2121	2556	3488	0.2		
	6	0	0	0	4	0	0	0	0	4	0	0	0	0	2	2	6	0.0		
	Tot	130	0	5400	604	841	873	0	1907	9754	0	0	0	1528	3219	4747	14501	1.0		
Brood Year 1984																				
	2	3	0	3326	4	164	0	0	9	3505	0	0	0	67	41	108	3614	0.1		
Tagged:	348991	3	0	4	3962	790	962	468	0	2036	8222	4	0	4	1117	869	1986	10212	0.3	
Total:	3156571	4	122	56	2275	233	514	474	3	3558	7234	0	0	0	3047	4906	7953	15187	0.5	
	5	51	0	910	276	1645	948	0	1232	5063	0	0	0	2074	5213	7287	12350	0.4		
	6	0	0	32	0	59	107	0	0	199	0	0	0	22	319	341	540	0.0		
	Tot	177	60	10506	1303	3344	1997	3	6835	24223	4	0	4	6326	11349	17675	41902	1.3		
Brood Year 1985																				
	2	0	62	754	68	0	0	0	29	913	0	0	0	15	0	15	928	0.0		
Tagged:	253772	3	63	0	656	88	108	96	6	476	1495	0	0	0	189	130	319	1814	0.1	
Total:	2987456	4	0	15	404	136	577	405	0	904	2441	0	0	0	503	1158	1662	4102	0.1	
	5	0	0	350	300	94	64	0	245	1053	0	0	0	112	2433	2545	3598	0.1		
	6	0	0	0	0	0	0	0	49	49	0	0	0	0	7	7	56	0.0		
	Tot	63	77	2165	593	779	565	6	1703	5950	0	0	0	819	3729	4548	10498	0.4		
Brood Year 1986																				
	2	0	0	530	0	130	60	85	81	886	0	0	0	131	19	150	1036	0.0		
Tagged:	178696	3	94	0	1830	119	1218	667	41	964	4933	0	0	0	1712	821	2532	7465	0.2	
Total:	3309673	4	193	0	2342	800	651	240	0	2871	7098	0	0	0	1397	3625	5022	12119	0.4	
	5	0	104	547	562	228	38	0	252	1731	0	0	0	807	1261	2067	3798	0.1		
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0		
	Tot	287	104	5249	1481	2227	1004	127	4168	14647	0	0	0	4045	5726	9771	24418	0.7		
Brood Year 1987																				
	2	0	0	429	0	44	0	0	149	622	0	0	0	14	25	39	661	0.0		
Tagged:	335826	3	34	0	1893	460	410	158	0	656	3612	0	0	0	118	232	350	3962	0.1	
Total:	3678173	4	29	0	1660	846	401	544	0	2424	5904	0	0	0	1087	1180	2267	8171	0.2	
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0		
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0		
	Tot	63	0	3982	1306	855	702	0	3230	10137	0	0	0	1219	1437	2656	12794	0.3		

Table 6. Mean brood year survival weighted by number tagged for Quinsam chinook (cont.).

QUINSAM CHINOOK

QUINSAM RIVER		CHINOOK		STOCK: ALL														TOTAL	% SURV
RELEASE INFORMATION	RECOV AGE	WEST COAST VAN ISLAND	COMM SPT	NORTH CENTRAL		INSIDE		WASH ORG	ALASKA	TOTAL MARINE CATCH	FRESH SPORT	IFF	TOTAL FW CATCH	ESCAPEMENT					
				COMM	SPT	COMM	SPT	COMM	SPT					CATCH	HATCH	NAT	TOTAL		
Brood Year 1988																			
	2	0	0	931	0	231	0	0	0	1162	0	0	0	33	28	61	1223	0.0	
Tagged:	295490	3	141	0	1778	409	279	338	0	758	3703	0	0	0	365	309	674	4377	0.1
Total:	3843347	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Tot	141	0	2709	409	509	338	0	758	4865	0	0	0	398	337	735	5600	0.1	
Brood Year 1989																			
	2	0	0	209	0	0	0	0	0	71	280	0	0	0	1	0	1	281	0.0
Tagged:	315002	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Total:	4373365	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Tot	0	0	209	0	0	0	0	0	71	280	0	0	0	1	0	1	281	0.0

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