Juvenile Salmonid Habitat Utilization in the Skeena River Estuary

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Abstract

The environmental assessment process is currently underway for several large-scale industrial development projects in the estuary of the Skeena River, a major salmon-bearing system in northwest British Columbia that supports significant commercial, recreational, and constitutionally protected Aboriginal fisheries. Here we report the results of a field sampling program that we undertook with trawl and beach seining in 2013 from 16 sites located within 5 regions to investigate the temporal and geographic occupation of juvenile salmonids throughout the Skeena estuary. We captured juvenile pink, chum, coho, Chinook, and sockeye salmon in all regions of the Skeena estuary and found that the different salmon species utilized the estuary differently across space and time. Areas proposed for industrial development contained some of the higher abundances of some species of salmon. Genetic stock identification revealed that many different sockeye and Chinook populations, from throughout the Skeena River watershed as well as nearby watersheds, use the area proposed for industrial development. Our data thus indicates that the area proposed for development represents habitat for salmon that form the basis for commercial, recreational, and First Nations fisheries from throughout the watershed and beyond.

Introduction

The Skeena River in northern British Columbia drains approximately 55,000 km^2 and supports significant fish resources (Gottesfeld and Rabnett 2008). For example, in 2009, approximately 668,000 sockeye (*Oncorhynchus nerka*), 2.5 million pink (*O. gorbuscha*), 88,000 coho (*O. kisutch*), and 36,000 Chinook (*O. tshawytscha*) swam through the estuary and into spawning areas throughout the Skeena watershed (Pacific Salmon Commission 2012). Total salmon returns are even higher as numerous commercial, recreational and First Nations food, social and ceremonial (FSC) fisheries throughout the watershed rely on these fishes. Variability of these salmon populations threatens fisheries; for instance low sockeye returns in 2013 led to closure of Skeena commercial, recreational, and First Nations fisheries due to conservation concerns.

Previous understanding of estuaries in general and the Skeena estuary in particular suggest that these habitats support large numbers of juvenile salmon. For example, Flora Bank, which represents 50-60% of tidal and subtidal eelgrass habitat in the Skeena estuary, was previously found to be among the most important juvenile pink salmon habitats in the Skeena watershed (Hoos 1975). During their downstream migration, all anadromous salmonids obviously transit through the Skeena estuary, and some may remain in the estuary for weeks or months. The early marine life history stages, including estuarine residence, are among the most critical life history stages for juvenile salmon (Parker 1968; Kareiva et al. 2000; Simenstad and Cordell 2000), and the growth attained during this period can determine whether they survive to reproduce (Farley 2007). Here we examine the habitat utilization of five species of Pacific salmon in the greater Skeena River estuary. In particular, we were interested in salmon habitat utilization in light of several large-scale industrial development projects pending in the Skeena River estuary, including a bulk potash loading facility, an expanded rail, road, and utility corridor, and two liquefied natural gas (LNG) terminals on Ridley and Lelu Islands (Figures 1 and 2).

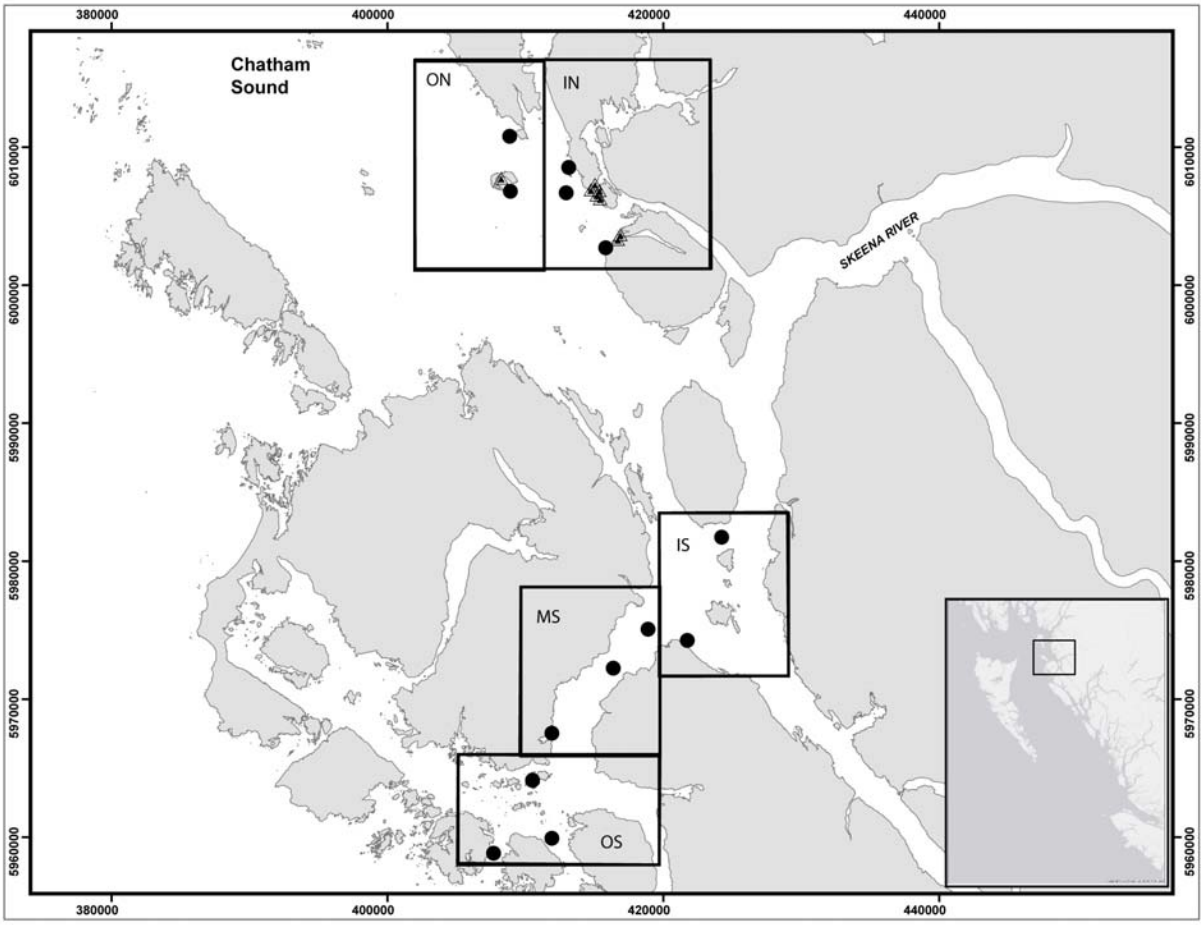

Figure 1. The Skeena River estuary, proposed development, and distribution of juvenile salmon. During the period of highest flow, the zone of freshwater influence extends from the mouth of the Skeena south to Ogden and Grenville Channels, and northwest to Chatham Sound, which receives freshwaters from the Skeena and Nass watersheds. Trawl sites are indicated by filled circles and beach seine sites are indicated by triangles. The study area is shown divided into our analysis regions and indicated by the letters IN for inside North, ON for outer north, IS for inside south, MS for middle south, and OS for outside south.

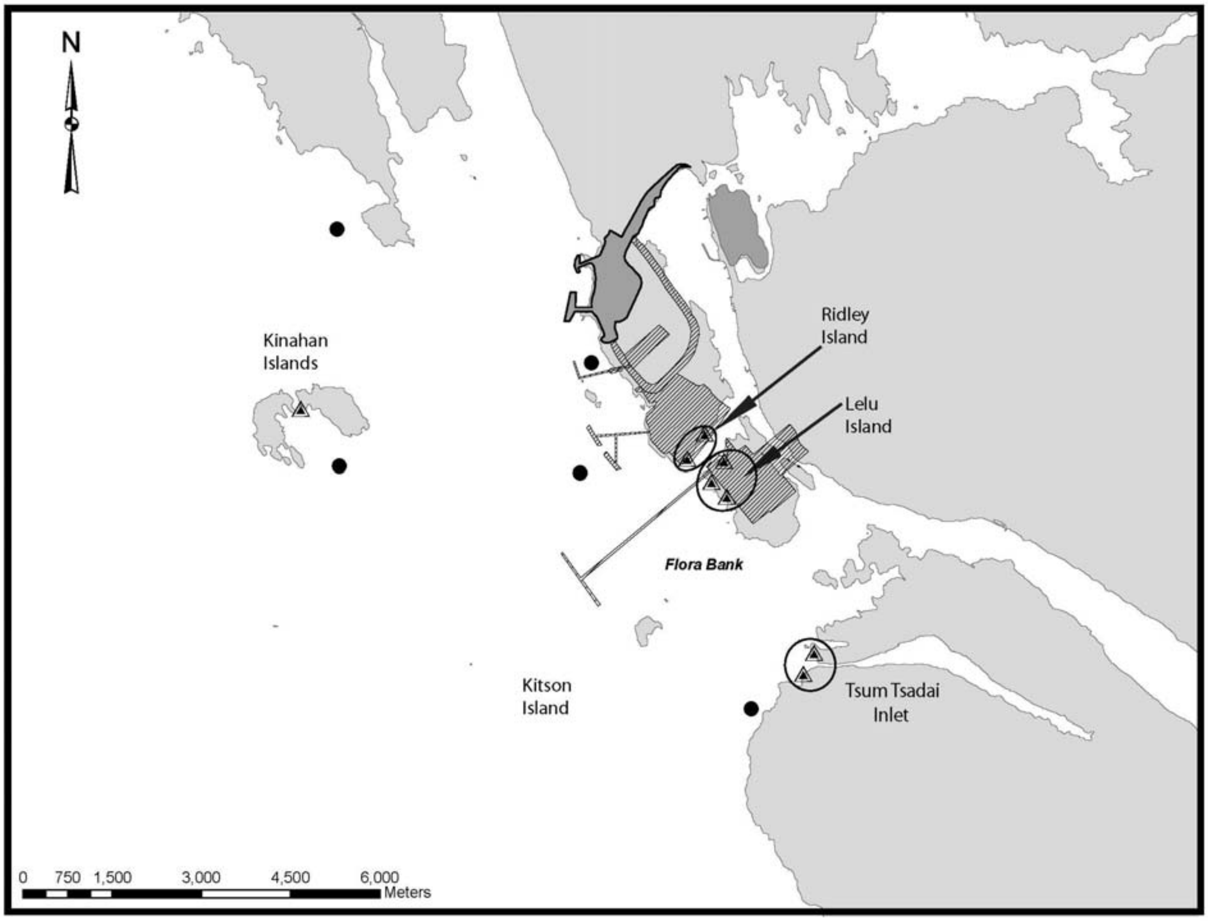

Figure 2. Sampling stations and juvenile salmonid catches in the northern part of the study area (denoted by the ON and IN boxes in Fig. 1a). Existing developments are shown in dark grey, while proposed development areas are diagonally shaded. Trawl sites are indicated by shaded circles and beach seine sampling stations are indicated by triangles. Beach seine site groups are indicated with open circles, except at Kinahan Islands where there was only one site.

Materials and Methods

Juvenile salmonids were collected from April 29 until July 1, 2013 with beach seine (5 sites) and trawl sampling (11 sites). We used these two techniques to sample both nearshore and offshore fish communities. Beach seine sampling was carried out weekly at shoreline sites near proposed industrial activities at the northern exit of the Skeena River (Figure 2). The beach seine net was 35 m long with a depth of 3 m, with 13 mm mesh at the tow end and 6 mm mesh at the bunt. Each beach seine sampling event consisted of a single set, during which the seine net was deployed downstream from an anchor point on the beach using a 3 m skiff. Trawl sampling was conducted in deeper waters at regular sites throughout the southern portion of the Skeena estuary (Figure 1), using a midwater trawl which was fished from an 11 m ex-gillnet vessel, HMV Pacific Coast. The trawl net was 18 m long with an opening 5 m wide and 4.6 m deep, with a rigid, baffled holding box designed for live capture at the cod-end (Gottesfeld 2009). The trawl net was deployed for a targeted duration of at least 15 minutes and up to 20 minutes for an approximate tow length of 1km, depending on the velocity of prevailing currents. Salmonids were counted, measured and released. Tissue samples were collected from a subsample of Chinook and sockeye specimens for genetic stock identification which was conducted using microsatellites in partnership with the Department of Fisheries and Oceans.

Trawl sites were aggregated into five different regions for analyses, according to their relative proximity to the northern or southern exit of the Skeena River, (Figure 1). We calculated average trawl catches for each region and sampling week. Trawl catches were normalized based on trawl duration by multiplying the catch by typical duration (20 minutes) and dividing by the observed duration. The beach seine sites, which were all located within the inside northern region, were grouped according to the island or inlet where each site was located (Figure 2). We calculated average beach seine catches for each group and sampling week.

Results and Discussion

We captured a total of 562 sockeye, 233 coho, 34 Chinook, over 250 chum and thousands of juvenile pink salmon during our sampling period between 29 April and 1 July. These data in their entirety are made available in Appendices 1 and 2. Juvenile pink salmon were captured in diminishing abundance in beach seines from the beginning of our sampling period on April 29 until the second week of May

(Figure 3). Smaller numbers of pink salmon were also captured by trawl throughout the sampling period (n=50 total). The highest abundances of juvenile chum salmon were observed between the second and fourth weeks of May. Coho smolts were observed in trawls from the middle of May until the end of our survey on July 1, and in high abundances in beach seine sets in the third and fourth weeks of May. Chinook smolts were observed by trawl and beach seine throughout the sampling period. Sockeye were continually present in the study area from May 13 until the end of our surveys on July 1, and captured regularly in the areas of proposed development after May 20, with peak abundances observed between the last week of May and the first week of June (Figures 3, and 4, and 5).

Juvenile salmon were observed at all trawl or beach seine sites that were sampled, and all five species of juvenile salmonids were captured in areas proposed for industrial development (Figures 4 and 5). Numerous non-target species were also caught, such as herring and surf smelt. Relatively high abundances of juvenile pink salmon were observed during early-season beach seine sets conducted at the inside and outer northern sites. Chum salmon were captured by beach seine at all sites, and appeared to be most numerous at one inside northern site in Tsum Tsadai Inlet. Coho and Chinook salmon juveniles were captured throughout the study area. Based on average catch per unit effort for trawls for all weeks sampled, the highest abundances of juvenile sockeye salmon were observed at inside and outer northern, and middle southern sites. We observed the highest trawl catches of Chinook, second highest catches of sockeye, and third highest catches of coho in the inside northern areas proposed for industrial development (Figures 4 and 5).

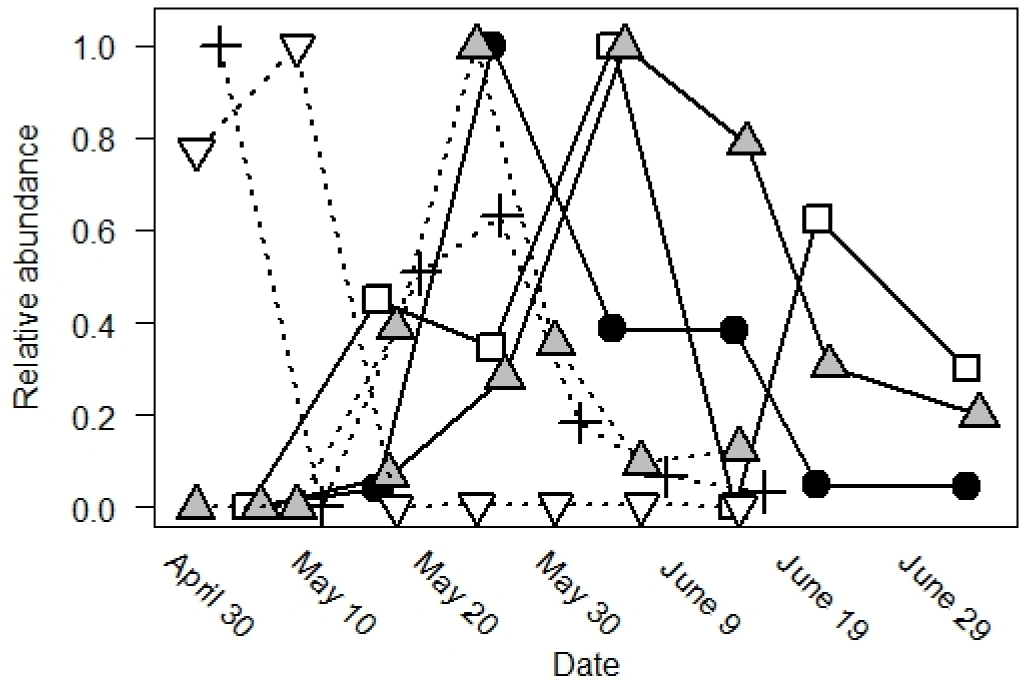

Figure 3. Temporal dynamics of different salmon species in the Skeena River estuary. Dotted lined indicate data from seine surveys and solid lines are indicate trawl survey data. Abundances are pooled across all sites in study area. Filled black circles are sockeye salmon, white squares are Chinook salmon, gray triangles are coho salmon, upside down white triangles are pink salmon, and crosses are chum salmon. Abundances are normalized so that that highest abundance for that species and survey time is 1.

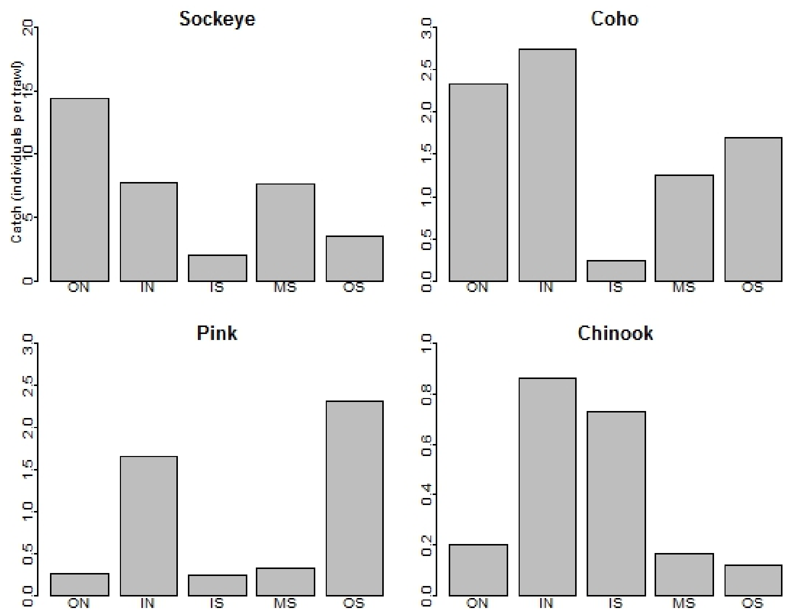

Figure 4. Average trawl catch of all species of juvenile salmonids by regions, pooled across all locations and sampling dates and normalized for 20 minute sets. Note different scales for y-axes. Region abbreviations are same as for Figure 1.

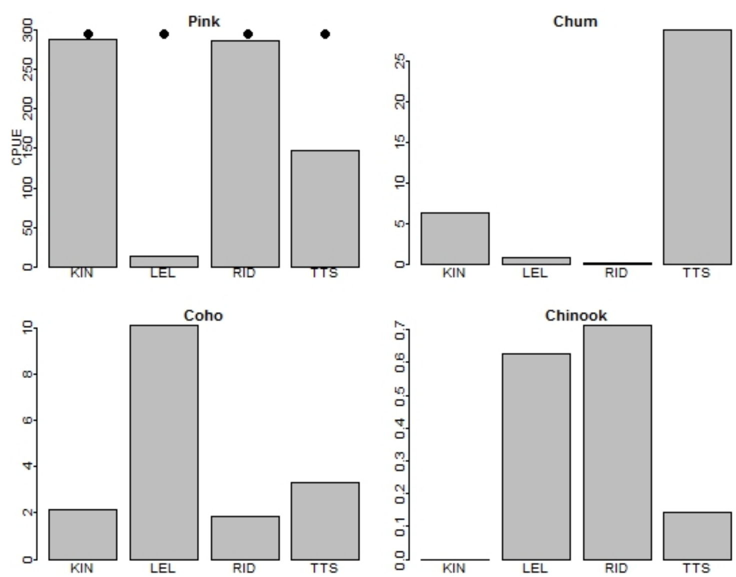

Figure 5. Average beach seine catches of all species of juvenile salmon by group, pooled across all sampling dates. Pink salmon catches greater than 100 per location are indicated by black dots above bars. Catches greater than 100 or 1000 individuals were calculated as 100 or 1000. Note different scales of y-axes. Locations are as follows: KIN=Kinahan Islands, LEL=Lelu Island, RID=Ridley Island, TTS=Tsum Tsadai Inlet.

The Skeena River estuary, including the proposed development footprints, support diverse and abundant juvenile salmon. We found that pink, chum, sockeye, coho, and Chinook smolts occupied these areas continually from the middle of May until at least the beginning of July. Our results are supported by previous research in the estuary, conducted in the 1950s and 1970s that found these areas to be critical habitats for juvenile salmonids (Hoos 1975), which is not surprising because it is well known that estuaries are critical habitat for juvenile salmon (Heard 1991; Simenstad and Cordell 2000; Beck et al. 2001). Our research suggests that juvenile salmon use the Skeena River estuary widely across space and time.

The salmon populations that we sampled support commercial, recreational, and First Nations fisheries. For example, one of the sockeye smolts that we collected at Kinahan Islands was previously tagged by a smolt enumeration program that occurred 450 km upstream at the outlet of Babine Lake (Figure 6). Babine Lake sockeye comprise approximately 90% of the aggregate Skeena River sockeye run that is targeted by the Area 4 commercial gillnet fishery at the mouth of the Skeena, a commercial terminal fishery in Babine Lake, and as well as First Nations FSC fisheries (Gottesfeld and Rabnett 2008).

Genetic analysis of the samples that were captured during our field sampling program demonstrate that the Chinook and sockeye that were captured in areas proposed for industrial development originated from streams throughout the Skeena Watershed. Specifically, we observed sockeye from: Alastair Lake in the lower Skeena River, Nanika River in the Bulkley, Morrison and Tahlo Lakes above Babine Lake, Halliday Slough in the middle Skeena, Bear and Sustut Lakes in the Upper Skeena, Stephens and Swan Lakes in the Kispiox drainage, Shawatlan Lake on the North Coast, and several wild and enhanced stocks from the Babine Lake system. The Chinook that were observed within the proposed development footprints came from the Kitsumkalum and Zymagotitz Rivers in the lower Skeena, Morice River in the Bulkley system, and Shegunia River in the middle Skeena. These fish are locally adapted to these different locations, originating from and returning to these sites, and as such are the basis of First Nations fisheries in the traditional territories of the Allied Tribes of Lax Kw'alaams, Gitxsan, Gitanyow, Wet'suwet'en, and Lake Babine Nations.

The Skeena River watershed is a region where annual salmon migrations sustain the ecosystem, culture, and economies (Gottesfeld and Rabnett 2008). First Nations fisheries are protected by the Canadian constitution (Government of Canada, Constitution Act, 1982). These results are directly relevant in considering the potential cumulative impacts of the proposed industrial development in the Skeena River estuary.

Figure 6. Tagged Babine smolt captured by trawl at Kinahan Islands, May 31, 2013

Note: The cover photograph shows juvenile pink and coho salmon captured by trawl on July 1, 2013 near Kitson Island. The environmental testing platform for the Pacific Northwest LNG terminal is in the background on the right side of the photo.

Acknowledgements

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Appendix 1. Trawl data from 2013 juvenile salmonid sampling program. Columns contain actual numbers of each species captured during each sampling event. Sample sites locations are given in UTM coordinates (Datum: NAD 1983). Region codes: IN=inside north, ON=outer north, IS=inside south, MS=middle south, OS=outside south. Species codes: SK=sockeye, CO=coho, PI=pink,

Location	Region	Date	Minutes	UTM zone	Start Easting	Start Northing	End Easting	End Northing	SK	CO	PI	CH
Coast Island	IN	03-May	15	9	412797	6009115	413424	6007951				
Agnew Bank	IN	03-May	15	9	412678	6006347	413342	6007421				
Kinahan Islands	ON	03-May	15	9	408389	6007353	409059	6006771				
Smith Island North	ON	03-May	9	9	416004	6003418	415664	6002727			1	
Coast Island	IN	13-May	20	9	412856	6009088	413366	6008094		1	2	1
Agnew Bank	IN	13-May	15	9	412142	6006374	413016	6007215		1	2	1
Kennedy Island South	IS	13-May	13	9	423366	5982344	424432	5982458	1		1	1
Kinahan Islands	ON	13-May	15	9	408431	6007448	409535	6006668				
Smith Island North	ON	13-May	20	9	415895	6002750	416312	6004040	1		2	
Pitt Island North	IS	14-May	15	9	422697	5973354	421211	5975240				
Ogden Channel (north)	MS	14-May	15	9	416989	5972130	416472	5973074	2			
Skene Cove	MS	14-May	15	9	411561	5967215	412518	5968013	3			
Beaver Passage	OS	14-May	15	9	411881	5960281	412516	5959131			3	
Gilbert Island	OS	14-May	21	9	409776	5964448	411268	5963960			14	
Coast Island	IN	20-May	15	9	412965	6009041	413517	6007977	8			
Agnew Bank	IN	20-May	15	9	412114	6006226	412930	6007238	4			1
Kinahan Islands	ON	20-May	15	9	408572	6007282	409162	6006270	1	1		
Tremayne Bay	ON	20-May	15	9	408833	6011707	409280	6010411	110			
Smith Island North	ON	20-May	15	9	415647	6002190	415963	6003220		4		1
Agnew Bank	IN	24-May	16	9	412308	6006040	413289	6007228	39	5		1
Kennedy Island South	IS	24-May	15	9	422892	5981857	424308	5982377				
Tremayne Bay	ON	24-May	15	9	408925	6011241	409398	6010135	1			
Pitt Island North	IS	25-May	15	9	422384	5973525	421280	5974696				
Ogden Channel (center)	MS	25-May	22	9	416135	5973153	416586	5971245	92			
Skene Cove	MS	25-May	15	9	412692	5967941	411412	5967130	3	1		
Beaver Passage	OS	25-May	15	9	411470	5960759	412288	5959689				
Gilbert Island	OS	25-May	15	9	410378	5964137	411393	5963877	14			
Coast Island	IN	31-May	20	9	412973	6009011	413763	6007519	4	6		
Agnew Bank	IN	31-May	20	9	412397	6006195	412968	6007561	7	5		

Appendix 1 cont'd.

Location	Region	Date	Minutes	UTM zone	Start Easting	Start Northing	End Easting	End Northing	SK	CO	PI	CH
Kinahan Islands	ON	31-May	15	9	408546	6007395	409360	6006842	7	12		1
Tremayne Bay	ON	31-May	17	9	409481	6009936	408919	6011163		2		
Smith Island North	ON	31-May	15	9	415779	6002518	416185	6003623	1	3		
Coast Island	IN	02-Jun	20	9	412461	6009415	413688	6007735	8	5		1
Agnew Bank	IN	02-Jun	21	9	412513	6005763	413720	6006087	34	4		2
Kennedy Island South	IS	02-Jun	15	9	423172	5982177	424559	5982457	6			
Pitt Island North	IS	02-Jun	24	9	422617	5973512	421192	5974676	8		1	4
Ogden Channel (center)	MS	02-Jun	30	9	416529	5973820	415539	5972526	9	3	1	
Kinahan Islands	ON	02-Jun	15	9	408390	6007432	409137	6006221	22			
Ogden Channel (center)	MS	03-Jun	32	9	415610	5971660	414504	5971073		2		1
Skene Cove	MS	03-Jun	20	9	412621	5968392	411486	5967173	13	2	1	
Gilbert Island	OS	03-Jun	38	9	409744	5964383	411245	5963957	33	1	2	
Schooner Passage	OS	03-Jun	17	9	408022	5959667	407699	5958244	1			1
Kennedy Island South	IS	11-Jun	15	9	423347	5981616	424858	5982177				
Ogden Channel (center)	MS	11-Jun	21	9	417435	5972842	414981	5972351	4	2		
Kinahan Islands	ON	11-Jun	20	9	408419	6007480	408893	6006576	89	7		
Tremayne Bay	ON	11-Jun	15	9	409000	6011474	409177	6010010				
Smith Island North	ON	11-Jun	16	9	415599	6001950	415999	6003283		1		
Coast Island	IN	12-Jun	20	9	412939	6008976	413462.8	6007962	3	3		
Agnew Bank	IN	12-Jun	15	9	412544	6006096	413428	6006968	2	1		
Ogden Channel (center)	MS	12-Jun	27	9	414442	5971942	415846	5971514				
Skene Cove	MS	12-Jun	39	9	411582	5967251	414323	5968286	7	1	1	
Beaver Passage	OS	12-Jun	15	9	411806	5960837	412362	5959640		2		
Gilbert Island	OS	12-Jun	33	9	409796	5964420	411245	5963944	2	9		
Coast Island	IN	18-Jun	23	9	413978	6007200	413131	6008517	4		1	4
Agnew Bank	IN	18-Jun	20	9	412524	6006060	413837	6006418		2		
Kennedy Island South	IS	18-Jun	19	9	423208	5980708	424434	5981609		1		
Pitt Island North	IS	18-Jun	15	9	421370	5974397	422413	5973866	1	1		
Ogden Channel (center)	MS	18-Jun	22	9	416587	5973010	414443	5971915				
Ogden Channel (north)	MS	18-Jun	23	9	418372	5976226	418288	5974180	1	1		1
Kinahan Islands	ON	18-Jun	16	9	408336	6007474	409318	6006584				
Tremayne Bay	ON	18-Jun	15	9	408772	6011558	409159	6010336	5		1	

Appendix 1 cont'd.

Location	Region	Date	Minutes	UTM zone	Start Easting	Start Northing	End Easting	End Northing	SK	CO	PI	CH
Skene Cove	MS	19-Jun	25	9	411341	5967106	413015	5967888		2		
Kinahan Islands	ON	19-Jun	20	9	408311	6007597	409628	6006322	2	3		
Beaver Passage	OS	19-Jun	17	9	412440	5959506	411326	5960390		1		
Gilbert Island	OS	19-Jun	27	9	409437	5964342	411261	5963916				
Kennedy Island South	IS	30-Jun	16	9	423160	5981706	424559	5982261	4			1
Pitt Island North	IS	30-Jun	15	9	422478	5973684	421256	5974623				
Ogden Channel (north)	MS	30-Jun	17	9	420123	5974409	418324	5974359		1		
Kinahan Islands	ON	30-Jun	16	9	408323	6007581	408887	6006314		2		
Tremayne Bay	ON	30-Jun	18	9	408122	6007743	409138	6010738				1
Coast Island	IN	01-Jul	14	9	413744	6007665	414236	6006945	1		7	
Agnew Bank	IN	01-Jul	22	9	412771	6006353	413488	6006759	5	2	9	
Ogden Channel (center)	MS	01-Jul	17	9	416476	5973424	416601	5971793				
Skene Cove	MS	01-Jul	15	9	411482	5967165	412367	5967830			1	
Gilbert Island	OS	01-Jul	14	9	409583	5964391	411190	5963903		1		

Appendix 2. Beach seine data from 2013 juvenile salmonid sampling program. Columns contain actual numbers of each species captured during each sampling event. Sample sites locations are given in UTM coordinates (Datum: NAD 1983). PI=pink, CM=chum, CH=Chinook, CO=coho

Location	Region	Date	UTM Zone	Easting	Northing	PI	CM	CO	CH
Kinahans	ON	29-Apr	9	408260	6007765	>1000			
Lelu Island	IN	30-Apr	9	415169	6006538	>100			
Ridley Island	IN	30-Apr	9	414759	6006929	>1000			
Tsum Tsadai Inlet	IN	30-Apr	9	416892	6003671	>1000	>100		
Kinahans	ON	07-May	9	408260	6007765	>1000			
Ridley Island	IN	09-May	9	414759	6006929	>1000			
Tsum Tsadai Inlet	IN	16-May	9	416892	6003671		34	10	
Ridley Island	IN	16-May	9	414759	6006929	1		5	
Kinahans	ON	16-May	9	408260	6007765	3	4	2	
Tsum Tsadai Inlet	IN	22-May	9	416892	6003671	10	60	6	
Kinahans	ON	22-May	9	408260	6007765	4	15	2	
Lelu Island	IN	23-May	9	415432	6006295			16	
Lelu Island	IN	23-May	9	415169	6006538		3	49	3
Ridley Island	IN	23-May	9	415054	6007340		1		
Lelu Island	IN	29-May	9	415432	6006295			13	
Lelu Island	IN	29-May	9	415382	6006887	7	3	2	2
Ridley Island	IN	29-May	9	415054	6007340			8	5
Tsum Tsadai Inlet	IN	29-May	9	416892	6003671	7	7	3	1
Kinahans	ON	29-May	9	408260	6007765	6	13		
Lelu Island	IN	05-Jun	9	415432	6006295	3		1	
Lelu Island	IN	05-Jun	9	415169	6006538				
Ridley Island	IN	05-Jun	9	414759	6006929				
Tsum Tsadai Inlet	IN	05-Jun	9	416892	6003671	9			
Kinahans	ON	05-Jun	9	408260	6007765	1	8	6	
Lelu Island	IN	13-Jun	9	415169	6006538				
Ridley Island	IN	13-Jun	9	415054	6007340				
Tsum Tsadai Inlet	IN	13-Jun	9	416714	6003315			4	
Tsum Tsadai Inlet	IN	13-Jun	9	416892	6003671				
Kinahans	ON	13-Jun	9	408260	6007765		4	5	