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APPENDICES

Appendix 1.—Characteristics of anadromous fish spawning habitat.

Part 1.—Means (standard deviations in parentheses) for some spawning habitat characteristics of sockeye and chinook salmon in the Situk River, 1988.

	Redd dimensions			Water		Substrate composition			Temperature (°C)	
	Length (m)	Width (m)	Area (m^2)	Depth (cm)	Velocity (cm/s)	Fine (%)	Gravel (%)	Coarse (%)	Water column	Intra-gravel
Sockeye	2.4 (0.7)	1.6 (0.4)	3.7 (2.2)	49.6 (17.3)	26.6 (33.0)	23.4 (14.4)	72.0 (17.9)	5.0 (12.8)	9.1 (2.2)	6.2 (2.0)
Chinook	5.6 (1.0)	3.3 (0.8)	19.0 (6.7)	79.6 (23.3)	73.0 (22.4)	5.3 (6.0)	76.1 (18.3)	18.7 (18.1)	12.2 (0.7)	11.9 (0.6)

Part 2.—Characteristics of spawning habitat commonly used by salmonids that spawn in the Situk River. A dash indicates that data were unavailable.

	Spawning site[a]		Water[a]		Substrate composition[b]			Temperature[a]	
	Redd area (m^2)	Area occupied (m^2)	Depth (cm)	Velocity (cm/s)	Fine (%)	Gravel (%)	Coarse (%)	Spawning (°C)	Incubation (°C)
Sockeye	1.8	6.7	>15	21-101	7.5	92	0.5	10.6-12.2	4.4-13.3
Ocean-type sockeye[c]	3.7	-	>25	2-20	22	66	12	4.2-9.0	3.5-10.0
Chinook	9.1-10.0	13.4-20.1	>24	30-91	6	72	22	5.6-13.9	5.0-14.4
Coho	2.8	11.7	>18	30-91	5	85	10	4.4-9.4	4.4-13.3
Pink	0.6	0.6	>15	21-101	34[d]	66[d]	-	7.2-12.8	4.4-13.3
Chum	2.3	9.2	>18	46-101	6	81	13	7.2-12.8	4.4-13.3
Steelhead	4.4	-	>24	40-91	-	-	-	3.9-9.4	-
Dolly Varden[e]	1.0	-	>30	40-95	3.5	96.5	0	6.1	0.5-8.3

[a] Bjornn and Reiser 1991.
[b] Burner 1951.
[c] Lorenz and Eiler 1989.
[d] McNeil and Ahnell 1964. Results excluded substrate > 10 cm in diameter.
[e] Blackett 1968.

Appendix 2.—Habitat characteristics by channel type for each study reach (Study 2), Situk River, Alaska, and adjacent watersheds 1987-89. A dash indicates no data; a = debris pool, b = willow edge, and c = channel edge.

Variable	Channel type															
	FP1f			FP1s		FP3f						FP3s				
Site no. NMFS	308	408	328	108	409	101	122	304	310	315	330	113	121	201	117	
Site no. USFS	308	408	328	501	409	501	201	304	310	315	330	501	112	201	203	
Day of year	161	194	203	212	195	201	223	164	232	223	201	205	222	219	220	
Reach area (m^2)	706	476	306	2630	1537	231	511	169	329	744	494	504	289	204	337	
Reach length (m)	75	69	58	180	106	98	82	60	58	87	78	90	50	48	50	
% Pool	46.2	61.9	8.6	53.9	0	63.2	32.3	95.2	42.1	47.5	31.2	42.2	42.0	64.0	43.4	
% Riffle	0.0	22.9	0.0	9.7	0	21.2	0.0	4.8	35.3	35.8	0.0	20.8	0.0	0.0	30.8	
% Glide	53.8	15.2	91.4	36.4	100	15.6	67.7	0.0	22.6	16.7	68.8	37.0	58.0	36.0	25.9	
Average depth (cm)	45.8	35.6	56.5	28.5	59.2	9.2	22.7	21.6	18.9	32.7	48.2	15.8	32.8	25.5	25.3	
Maximum depth (cm)	82	85	73	150	87	110	64	54	48	54	100	48	75	110	110	
Average width (m)	9.4	6.9	5.3	14.6	14.5	2.4	6.2	2.8	5.7	8.6	6.3	5.6	5.8	4.2	6.7	
Water temperature (°C)	11.0	13.0	11.5	12.5	15.0	16.7	10.2	13.6	10.0	8.5	9.8	11.8	7.3	11.4	11.0	
Stream gradient (%)	0.8	-	-	0.5	0.7	0.5	1.0	<1.0	<1.0	0.0	0.0	0.4	0.5	0.3	0.5	
Discharge (m^3/s)	0.46	-	0.72	-	0.58	0.05	-	0.01	0.01	0.13	0.60	0.11	0.12	0.08	-	
Substrate (% fine)	45.6	41.8	96.6	0.0	100.0	0.0	0.0	78.1	42.1	13.5	97.1	0.0	20.0	75.0	4.0	
LWD																
No. of pieces	2	13	0	1	2	4	22	9	5	6	14	0	0	0	6	
Pieces/100 m	0.3	18.8	0.0	0.6	1.9	4.1	26.8	15.0	8.6	6.9	17.9	0.0	0.0	0.0	12.0	
Volume (m^3)	1.1	8.5	0.0	0.2	1.8	3.1	26.6	47.9	9.0	14.1	31.0	0.0	0.0	0.0	6.6	
Volume (m^3/100 m^2)	0.2	1.8	0.0	<0.1	1.7	1.3	5.2	28.3	2.7	1.9	6.3	0.0	0.0	0.0	2.0	

Appendix 2.—Continued.

Variable	Channel type					
	FP4f			FP4s		
Site no. NMFS	301	311	318	103	317	104
Site no. USFS	301	236	189	503	200	504
Day of year	158	236	189	202	200	220
Reach area (m^2)	2094	2953	1684	626	923	3593
Reach length (m)	136	132	122	85	108	180
% Pool	63.6	25.4	66.3	25.4	53.7	66.6
% Riffle	20.3	5.5	7.1	31.3	13.0	14.5
% Glide	16.1	69.1	26.6	43.5	33.3	19.0
Average depth (cm)	17.9	41.0	31.0	18.2	40.6	27.5
Maximum depth (cm)	56	65	52	67	62	101
Average width (m)	15.4	22.4	13.5	7.4	8.6	20.0
Water temperature (°C)	16.0	8.5	8.5	12.2	11.7	7.7
Stream gradient (%)	0.0	1.0	-	1.0	-	0.6
Discharge (m^3/s)	0.34	1.69	0.29	0.42	0.29	0.34
Substrate (% fine)	0.0	26.6	11.7	0.0	37.4	25.0
LWD						
Number pieces	39	2	13	3	-	7
Pieces/100 m	28.7	1.5	0.0	3.5	-	3.9
Volume (m^3)	44.8	0.1	0.6	13.2	-	5.6
Volume (m^3/100 m^2)	2.1	0.1	0.4	2.1	-	0.2

Appendix 2.—Continued.

Variable	Channel type											
	FP5f											
Site no. NMFS	410	411	412	115	111	322[a]	415[a]	416[a]	415[b]	416[b]	415[c]	416[c]
Site no. USFS	410	411	412	207	507	322	415	416	415	516	415	416
Day of year	214	221	243	203	211	188	220	223	220	223	220	223
Reach area (m^2)	3233	3683	3090	2504	7139	740	213	300	74	80	74	74
Reach length (m)	122	127	100	110	220	75	30	40	21	21	20	20
% Pool	16.5	7.4	5.6	25.9	7.6	100.0	100.0	100.0	0.0	0.0	0.0	16.7
% Riffle	66.5	59.6	77.0	44.2	42.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Glide	17.0	33.0	17.4	29.9	50.6	0.0	0.0	0.0	100.0	100.0	100.0	83.3
Average depth (cm)	47.2	35.0	30.8	34.5	30.7	46.0	153.0	121.0	95.0	75.0	26.3	35.7
Maximum depth (cm)	70	58	78	140	140	75	270	260	180	110	46	100
Average width (m)	26.5	29.0	30.9	22.8	32.5	9.8	7.1	7.5	3.5	3.8	3.7	3.7
Water temperature (°C)	-	18.0	-	12.4	12.0	-	-	-	-	-	-	-
Stream gradient (%)	-	-	-	0.5	0.7	-	-	-	-	-	-	-
Discharge (m^3/s)	-	-	-	1.96	5.71	5.41	-	-	-	-	-	-
Substrate (% fine)	7.9	11.4	8.2	-	-	-	-	-	-	-	-	-
LWD												
Number pieces	3	14	8	34	5	107	25	8	0	0	0	1
Pieces/100 m	2.5	11.0	8.0	30.9	2.3	142.7	83.3	20.0	0.0	0.0	0.0	5.0
Volume (m^3)	11.3	29.9	2.0	30.2	2.9	292.8	-	-	0.0	0.0	0.0	-
Volume (m^3/100 m^2)	0.3	0.8	0.01	1.2	<0.1	39.6	-	-	0.0	0.0	0.0	-

Appendix 2.—Continued.

Variable	Channel type								
	FP5s								
Site no. NMFS	319[a]	413[a]	414[a]	309[b]	323[b]	413[b]	414[b]	413[c]	414[c]
Site no. USFS	319	413	414	309	323	413	414	413	414
Day of year	237	219	222	162	223	219	222	219	222
Reach area (m^2)	300	230	195	504	169	88	86	74	74
Reach length (m)	62	45	33	134	55	21	21	20	20
% Pool	100.0	100.0	100.0	100.0	100.0	0.0	0.0	33.3	33.3
% Riffle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Glide	0.0	0.0	0.0	0.0	0.0	100.0	100.0	66.7	66.7
Average depth (cm)	50.5	77.0	108.0	109.4	125.8	62.0	116.0	29.3	27.7
Maximum depth (cm)	80	250	180	201	247	90	150	72	60
Average width (m)	4.8	5.1	5.0	3.7	3.1	4.2	5.9	3.7	3.7
Water temperature (°C)	9.5	-	-	12.8	11.5	-	-	-	-
Stream gradient (%)	-	-	-	1.0	-	-	-	-	-
Discharge (m^3/s)	-	-	-	6.02	-	-	-	-	-
Substrate (% fine)	-	-	-	-	-	-	-	-	-
LWD									
Number pieces	56	14	9	1	0	0	0	0	1
Pieces/100 m	90.3	31.1	27.3	0.7	0.0	0.0	0.0	0.0	5.0
Volume (m^3)	118.5	-	-	0.2	0.0	0.0	0.0	0.0	-
Volume (m^3/100 m^2)	39.5	-	-	0.2	0.0	0.0	0.0	0.0	-

Appendix 2.—Continued.

Variable	Channel type													
	PA1							PA2	PA3					
Site no. NMFS	102	302	305	324	325	327	329	120	106	123	105	303	326
Site no. USFS	502	302	305	324	325	327	329	204	506	210	505	303	326
Day of year	202	159	160	186	235	22	199	221	204	223	208	164	233
Reach area (m^2)	130	71	231	53	168	114	201	2292	268	748	885	1204	798
Reach length (m)	60	38	65	39	40	68	62	133	74	75	115	79	75
% Pool	79.8	100.0	100.0	93.0	8.1	83.1	94.9	21.2	100.0	100.0	98.2	96.3	99.2
% Riffle	6.3	0.0	0.0	0.0	0.0	16.9	5.1	0.0	0.0	0.0	1.8	1.9	0.0
% Glide	13.9	0.0	0.0	7.0	91.9	0.0	0.0	78.8	0.0	0.0	0.0	1.8	0.8
Average depth (cm)	14.2	14.8	21.5	44.7	49.7	39.6	29.5	13.1	11.3	27.7	16.0	33.9	61.8
Maximum depth (cm)	52	25	39	100	74	60	68	38	32	74	44	56	110
Average width (m)	2.2	1.9	3.6	1.3	4.2	1.7	3.2	17.2	3.6	10.1	7.7	15.2	10.6
Water temperature (°C)	11.7	11.5	13.1	12.3	11.0	6.8	12.8	17.0	21.4	12.1	8.0	12.1	9.4
Stream gradient (%)	1.0	<0.5	<0.5	-	-	-	-	-	0.8	<0.5	<0.5	<0.5	-
Discharge (m^3/s)	0.01	<0.01	0.02	0.02	0.33	0.02	0.01	-	-	0.04	<0.01	0.15	0.01
Substrate (% fine)	30.0	85.0	100.0	96.5	71.8	49.5	73.3	6.0	5.0	12.0	80.0	88.8	79.9
LWD													
Number pieces	0	0	9	0	2	0	5	0	0	2	0	0	3
Pieces/100 m	0.0	0.0	3.9	0.0	1.2	0.0	2.5	0.0	0.0	2.7	0.0	0	0.4
Volume (m^3)	0.0	0.0	3.1	0.0	0.5	0.0	0.4	0.0	0.0	0.1	0.0	0.0	2.0
Volume ($m^3/100\ m^2$)	0.0	0.0	1.3	0.0	0.3	0.0	0.2	0.0	0.0	<0.1	0.0	0.0	0.3

Appendix 3.—Population number and density of juvenile salmonids by channel type and study reach, (Study 2) Situk River, Alaska, and adjacent watersheds 1987-89. (a = stream from adjacent watershed; b = smolt; p = fry present but population not estimated.)

Variable	Channel type															
	FP1f			FP1s		FP3f						FP3s				
Site no. NMFS	308[a]	328[a]	408[a]	409[a]	108[a]	101	122[a]	304	310	315	330[a]	113[a]	121[a]	201	117	
Site no. USFS	308	328	408	409	501	501	301	304	310	315	330	501	112	201	203	
Day of year	161	203	194	195	213	202	224	164	232	223	201	206	223	220	220	
Reach area (m^2)	706	306	476	1537	2630	231	511	169	328	744	493	504	289	204	337	
Reach length (m)	75	58	69	106	180	98	82	60	58	87	78	90	50	48	50	
Population no.																
Coho	727	455	662	1281	3693	705	788	308	373	1879	629	575	324	518	1387	
Proportion fry	0.29	0.77	0.80	0.04	0.93	0.96	0.36	0.91	0.94	0.90	0.75	0.88	0.90	0.67	0.85	
Fry	211	350	528	56	3420	674	284	279	351	1690	472	503	293	345	1178	
Parr	516	105	134	1225	273	31	504	29	22	188	157	72	31	173	209	
Sockeye	0	0	0	8	26	0	0	0	0	0	0	0	0	0	8	
Fry	0	0	0	0	26	0	0	0	0	0	0	0	0	0	8	
Parr	9	0	0	8	0	0	0	0	0	0	0	0	0	0	0	
Steelhead	3	11	67	2	0	0	0	0	104	28	0	5	0	25	10	
Fry	0	0	0	0	0	0	0	0	88	0	0	0	0	p	p	
Parr	3	11	67	2	0	0	0	0	16	28	0	5	0	25	10	
Chinook fry	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
Dolly Varden	1	0	0	0	1	3	23	3	19	835	14	1	35	0	100	
Population density ($no./100\ m^2$)																
Coho	103	149	139	83	140	305	154	182	114	252	126	114	112	254	412	
Fry	30	115	111	4	130	292	56	165	106	227	95	100	101	169	350	
Parr	73	34	28	80	10	13	99	17	7	25	31	14	11	85	62	
Sockeye	1	0	0	1	1	0	0	0	0	0	0	0	0	0	2	
Fry	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	
Parr	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
Steelhead	0	3	14	<1	0	0	0	0	31	4	0	1	0	12	3	
Fry	0	0	0	0	0	0	0	0	27	0	0	0	0	p	p	
Parr	0	3	14	0	0	0	0	0	5	4	0	1	0	12	3	
Chinook fry	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	
Dolly Varden	<1	0	0	0	0	1	5	2	5	112	3	<1	12	0	30	

Appendix 3.—Continued.

Variable	Channel type					
	FP4f			FP4s		
Site no. NMFS	301	311	318	103	317	104
Site no. USFS	301	311	318	503	317	504
Day of year	158	236	189	203	200	221
Reach area (m^2)	2094	2953	1684	626	923	3593
Reach length (m)	136	132	122	85	108	180
Population no.						
Coho	10189	2811	6379	740	5143	1192
proportion fry	0.97	0.99	0.99	0.79	0.69	0.89
fry	9885	2783	6315	585	3549	1056
parr	304	28	64	155	1594	136
Sockeye	672	188	736	0	1	516
fry	0	188	736	0	1	516
parr	672	0	0	0	0	0
Steelhead	710	572	1	454	610	4
fry	0	562	0	p	0	0
parr	710	10	1	454	610	4
Chinook fry	0	2	0	0	3	0
Dolly Varden	8	909	8329	100	354	15835
Population density (no./100 m^2)						
Coho	487	95	379	118	557	33
fry	472	95	377	93	385	29
parr	15	1	2	25	173	4
Sockeye	32	6	44	0	<1	14
fry	0	6	44	0	<1	14
parr	32[b]	0	0	0	0	0
Steelhead	34	19	<1	73	66	<1
fry	0	19	0	p	0	0
parr	34	<1	0	73	66	<1
Chinook fry	0	<1	0	0	0	0
Dolly Varden	<1	31	495	16	38	441

Appendix 3.—Continued.

Variable	Channel type										
	FP5f						FP5s				
Site no. NMFS	410	111	115	415[c]	416[c]	322[a]	309[d]	319[e]	323[d]	413[c]	414[c]
Site no. USFS	410	507	207	415	416	322	309	319	323	413	414
Day of year	214	212	204	220	223	188	167	237	223	219	222
Reach area (m^2)	3233	7139	2504	361	454	740	504	300	169	392	355
Reach length (m)	122	220	110	71	81	75	134	62	55	106	74
Population no.											
Coho	12514	184	3469	677	695	1989	1465	408	1670	2470	4555
proportion fry	0.97	0.99	0.87	0.97	0.94	0.96	0.85	0.96	0.97	0.97	0.99
fry	12193	181	3004	656	655	1909	1245	393	1620	2393	4510
parr	321	2	465	21	40	89	220	15	50	77	45
Sockeye	1	2	0	0	0	0	30	0	0	0	0
fry	1	2	0	0	0	0	30	0	0	0	0
parr	0	0	0	0	0	0	0	0	0	0	0
Steelhead	285	27	18	30	28	273	59	7	168	476	200
fry	24	p	p	9	2	0	0	0	0	84	122
parr	261	27	18	21	26	273	59	7	168	392	78
Chinook fry	331	0	0	2	25	1177	523	0	122	80	23
Dolly Varden	47	3	3	5	2	15	36	0	7	16	9
Population density (no./100 m^2)											
Coho	387	3	139	188	153	123	291	30	988	631	1284
fry	378	3	120	182	144	118	247	29	959	611	1271
parr	10	<1	19	6	9	5	44	1	30	20	13
Sockeye	<1	<1	0	0	0	0	1	0	0	0	0
fry	<1	<1	0	0	0	0	1	0	0	0	0
parr	0	0	0	0	0	0	0	0	0	0	0
Steelhead	9	<1	1	8	6	17	12	1	99	122	56
fry	1	p	p	3	0	0	0	0	0	21	34
parr	8	<1	1	6	6	17	12	1	99	100	22
Chinook fry	10	0	0	1	6	73	104	0	72	20	6
Dolly Varden	1	<1	<1	1	<1	<1	7	0	4	4	3

Appendix 3.—Continued.

Variable	Channel type												
	PA1							PA2	PA3				
Site no. NMFS	102	302	305[a]	324	325	327	329[a]	120	106	123	105	303	326
Site no. USFS	502	302	305	324	325	327	329	204	506	210	505	303	326
Day of year	203	159	160	186	235	221	199	222	205	224	209	164	233
Reach area (m^2)	130	71	231	53	168	114	201	2292	268	745	885	1204	798
Reach length (m)	60	38	65	39	40	68	62	113	74	75	115	79	75
Population no.	233												
Coho	140	501	27	246	608	21	546	4061	2159	639	231	11893	895
proportion fry	0.56	1.0	0	0.52	0.84	1.0	0.93	0.88	0.83	0.77	0.88	0.99	0.90
fry	78	501	0	128	511	21	508	3582	1785	493	203	11721	806
parr	62	0	27	118	97	0	38	479	373	146	28	172	89
Sockeye	2	0	1	4	0	0	0	16	267	161	0	31	64
fry	2	0	1	4	0	0	0	16	267	161	0	31	64
parr	0	0	0	0	0	0	0	0	0	0	0	71	0
Steelhead	6	0	0	7	39	0	13	0	0	0	0	0	0
fry	0	0	0	0	29	0	0	0	0	0	0	0	0
parr	6	0	0	7	10	0	13	0	0	0	0	0	0
Chinook fry	0	0	0	0	4	0	0	0	0	0	0	0	0
Dolly Varden	20	0	0	41	150	6	6	0	52	4	370	59	24
Population density (no./100 m^2)	20	0	0	172	89								
Coho	108	703	12	469	362	18	272	177	806	86	26	987	112
fry	60	703	0	244	304	18	253	156	667	66	23	973	101
parr	47	0	12	226	58	0	19	21	139	20	3	14	11
Sockeye	2	0	0	10	0	0	0	1	100	22	0	7	8
fry	2	0	0	10	0	0	0	1	100	22	0	1	8
parr	0	0	0	0	0	0	0	0	0	0	0	6	0
Steelhead	5	0	0	14	35	1	8	0	0	0	0	0	0
fry	0	0	0	0	30	0	0	0	0	0	0	0	0
parr	5	0	0	14	6	1	8	0	0	0	0	0	0
Chinook fry	0	0	0	0	3	0	0	0	0	0	0	0	0
Dolly Varden	15	0	0	79	89	5	3	0	19	1	42	5	3

GLOSSARY

The following definitions pertain to terms and acronyms as used specifically in this report.

ADF&G: Alaska Department of Fish and Game.

Channel type: Stream segments that have fairly consistent physical characteristics. A stream classification system developed by the U.S. Forest Service and based on channel types was used in Study 2.

Estuary basin: The deepwater portion of the Situk estuary that is permanently flooded.

Fork Length (FL): Fish length measured from tip of snout to fork of tail.

Fry: A juvenile salmonid that has reared less than a year in fresh water (age 0).

Juvenile: A salmonid fry, parr, presmolt, or smolt prior to entering seawater.

Lake type: Sockeye that rear in lakes during their juvenile freshwater life stage.

Lower river: The approximate 3.5 km lowermost section of the main-stem Situk River influenced by daily tides.

LWD: Large woody debris; a term used to describe logs, tree boles, rootwads, and limbs that are in or near the stream channel. Woody material >10 cm in diameter and ≥3 m long.

MOU: Memorandum of understanding; an official written agreement between agencies.

MS-222: Tricaine methanesulfonate; a fish anesthetic and tranquilizer.

NMFS: National Marine Fisheries Service.

Ocean type: Sockeye and chinook salmon that migrate to sea their first year (age 0).

Parr: A juvenile salmonid that has reared one or more years in fresh water; has distinct parr marks and no silver body coloring.

Predicted flood zone: The portions of the Situk River, Lost River, and Kunayosh Creek watersheds that will be inundated from the overflow of glacial water from Russell Lake after the Hubbard Glacier dams Russell Fiord.

Presmolt: A juvenile salmonid with physical characteristics intermediate between a parr and a smolt (faint parr marks and silvery sheen to scales).

Restoration: The means of returning the carrying capacity of salmonid habitat to a previously existing level.

Restoration strategies: Possible approaches to consider when restoring habitat and anadromous fish after flooding, based on research and other available information presented in this report.

Riverine: River habitat.

Rotary-screw trap: A floating trap with a revolving cone used to catch juvenile downstream migrant salmonids (see Fig. 7.2).

Smolt: Juvenile salmonids that are physiologically capable of adapting to seawater; have distinct morphological characteristics (e.g. silvered body, darkened fin tips).

Stock: Group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction.

Tidal slough: Quiet-water estuarine habitat in tidal wetlands, containing brackish water and typically bordered by *Carex* sp.

Upper river: The section of the main-stem Situk River upstream of tidal influence.

USFS: United States Forest Service.