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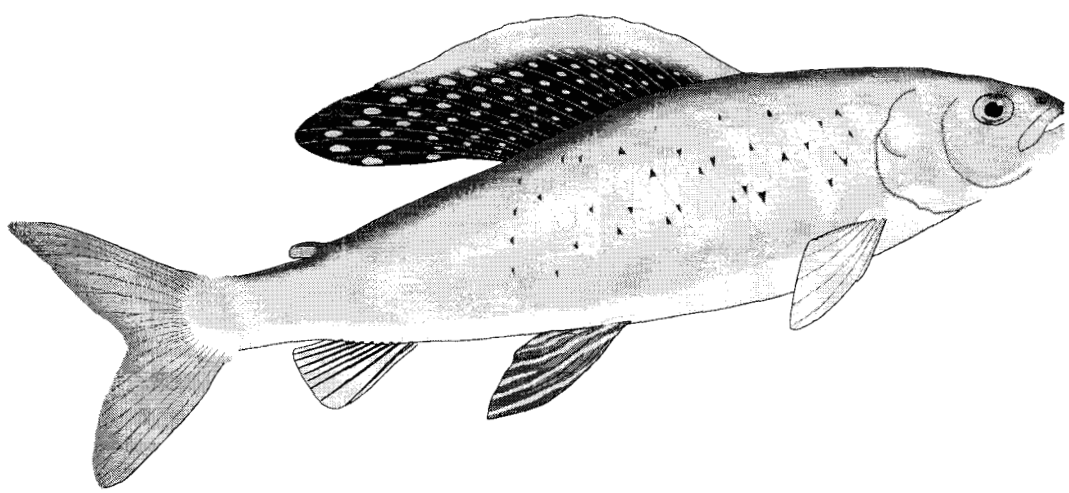
West Channel Sagavanirktok River Spine Road Crossing Fisheries Investigations, 1997-1999

by Alvin G. Ott and William A. Morris



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Alaska Department of Fish and Game

Habitat and Restoration Division

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Acknowledgments

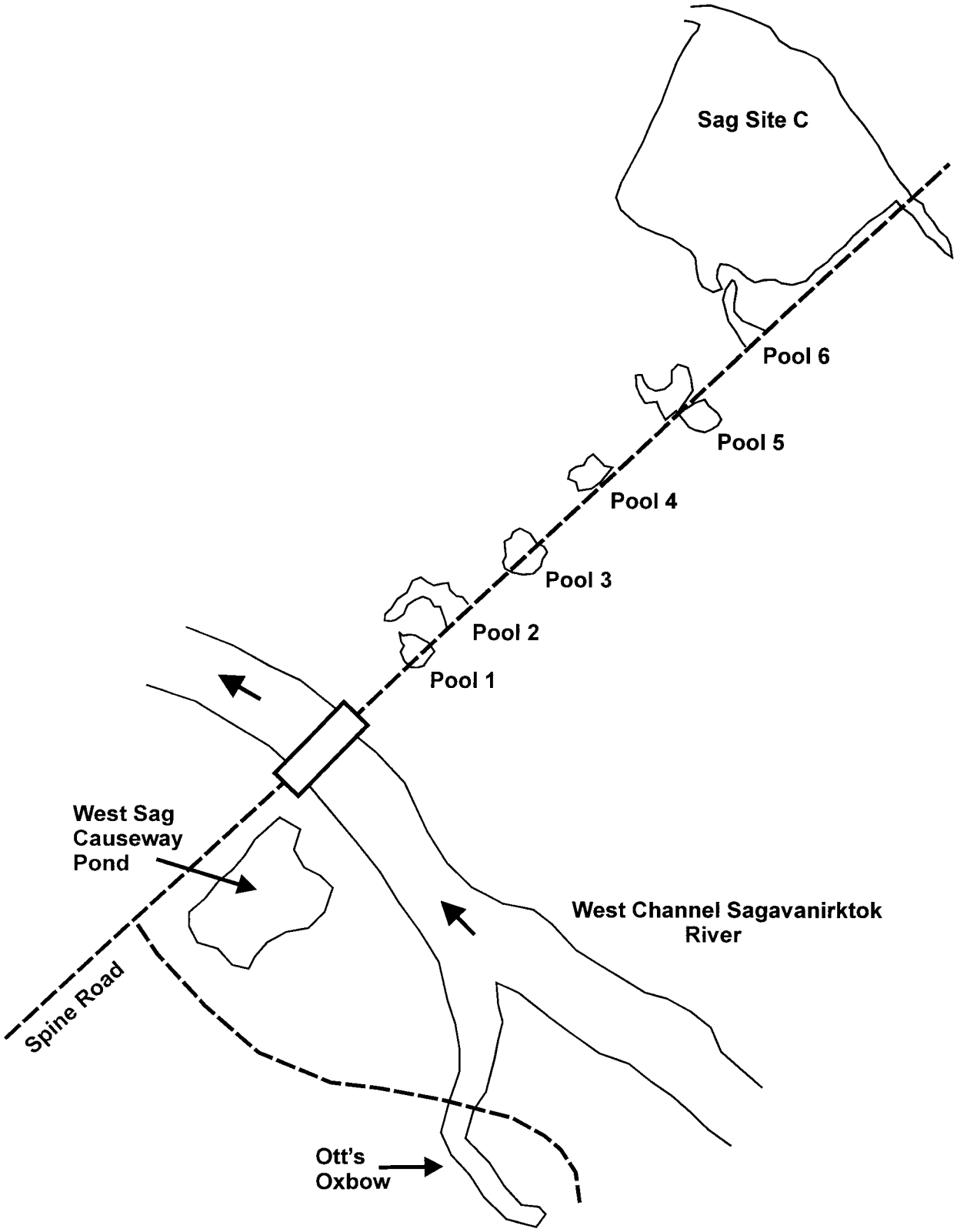
Our thanks to ARCO Alaska Inc. (Mr. Mike Joyce) for their logistical and financial support for fish and water quality sampling in the West Channel of the Sagavanirktok River in the vicinity of the Spine Road crossing. Mr. Jack Winters (Alaska Department of Fish and Game) and Mr. Mike Joyce provided constructive review of our report. Ms. Stacey Simpers, Mr. Carl Hemming, and Ms. Nancy Ihlenfeldt assisted with field data collection. Ms. Nancy Ihlenfeldt prepared maps for the report.

Introduction

Scour pools located along the Spine Road crossing of the West Channel Sagavanirktok River and Ott's Oxbow (a former mine site connected to the river with a culvert under a road crossing) have been investigated since the mid-1980s (Ott 1993, Hemming 1991, Ott 1989) (Figure 1). Recommendations for restoration work at the Spine Road crossing of the West Channel Sagavanirktok River were made in 1989 and were restated in 1993 (Ott 1993, Ott 1989). Fish Habitat Permits have been issued over the past 20 years for water use from Sag Site C, placement of additional culvert batteries in the road, maintenance of existing culvert batteries, rehabilitation of Sag Site C, repair of dikes along the west bank of the river, erosion control and scour protection at the bridge crossing, and for pipeline maintenance.

In 1996, the U.S. Army Corps of Engineers (ACOE) issued an individual permit (Sagavanirktok River 151, 2-960253) to ARCO Alaska Inc. (AAI) for work consisting of dredging, channelization, and the discharge of dredged material upstream of seven culvert batteries in the Spine Road crossing of the West Channel Sagavanirktok River. The ACOE permit to AAI contained three special conditions that required monitoring of scour pools separated from stream flows during periods of low or no water. Scour pool monitoring was to include site photographs, a description of each site and location, scour pool size and depth, and a record of the number, species, and size of fish entrapped. Annual monitoring reports were to be prepared and submitted to the ACOE and, at the end of a three-year monitoring period, a summary report was to be submitted. Our report summarizes a three-year sample program conducted at six culvert batteries with scour pools isolated from surface flows during periods of low flow in the West Channel Sagavanirktok River. We also report fish and water quality data collected in two other man-made disturbances (Ott's Oxbow and West Sag Causeway Pond) in the floodplain of the river that are isolated from main river channel habitats during low flow conditions.

Figure 1. Spine Road crossing of the West Channel Sagavanirktok River.



Methods

Sampling Sites

Fish and water quality data were collected in six scour pools, an abandoned flooded material site (Ott's Oxbow), and a backwater area (West Sag Causeway Pond) of the West Channel Sagavanirktok River in the vicinity of the Spine Road crossing (Figure 1). Culvert batteries are located in the Spine Road at the six scour pool sites. A single 48-inch diameter steel pipe connects Ott's Oxbow with the West Channel of the Sagavanirktok River. A small channel that eroded through a river training dike connects the West Sag Causeway Pond with the river. The six scour pools, Ott's Oxbow, and West Sag Causeway Pond are all isolated (i.e., no surface flow) during low water and at normal mid-summer flows in the West Channel Sagavanirktok River.

Fish

Fish sampling was conducted using two sizes of fyke-nets. General net specifications were the same (wings, mesh, and center leads), but entrance frame size varied. Entrance frames were either 0.9 m^2 or 1.2 m^2. Fyke-nets were 3.7 m long, had five hoops, a 1.8-m cod end, and 0.9 m by 7.6 m net wings attached to the entrance frames. The center lead was 30.4 m long and was deployed to the maximum extent possible without submerging the top of the entrance frame. Nets were set with the center lead either perpendicular to or at an angle to the shore, depending upon configuration of the sample area and distance to deep water. Fyke-nets were fished unbaited.

Generally, fyke-nets were fished for 24 hours. Fish were removed from the nets, identified to species, measured (mm), and transported to and released in deep water habitat (Sag Site C or the main channel of the West Channel of the Sagavanirktok River). When a large number of a fish species of similar size were captured, we measured only a representative subsample to minimize mortality associated with handling.

Water Quality

Temperature (°C), dissolved oxygen concentration (mg/L), dissolved oxygen percent saturation (temperature and barometrically corrected), pH, and conductivity (*u* S/cm) were measured with a Hydrolab® Minisonde® water quality multiprobe connected to a Surveyor® 4 water quality display unit. The meter was calibrated to suggested specifications prior to use in the field. The dissolved oxygen concentration was calibrated with the Winkler Titration Method (average of three measurements). Conductivity and pH were calibrated with standard solutions. Water quality measurements were made at a depth of 1 m.

Results

Fyke-net sampling in the six scour pools in 1997, 1998, and 1999 resulted in the capture of seven fish species: Arctic grayling (*Thymallus arcticus*); round whitefish (*Prosopium cylindraceum*); broad whitefish (*Coregonus nasus*); slimy sculpin (*Cottus cognatus*); ninespine stickleback (*Pungitius pungitius*); Dolly Varden (*Salvelinus malma*); and burbot (*Lota lota*) (Appendix 1). In summer 1996 prior to the start of our three-year fish sample program, we sampled Scour Pools 1, 2, and 3, catching 153 Arctic grayling, 76 round whitefish, 118 broad whitefish, and 24 slimy sculpin (Ott and Simpers 1997).

A physical description of the six scour pools sampled is presented in Appendix 2 (site description). Photographs of Scour Pools 1 through 6 are shown in Figures 2 through 7. During the three-year sample period, there was no evidence of extensive changes in the physical characteristics of the scour pools. The scour pools form quickly following the placement of a new culvert battery, but they are relatively stable after initial scour.

Scour Pools 1 through 5 were sampled once during 1997 and all six scour pools were sampled with fyke-nets once in 1998, and twice in 1999. Sampling was conducted twice in 1999; in June after breakup and in August following a high discharge event that reflooded the scour pools. The second August 1999 sample period demonstrated that fish entrapment occurred twice in summer 1999. In the three years of sampling, we caught 302 Arctic grayling, 363 round whitefish, 300 broad whitefish, 123 slimy sculpin, 12 burbot, and 1 Dolly Varden (Table 1). The catch of ninespine stickleback generally was low, except in Scour Pool #6 in August 1999 when 250 were captured. Catch by species varied annually, but the dominant species captured over the three years of this study were Arctic grayling, round whitefish, and broad whitefish. The majority of the Arctic grayling, round whitefish, and broad whitefish entrapped in the scour pools were small; young-of-the-year or age 1+ fish (Figure 8).

In August 1998 and 1999, we sampled Ott's Oxbow and West Sag Causeway Pond, collecting 121 Arctic grayling, 16 round whitefish, 254 broad whitefish, 3 slimy sculpin, 163 ninespine stickleback, and 16 burbot (Table 2). Again, the majority of the fish collected were small; age 0 or age 1+ fish (Figure 9).

Figure 2. Scour Pool #1 looking south toward the Spine Road. Cod end of net set in about 0.5 m of water with center lead angled to the southwest.

Figure 3. Scour Pool #2 looking north from the Spine Road. Cod end of net set in about 1.0 m of water with center lead angled to the north.

Figure 4. Scour Pool #3 looking south toward the Spine Road. Cod end of net set in about 0.5 m of water with center lead angled to the southwest.

Figure 5. Scour Pool #4 looking north from the Spine Road. Cod end of net set in about 0.5 m of water with center lead angled to the west.

Figure 6. Scour Pool #5 looking north from the Spine Road. Cod end of net set in about 0.5 m of water with center lead angled to the southwest.

Figure 7. Scour Pool #6 looking north from the Spine Road. Channel below scour pool was seined.

Table 1. The total number of fish, by species, captured in the six scour pools along the Spine Road crossing of the West Channel Sagavanirktok River.

Scour Pool Number	Sample Year	Number of AG	Number of RWF	Number of BWF	Number of CN	Number of NSB	Number of DV	Number of BB
1	Jul-97	2	28	5	4	0	0	0
1	Aug-98	7	15	11	1	0	0	1
1 and 2	Jun-99	0	1	1	2	1	0	3
1	Aug-99	8	35	5	16	4	0	0
2	Jul-97	15	4	103	5	4	0	0
2	Aug-98	8	4	39	0	2	0	0
2	Aug-99	96	134	8	3	15	0	1
3	Jul-97	0	0	4	0	0	0	0
3	Aug-98	8	1	12	0	2	0	0
3	Jun-99	0	0	0	0	0	0	0
3	Aug-99	30	16	35	0	3	0	0
4	Jul-97	0	0	2	0	0	0	0
4	Aug-98	2	4	2	2	0	0	2
4	Jun-99	0	0	0	0	0	0	0
4	Aug-99	3	1	1	0	4	0	0
5	Jul-97	36	59	4	14	3	0	0
5	Aug-98	34	44	56	2	10	0	0
5	Jun-99	8	3	1	8	0	0	0
5	Aug-99	31	12	8	48	44	0	0
6	Aug-98	11	0	0	4	4	1	0
6	Jun-99	0	1	0	3	0	0	0
6	Aug-99	3	1	3	11	250	0	5
Total # of Fish/Species		302	363	300	123	346	1	12

AG = Arctic grayling, RWF = round whitefish, BWF = broad whitefish, CN = slimy sculpin, NSB = ninespine stickleback, DV = Dolly Varden, and BB = burbot

Figure 8. Length frequency distribution of Arctic grayling, round whitefish, and broad whitefish caught in August 1998 and 1999 from Scour Pools 1 through 6.

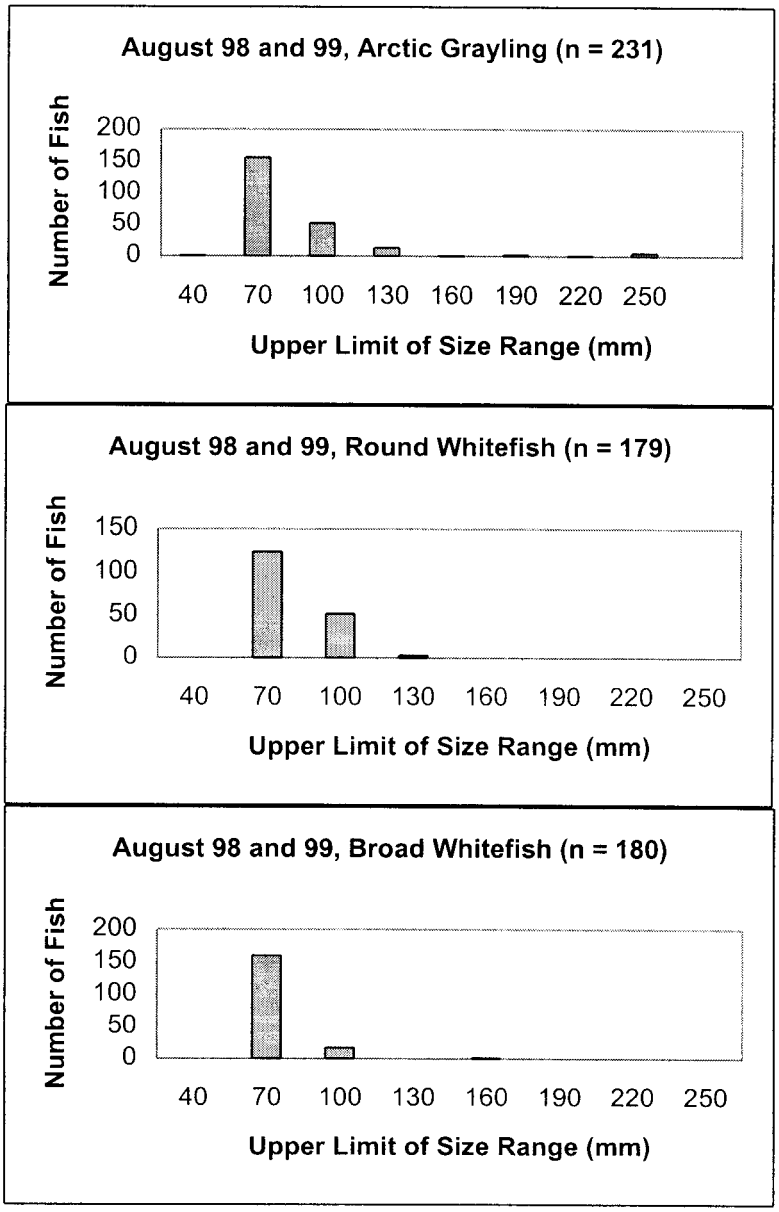
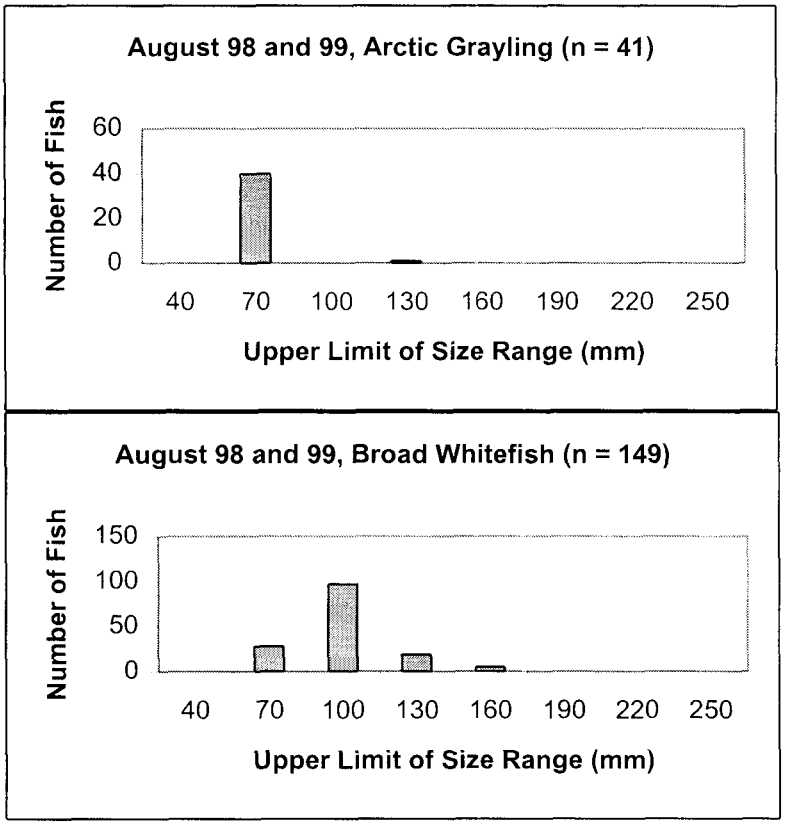


Table 2. The total number of fish, by species, captured in Ott's Oxbow and West Sag Causeway Pond in August 1998 and 1999.

Sample Area	Sample Year	Number of AG	Number of RWF	Number of BWF	Number of CN	Number of NSB	Number of DV	Number of BB
Ott's Oxbow	Aug-98	0	4	159	0	106	0	15
Ott's Oxbow	Aug-99	20	6	44	0	23	0	0
West Sag Pond	Aug-98	99	4	44	0	10	0	1
West Sag Pond	Aug-99	2	2	7	3	24	0	0
Total # of Fish/Species		121	16	254	3	163	0	16

AG = Arctic grayling, RWF = round whitefish, BWF = broad whitefish, CN = slimy sculpin, NSB = ninespine stickleback, DV = Dolly Varden, and BB = burbot

Figure 9. Length frequency distribution of Arctic grayling and broad whitefish caught in August 1998 and 1999 from Ott's Oxbow and West Sag Causeway Pond.



Ott's Oxbow, a shallow, backwater area infrequently connected with the main channel of the river, was used extensively by juvenile broad whitefish. In August 1990, we caught 237 broad whitefish in a 24-hour fyke-net set in Ott's Oxbow (Hemming 1991).

Water quality data were collected from the six scour pools, Ott's Oxbow, and West Sag Causeway Pond (Table 3). Results indicate that these habitat types are ideal for and attractive to juvenile fish that select warmer waters for increased growth. Water temperatures were warm and dissolved oxygen concentrations were high; favorable conditions for fish food organism productivity. However, once isolated, all fish remaining in the six scour pools, Ott's Oxbow, and West Sag Causeway Pond probably do not survive the winter, as these sites are shallow and probably freeze to the bottom by late winter.

Table 3. Water quality in Scour Pools 1 through 6, Ott's Oxbow, and West Sag Causeway Pond.

Sagavanirktok River Scour Pool Study Water Quality Sampling, June 1999

Scour Pool	Temp C	DO mg/L	% DO Saturation	Specific Conductance u S/cm	pH
#1	12.26	10.90	101.0	228.9	8.29
#2	11.47	11.08	99.6	227.0	8.23
#3	11.08	11.12	99.9	180.5	8.14
#4	9.71	11.37	98.9	247.6	8.21
#5	11.71	11.10	101.1	217.6	8.13
#6	7.74	11.88	98.5	231.8	8.14

Sagavanirktok River Scour Pool Study Water Quality Sampling, August 1998

Scour Pool	Temp C	DO mg/L	% DO Saturation	Specific Conductance u S/cm	pH
#1	9.79	10.92	97.6	378.9	8.75
#2	9.59	11.05	98.2	346.8	8.74
#3	9.77	11.00	98.1	435.6	8.73
#4	9.19	11.04	97.0	397.5	8.66
#5	8.22	11.07	96.7	392.2	8.57
#6	8.76	11.37	99.0	429.7	8.63
Ott's Oxbow	10.45	10.68	96.7	314.7	8.54
West Sag Pond	10.27	11.07	99.9	226.6	8.67

Recommendations

Restoration work to mitigate adverse impacts to anadromous and resident fish species is needed for the West Channel of the Sagavanirktok River in the vicinity of the Spine Road crossing. Substantial fish entrapment has been documented in the six scour pools, Ott's Oxbow, and West Sag Causeway Pond. The largest number of fish subjected to entrapment and in all likelihood, winter mortality, included Arctic grayling, round whitefish, and broad whitefish. General recommendations for mitigation of current impacts to fish of the West Channel of the Sagavanirktok River were contained in Ott (1989) and are repeated below:

SHORT TERM - "side channels on the eastern side of the West Channel of the Sagavanirktok River should be attached to Sag Site C which contains adequate overwintering habitat, a rehabilitation plan for these channels should be developed and submitted to the ADF&G for review and approval"

LONG TERM - "the entire Spine Road crossing and associated drainage and river training structures should be reevaluated with the objective of returning this channel of the Sagavanirktok River to a normal flow pattern"

Our recommended long-term solution for the West Channel of the Sagavanirktok River remains unchanged. Recommendations for remedial work at Ott's Oxbow also were made in 1989 (Ott 1989), but no suggestions were made for the West Sag Causeway Pond. In 1989, Ott did not make a short term recommendation for Ott's Oxbow, but did suggest long-term consideration be given to development of a mining plan for Ott's Oxbow that would increase winter habitat along with replacement of the existing 48-inch steel wall pipe with several large culverts. The suggested short-term approaches to mitigation for the Spine Road crossing of West Channel of the Sagavanirktok River as made in 1989 are refined and explained in more detail below:

(1) Scour Pools #1 through #6 - A detailed mining plan should be developed with the objective of providing a surface flow connection, at summer low flows, from ponded water in the six scour pools to deep water habitat in Sag Site C. The area should be surveyed and channel excavations made to provide at least 0.5 m of water depth from the scour pools to Sag Site C. Channel connections should be fairly wide (10 m) with shallow water margins to increase habitat quality. Based on data gathered on fish use of the scour pools, connecting these pools

with Sag Site C should enhance aquatic habitat for both anadromous and resident fish species. Based on the relative stability of the existing scour pools, maintenance requirements for the channel excavations between the pools and Sag Site C should be minor, but plans for maintenance if needed should be included.

(2) West Sag Causeway Pond - A rehabilitation plan should be developed that provides for a continuous surface flow connection between the ponded area and the main channel of the West Channel of the Sagavanirktok River. This channel connection may require a higher level of maintenance due to the proximity of the main river channel. Another possible option would be to rebuild the dike and maintain the structure to prevent fish access into the ponded area.

(3) Ott's Oxbow - Based on fish and water quality data collected, it was apparent that the existing habitat characteristics of Ott's Oxbow are highly productive. We still recommend that a mining/rehabilitation plan be developed for the entire floodplain of the river on the upslope side of the road crossing. Deep water habitat should be a major component of the mining/rehabilitation plan, but provisions should be made to ensure at least 50% of the surface area is shallow (less than 1 foot). The transition from deep water to shallow water should be at a shallow slope (i.e., less than one percent). The existing 48-inch steel wall pipe should be replaced with a larger diameter pipe and the new pipe should be set with the invert at least 12 inches below the thalweg. Some instream work also may be required to ensure a connection between the outflow waters from the pipe and the main channel of the West Channel of the Sagavanirktok River. The area should be surveyed prior to development of a restoration plan for Ott's Oxbow. Creation of overwintering habitat in a site connected with the West Channel of the Sagavanirktok River would greatly increase the amount of this habitat type in the lower river.

Monitoring of the six scour pools, Ott's Oxbow, and West Sag Causeway Pond should continue and should be expanded to include other areas within the floodplain affected by the Spine Road crossing. A schedule for preparing and implementing both the short-term and long-term mitigation plans should be established.

Literature Cited

Hemming, C.R. 1991. Fish and habitat investigations of flooded North Slope gravel mine sites, 1990. Technical Report No. 91-3, Alaska Department of Fish and Game, Habitat and Restoration Division, Juneau. 44 pp.

Ott, A.G. and S. Simpers. 1997. Trip report, West Channel of the Sagavanirktok River July 28 and 29, 1997. Alaska Department of Fish and Game, Habitat and Restoration Division. 13 pp.

Ott, A.G. 1993. An evaluation of the effectiveness of rehabilitation at selected streams in North Slope oilfields. Technical Report No. 93-5. Alaska Department of Fish and Game, Habitat and Restoration Division, Juneau. 61 pp.

Ott, A.G. 1989. North Slope oil and gas cross drainage report. Alaska Department of Fish and Game, Habitat and Restoration Division, Juneau. 72 pp.

Appendix 1 - Fish Data

Scour Pool #1, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97	86	57	46	71			
	155	67	48				
		67					
		70					
		72					
		72					
		72					
		74					
		74					
		74					
		76					
		77					
		78					
		79					
		82					
		84					
		84					
		84					
		84					
		88					
7/28/97		65	106				
		70					
		74					
		76					
		78					
7/29/97		64	44	65			
		73	45	71			
		89		86			
Total # Fish	2	28	5	4	0	0	0

Abbreviations - AG (Arctic grayling); RWF (round whitefish); BWF (broad whitefish); CN (slimy sculpin); NSB (ninespine stickleback); DV (Dolly Varden); and BB (burbot)

All fish captured in fyke-nets, length of individual fish in mm.

Appendix 1 (continued)

Scour Pool #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97	72	47	48				
	75		48				
	80		48				
			50				
			50				
			51				
			52				
			52				
			53				
			54				
			98				
7/28/97	58	92	53	87			
	70			88			
	74						
	78						
	80						
	82						
	86						
	125						
7/29/97	74	68	47	41	47		
	77	89	47	87	50		
	91		48	103	53		
	122		48		62		
			50				
			50				
			52				
			52				
			53				
			54				
Total # Fish	15	4	103	5	4	0	0
# Fish Not Measured			81				

Appendix 1 (continued)

Scour Pool #3, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97			56				
7/28/97			50				
			52				
			56				
7/29/97							
Total # Fish	0	0	4	0	0	0	0

Appendix 1 (continued)

Scour Pool #4, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97			52				
7/28/97			48				
7/29/97							
Total # Fish	0	0	2	0	0	0	0

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97	63	68	100	76	58		
	64	68		78			
	67	68		82			
	67	71		90			
	67	72					
	68	72					
	69	73					
	69	74					
	70	75					
	70	75					
	72	75					
	87	75					
	95	75					
	98	77					
	100	82					
	102	82					
	108	82					
	117	82					
	118	83					
	138	84					
		87					
		88					
		90					
		92					
		98					
		100					
		100					
		102					
		102					
		104					
		105					
		106					
		108					
		110					
		111					
		118					
		120					
		121					
		122					

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
7/28/97 (con't)		130					
7/28/97	59	69		74			
	64	70		90			
	66	77					
	67	77					
	67	78					
	111	81					
	112	82					
	116	82					
		100					
		115					
7/29/97	64	60	43	42	60		
	68	63	44	74	63		
	72	64	47	78			
	74	64		81			
	76	70		87			
	83	72		92			
	98	76		94			
	98	102		103			
		103					
Total # Fish	36	59	4	14	3	0	0

Appendix 1 (continued)

Scour Pool #1, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/5/98	75	81	60	74			112
	78	84	60				
	84	87	60				
	84	88	62				
	84	88	63				
	87	88	64				
	96	89	64				
		89	64				
		89	65				
		90	65				
		92	66				
		94					
		98					
		100					
		101					
Total # Fish	7	15	11	1	0	0	1

Appendix 1 (continued)

Scour Pool #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/5/98	75	50	62		62		
	82	88	62		75		
	83	92	62				
	86	104	62				
	90		62				
	90		62				
	93		62				
	235		62				
			62				
			63				
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			66				
			66				
			67				
			67				
			68				
Total # Fish	8	4	39	0	2	0	0

Appendix 1 (continued)

Scour Pool #3, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/5/98	82	58	65		61		
	97		68		70		
	101		68				
	102		68				
	104		70				
	110		70				
	112		70				
	232		71				
			71				
			72				
			73				
			73				
Total # Fish	8	1	12	0	2	0	0

Appendix 1 (continued)

Scour Pool #4, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/6/98	95	51	64	87			30
	105	55	64	110			30
		59					
		98					
Total # Fish	2	4	2	2	0	0	2

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/6/98	80	65	395	63	58		
(Downstream	85	71	415				
of Spine Road)	85	71					
	86	72					
	93	72					
		74					
		75					
		77					
		77					
		79					
		80					
		80					
		81					
		82					
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		95					
		95					
		96					
8/7/98	64	54	55		55		
(Upstream of	73	54	55				
Spine Road)	74	54	56				
	78	54	56				
	78	54	57				
	79	54	58				
	80	56	59				
	83	57	59				

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/7/98 (con't)	84	60	59				
	84	84	59				
	84		59				
	85		59				
	85		59				
	85		59				
	85		60				
	86		60				
	86		60				
	86		60				
	87		60				
	89		60				
	90		60				
	92		61				
	134		61				
	174		61				
	178		61				
	209		61				
	228		62				
	243		62				
	245		62				
			62				
			62				
			62				
			62				
			62				
			63				
			63				
			63				
			63				
			63				
			63				
			64				
			64				
			64				
			64				
			64				
			64				
			64				
			65				

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/7/98 (con't)			65				
			65				
			65				
			66				
			68				
			80				
8/7/98		73		38	61		
(Downstream		74			60		
of Spine Road)		78			57		
		87			60		
					66		
					54		
					57		
					60		
Total # Fish	34	44	56	2	10	0	0

Appendix 1 (continued)

Scour Pool #6, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/6/98	83			78	46	202	
	83			84	54		
	83			87	57		
	84			100	58		
	85						
	85						
	93						
	94						
	113						
	113						
	115						
Total # Fish	11	0	0	4	4	1	0

Appendix 1 (continued)

West Sag Causeway Pond, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/26/98	49	63	72				185
	50	64	73				
	50	70	73				
	51	101	74				
	52		74				
	54		74				
	54		75				
	54		75				
	54		76				
	54		76				
	54		77				
	55		77				
	55		78				
	55		80				
	55		80				
	56		80				
	56		81				
	56		81				
	59		81				
			81				
			83				
			109				
			111				
			114				
			114				
			117				
			118				
			119				
			120				
			120				
			120				
			122				
			123				
			124				
			124				
			126				
			128				
			128				
			128				

Appendix 1 (continued)

West Sag Causeway Pond, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/26/98 (con't)			130				
			131				
			133				
			135				
			137				
Total # Fish	99	4	44	0	10	0	1
# Fish Not Measured	80				10		

Appendix 1 (continued)

Ott's Oxbow, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/11/98		58	64				45
		64	64				46
		107	68				47
		110	69				50
			70				50
			71				50
			71				50
			72				51
			72				51
			72				52
			72				52
			72				52
			73				54
			73				55
			73				56
			73				
			73				
			73				
			73				
			73				
			73				
			74				
			74				
			74				
			74				
			74				
			74				
			74				
			74				
			74				
			74				
			75				
			75				
			75				
			75				
			75				
			75				
			75				
			76				

Appendix 1 (continued)

Ott's Oxbow, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/11/98 (con't)			76				
			76				
			77				
			77				
			77				
			77				
			77				
			77				
			77				
			78				
			78				
			80				
			80				
			81				
			83				
Total # Fish	0	4	159	0	106	0	15
# Fish Not Measured			105		106		

Appendix 1 (continued)

Scour Pool #1 and #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/24/99		116	409	39			440
#1 and #2 Connected				35			450
							320
Total # Fish	0	1	1	2	1	0	3
# Fish Not Measured					1		

Appendix 1 (continued)

Scour Pool #1 and #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/24/99		116	409	39			440
#1 and #2 Connected				35			450
							320
Total # Fish	0	1	1	2	1	0	3
# Fish Not Measured					1		

Appendix 1 (continued)

Scour Pool #1, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/28/99	46	50	64	50			
	46	53	64	51			
	48	53	65	53			
	50	53	65	54			
	50	54	66	55			
	104	55		55			
		55		56			
		55		56			
		57		58			
		57		58			
		60		60			
				60			
				60			
				60			
				95			
8/29/99	54	54		58			
	55	55					
Total # Fish	8	35	5	16	4	0	0
# Fish Not Measured		22			4		

Appendix 1 (continued)

Scour Pool #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/27/99	39	50	64				
	44	50	68				
	45	52	72				
	45	53					
	45	54					
	46	54					
	46	54					
	46	55					
	47	56					
	47	56					
	47	56					
	47	56					
	47	56					
	47	56					
	48	56					
	48	56					
	48	56					
	49	56					
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	49	57					
	49	57					
	49	57					
	49	57					
	49	57					
	49	57					
	49	57					
	50	57					
	50	57					
	50	57					
	50	58					
	50	58					
	50	58					
	50	58					
	50	58					
	50	58					
	50	58					
	50	58					

Appendix 1 (continued)

Scour Pool #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/27/99 (con't)	50	58					
	50	58					
	50	58					
	50	59					
	50	59					
	50	59					
	50	60					
	50	60					
	51	60					
	51	60					
	51	60					
	51	60					
	51	60					
	51	60					
	51	60					
	51	61					
	51	61					
	52	61					
	52	61					
	52	63					
	52	63					
	52	64					
	52						
	52						
	52						
	52						
	53						
	53						
	53						
	53						
	54						
	54						
	54						
	54						
	55						
	94						
	103						
	110						

Appendix 1 (continued)

Scour Pool #2, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/27/99 (con't)	128						
8/28/99	46	54	64	26			295
	47	56	65	64			
	48	56	67	75			
	48	59	68				
	48	60	145				
	50	60					
	50	60					
	51	60					
	51	61					
	54	63					
		115					
Total # Fish	96	134	8	3	15	0	1
# Fish Not Measured	10	64			15		

Appendix 1 (continued)

Scour Pool #3, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/23/99							
8/27/99	43	51	65				
	43	54	71				
	44	58	74				
	44	60	75				
	45						
	46						
	47						
	48						
	49						
	50						
	50						
	50						
	52						
	53						
	53						
	53						
	54						
	54						
	55						
	55						
	55						
	56						
	57						
	58						
8/28/99	42	54	60				
	44	55	60				
	44	55	60				
	50	55	60				
	53	55	60				
	56	56	62				
		56	62				
		56	63				
		56	64				
		58	64				
		60	65				
		62	65				

Appendix 1 (continued)

Scour Pool #3, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/28/99 (con't)			65				
			65				
			66				
			66				
			66				
			66				
			66				
			67				
			68				
			70				
			70				
			70				
			71				
			72				
			72				
			72				
			72				
			73				
			74				
Total # Fish	30	16	35	0	3	0	0
# Fish Not Measured					3		

Appendix 1 (continued)

Scour Pool #4, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/23/99							
8/27/99	48	62	59				
	52						
	53						
Total # Fish	3	1	1	0	4	0	0
# Fish Not Measured					4		

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/23/99	74	103	158	39			
	93	105		53			
	95	125		57			
	97			59			
	103			64			
	109			64			
	235			65			
	299			85			
8/25/99 (two nets)	48	58	55	41			
(Upstream and	49		60	42			
Downstream of	50		70	52			
Spine Road)	51			54			
	51			56			
	54			58			
				60			
				62			
				63			
				64			
				65			
				65			
				70			
				71			
				73			
				73			
				85			
				87			
8/26/99 (two nets)	44	53	56	42			
(Upstream and	44	53	58	43			
Downstream of	44	55	60	46			
Spine Road)	45	56	64	49			
	45	56	67	52			
	46	56		53			
	47	56		55			
	47	57		62			
	47	59		62			
	48	60		62			
	48	82		62			

Appendix 1 (continued)

Scour Pool #5, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/26/99 (con't)	48			63			
	49			63			
	50			64			
	50			65			
	50			66			
	52			66			
	52			69			
	52			70			
	55			71			
	55			73			
	55			73			
	56			74			
	56			75			
	58			77			
				78			
				78			
				80			
				83			
				86			
Total # Fish	39	15	9	56	44	0	0
# Fish Not Measured					44		

Appendix 1 (continued)

Scour Pool #6, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
6/25/99		117		87			
				56			
				56			
8/25/99	43		55	36			
	53		56	52			
	53		57	76			
				85			
				86			
8/26/99		46		37			50
				55			52
				75			52
				80			55
				80			56
				85			
Total # Fish	3	2	3	14	250*	0	5
# Fish Not Measured					250		

*August 25 and 26, catch of ninespine stickleback was 150 and 100, respectively.

Appendix 1 (continued)

West Sag Causeway Pond, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/29/99	54	52	62	53			
	104	55	66	67			
			69	72			
			70				
			71				
			75				
			142				
Total # Fish	2	2	7	3	24	0	0
# Fish Not Measured					24		

Appendix 1 (continued)

Ott's Oxbow, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/29/99	41	56	64				
	43	60	65				
	43	60	66				
	44	63	66				
	45	63	67				
	46	63	67				
	46		67				
	47		67				
	48		67				
	48		69				
	49		69				
	49		69				
	50		70				
	50		70				
	50		70				
	50		70				
	51		70				
	54		70				
	55		70				
	55		71				
			71				
			71				
			72				
			73				
			73				
			73				
			74				
			74				
			74				
			74				
			75				
			75				
			75				
			75				
			76				
			76				
			76				
			76				
			76				

Appendix 1 (concluded)

Ott's Oxbow, West Channel Sagavanirktok River							
Date	AG (mm)	RWF (mm)	BWF (mm)	CN (mm)	NSB (mm)	DV (mm)	BB (mm)
8/29/99 (con't)			76				
			77				
			77				
			80				
			80				
Total # Fish	20	6	44	0	23	0	0
# Fish Not Measured					23		