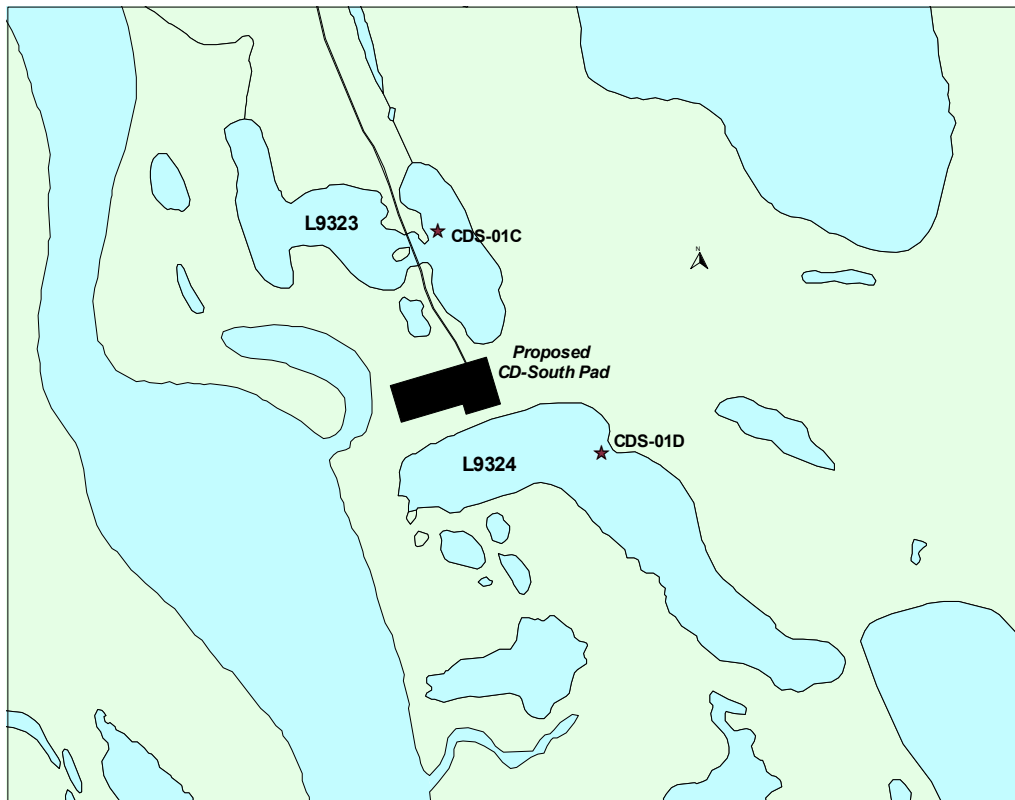


# FISH HABITAT IN LAKES OF THE COLVILLE RIVER UNIT SATELLITE DEVELOPMENT CD-SOUTH: 2002

Final Data Report

December 2002



Prepared by:

MJM Research  
1012 Shoreland Drive  
Lopez Island, WA

Prepared for:

ConocoPhillips Alaska, Inc.  
700 G Street  
Anchorage, AK

and

Anadarko Petroleum Corp.  
1200 Timberloch Place  
The Woodlands, TX

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CD-SOUTH: 2002**

**INTRODUCTION**

ConocoPhillips Alaska Inc. has been exploring for oil within the CD-South Exploration Area (Figure 1). During exploration, rivers and lakes are crossed by ice roads and water is withdrawn from lakes to support both industrial and domestic needs. Additional potential impacts will arise when the area is developed for oil extraction, thus it is important to obtain biological information to define the pre-development baseline conditions.

Because of the biological sensitivity of this area, the fish and fish habitats in or near this region of the Colville Delta have been studied since 1995 (Moulton 1997). These earlier surveys revealed that lakes within the delta are relatively deep, averaging almost 15 ft deep. This is unlike lakes in the Prudhoe Bay and Kuparuk oil fields, where lakes are rarely in excess of 7 ft deep. The combination of deep water, which allows successful wintering, and proximity to a major river creates abundant habitat for fish and many species are found in lakes throughout the delta (Moulton 1998). As a result, over 85% of the lakes within the delta support fish populations, while fish are rare in the thaw lakes east of the Colville River (Moulton 1998).

Studies of fish habitats in the channels and tapped lakes of the delta were initiated in 1995 prior to development of the Alpine field in order to obtain information needed for permitting the field. Those studies revealed that the minor channels, such as the Sakoonang Channel, are lightly used during summer, mostly by juvenile fishes. Highest densities of fish were found in tapped lakes, with catches again primarily juveniles, dominated by broad whitefish and least cisco (Moulton 1997). During summer, adult fishes for many of the dominant species range widely through Harrison Bay and along the Beaufort Sea coast, only returning in fall to winter within the delta.

In order to submit applications for exploration and development permits, information specific to the activity area is required in order to evaluate the biological sensitivity of lakes and river channels in the region. This study was designed to provide additional physical and biological information on two lakes associated with CD-South exploration and development to understand their use by various fish species. Results of the survey can be used, in concert with previous surveys within the area, to identify sensitive areas when developing spill-response plans, and to assess the need for monitoring during field operation.

The objective of this study is to evaluate fish presence and patterns of habitat use in two perched lakes (L9323 and L9324) in the CD-South Exploration Area. The study area for the CD-South fisheries investigations is generally defined as the lakes and river channels between the Alpine Development and the vicinity of the proposed CD-South pad, and approximately 2500 meters east

and west of the proposed CD-South road (Figure 1). The two selected lakes may be used to support development. The two lakes were sampled with fyke nets to develop information on the population status of fish inhabiting these lakes prior to field development and possible use of these lakes as water sources. This study supplements information gathered in 2001 and reported in Moulton (2002).

## METHODS

Fyke nets were used in 2002 to sample 2 perched lakes in the CD-South study area (Table 1, Figure 3). Both lakes had been previously sampled in a similar manner in 2001.

Sampling was by fyke net so that fish could be released unharmed. Sampling covered mid July (July 11-20). Fyke nets used during the 2001 sampling had an opening 0.9 m deep by 1.1 m wide, the trap end was 4.9 m long, made of 9.5 mm mesh. The wings (5 m long) and lead (15 m long) were made of 12.7 mm mesh. The nets were emptied daily. Fish were measured and released, with no fish retained for laboratory analysis. Duration of each set was recorded to allow calculation of catch rates. Water chemistry measurements taken in conjunction with the fyke net sampling included water temperature, specific conductance, dissolved oxygen, turbidity and pH.

Fish greater than 179 mm were tagged to reveal the extent to which fish caught in the CD-South study area contribute to the subsistence catch. Floy FD-94 anchor tags (monofilament = 1/2 inch, vinyl = 3/4 inch) were applied to whitefish and cisco caught by fyke net. Recapture was monitored in research sampling within the Colville Delta and eastern NPR-A study areas, in the Nuiqsut subsistence fishery and in the Colville Delta commercial fishery.

Water chemistry parameters were measured at each fyke net to assess habitat conditions. Water chemistry measurements included surface measures of water temperature, specific conductance, dissolved oxygen, pH, and turbidity. Temperature, specific conductance and dissolved oxygen were in situ surface measurements taken just below the surface along the edge of each lake with a YSI Model 85 meter. A sample was returned to the field office to measure pH and turbidity. PH was measured with a Corning pH meter. Turbidity was measured with an H.F. Scientific DRT15CE turbidity meter.

Bathymetric data were collected in L9323 to allow estimating lake volume. In 2002, location and depth were recorded on a Lowrance Model LCX-15MT integrated GPS/depth sounder. Location and depth were recorded every 1-2 seconds. Over 20 depth transects were recorded on the lake. Lake volume was estimated by contour mapping of depth intervals. A contour map was prepared by plotting the position and depth data obtained by GPS on GIS basemaps using ArcView 3.2 and plotting the contours in 2 ft intervals on a map of the surveyed lake. The surface area of each contour was obtained, then the volume was estimated using the formula for truncated cones:

$$V = h/3*(A1+A2+(A1*A2) (1/2))$$

Where  $h$  = vertical depth of the stratum,  $A_1$  = area of the upper surface, and  $A_2$  = area of the lower surface of the stratum whose volume is to be determined. The volumes of individual strata are summed to obtain the volume of the desired depth intervals.



## RESULTS AND DISCUSSION

Fyke net sampling was conducted in 2002 at two stations on two perched lakes (L9323 and L9324) that had been sampled during 2001 (Table 2). The 2002 effort of 453 net hours in the lakes resulted in a catch of 7,481 fish from 11 species (Table 3).

Water temperature was higher in 2002 compared to 2001 (Figure 3). From July 13-20, a period sampled in both 2001 and 2002, the water temperature averaged 3.6°C warmer in 2002. The specific conductance in L9323, at 67 microSiemens, averaged 12 microSiemens higher than in L9324, indicating low concentrations of dissolved solids in both lakes. Turbidity was generally higher in L9324 than in L9323, except during a period of high wind in 2001 (Figure 3).

### Lake L9323

Lake L9323 is a perched lake lying north of the proposed CD-South pad. The lake is apparently not flooded on a frequent basis because least cisco residing in the lake are stunted, averaging only 235 mm at age 11 (Moulton 1998), which indicates little interchange with the anadromous population.

In 2001, the fyke net catch was dominated by least cisco and ninespine stickleback, which together represented 90% of the fish caught (Table 3). The same pattern held in 2002, when these two species accounted for over 95% of the catch. In 2002, only 5 species were taken, compared with 7 taken in 2001. Migratory species were in low abundance, again indicating the low frequency at which the lake is flooded. No new species were added during 2002. Catch rates decreased in 2002 relative to 2001 (Table 3, Figures 5-6). Only ninespine stickleback were caught at a similar rate in both years. The catch of least cisco in 2002 was almost age 1 fish (Figure 7). The lack of large least cisco over both years (few exceeded 200 mm) is consistent with previous sampling results, which identified a high density of stunted least cisco in the lake.

Fyke nets are relatively inefficient in lake L9323 because the littoral area is restricted. The banks drop off quickly leaving little area for effective sets. Sampling by gill net in 1996 produced a catch rate of 232.1 fish per day of least cisco, broad whitefish and round whitefish. Sampling by fyke net in 2001 and 2002 produced a overall catch rate of only 10.2 fish per day for the same three species.

### Lake L9324

Lake L9324 is a perched lake lying south of the proposed CD-South pad. During high water, the lake connects to both the Nigliq Channel at its northwest end and the Sakoonang Channel via a drained lake through its southeast end. Catches in 2001 were high, with a high diversity (Table 4). In 2002, catches were higher in all the dominant species, and were similar to those recorded in Nanuk Lake, a nearby tapped lake, in 2001 (Moulton 2002). These catches were spread throughout the sampling period and were not caused by isolated high catches (Figures 7-10), thus likely reflect a real increase in fish numbers. The size ranges observed in 2002 were similar to those recorded in

2001 (Figures 6, 11-14), although in greater numbers. The lake apparently floods during high water in early summer, which brings many fish into the lake. The apparent increasing fish density many indicate that the lake is flooding more frequently during break-up and may be converted to a tapped lake in the near future.

A juvenile chum salmon (62 mm) was captured in L9324 in 2002. This is the fourth chum salmon juvenile taken in the delta since 1999. These fish are likely progeny from chum salmon spawning upstream in the Colville drainage, possibly in the Anaktuvuk River, which has historically been known to support chum salmon spawning. George Gryc, retired from the US Geological Survey, reported observing Simon Paneak of Anaktuvuk Pass harvest chum salmon from the Anaktuvuk River in 1950 (G. Gryc, 2001, pers. comm.).

### **Tag Releases in CD-South during 2002**

A total of 176 tagged fish were released in the CD-South study area during 2002, primarily least cisco and broad whitefish (Table 6). This brings the total number of tags released to 201 over 2001 and 2002. Four least cisco, two broad whitefish and one humpback whitefish were recovered at the release location, usually two to three days after release (Table 7). No tagged fish from 2001 releases were caught in 2002.

### **Evaluation of Water Availability in Lake L9323**

Contour mapping of lake L9323 in 2002 slightly modified the amount of water estimated to be available from this lake (Figure 15). Based on bathymetry data obtained through 2002, the lake could provide an estimated 10.4 million gallons for water use. The less-complete survey of the lake in 2001 yielded an estimated 10.9 million gallons of available water (Moulton 2002).

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Table 1. Fyke net stations occupied in the CD-South study area during 2002.  
(latitude and longitude based on NAD27 datum)

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Station	Latitude	Longitude	Location	Dates Fished
CDS-01C	70.29825	150.98835	L9323 (perched lake)	July 12-20
CDS-01D	70.29103	150.97321	L9324 (perched lake)	July 12-20

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Table 2. Catches of fish by station from fyke net sampling in lakes in the CD-South study area, 2002.

**L9323**

Species											2002
	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	Total
Broad whitefish											0
Humpback whitefish											0
Least cisco	1	1	1		1	2	2	3	2	12	25
Round whitefish			1								1
Alaska blackfish	1	1	1			1	1	1	1		7
Slimy sculpin			1				1	1	1		4
Ninespine stickleback	11	19	7	37	12	18	18	41	53	54	270
Effort (hrs)	22.0	22.3	25.1	20.9	23.4	24.7	22.9	25.7	21.8	22.5	231.3

**L9324**

Species											2002
	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	Total
Chum Salmon									1		1
Broad whitefish	164	30	7	129	1	314	477	224	95	118	1559
Humpback whitefish	8	5	2	25		28	39	33	16	29	185
Arctic cisco	1	1		10		18			2	1	33
Least cisco	166	12	5	83	8	808	580	761	425	1699	4547
Round whitefish	31	39		184	1	183	119	89	47	74	767
Dolly Varden char											0
Arctic grayling	4	3		3		5	4	10	2	4	35
Alaska blackfish						1	1			1	3
Longnose sucker							1				1
Arctic lamprey											0
Ninespine stickleback	2	2	4	2		4	8	10.0		11	43
Effort (hrs)	21.8	22.2	25.7	20.5	22.3	24.5	23.0	21.8	19.2	20.5	221.5

Table 3. Catches of fish by station from fyke net sampling in lakes in the CD-South study area, 2002.

<b>Species</b>	<b>L9323 perched lake</b>	<b>L9324 perched lake</b>	<b>Total</b>
Chum Salmon	0	1	1
Broad whitefish	0	1,559	1,559
Humpback whitefish	0	185	185
Arctic cisco	0	33	33
Least cisco	25	4,547	4,572
Round whitefish	1	767	768
Arctic grayling	0	35	35
Alaska blackfish	7	3	10
Longnose sucker	0	1	1
Slimy sculpin	4	0	4
Ninespine stickleback	270	43	313
Total Catch	307	7,174	7,481
Number of Species	5	10	11
Total Effort (hrs)	231	222	453

Table 4. Fish catches in CD-South fyke net sampling during July 2001 and 2002

L9323

Species	Catch		Catch Rate	
	2001	2002	2001	2002
	(number of fish)		(fish per day)	
Broad whitefish	3	0	0.2	0.0
Humpback whitefish	8	0	0.6	0.0
Least cisco	199	25	14.6	2.6
Round whitefish	10	1	0.7	0.1
Alaska blackfish	36	7	2.6	0.7
Slimy sculpin	16	4	1.2	0.4
Ninespine stickleback	530	270	38.9	28.0
Effort (hrs)	327.3	231.3		

L9324

Species	Catch		Catch Rate	
	2001	2002	2001	2002
	(number of fish)		(fish per day)	
Chum Salmon	0	1	0.0	0.1
Broad whitefish	73	1,559	10.6	168.9
Humpback whitefish	60	185	8.7	20.0
Arctic cisco	13	33	1.9	3.6
Least cisco	1,006	4,547	145.7	492.7
Round whitefish	134	767	19.4	83.1
Dolly Varden char	6	0	0.9	0.0
Arctic grayling	7	35	1.0	3.8
Alaska blackfish	3	3	0.4	0.3
Longnose sucker	3	1	0.4	0.1
Arctic lamprey	1	0	0.1	0.0
Slimy sculpin	1	0	0.1	0.0
Ninespine stickleback	34	43	4.9	4.7
Effort (hrs)	165.8	221.5		

Table 5. Observed handling mortality for fyke nets in the CD-South study area, 2002.

<b>Species</b>	<b>Number of Mortalities</b>	<b>Total Caught</b>	<b>Percent Mortality</b>
Broad whitefish	83	1,559	5.3
Humpback whitefish	2	185	1.1
Arctic cisco	0	33	0.0
Least cisco	84	4,572	1.8
Round whitefish	17	768	2.2
Arctic grayling	0	35	0.0
Alaska blackfish	0	10	0.0
Longnose sucker	0	1	0.0
Slimy sculpin	0	4	0.0
Ninespine stickleback	1	313	0.3



Table 6. Tag releases and recaptures in the CD-South study area, by station and species, 2001-2002.

Station	Year Released	Broad Whitefish	Humpback Whitefish	Least Cisco	Arctic Cisco	Round Whitefish	Arctic Grayling
<b>Released</b>							
L9323	2001	0	0	4	0	0	0
	2002	0	0	0	0	0	0
L9324	2001	11	0	10	0	0	0
	2002	52	12	104	2	5	1
Release Total:		63	12	118	2	5	1
<b>Recaptured</b>							
L9323	2001	0	0	0	0	0	0
	2002	0	0	0	0	0	0
L9324	2001	0	0	0	0	0	0
	2002	2	1	4	0	0	0
Recapture Total:		2	1	4	0		0

Table 7. Release and recapture information for recovered tagged fish in lake L9324, 2002.

Species	Fork Length (mm)	Release Date	Recapture Date	Days Out
Broad whitefish	188	Jul 16 02	Jul 18 02	2
	200	Jul 14 02	Jul 19 02	5
Humpback whitefish	215	Jul 16 02	Jul 19 02	3
Least cisco	190	Jul 14 02	Jul 16 02	2
	207	Jul 17 02	Jul 19 02	2
	248	Jul 14 02	Jul 17 02	3
	262	Jul 14 02	Jul 16 02	2



**Figure 1. CD-South study area showing proposed CD-South road and facilities pad in relation to Nuiqsut and Alpine facilities (approximate boundary of study area indicated by enclosure).**

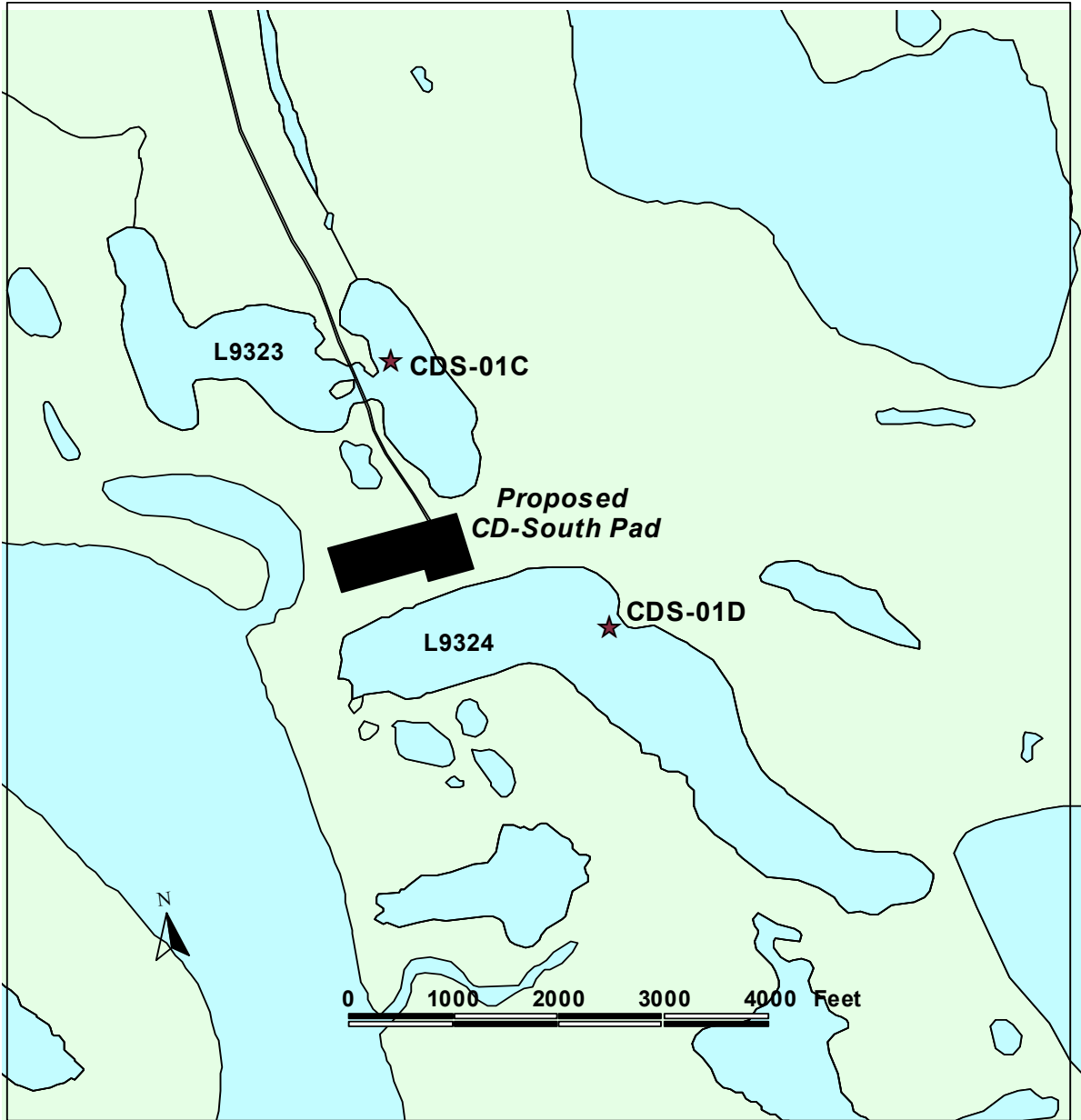


Figure 2. Fyke net stations sampled in 2002 relative to the proposed CD-South pad.

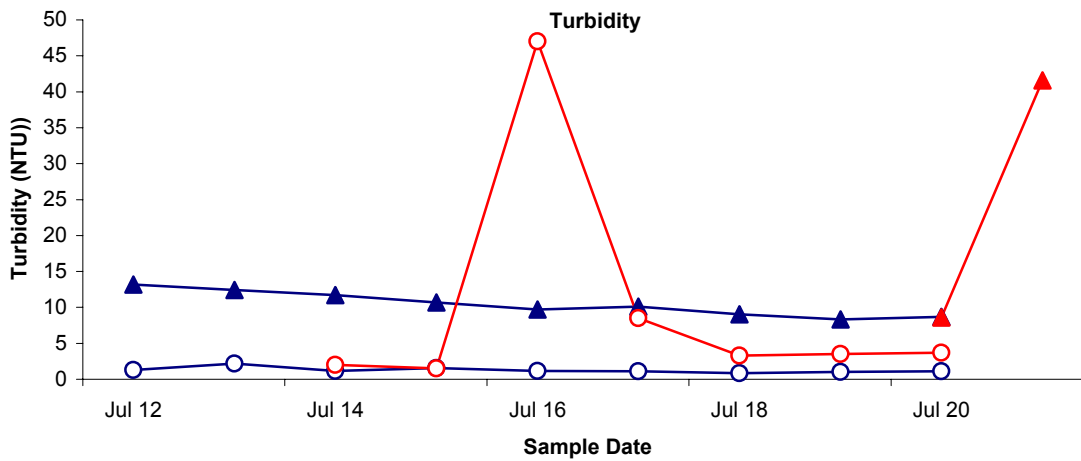
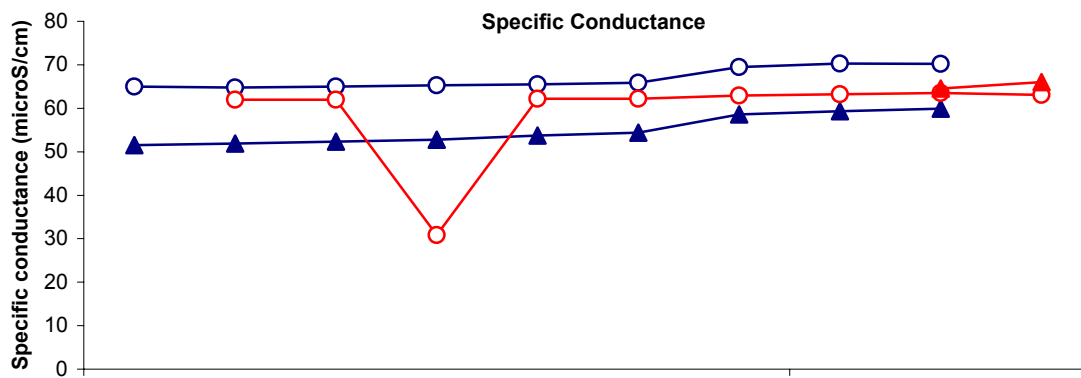
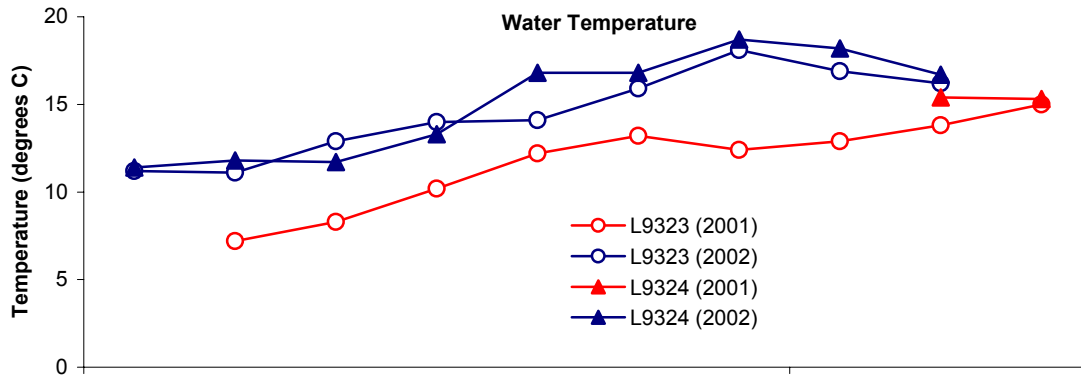


Figure 3. Water temperature, specific conductance and turbidity at fyke net stations sampled in the CD-South study area, 2001.

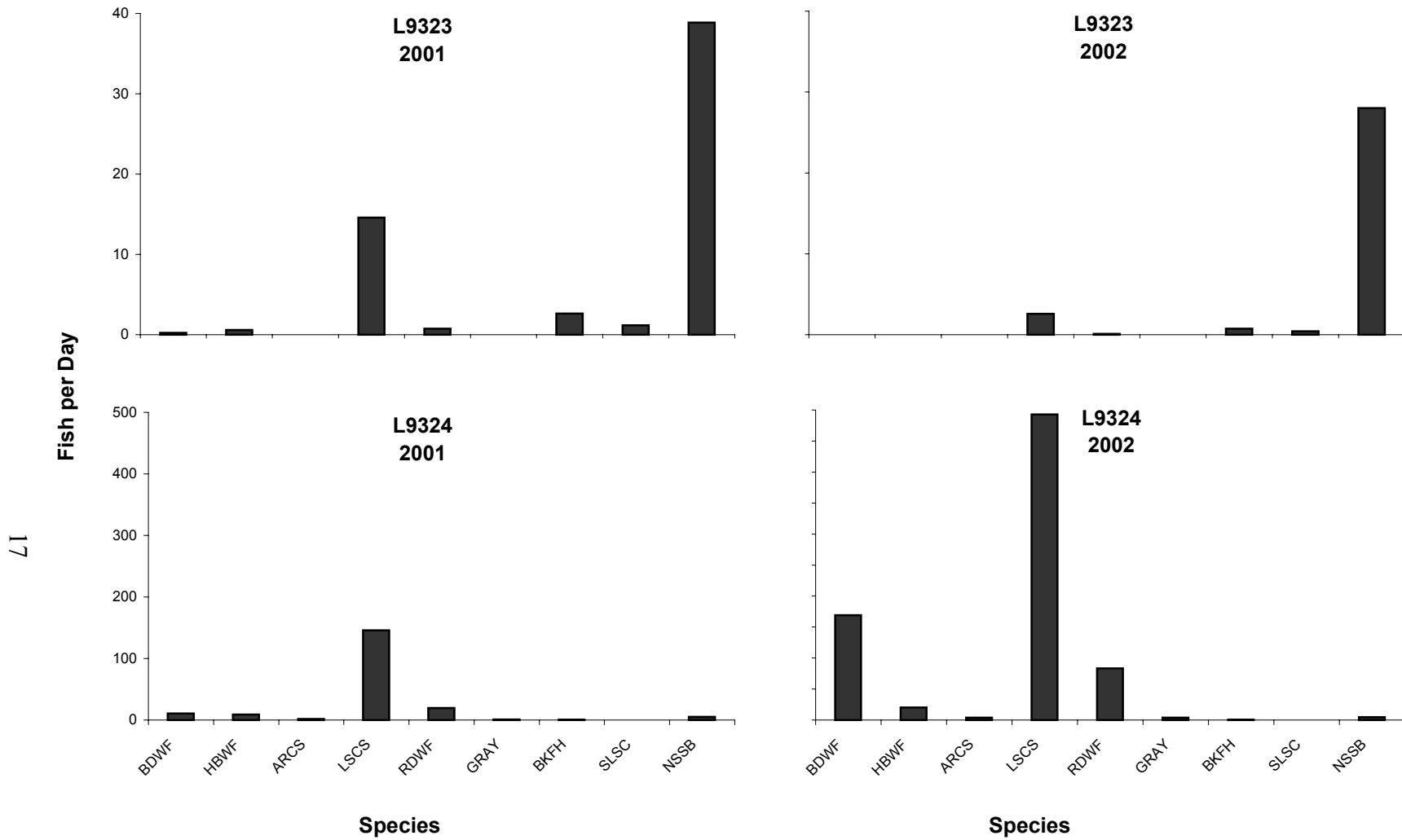


Figure 4. Comparison of catch rates by species at stations in the CD-South study area based on fyke net sampling during 2001 and 2002. (note change of scale between L9323 and L9324)

BDWF = broad whitefish	LSCS = least cisco	BKFH = Alaska blackfish
HBWF = humpback whitefish	RDWF = round whitefish	SLSC = slimy sculpin
ARCS = arctic cisco	GRAY = arctic grayling	NSSB = ninespine stickleback

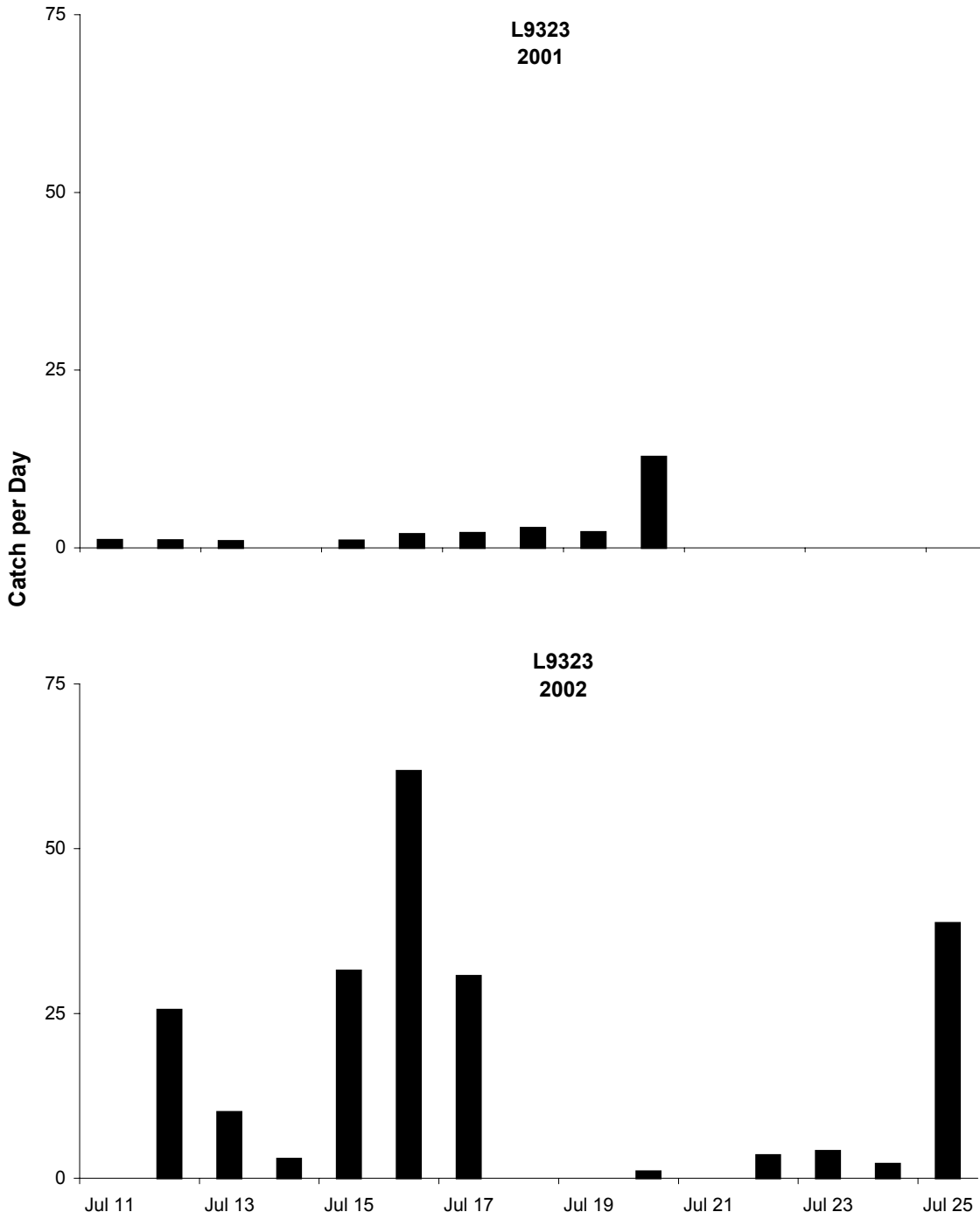


Figure 5. Daily catch rate of least cisco at L9323, July 2001-2002.

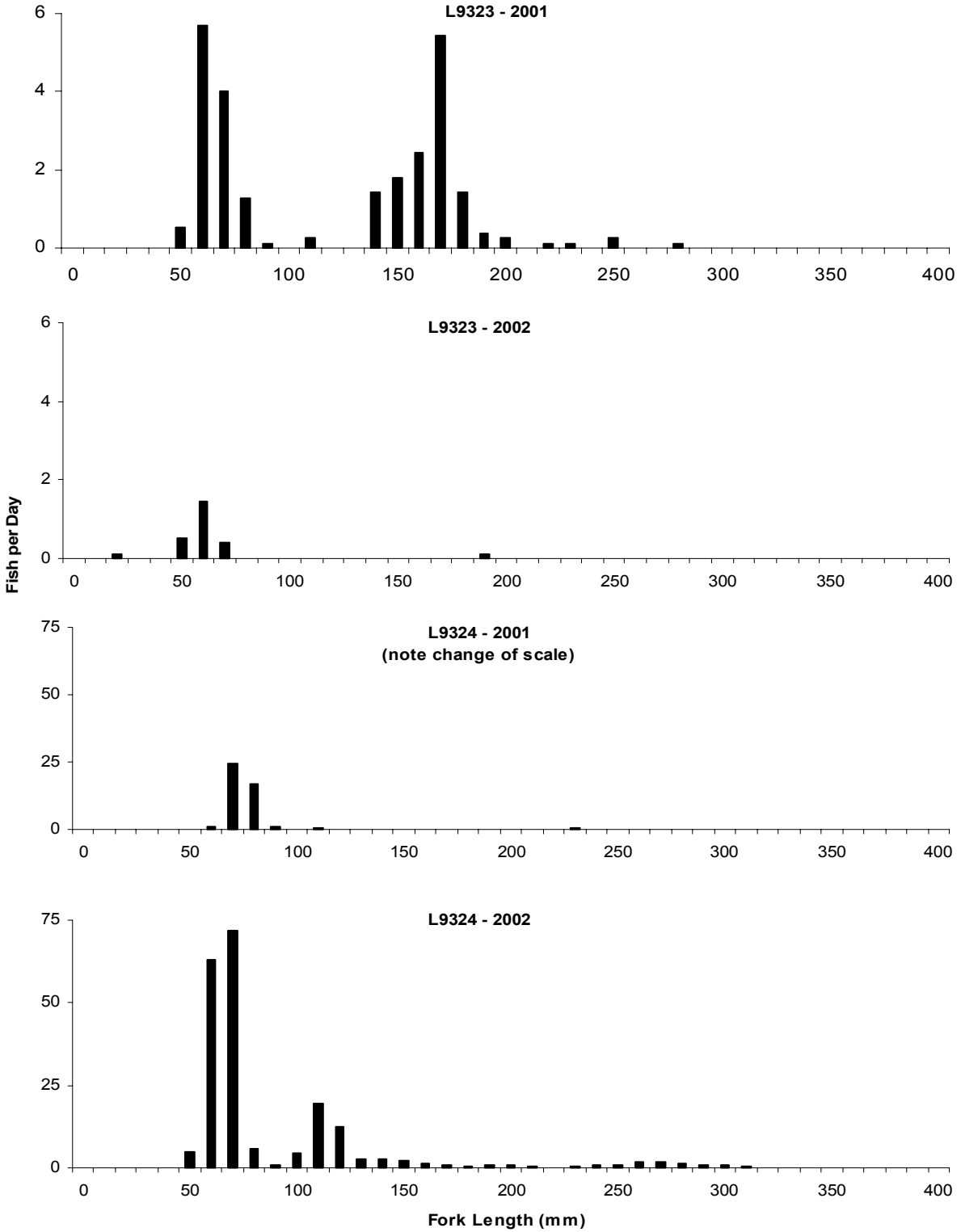


Figure 6. Length frequencies of least cisco caught by fyke net in L9323 and L9324 2001-2002 (least cisco mature at about 250 mm).



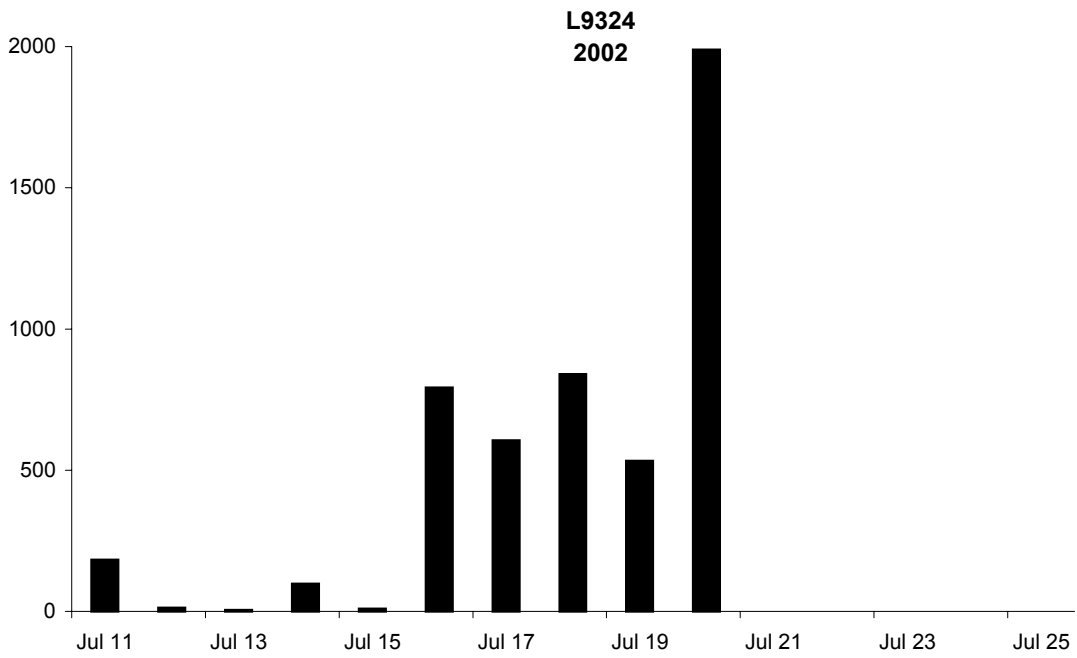
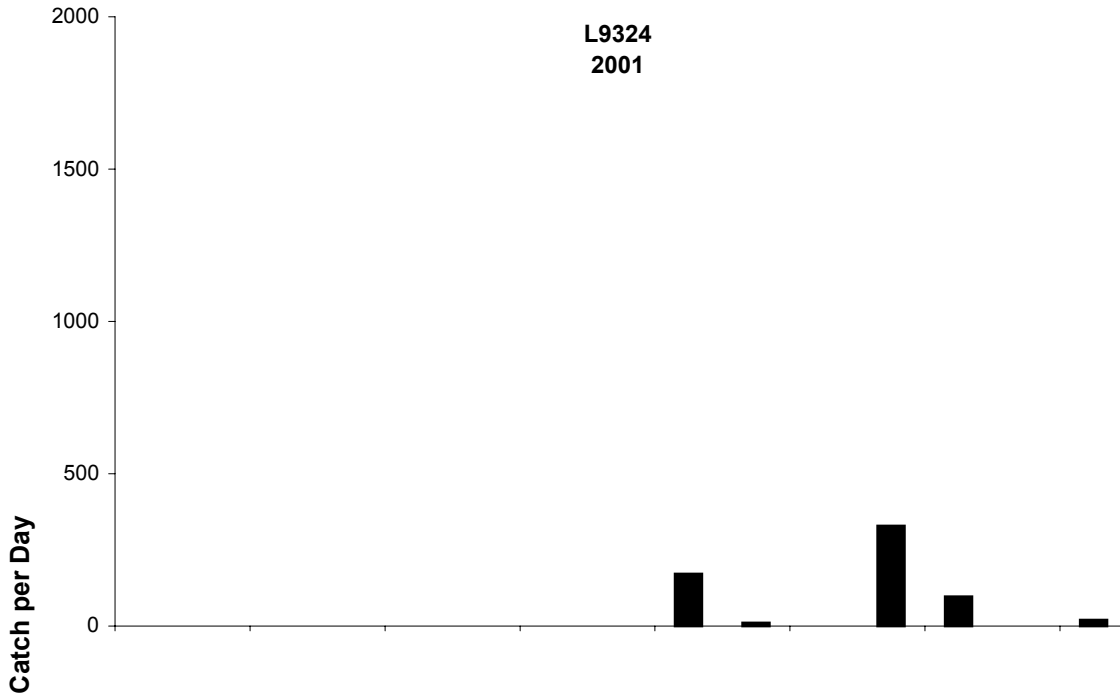


Figure 7. Daily catch rate of least cisco at L9324, July 2001-2002.

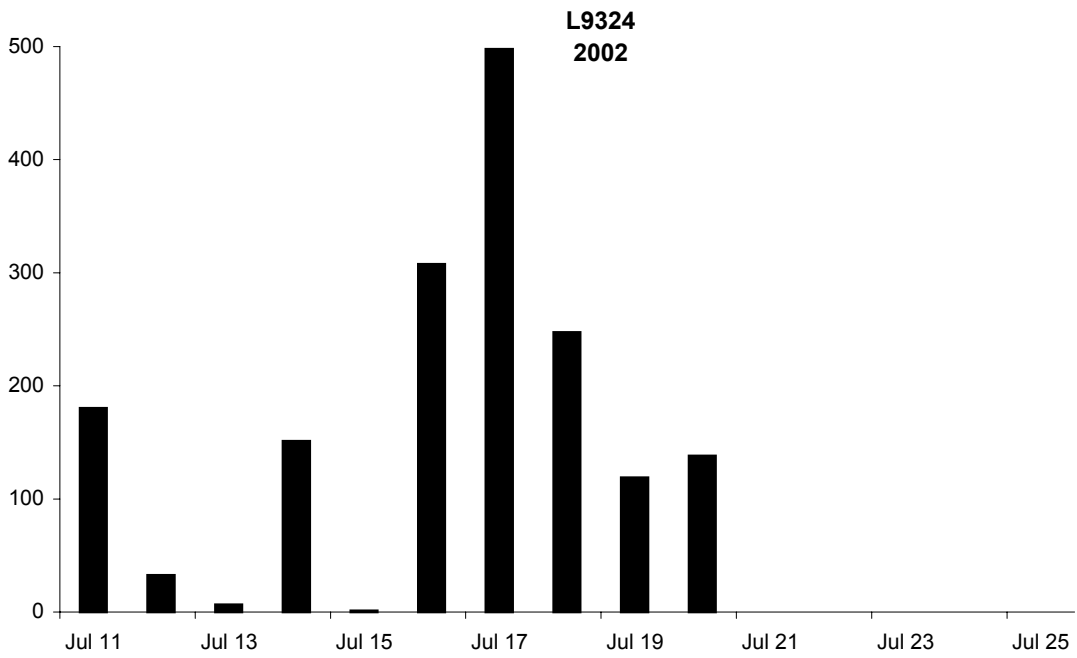
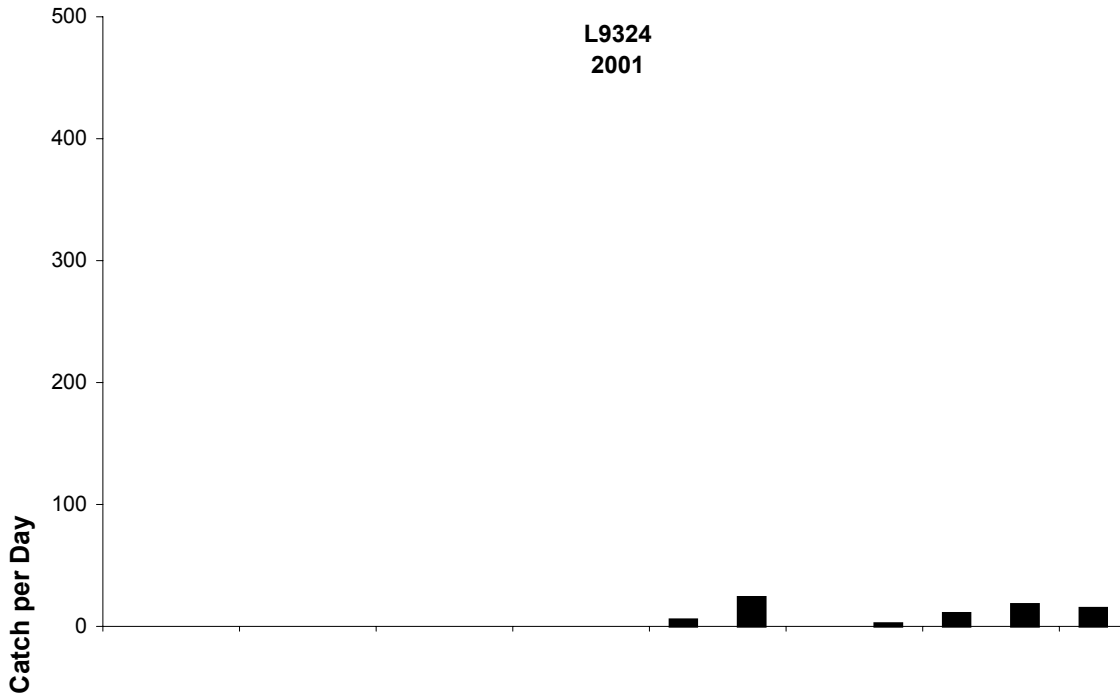


Figure 8. Daily catch rate of broad whitefish at L9324, July 2001-2002.

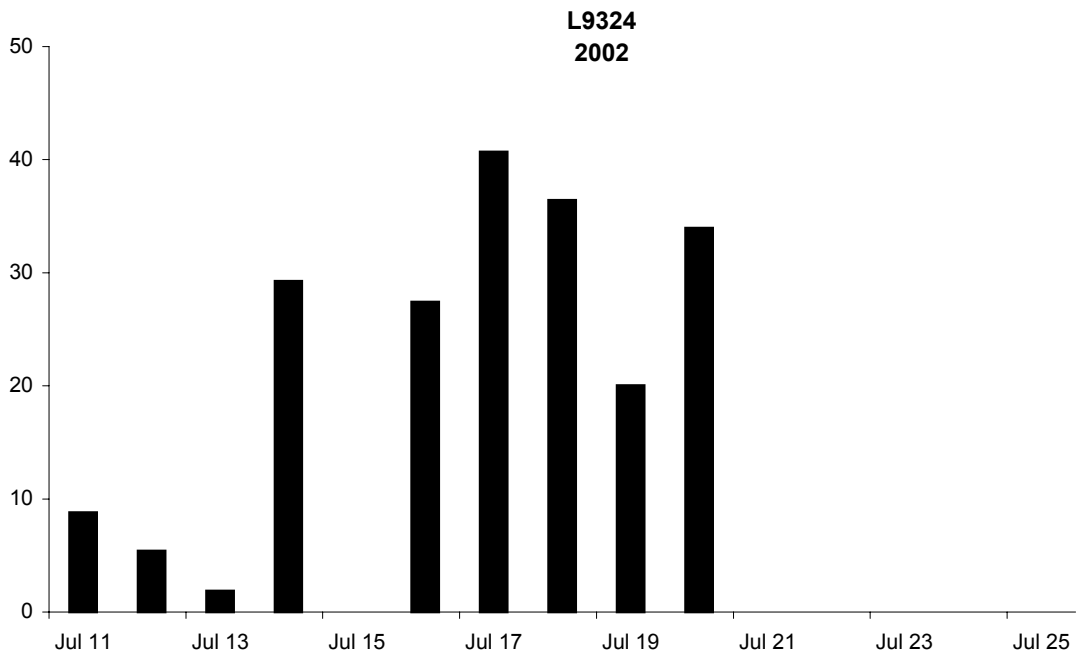
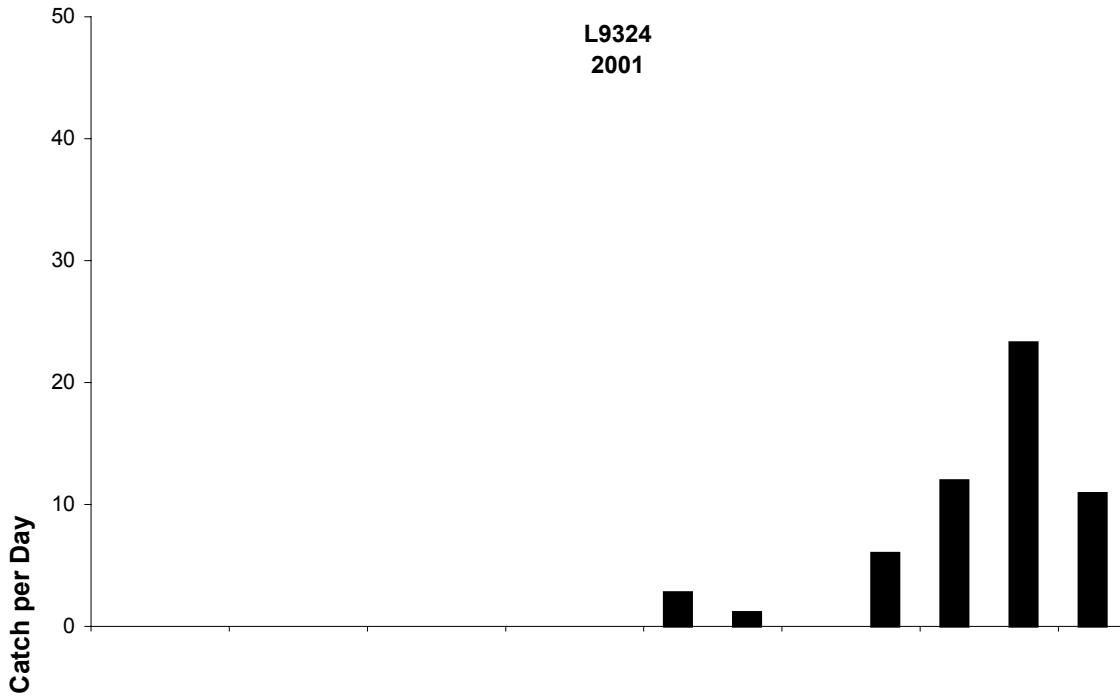


Figure 9. Daily catch rate of humpback whitefish at L9324, July 2001-2002.

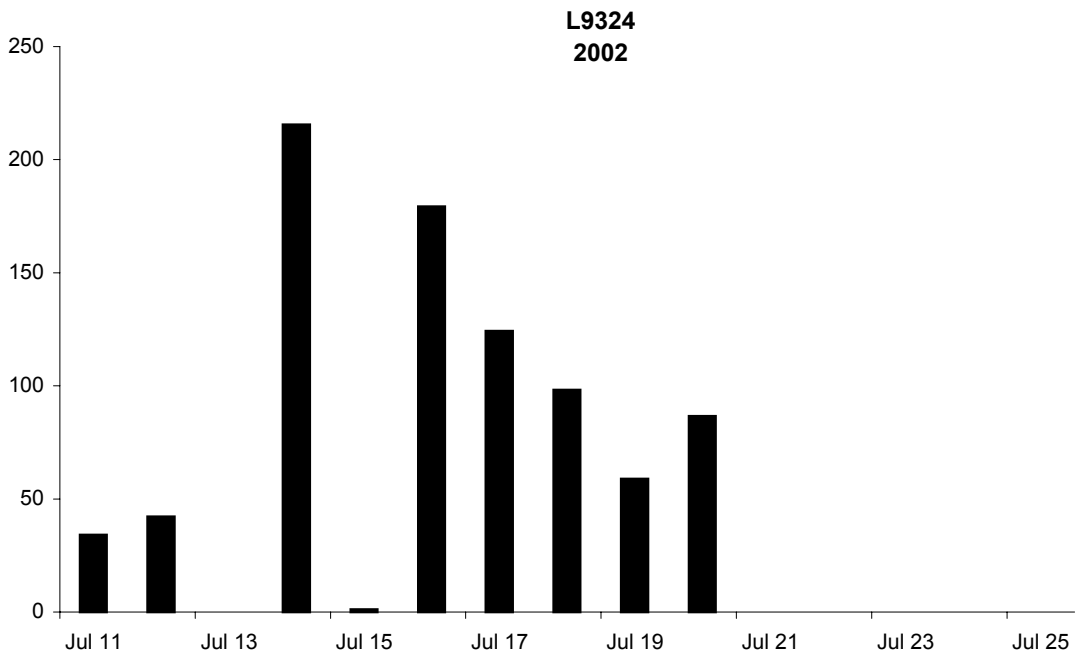
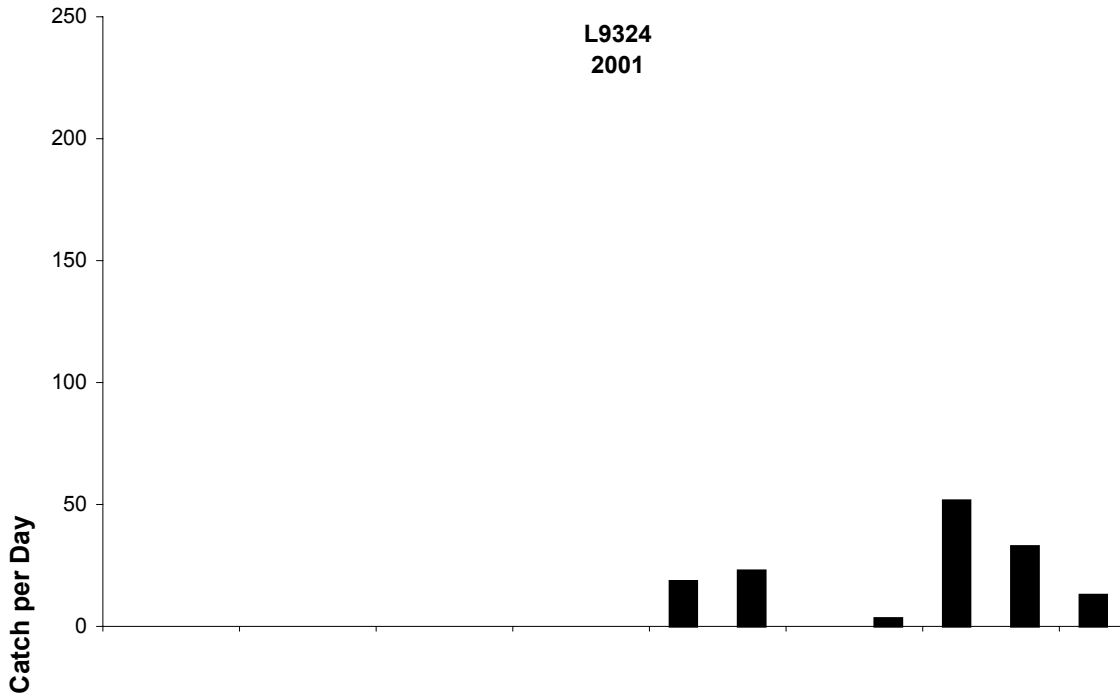


Figure 10. Daily catch rate of round whitefish at CD-South study area fyke net stations, 2001.

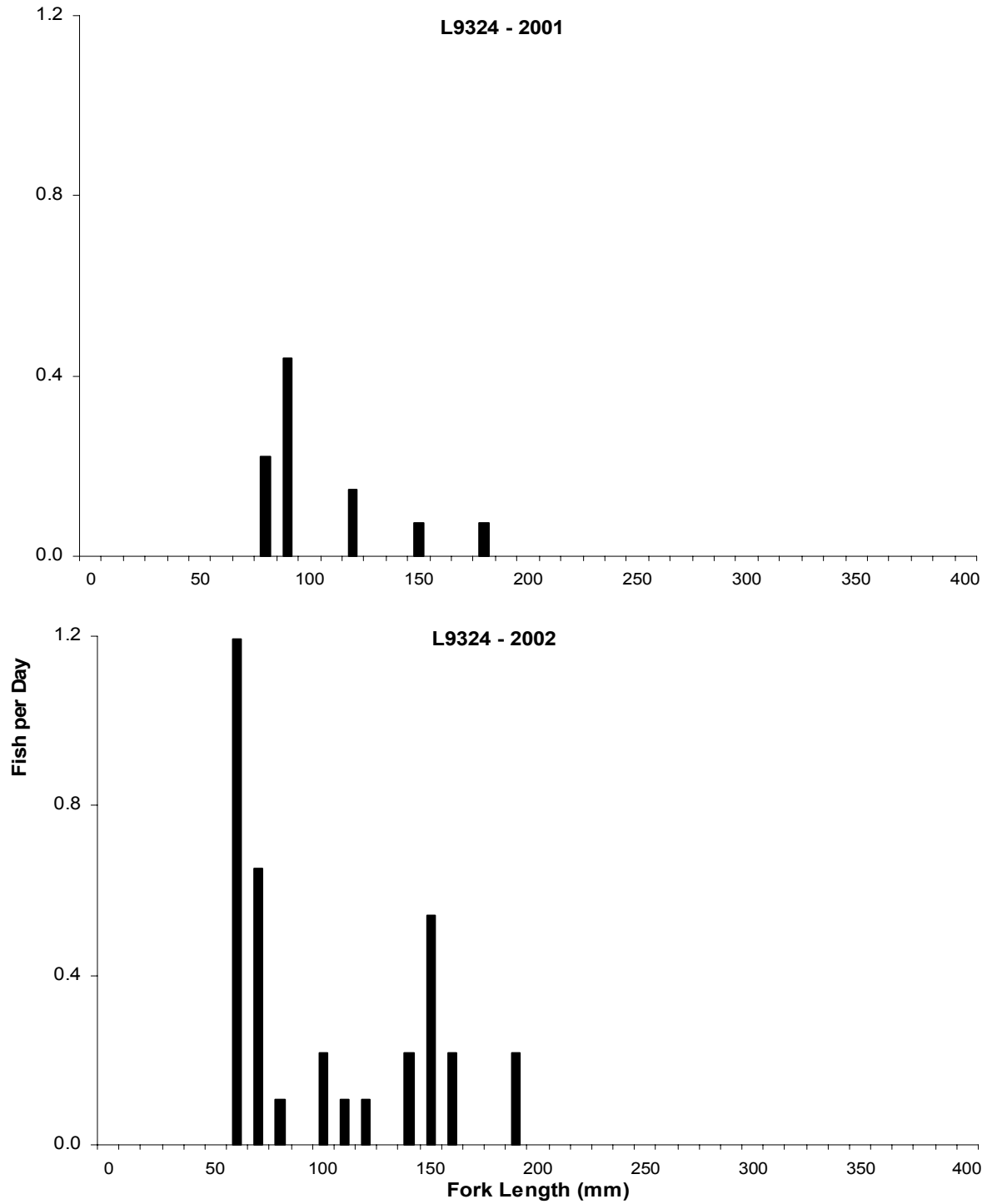


Figure 11. Length frequencies of arctic cisco caught by fyke net in the CD-South study area by station, 2001 (arctic cisco mature at about 350 mm).

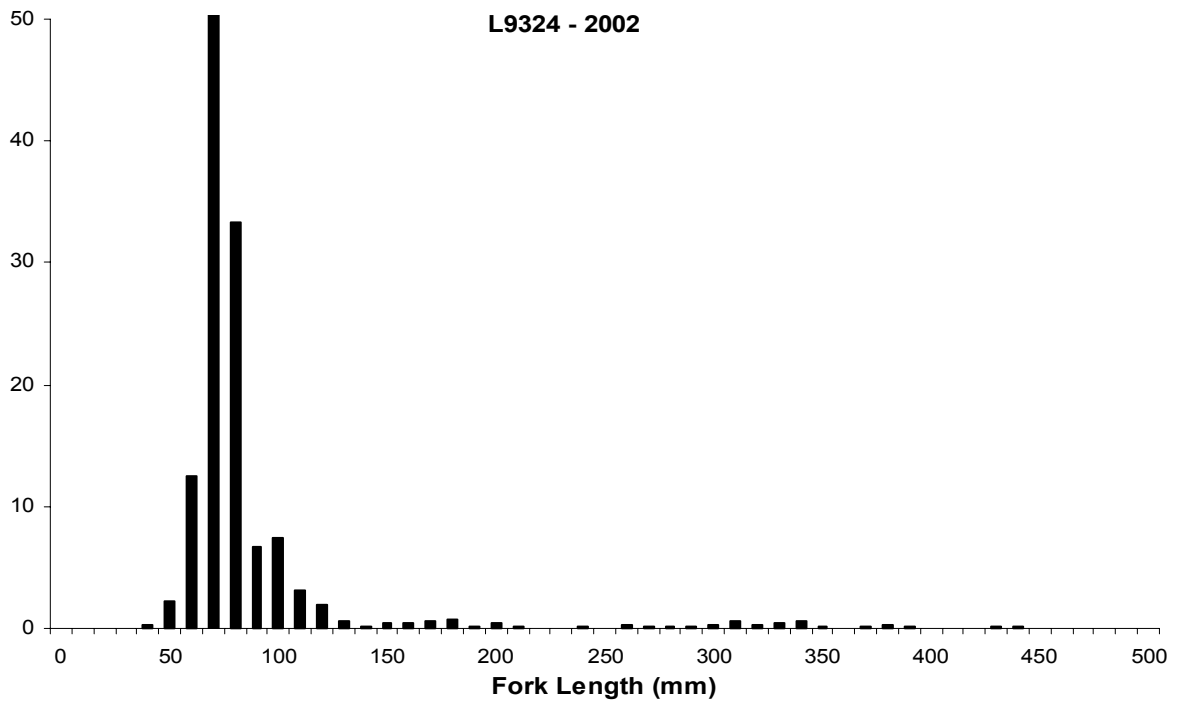
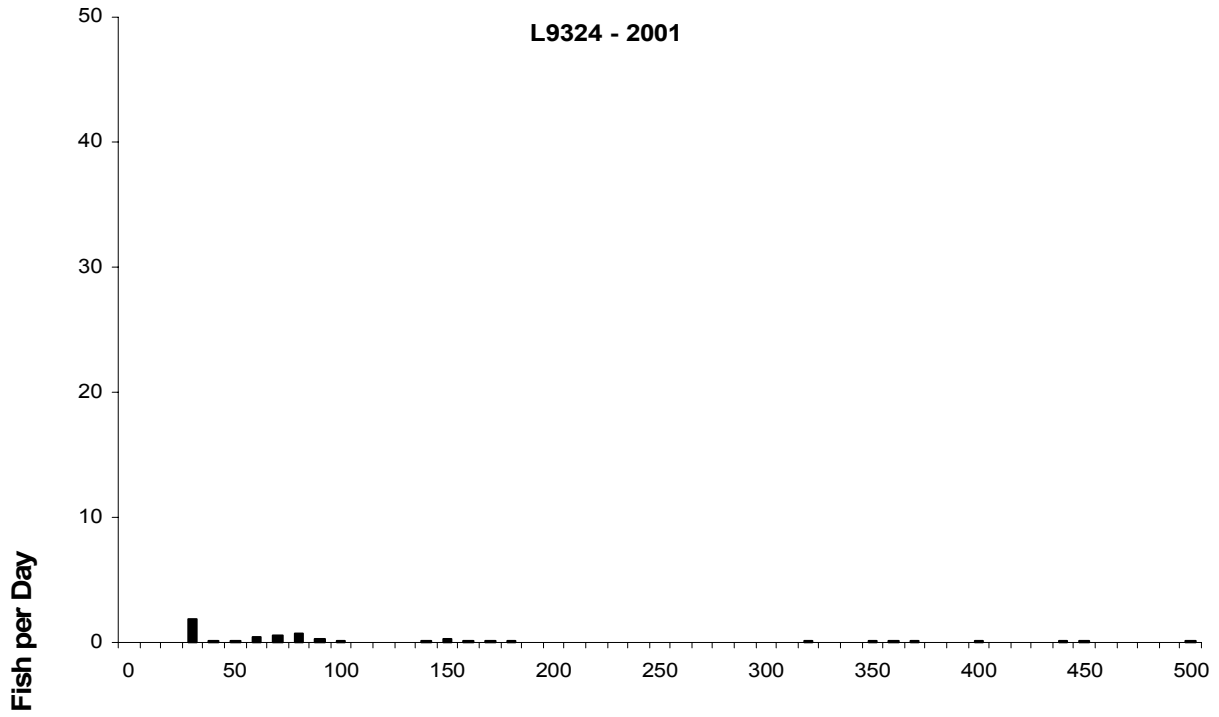


Figure 12. Length frequencies of broad whitefish caught by fyke net in L9324, 2001-2002 (broad whitefish mature at about 480 mm).

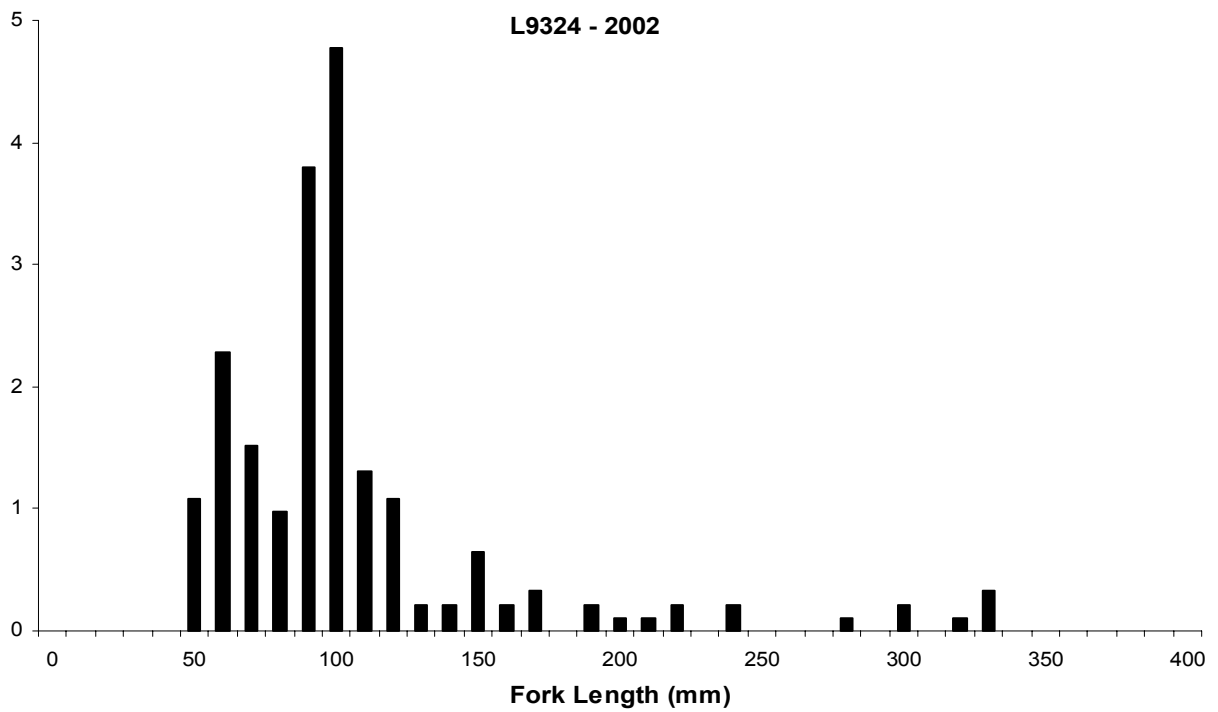
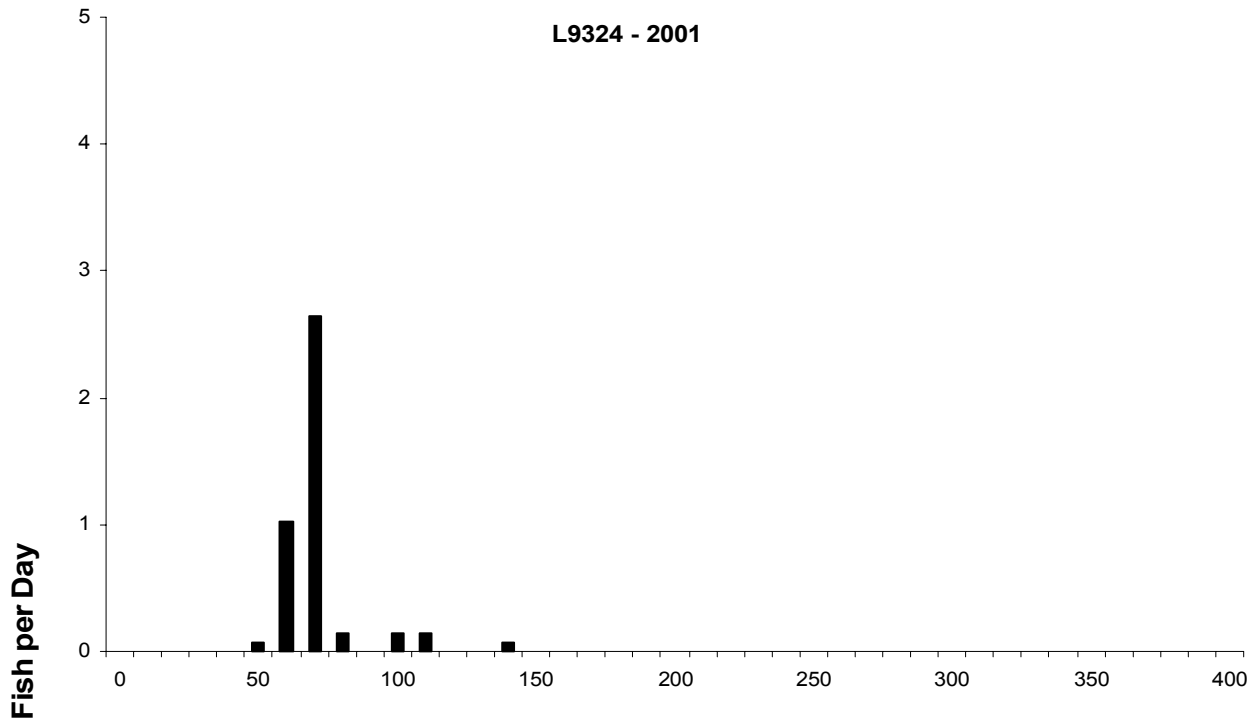


Figure 13. Length frequencies of humpback whitefish caught by fyke net in L9324, 2001-2002 (humpback whitefish mature at about 350 mm).

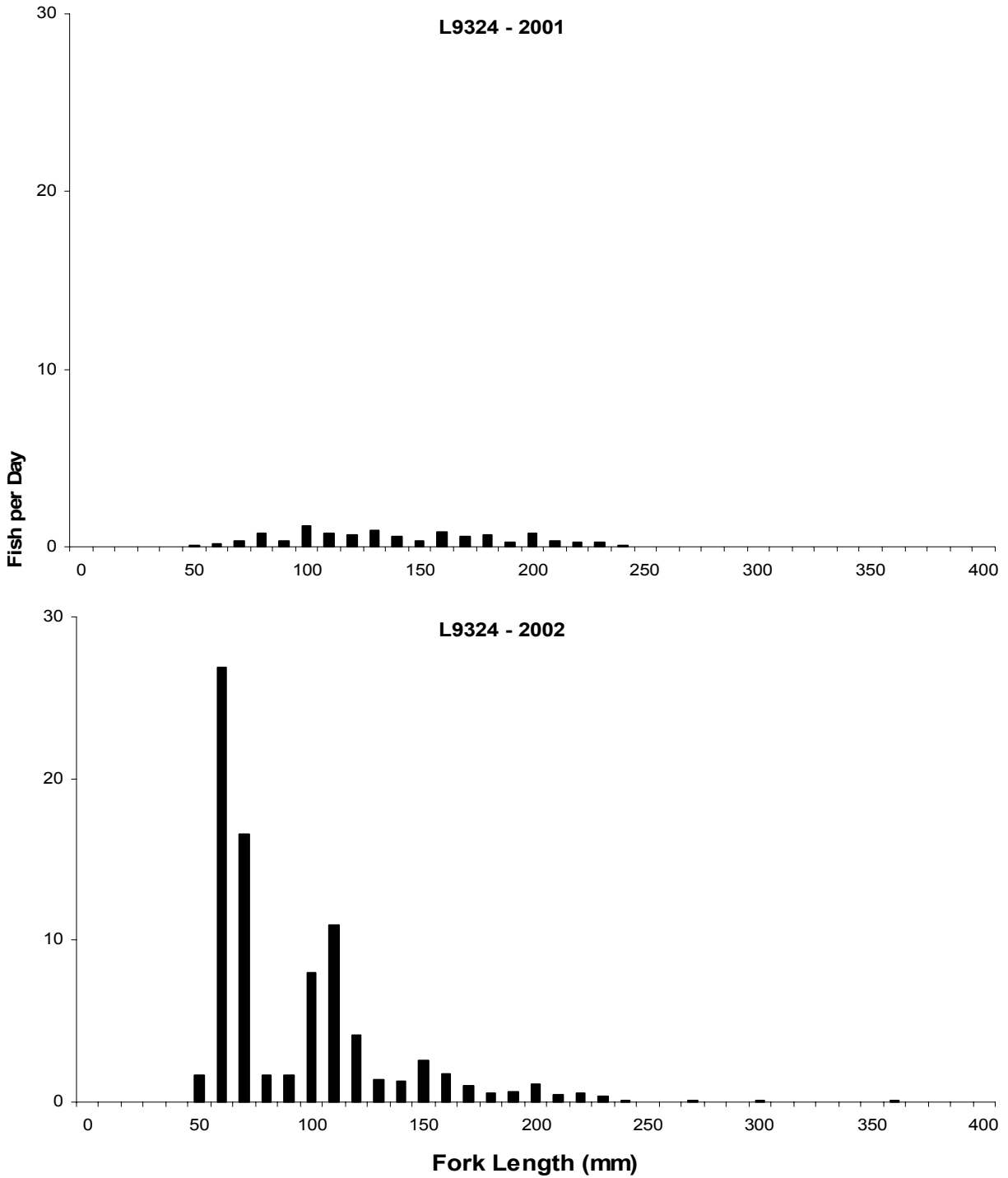


Figure 14. Length frequencies of round whitefish caught by fyke net in L9324, 2001-2002 (round whitefish mature at about 350 mm).



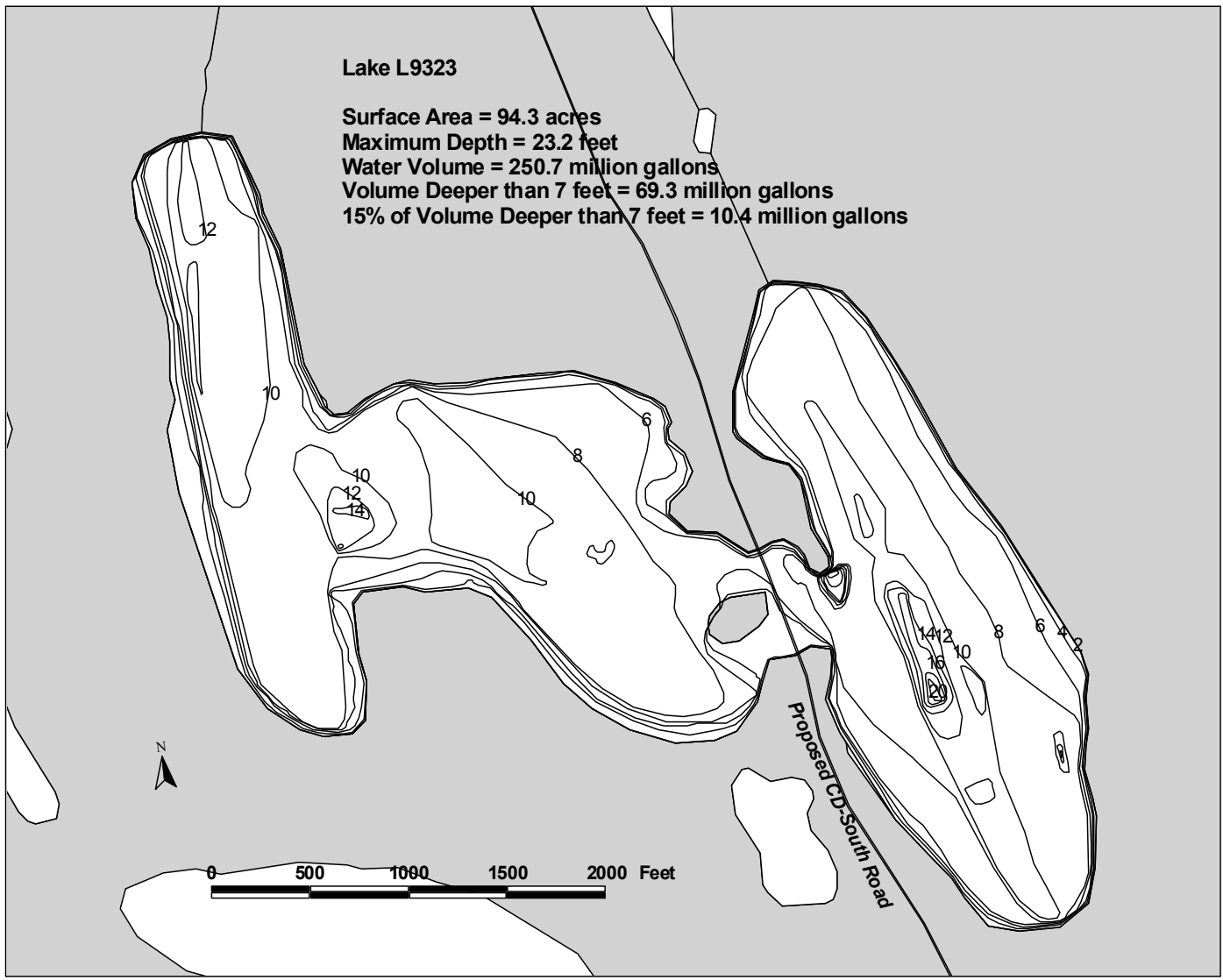


Figure 15. Depth contours of lake L9323 based on 2002 depth surveys, in 2 foot intervals.

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Appendix Table 1. Water chemistry parameters measured in conjunction with fyke net sampling at lake L9323, 2001-2002.

Year	Date	Time	Water Temp (oC)	Dissolved Oxygen		Specific Conductance (microS/cm)	pH	Turbidity (NTU)
				(mg/l)	(%)			
<b>2001</b>								
	Jul 13 01	11:45	7.2	11.6	96	62	8.1	5.0
	Jul 14 01	13:06	8.3	11.3	95	62	8.0	3.3
	Jul 15 01	13:25	10.2	9.5	85	31	7.9	4.1
	Jul 16 01	13:20	12.2	10.6	101	62	7.9	3.0
	Jul 17 01	9:24	13.2	10.4	99	62	7.8	7.0
	Jul 18 01	8:45	12.4	9.1	86	63	8.0	3.0
	Jul 19 01	12:13	12.9	10.2	98	63	7.9	6.0
	Jul 20 01	12:25	13.8	9.5	92	63	8.0	2.3
	Jul 21 01	11:58	15.0	9.5	94	63	8.4	4.3
	Jul 23 01	12:45	15.6	9.1	92	64	8.0	2.3
	Jul 24 01	12:00	14.5	8.8	85	65	7.9	1.9
	Jul 25 01	10:05	13.1	8.7	79	66	7.9	2.6
	Jul 26 01	10:30	13.6	9.0	86	65	7.9	2.3
	Aug 18 01	15:05	7.9	11.8	99	67	8.0	1.8
	Aug 19 01	9:51	6.0	11.1	91	92	8.0	3.4
	Aug 20 01	9:35	5.4	12.7	100	67	7.9	3.4
	Aug 21 01	9:40	5.7	12.6	95	67	8.0	2.0
	Aug 24 01	11:30	4.9	12.5	97	69	7.8	1.7
	Aug 25 01	9:20	4.6	12.2	95	66	7.7	1.3
<b>2002</b>								
	Jul 12 02	13:15	11.2	10.9	100	65	8.1	1.3
	Jul 13 02	14:20	11.1	11.4	98	65	7.8	2.2
	Jul 14 02	12:00	12.9	11.6	109	65	8.0	1.1
	Jul 15 02	11:21	14.0	11.4	111	65	8.0	1.6
	Jul 16 02	12:05	14.1	11.3	109	66	8.0	1.2
	Jul 17 02	11:00	15.9	10.2	99	66	8.1	1.1
	Jul 18 02	12:45	18.1	9.2	99	70	8.0	0.9
	Jul 19 02	10:30	16.9	9.4	97	70	8.1	1.0
	Jul 20 02	9:00	16.2	9.9	100	70	8.1	1.1

Appendix Table 2. Water chemistry parameters measured in conjunction with fyke net sampling at lake L9324, 2001-2002.

Year	Date	Time	Water Temp (oC)	Dissolved Oxygen		Specific Conductance (microS/cm)	pH	Turbidity (NTU)
				(mg/l)	(%)			
<b>2001</b>								
	Jul 20 01	14:34	15.4	9.0	91	65	7.9	8.6
	Jul 21 01	11:00	15.3	9.5	94	66	8.2	41.6
	Jul 23 01	15:25	17.6	8.8	95	68	7.8	62.8
	Jul 24 01	10:43	13.1	9.3	89	68	7.8	22.4
	Jul 25 01	9:12	13.1	8.9	85	70	7.9	13.7
	Jul 26 01	9:17	12.8	9.0	88	71	7.9	6.5
	Aug 18 01	17:25	7.1	12.1	101	83	7.9	3.1
	Aug 19 01	8:53	5.6	11.9	95	101	8.2	5.7
	Aug 20 01	8:40	4.9	12.9	99	83	8.1	5.0
	Aug 21 01	10:43	4.9	12.2	95	83	7.8	3.9
	Aug 24 01						7.8	2.9
	Aug 25 01	9:50	4.3	12.9	100	49	7.8	2.8
<b>2002</b>								
	Jul 12 02	13:45	11.4	11.0	100	52	8.1	13.2
	Jul 13 02	15:15	11.8	10.9	98	52	7.6	12.4
	Jul 14 02	13:40	11.7	11.4	106	52	7.9	11.7
	Jul 15 02	12:00	13.3	10.9	105	53	7.9	10.7
	Jul 16 02	12:30	16.8	10.4	108	54	7.9	9.7
	Jul 17 02	11:30	16.8			54	7.9	10.1
	Jul 18 02	13:25	18.7	9.1	98	59	8.0	9.1
	Jul 19 02	11:20	18.2	9.5	99	59	7.9	8.3
	Jul 20 02	9:35	16.7	9.5	98	60	7.9	8.7

Appendix Table 3. Length frequencies of least cisco caught by fyke net in lake L9323, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0										0
10										0
20									1	1
30										0
40										0
50		1			2		1		1	5
60				1			2	2	9	14
70	1					2			1	4
80										0
90										0
100										0
110										0
120										0
130										0
140										0
150										0
160										0
170										0
180										0
190			1							1
200										0
210										0
220										0
230										0
240										0
250										0
260										0
270										0
280										0
290										0
300										0
310										0
320										0
330										0
340										0
350										0
360										0
370										0
380										0
390										0
400										0
<b>Total:</b>	1	1		1	2	2	3	2	12	25

Appendix Table 4. Length frequencies of least cisco caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40						2					2
50	8	3	1	2		29	1				44
60	122	6	3	9	4	344	34	19	17	23	581
70	23	1	1	16	2	325	65	79	78	72	662
80				1		22	2	4	11	15	55
90	1			1		3	1			1	7
100	4	1		2		6	10	5	7	8	43
110	5	1		15	1	12	48	19	39	42	182
120				6	1	14	24	13	24	32	114
130						3	10	1	6	3	23
140	1			3		2	8	2	5	2	23
150				1			11	2	4	2	20
160				3		1	6		2		12
170				2		2	2		1	1	8
180				2			2	1		1	6
190				3		4	3				10
200						2	4		1		7
210				1		1	1		1		4
220								1			1
230						3	1		2		6
240				1		2	4				7
250	1			1		4	2				8
260	1			3		6	2	5	1		18
270				5		3	3		3	1	15
280				3		5	3	2			13
290						4	3	2	1		10
300						4	1	2			7
310				1		1	1				3
320				1			1				2
330						1					1
340											0
350						1					1
360						1		1			2
370											0
380											0
390											0
400						1					1
<b>Total:</b>	<b>166</b>	<b>12</b>	<b>5</b>	<b>82</b>	<b>8</b>	<b>808</b>	<b>253</b>	<b>158</b>	<b>203</b>	<b>203</b>	<b>1898</b>

Appendix Table 5. Length frequencies of arctic cisco caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40											0
50											0
60				3		8					11
70				2		4					6
80	1										1
90											0
100		1				1					2
110				1							1
120				1							1
130											0
140				1				1			2
150				1		2		1	1		5
160				1		1					2
170											0
180											0
190						2					2
200											0
210											0
220											0
230											0
240											0
250											0
260											0
270											0
280											0
290											0
300											0
310											0
320											0
330											0
340											0
350											0
360											0
370											0
380											0
390											0
400											0
<b>Total:</b>	1	1	0	10	0	18	0	0	2	1	33



Appendix Table 6. Length frequencies of broad whitefish caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40			1			2					3
50	4	1	3	7		4		1		1	21
60	35	11		16		30	8	9	3	3	115
70	95	11		56		100	67	67	37	35	468
80	20	5	3	31	1	98	29	27	39	54	307
90	3	1		6		27	8	5	5	7	62
100	6			2		15	32	7	2	4	68
110				2		11	10	2	1	3	29
120						9	6	1	1	2	18
130						1	4		1		6
140						1		1			2
150						1	3				4
160				1			2	1			4
170						1	2		1	1	5
180				2		2	2	1			7
190							1			1	2
200				1			1		2		4
210							1				1
220											0
230											0
240							1				1
250											0
260							3				3
270							1		1		2
280								2			2
290							2				2
300							1	1	1		3
310						3	3				6
320						1	1	1			3
330	1					1		2			4
340						2	3	1			6
350						1				1	2
360											0
370						1					1
380						3					3
390							1				1
400											0
410											0
420											0
430								1			1
440							1	1			2
450											0
460											0
470											0
480											0
490											0
500											0
Total:	164	29	7	124	1	314	193	131	95	110	1168

Appendix Table 7. Length frequencies of humpback whitefish caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40											0
50	1	1		1			3	1	1	2	10
60			1	2			1	10	2	5	21
70	1			2		1	3	3	1	3	14
80	2	1		1		3	1	1			9
90	2	2	1	3		4	10	4	3	6	35
100	2			6		6	13	4	5	8	44
110				1		3	3	2	1	2	12
120		1		4		1	1	3	1		10
130							1	1			2
140							1	1			2
150				1		1	2			2	6
160				1				1			2
170						2			1		3
180											0
190							1		1		2
200				1							1
210						1					1
220								2			2
230											0
240				2							2
250											0
260											0
270											0
280						1					1
290											0
300						2					2
310											0
320										1	1
330						3					3
340											0
350											0
360											0
370											0
380											0
390											0
400											0
<b>Total:</b>	<b>8</b>	<b>5</b>	<b>2</b>	<b>25</b>		<b>28</b>	<b>39</b>	<b>33</b>	<b>16</b>	<b>29</b>	<b>185</b>

Appendix Table 8. Length frequencies of round whitefish caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40											0
50	2			9		2			2		15
60	19	24		69		62	36	21	8	9	248
70		7		41		36	20	19	8	22	153
80				3		6	2	1		2	15
90	1	1		4		3	1	1	1	3	15
100	2	7		18		8	9	17	7	6	74
110	3			13		26	27	9	9	14	101
120	1			4		17	3	5	3	5	38
130		1		1		2	3	2		4	13
140				5		3	1	2		1	12
150				4		5	5	4	1	5	24
160				5		4	4	3			16
170	1			1		2		1	3	1	9
180		1				1	1	1	1		5
190				3			1	1	1		6
200	1			2	1	2	3		1		10
210						1		2		1	4
220						3	1			1	5
230				1					2		3
240							1				1
250											0
260											0
270								1			1
280											0
290											0
300							1				1
310											0
320											0
330											0
340											0
350											0
360				1							1
370											0
380											0
390											0
400											0
<b>Total:</b>	<b>31</b>	<b>41</b>	<b>0</b>	<b>185</b>	<b>1</b>	<b>183</b>	<b>119</b>	<b>89</b>	<b>47</b>	<b>74</b>	<b>770</b>

Appendix Table 9. Length frequencies of arctic grayling caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40											0
50	2	2				2					6
60	1	1		1		2	1	7	2	2	17
70										1	1
80											0
90				1							1
100							2	2			4
110										1	1
120	1					1	1				3
130											0
140											0
150								1			1
160											0
170											0
180											0
190											0
200											0
210											0
220											0
230											0
240											0
250											0
260											0
270											0
280											0
290											0
300											0
310											0
320											0
330											0
340											0
350											0
360				1							1
370											0
380											0
390											0
400											0
<b>Total:</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>5</b>	<b>4</b>	<b>10</b>	<b>2</b>	<b>4</b>	<b>35</b>

Appendix Table 10. Length frequencies of Alaska blackfish caught by fyke net in lake L9324, 2002.

Fork Length (mm)	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	2002 Total
0											0
10											0
20											0
30											0
40											0
50											0
60											0
70							1			1	2
80											0
90											0
100											0
110											0
120											0
130											0
140											0
150											0
160											0
170											0
180											0
190											0
200											0
<b>Total:</b>	0	0	0	0	0	0	1	0	0	1	2

Appendix Table 11. Tagged fish released in the CD-South study area, 2002.

Release Station	Release Date	Species	Fork Length (mm)	Tag Number	Capture Station	Capture Date
CDS-01C	7/13/2002	LSCS	195	MJM020304		
CDS-01D	7/11/2002	LSCS	259	MJM020126		
CDS-01D	7/11/2002	LSCS	268	MJM020112		
CDS-01D	7/11/2002	RDWF	203	MJM020127		
CDS-01D	7/11/2002	BDWF	337	MJM011701		
CDS-01D	7/14/2002	LSCS	190	MJM020306		
CDS-01D	7/14/2002	LSCS	327	MJM020307		
CDS-01D	7/14/2002	LSCS	248	MJM020308	CDS-01D	7/17/2002
CDS-01D	7/14/2002	LSCS	194	MJM020311		
CDS-01D	7/14/2002	RDWF	360	MJM020310		
CDS-01D	7/14/2002	BDWF	184	MJM020312		
CDS-01D	7/14/2002	LSCS	184	MJM020314		
CDS-01D	7/14/2002	HBWF	247	MJM020316		
CDS-01D	7/14/2002	HBWF	200	MJM020317		
CDS-01D	7/14/2002	LSCS	190	MJM020318	CDS-01D	7/16/2002
CDS-01D	7/14/2002	BDWF	200	MJM020320	CDS-01D	7/19/2002
CDS-01D	7/14/2002	LSCS	268	MJM020327		
CDS-01D	7/14/2002	LSCS	277	MJM020328		
CDS-01D	7/14/2002	LSCS	265	MJM020319		
CDS-01D	7/14/2002	LSCS	255	MJM020326		
CDS-01D	7/14/2002	LSCS	212	MJM020329		
CDS-01D	7/14/2002	LSCS	276	MJM020333		
CDS-01D	7/14/2002	GRAY	368	MJM020344		
CDS-01D	7/14/2002	HBWF	246	MJM020334		
CDS-01D	7/14/2002	LSCS	183	MJM020335		
CDS-01D	7/14/2002	LSCS	289	MJM020340		
CDS-01D	7/14/2002	LSCS	280	MJM020339		
CDS-01D	7/14/2002	LSCS	273	MJM020342		
CDS-01D	7/14/2002	LSCS	262	MJM020343	CDS-01D	7/16/2002
CDS-01D	7/16/2002	BDWF	315	MJM020345		
CDS-01D	7/16/2002	BDWF	380	MJM020347		
CDS-01D	7/16/2002	BDWF	384	MJM020349		
CDS-01D	7/16/2002	HBWF	215	MJM020348	CDS-01D	7/19/2002
CDS-01D	7/16/2002	LSCS	291	MJM020350		
CDS-01D	7/16/2002	LSCS	315	MJM020376		
CDS-01D	7/16/2002	LSCS	400	MJM020379		
CDS-01D	7/16/2002	BDWF	343	MJM020378		
CDS-01D	7/16/2002	BDWF	345	MJM020390		
CDS-01D	7/16/2002	BDWF	381	MJM020388		
CDS-01D	7/16/2002	BDWF	370	MJM020391		
CDS-01D	7/16/2002	LSCS	298	MJM020380		
CDS-01D	7/16/2002	LSCS	331	MJM020381		
CDS-01D	7/16/2002	LSCS	284	MJM020386		
CDS-01D	7/16/2002	BDWF	323	MJM020387		
CDS-01D	7/16/2002	LSCS	369	MJM020395		
CDS-01D	7/16/2002	LSCS	359	MJM020389		
CDS-01D	7/16/2002	LSCS	290	MJM020392		
CDS-01D	7/16/2002	LSCS	285	MJM020393		
CDS-01D	7/16/2002	BDWF	310	MJM020396		
CDS-01D	7/16/2002	LSCS	304	MJM020398		
CDS-01D	7/16/2002	HBWF	335	MJM020358		
CDS-01D	7/16/2002	LSCS	262	MJM020399		
CDS-01D	7/16/2002	LSCS	190	MJM020355		
CDS-01D	7/16/2002	BDWF	332	MJM020357		

Appendix Table 11. Tagged fish released in the CD-South study area, 2002.

Release Station	Release Date	Species	Fork Length (mm)	Tag Number	Capture Station	Capture Date
CDS-01D	7/16/2002	LSCS	267	MJM020400		
CDS-01D	7/16/2002	LSCS	211	MJM020351		
CDS-01D	7/16/2002	LSCS	267	MJM020352		
CDS-01D	7/16/2002	LSCS	274	MJM020353		
CDS-01D	7/16/2002	LSCS	262	MJM020354		
CDS-01D	7/16/2002	HBWF	306	MJM020359		
CDS-01D	7/16/2002	HBWF	331	MJM020362		
CDS-01D	7/16/2002	ARCS	196	MJM020371		
CDS-01D	7/16/2002	BDWF	358	MJM020374		
CDS-01D	7/16/2002	BDWF	188	MJM020153	CDS-01D	7/18/2002
CDS-01D	7/16/2002	LSCS	284	MJM020158		
CDS-01D	7/16/2002	HBWF	338	MJM020159		
CDS-01D	7/16/2002	HBWF	280	MJM020161		
CDS-01D	7/16/2002	BDWF	176	MJM020163		
CDS-01D	7/16/2002	HBWF	308	MJM020164		
CDS-01D	7/16/2002	BDWF	312	MJM020165		
CDS-01D	7/16/2002	LSCS	295	MJM020166		
CDS-01D	7/16/2002	LSCS	237	MJM020360		
CDS-01D	7/16/2002	LSCS	276	MJM020363		
CDS-01D	7/16/2002	LSCS	307	MJM020364		
CDS-01D	7/16/2002	LSCS	231	MJM020365		
CDS-01D	7/16/2002	LSCS	280	MJM020366		
CDS-01D	7/16/2002	LSCS	191	MJM020367		
CDS-01D	7/16/2002	LSCS	265	MJM020368		
CDS-01D	7/16/2002	LSCS	236	MJM020369		
CDS-01D	7/16/2002	LSCS	255	MJM020370		
CDS-01D	7/16/2002	LSCS	200	MJM020372		
CDS-01D	7/16/2002	LSCS	200	MJM020373		
CDS-01D	7/16/2002	LSCS	240	MJM020375		
CDS-01D	7/16/2002	LSCS	309	MJM020152		
CDS-01D	7/16/2002	ARCS	195	MJM020156		
CDS-01D	7/16/2002	LSCS	242	MJM020154		
CDS-01D	7/16/2002	LSCS	256	MJM020155		
CDS-01D	7/16/2002	LSCS	277	MJM020157		
CDS-01D	7/16/2002	LSCS	255	MJM020160		
CDS-01D	7/16/2002	LSCS	199	MJM020162		
CDS-01D	7/17/2002	LSCS	190	MJM020166		
CDS-01D	7/17/2002	LSCS	272	MJM020167		
CDS-01D	7/17/2002	LSCS	232	MJM020168		
CDS-01D	7/17/2002	LSCS	284	MJM020169		
CDS-01D	7/17/2002	LSCS	182	MJM020170		
CDS-01D	7/17/2002	LSCS	240	MJM020173		
CDS-01D	7/17/2002	LSCS	245	MJM020174		
CDS-01D	7/17/2002	LSCS	293	MJM020176		
CDS-01D	7/17/2002	LSCS	273	MJM020177		
CDS-01D	7/17/2002	LSCS	194	MJM020172		
CDS-01D	7/17/2002	BDWF	243	MJM020175		
CDS-01D	7/17/2002	RDWF	248	MJM020183		
CDS-01D	7/17/2002	BDWF	344	MJM020185		
CDS-01D	7/17/2002	LSCS	218	MJM020178		
CDS-01D	7/17/2002	LSCS	291	MJM020179		
CDS-01D	7/17/2002	LSCS	258	MJM020180		
CDS-01D	7/17/2002	LSCS	209	MJM020181		
CDS-01D	7/17/2002	LSCS	188	MJM020182		

Appendix Table 11. Tagged fish released in the CD-South study area, 2002.

Release Station	Release Date	Species	Fork Length (mm)	Tag Number	Capture Station	Capture Date
CDS-01D	7/17/2002	LSCS	207	MJM020186	CDS-01D	7/19/2002
CDS-01D	7/17/2002	LSCS	315	MJM020188		
CDS-01D	7/17/2002	LSCS	302	MJM020189		
CDS-01D	7/17/2002	LSCS	325	MJM020190		
CDS-01D	7/17/2002	LSCS	254	MJM020193		
CDS-01D	7/17/2002	LSCS	199	MJM020194		
CDS-01D	7/17/2002	BDWF	274	MJM020197		
CDS-01D	7/17/2002	LSCS	248	MJM020196		
CDS-01D	7/17/2002	LSCS	280	MJM020402		
CDS-01D	7/17/2002	LSCS	293	MJM020404		
CDS-01D	7/17/2002	BDWF	196	MJM020184		
CDS-01D	7/17/2002	BDWF	217	MJM020187		
CDS-01D	7/17/2002	BDWF	303	MJM020191		
CDS-01D	7/17/2002	BDWF	262	MJM020192		
CDS-01D	7/17/2002	BDWF	207	MJM020195		
CDS-01D	7/17/2002	BDWF	322	MJM020198		
CDS-01D	7/17/2002	BDWF	313	MJM020199		
CDS-01D	7/17/2002	BDWF	349	MJM020200		
CDS-01D	7/17/2002	BDWF	263	MJM020401		
CDS-01D	7/17/2002	LSCS	209	MJM020406		
CDS-01D	7/17/2002	LSCS	266	MJM020407		
CDS-01D	7/17/2002	LSCS	282	MJM020412		
CDS-01D	7/17/2002	BDWF	397	MJM020410		
CDS-01D	7/17/2002	BDWF	446	MJM020411		
CDS-01D	7/17/2002	BDWF	315	MJM020417		
CDS-01D	7/17/2002	BDWF	297	MJM020418		
CDS-01D	7/17/2002	BDWF	298	MJM020419		
CDS-01D	7/17/2002	LSCS	274	MJM020416		
CDS-01D	7/17/2002	BDWF	184	MJM020405		
CDS-01D	7/17/2002	BDWF	266	MJM020408		
CDS-01D	7/17/2002	RDWF	309	MJM020414		
CDS-01D	7/17/2002	BDWF	343	MJM020415		
CDS-01D	7/17/2002	BDWF	315	MJM020421		
CDS-01D	7/17/2002	HBWF	195	MJM020422		
CDS-01D	7/17/2002	BDWF	189	MJM020423		
CDS-01D	7/17/2002	LSCS	200	MJM020424		
CDS-01D	7/18/2002	RDWF	276	MJM011704		
CDS-01D	7/18/2002	BDWF	348	MJM011716		
CDS-01D	7/18/2002	BDWF	280	MJM011717		
CDS-01D	7/18/2002	BDWF	430	MJM011718		
CDS-01D	7/18/2002	BDWF	288	MJM011720		
CDS-01D	7/18/2002	BDWF	446	MJM011723		
CDS-01D	7/18/2002	LSCS	297	MJM011702		
CDS-01D	7/18/2002	LSCS	305	MJM011703		
CDS-01D	7/18/2002	LSCS	364	MJM011706		
CDS-01D	7/18/2002	LSCS	263	MJM011707		
CDS-01D	7/18/2002	BDWF	333	MJM011705		
CDS-01D	7/18/2002	BDWF	334	MJM011708		
CDS-01D	7/18/2002	BDWF	320	MJM011709		
CDS-01D	7/18/2002	BDWF	303	MJM011710		
CDS-01D	7/18/2002	LSCS	300	MJM011711		
CDS-01D	7/18/2002	LSCS	282	MJM011712		
CDS-01D	7/18/2002	LSCS	263	MJM011713		
CDS-01D	7/18/2002	LSCS	284	MJM011714		



Appendix Table 11. Tagged fish released in the CD-South study area, 2002.

Release Station	Release Date	Species	Fork Length (mm)	Tag Number	Capture Station	Capture Date
CDS-01D	7/18/2002	LSCS	262	MJM011715		
CDS-01D	7/18/2002	LSCS	295	MJM011719		
CDS-01D	7/18/2002	LSCS	268	MJM011722		
CDS-01D	7/18/2002	LSCS	262	MJM011724		
CDS-01D	7/19/2002	LSCS	271	MJM020426		
CDS-01D	7/19/2002	LSCS	238	MJM020427		
CDS-01D	7/19/2002	LSCS	212	MJM020428		
CDS-01D	7/19/2002	LSCS	267	MJM020429		
CDS-01D	7/19/2002	LSCS	270	MJM020430		
CDS-01D	7/19/2002	BDWF	307	MJM020432		
CDS-01D	7/19/2002	BDWF	205	MJM020434		
CDS-01D	7/19/2002	LSCS	238	MJM020435		
CDS-01D	7/19/2002	BDWF	275	MJM020436		
CDS-01D	7/19/2002	RDWF	230	MJM020438		
CDS-01D	7/19/2002	LSCS	290	MJM020440		
CDS-01D	7/20/2002	HBWF	325	MJM020444		
CDS-01D	7/20/2002	BDWF	199	MJM020441		
CDS-01D	7/20/2002	BDWF	354	MJM020442		

BDWF = broad whitefish

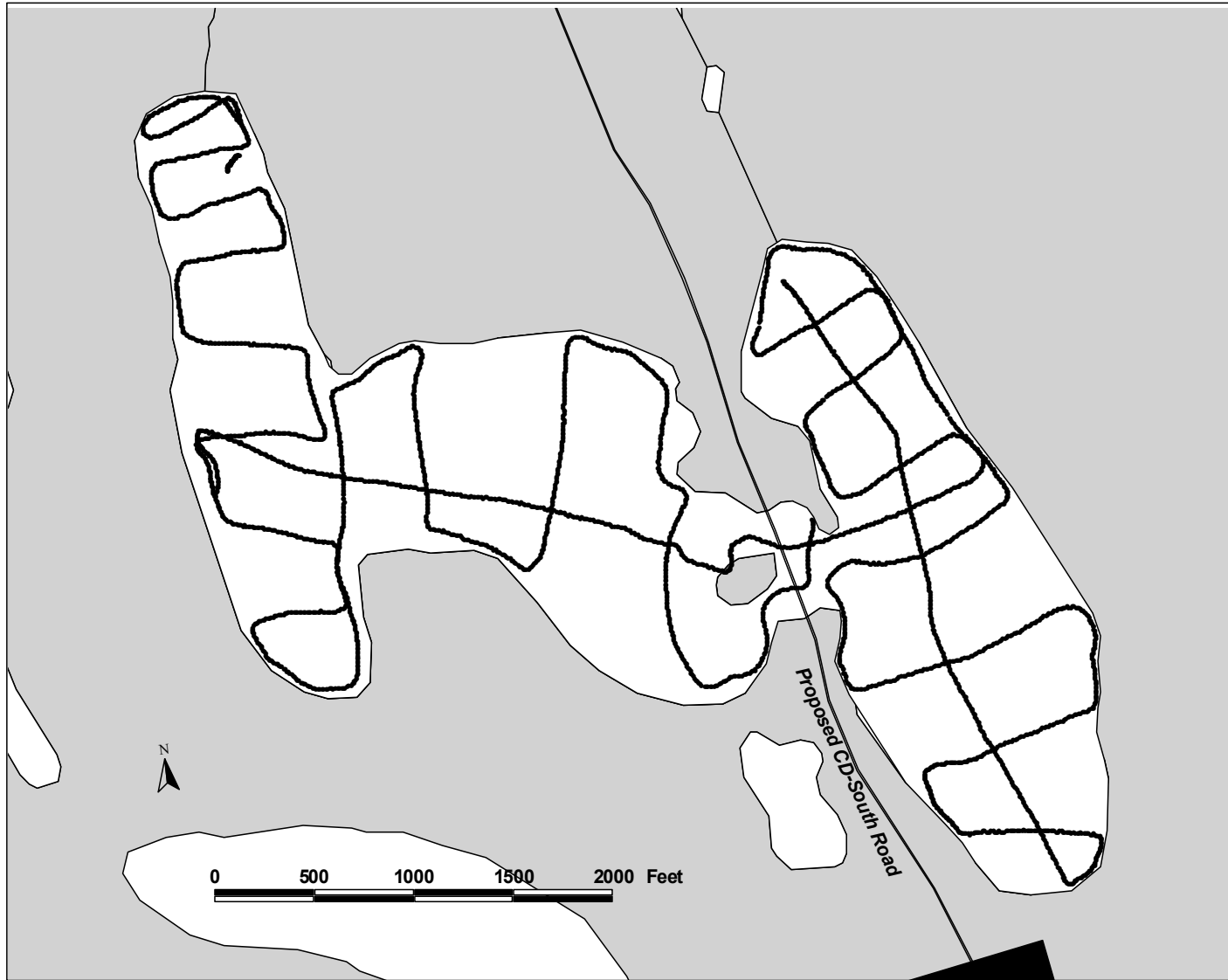
HBWF = humpback whitefish

RDWF = round whitefish

LSCS = least cisco

ARCS = arctic cisco

GRAY = arctic grayling



Appendix Figure 1. Bathymetric transects obtained from lake L9323 during 2002.