

SURVEY OF LAKES IN ASSOCIATION WITH THE 2005 NPRA ICE ROAD

Final Data Report

December 2004



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INTRODUCTION

ConocoPhillips Alaska Inc. has been exploring for oil within the eastern portion of the National Petroleum Reserve–Alaska (NPR-A) since the winter of 1999/2000. Exploration includes crossing rivers and lakes with ice roads and withdrawal of water from lakes to support both industrial and domestic needs.

During review of exploration, and potentially development, permits, information is required on the biological sensitivity of lakes in the region. The study was designed to provide physical and biological information on these lakes to understand their use by various fish species. In addition, results of the survey can be used, in concert with previous surveys within the area, to direct any future investigations that may be needed.

Objectives of the study were to document fish presence and habitat use in eastern NPR-A lakes for lakes that may be used to support exploration activities. The region evaluated in this report covers the eastern portion of the potential 2005 NPR-A ice road.

The objectives of the survey were to:

- 1) update lake bathymetry in previously surveyed lakes using new (post-2001) survey techniques,
- 2) inventory fish species in lakes within the project study area that had previously not been surveyed,
- 3) measure water chemistry parameters to assess suitability of water for potential uses.

The 2004 field effort continued sampling begun in 1999 in the eastern NPR-A Exploration Area. Previous surveys in this study region are reported in Moulton (2002).

Lakes in the area may be needed as sources of freshwater during oil exploration, for ice road and ice pad construction, as well as for short-term potable water supplies. Permitting decisions on water withdrawal will need to consider potential impacts to fish that depend on an adequate water supply for surviving winter. The inventory of fish and fish habitat provides information for assisting permitting decisions regarding water use and ice road routing. Surveys in lakes consisted of short-duration gill net sampling during July, supplemented with minnow trap sets, seine hauls, and visual observations.

Bathymetric and water chemistry data were collected in conjunction with fish sampling. The bathymetric information allows estimating lake volumes. Water chemistry parameters measured include water temperature, specific conductance, dissolved oxygen, pH and turbidity.

METHODS

The biological survey consisted of sampling with gill nets, fyke nets and minnow traps combined with physical measurements. Lakes were sampled either with short-duration gill net sets (typically 4 to 6 hours) or fyke nets set for 3-4 days. The gill nets are multimesh, 120 feet long, with six panels of variable mesh, mesh size ranging from 1 to 3.5 inches stretched mesh. These nets have been previously used to collect inventory-level data from lakes throughout the Colville Delta and nearby areas. Sets were kept to a short duration to minimize the chance for entangling waterfowl and to minimize fish mortality. Since the objective of the gill netting is to document presence/absence, the nets were pulled after fish were detected. Fyke nets used 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. Fyke nets were emptied daily. Fish captured were measured and released. Duration of each set was recorded to allow calculation of catch rates.

Minnow traps were used to identify smaller fish species that may not be detected by gill nets. Minnow traps baited with preserved salmon eggs were set in pairs at the edge of surveyed lakes. The traps were set and retrieved in concert with the gill net sampling.

Water chemistry parameters were measured to assess habitat conditions and provide information on the suitability of the water for domestic and industrial uses. 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 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 an Oaktron Acorn Series pH5 meter. Turbidity was measured with an H.F. Scientific DRT15CE turbidity meter. A water sample was sent to Northern Test Labs for laboratory determination of chloride, sodium, calcium, magnesium, and hardness (as CaCO₃).

Bathymetric data were collected to allow estimating lake volume. In 2002 and 2003, location and depth were recorded on a Lowrance Model LCX-15MT integrated GPS/depth sounder. Location and depth were recorded at approximately 1-2 second intervals. The study design was to record at least six to eight depth transects on each lake. Lake volume was estimated by contour mapping of depth intervals. Contour maps were prepared by plotting the position and depth data obtained by GPS on GIS basemaps and plotting the contours in 1 or 2 ft intervals on maps of the surveyed lakes. One foot intervals were plotted for lakes where the maximum depth was 10 ft or less, two foot intervals were used on deeper lakes. 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, A1 = area of the upper surface, and A2 = 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.

The amount allowed for winter water withdrawal when sensitive fish species are present is currently set at 15% of the volume of the lake deeper than 7 feet. When resistant fish species (i.e. ninespine stickleback and Alaska blackfish) are present, the current allocation allowed by Alaska Dept. of Natural Resources is 30% of the volume deeper than 5 feet. There is no withdrawal limit if fish are not present.

The area potentially available for ice aggregate was estimated by calculating the area of the lake shallower than 4 feet, assuming that the ice would grow to at least 4 feet prior to the need for aggregate. If the ice is shallower than 4 feet at the time of ice removal, then the area available will be less.

Lake Summaries

This report uses lake numbering based a researcher/year code. The lake number contains several pieces of information, including the code of the sampler and the year of sampling.

Sampler Code:

MC = McElderry and Craig (1981); sampling in 1979

B = Bendock sampling from 1977-1986

L = Lobdell; water chemistry sampling in 1991-1999

M = Moulton; fish sampling in 1995-2004

MB = Michael Baker Jr., Inc. water chemistry sampling in 2002-2004

N = Netsch et al. (1977) NPRA sampling in 1977

First Two Numerals:

Year of Initial Sampling

(if Moulton sampled a lake previously sampled by McElderry and Craig, then the McElderry and Craig lake number is used)

Last Two Numerals:

Numbers from 1 to 99 used to identify the individual lake sampled within a given year

Information contained for each surveyed lake (if measured) includes:

1. A diagram of the lake,
2. Other names utilized for the same lake,
3. Lake location, in latitude/longitude,
4. The USGS quadrangle sheet and the township and range in which the lake is situated
5. Habitat classification,
6. Surface area in acres, obtained from USGS digital maps,
7. Maximum depth in feet,
8. Presence or absence of an outlet,
9. pH,
10. Calculated lake volume and volume of water permitted for winter withdrawal,
11. Water chemistry measurements,

12. Catch record, including gear used, date sampled, species caught and size range,
13. Where appropriate data exist, the length frequency of dominant species is plotted,
14. The depth distribution based on bathymetric transects that were recorded.

Six different lake types are defined, based primarily on the potential for access by fish. Definitions for the lake types are as follows:

Perched (Frequent Flooding) = Perched lake near a floodplain, but above the water surface elevation of the active channel, with an obvious high water channel. These lakes are likely subject to annual flooding.

Perched (Infrequent Flooding) = Perched lake near a floodplain, but above the water surface elevation of the active channel, with no obvious high water channel. These lakes are likely subject to flooding on an infrequent basis (every five years or more).

Deflation = Deflation lake, a lake formed when sand dunes become revegetated and the basins between the dunes become filled with water. Deflation lakes are typically the deepest coastal plain lakes.

Drainage = Drainage Lake, a lake that is part of a defined drainage system, i.e. there is an active connection to a creek.

Oxbow = Oxbow lake, formed from abandoned river channels.

Tundra = Tundra Lake, a thaw lake not within or connected to a river drainage, little potential for fish access on a regular basis.

RESULTS AND DISCUSSION

Biological Observations

A total of 8 lakes were sampled in 2004 in connection with potential ice road construction during 2005 in eastern NPR-A (Table 1, Figure 2). Least cisco, humpback whitefish, and/or Arctic grayling were captured in 2 of the NPR-A lakes (Table 2), which is consistent with earlier reports from the region (Netsch et al. 1977, McElderry and Craig 1981, Bendock and Burr 1984). Ninespine stickleback were caught or observed in an additional 7 lakes and are suspected to be present in one additional lake (L9803). Length information is presented for each fish-bearing lake in the Lake Summaries.

Water Chemistry Measurements

Water chemistry parameters measured in the studied lakes are presented Table 3. Surface water

temperature during sampling in 2004 ranged from 6.2 to 14.6 °C. As expected for natural surface waters, dissolved oxygen was high, averaging around 95% saturation. Specific conductance ranged from 62 to 236 microSiemens/sm, while pH was between 7.4 to 7.8. The generally low specific conductance and low ion concentration indicates little marine influence in most lakes in this region.

Evaluation of Fish Concerns

Information from fish sampling and depth measurements was used to evaluate each lake regarding its potential to support fish. Obviously, if fish were captured during gill net sampling, the lake was classified as fish-bearing. Gill net sets were relatively short, however, so absence of catch does not necessarily mean a lake does not support fish. Lakes also were assessed for their proximity to fish-bearing streams and their depth. Lakes deeper than 7 feet are likely to retain unfrozen water during winter, thus have potential to overwinter fish. Deep lakes that are near fish-bearing streams and are likely to have a connection with the stream at some point during the year are classified as potential fish-bearing lakes, with additional sampling needed if further clarification of the designation is desired. Results of the evaluation are included in Table 4.

Lakes in which fish were verified as present are divided into those lakes containing species sensitive to habitat changes likely to be associated with water withdrawal and those containing species more resistant to such changes. Species sensitive to impacts of water withdrawal (such as reduced dissolved oxygen and increased dissolved solids) include lake trout, broad whitefish, least cisco and arctic grayling, while the more resistant species are Alaska blackfish and ninespine stickleback. Alaska blackfish are particularly resistant to low dissolved oxygen, being able to breathe atmospheric oxygen (Armstrong 1994). Residents of the Yukon Delta have reported observing Alaska blackfish oriented along cracks in the ice during winter to use oxygen in ponds that have gone anoxic. Ninespine stickleback can also withstand low dissolved oxygen (Lewis et al. 1972), although not the same extent as Alaska blackfish. Ninespine stickleback, however, can withstand higher levels of dissolved solids, and often frequent brackish nearshore waters during summer.

When sensitive fish are present, the amount of water available during winter is limited to 15% of the volume under 7 feet of ice. The water withdrawal criteria are relaxed when only resistant fish species are present because of the greater tolerance to lower dissolved oxygen and higher concentrations of dissolved solids. In this case, up to 30% of the water volume under 5 feet of ice is allowed for winter withdrawal. For lakes that do not contain fish, there is currently no limit to the amount taken. For practical reasons, the volume available is limited to the volume of unfrozen water under the ice at the time of withdrawal. In most cases, the withdrawal occurs when the ice is 4 feet thick or greater. In order to provide some estimate of water likely to be available, the volume of water under 4 feet of ice is provided.

Based on the above lake evaluation, all 10 lakes were confirmed or suspected to contain fish, with 2 containing sensitive species and an additional 8 containing or suspected to contain ninespine stickleback or Alaska blackfish. Lakes containing sensitive fish species in this region are connected to nearby streams at least during a portion of the open-water season (Figure 2).

Based on the above analysis, 52.1 million gallons of water are likely to be available for winter use

from lakes surveyed during 2004 in association with the 2005 NPRA ice road.

The area covered by water less than 4 feet deep, and therefore likely to be suitable for removing ice aggregate, was estimated for each lake (Table 5). A map of the potential ice aggregate area for each lake is included in the individual lake summaries. Based on the above analysis, 1,175 acres are likely to be available for ice chips from lakes surveyed during 2004 in association with the 2005 NPRA ice road.

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Table 1. Summary of lakes sampled in eastern NPRA during 2004 for potential 2005 ice road use.

Lake Name	Latitude (NAD83)	Longitude	Town	Range	Section	Surface Area (acres)	Maximum Depth (feet)	Calculated Volume (mill. gals)
L9803	70.25889	151.18904	10/11N	4E	5/32	170.7	6.7	176.47
L9804	70.24263	151.21213	10N	4E	6/7	252.7	5.2	235.95
L9805	70.23779	151.15888	10N	4E	5/8/9	439.4	5.7	429.96
L9806	70.24957	151.09729	10N	4E	3/4/10	361.7	6.8	423.15
L9817	70.23310	151.34001	10N	3E	10	62.3	9.3	104.88
M9910	70.25340	151.71385	10N	2E	6	161.9	9.0	301.6
M0009	70.27871	151.83024	11N	1E	26	50.8	10.1	52.09
M0020	70.27144	151.72814	11N	2E	30	119.6	18.5	310.90
M0025	70.28070	151.79700	11N	1E	26	46.2	8.2	53.32
R0076	70.29379	151.83276	11N	1E	22/23	335.9	8.0	404.10

Table 2. Catches of fish from lakes sampled in eastern NPRA during 2004 for potential 2005 ice road use.

Lake Name	Sample Date	Fyke Nets		Gill Nets		Minnow Traps	
		Set Duration (hours)	Fish Species ¹	Set Duration (hours)	Fish Species ¹	Set Duration (hours)	Fish Species ¹
L9803	not sampled	--		--		--	
L9804	Jul 18-20 04	67.8	NSSB	--		--	
L9805	Jul 19-21 04	69.7	NSSB	--		--	
L9806	Jul 14-17 04	91.6	NSSB	--		--	
L9817	Jul 17 99	--		7.5	none	--	
	Jul 30 to Aug 4 02	140.5	NSSB	--		--	
	Jul 16-19 04	95.8	NSSB	--		--	
M9910	Jul 11 99	--		1.2	GRAY	--	
	Jul 27-Aug 3 01	376.0	HBWF,LSCS,GRAY NSSB,BKFH	--		--	
M0009	Jul 17 00	--		6.8	none	--	
	Jul 26-28 04	71.3	NSSB	--		--	
M0020	Jul 27 00	--		1.8	LSCS	1.9	none
M0025	Jul 31 00	--		8.0	none	9.5	none
	Jul 24-27 04	92.1	NSSB	--		--	
R0076	Aug 04 04	--		6.4	none	6.8	NSSB

-- = not measured

¹ NSSB = Ninespine stickleback, HBWF = humpback whitefish, LSCS = least cisco, GRAY = Arctic grayling, BKFH = Alaska blackfish

Table 3. Water chemistry parameters measured in conjunction with lake sampling in eastern NPRA during 2004 for potential 2005 ice road use.

Lake	Date	Water Temp (°C)	Dissolved Oxygen		Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)
			(mg/l)	(%)								
L9803	Jul 09 04	10.7	10.9	99	82	1.0	7.66	--	--	--	--	--
L9804	--	--	--	--	--	--	--	--	--	--	--	--
L9805	Jul 10 04	10.6	11.1	100	126	1.9	7.72	--	--	--	--	--
L9806	Jul 10 04	12.1	10.7	99	159	3.1	7.74	--	--	--	--	--
L9817	Jul 28 04	14.6	8.5	83	236	0.6	7.79	--	--	--	--	--
M9910	Aug 03 04	7.5	11.0	92	87	1.4	7.61	12.1	2.2	5.1	2.7	39
M0009	Jul 17 00	12.9	10.5	99	69	--	7.60	7.6	1.5	7.7	3.1	25
	Aug 02 04	6.8	11.1	92	65	1.8	7.39	--	--	--	--	--
M0020	Jul 27 00	10.1	11.5	95	142	--	7.91	18.4	3.2	11.1	4.9	59
M0025	Jul 31 00	9.9	--	--	100	--	--	10.5	2.6	10.7	4.9	37
	Aug 02 04	7.2	10.8	95	86	1.7	7.44	--	--	--	--	--
R0076	Aug 04 04	6.2	12.1	99	86	2.4	7.50	11.5	2.4	7.9	3.5	38

-- = not measured

Table 4. Estimated water volumes available for winter withdrawal from surveyed lakes in eastern NPR during 2004 for potential 2005 ice road use.

(requested water based on 15% of winter volume deeper than 7 ft when sensitive species are present, 30% of winter volume deeper than 5 ft when resistant or no fish are likely to be present).

Lake	Surface Area (acres)	Max. Depth (feet)	Calculated Volume (mil. gals)	Volume Under 4ft of Ice (mil. gals)	30% of 5 ft Winter Volume (mil. gals)	15% of 7 ft Winter Volume (mil. gals)	Sensitive Fish Species Present ¹	Resistant Fish Species Present ²	Available Water (mil. gals)
L9803	170.7	6.7	176.47	12.00	0.44	0.00	none	(NSSB)	0.44
L9804	252.7	5.2	235.95	3.32	0.00	0.00	none	NSSB	0.00
L9805	439.4	5.7	429.96	11.90	0.01	0.00	none	NSSB	0.01
L9806	361.7	6.8	423.15	101.65	14.63	0.00	none	NSSB	14.63
L9817	62.3	9.3	104.88	32.55	5.49	0.45	none	NSSB	**
M9910	161.9	9.0	301.57	110.81	21.28	1.44	HBWF,LSCS,GRAY	NSSB,BKFH	1.44
M0009	50.8	10.1	52.09	8.01	0.54	0.00	none	NSSB	0.54
M0020	119.6	18.5	310.90	177.96	45.05	14.98	LSCS	none	14.98
M0025	46.2	8.2	53.32	14.02	2.40	0.07	none	NSSB	2.40
R0076	335.9	8.0	404.10	105.05	17.67	0.36	none	NSSB	17.67

HBWF = humpback whitefish

LSCS = least cisco

GRAY = arctic grayling

NSSB = ninespine stickleback

BKFH = Alaska blackfish

(NSSB) = assumed to be present

** = this lake is the subject of a special permit request

Table 5. Estimated area available for removing ice aggregate, based on the area covered by water shallower than 4 feet, in eastern NPRA during 2004 for potential 2005 ice road use.

Lake	Surface Area (acres)	Max. Depth (feet)	Acres covered
			by Water shallower 4 feet
L9803	170.7	6.7	113.8
L9804	252.7	5.2	222.9
L9805	439.4	5.7	336.6
L9806	361.7	6.8	189.6
L9817	62.3	9.3	11.5
M9910	161.9	9.0	33.2
M0009	50.8	10.1	27.4
M0020	119.6	18.5	31.7
M0025	46.2	8.2	26.1
R0076	335.9	8.0	182.5

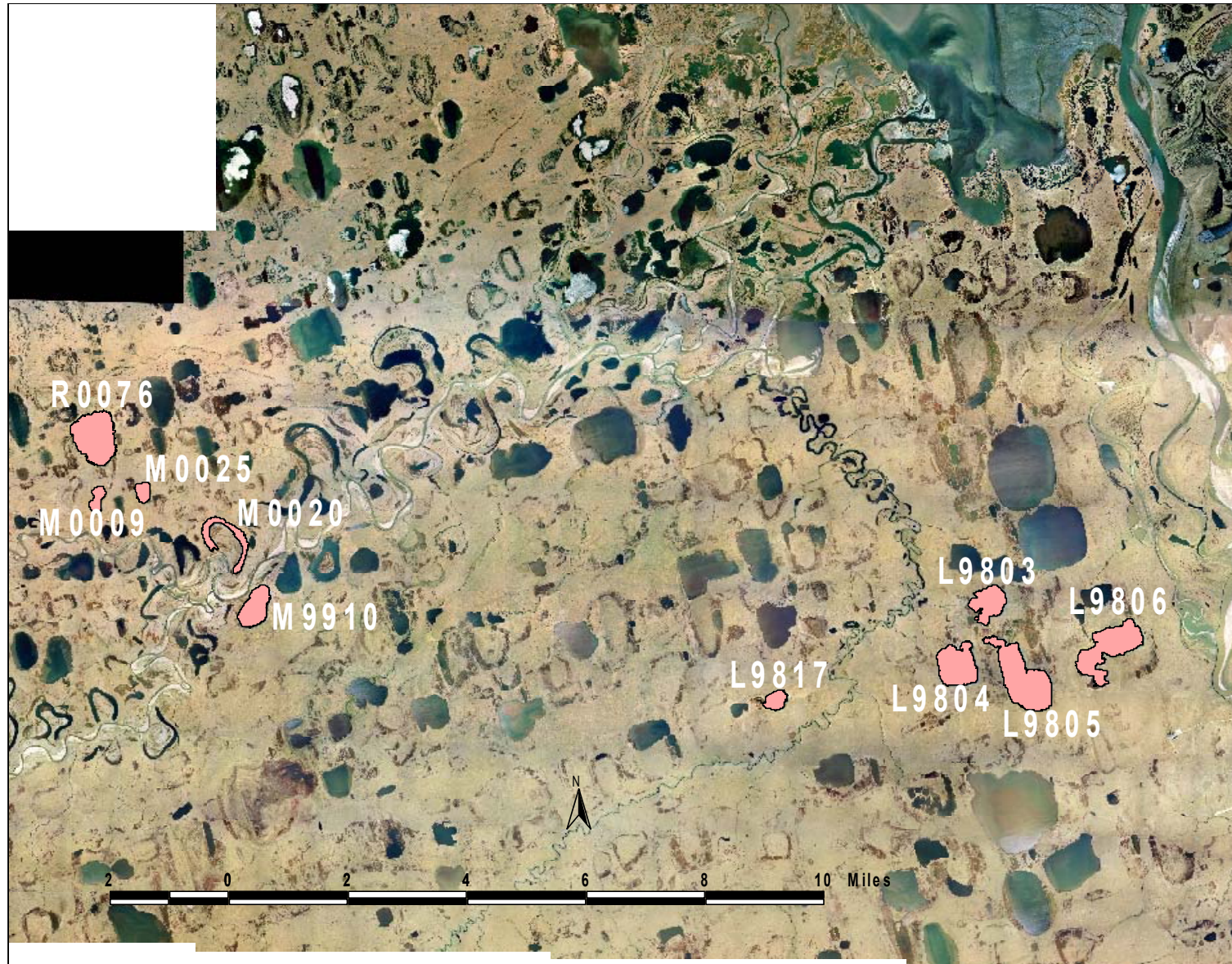


Figure 1. Lakes surveyed in 2004 for potential use during construction of the 2005 NPRA ice road.

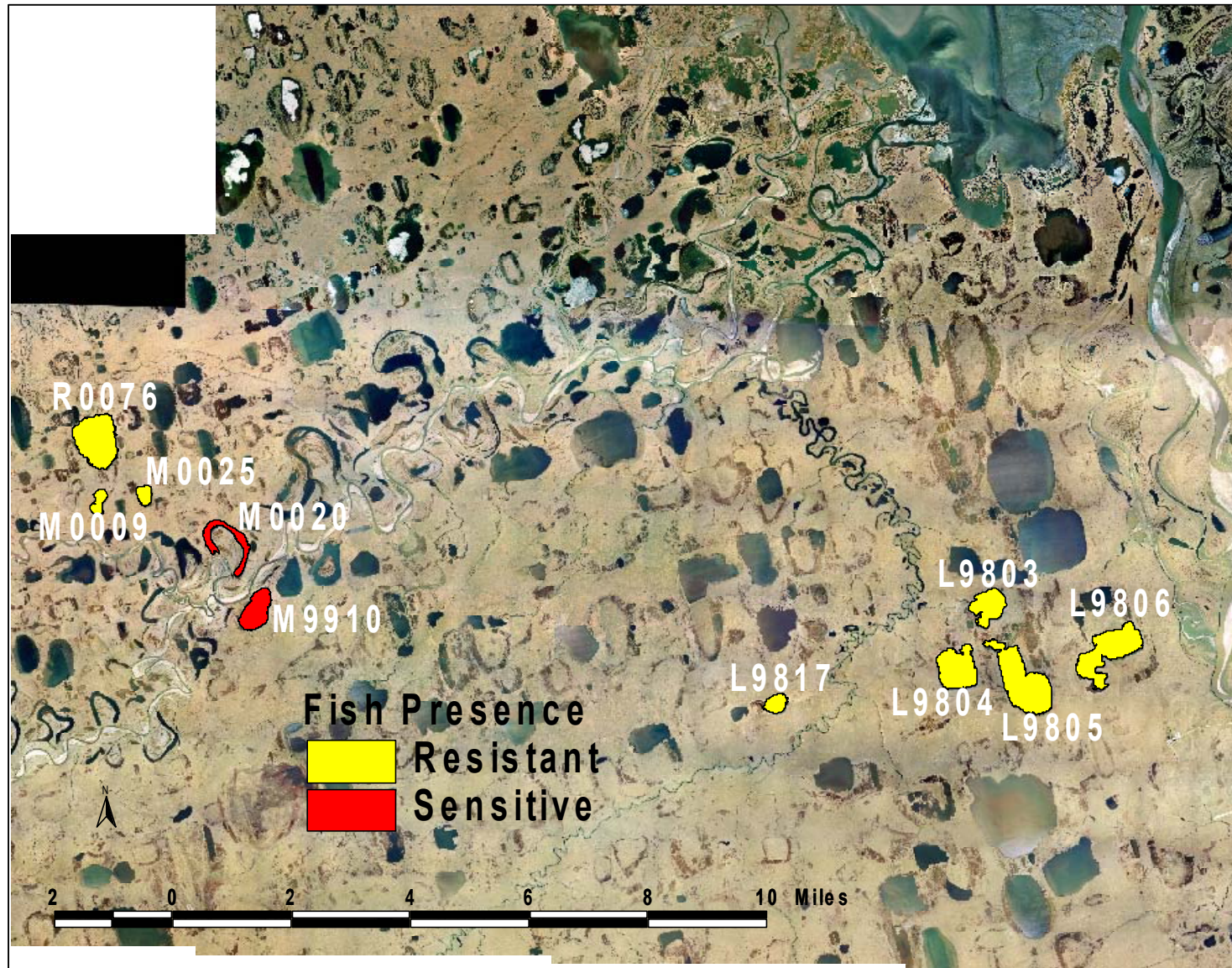
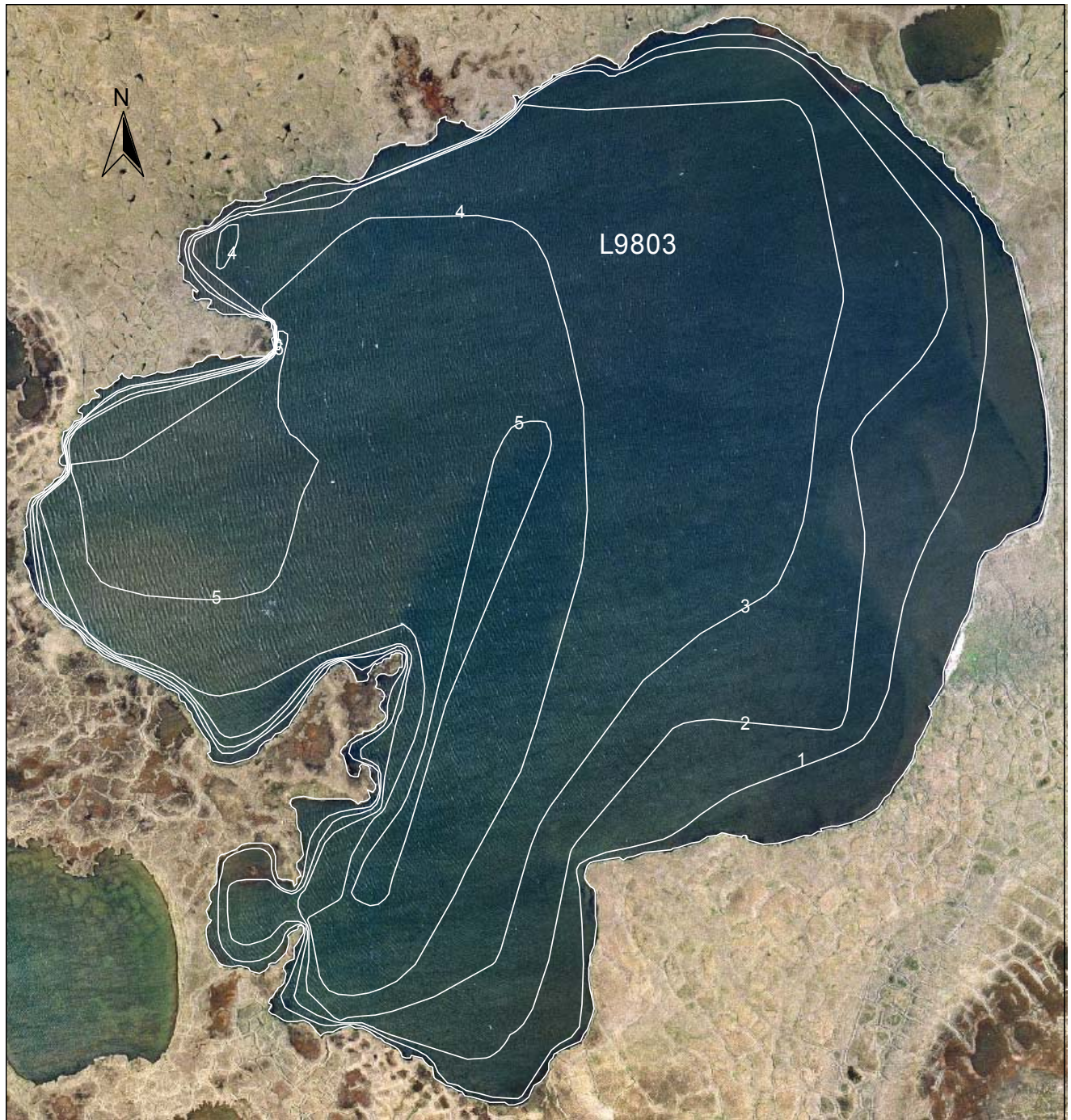


Figure 2. Distribution of sensitive and resistant fish species in lakes sampled in the 2005 NPR A ice road study area during 2004 summer field season.

Lake Summaries



500 0 500 1000 1500 2000 Feet

Depth contours of lake L9803, based on transects surveyed on July 9, 2004
(depth intervals in 1 foot increments)

Lake L9803

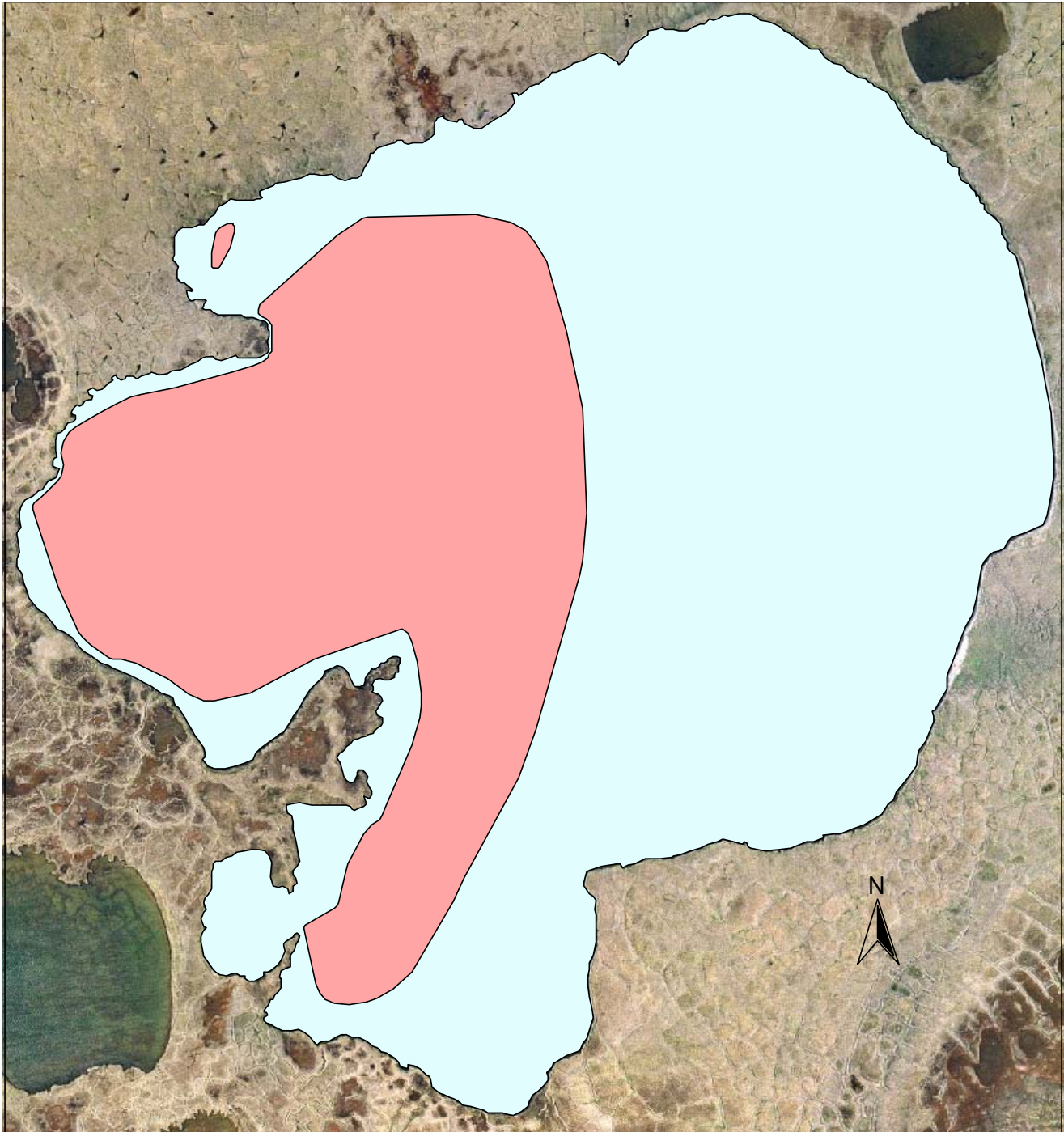
Other Names:
Location: 70.25889°N 151.18904°W
USGS Quad Sheet: Harrison Bay B-2: T10/11N R4E Sec. 5/32
Habitat: Tundra Lake
Area: 171 acres
Maximum Depth: 6.7 feet
Active Outlet: No
Calculated Volume: 176.5 million gallons
Permittable Volume: 0.44 million gallons
Potential Aggregate 113.8 acres (water depth 4 ft or less)

Water Quality:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2004						82.3	1.0	7.66	this study

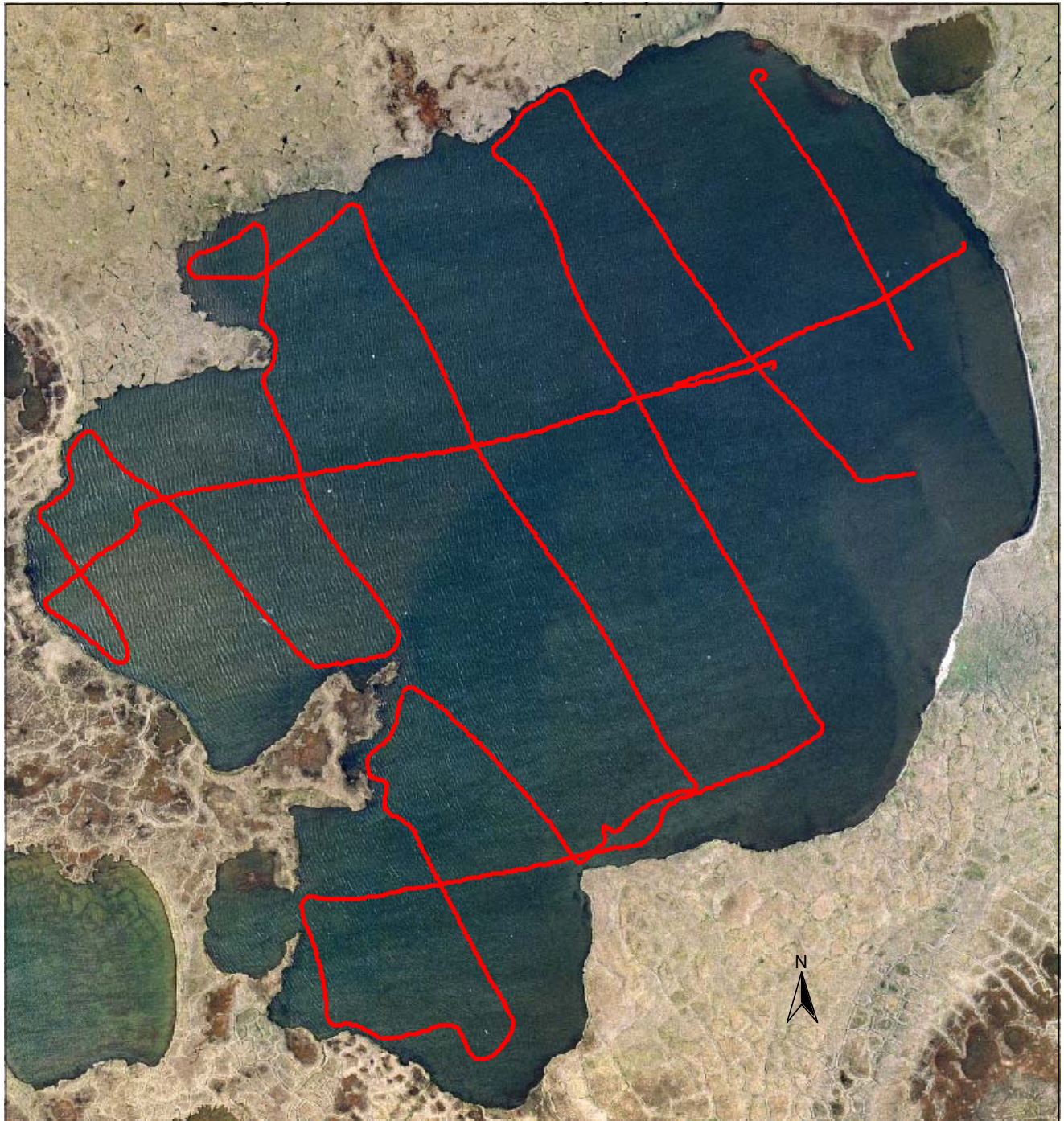
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
not sampled, ninespine stickleback assumed to be present				



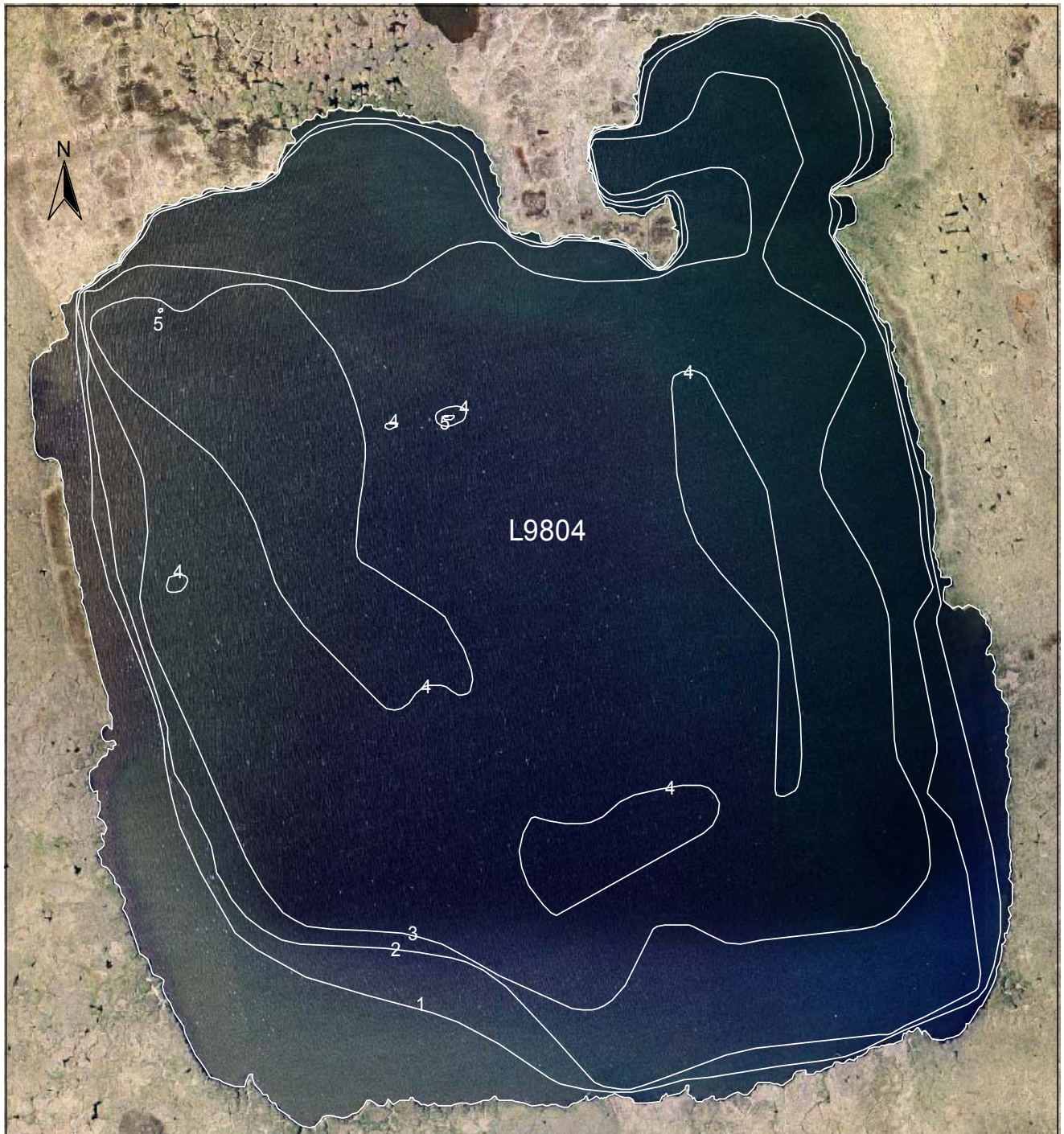
1000 0 1000 2000 Feet

Regions of lake L9803 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on July 9, 2004



500 0 500 1000 1500 2000 Feet

Depth transects surveyed at lake L9803 on July 9, 2004



1000 0 1000 2000 Feet

Depth contours of lake L9804, based on transects surveyed on August 4, 2004
(depth intervals in 1 foot increments)

Lake L9804

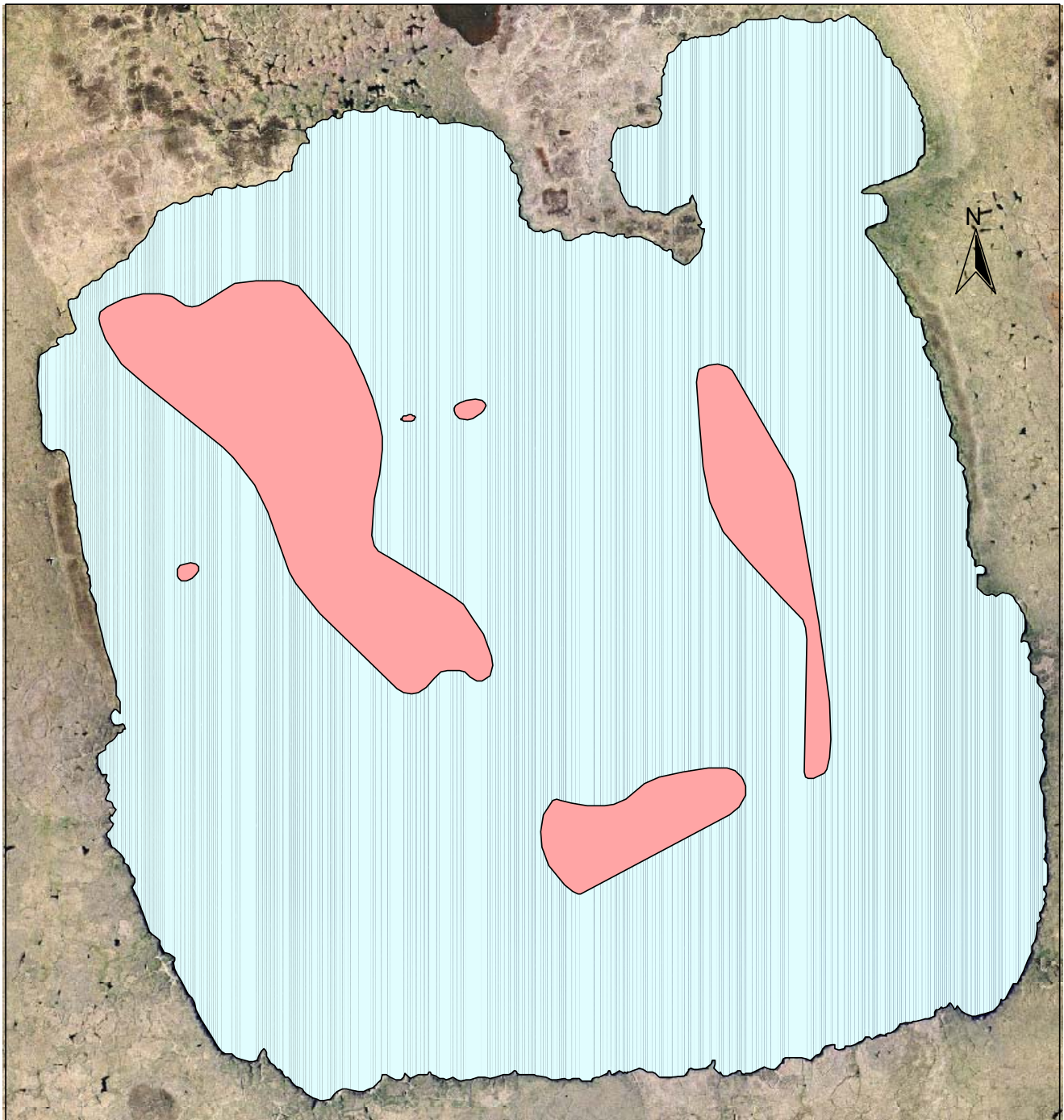
Other Names:
Location: 70.24263°N 151.21213°W
USGS Quad Sheet: Harrison Bay A-2/A-3: T10N R4E Sec. 6/7
Habitat: Tundra Lake
Area: 253 acres
Maximum Depth: 5.2 feet
Active Outlet: No
Calculated Volume: 235.9 million gallons
Permittable Volume: 0.00 million gallons
Potential Aggregate 222.9 acres (water depth 4 ft or less)

Water Quality:

Date of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
Jul 18 04						157	3.3	7.91	this study
Jul 19 04						159	2.9	7.91	this study
Jul 20 04						161	2.7	7.99	this study
Jul 21 04						162	2.0	8.01	this study

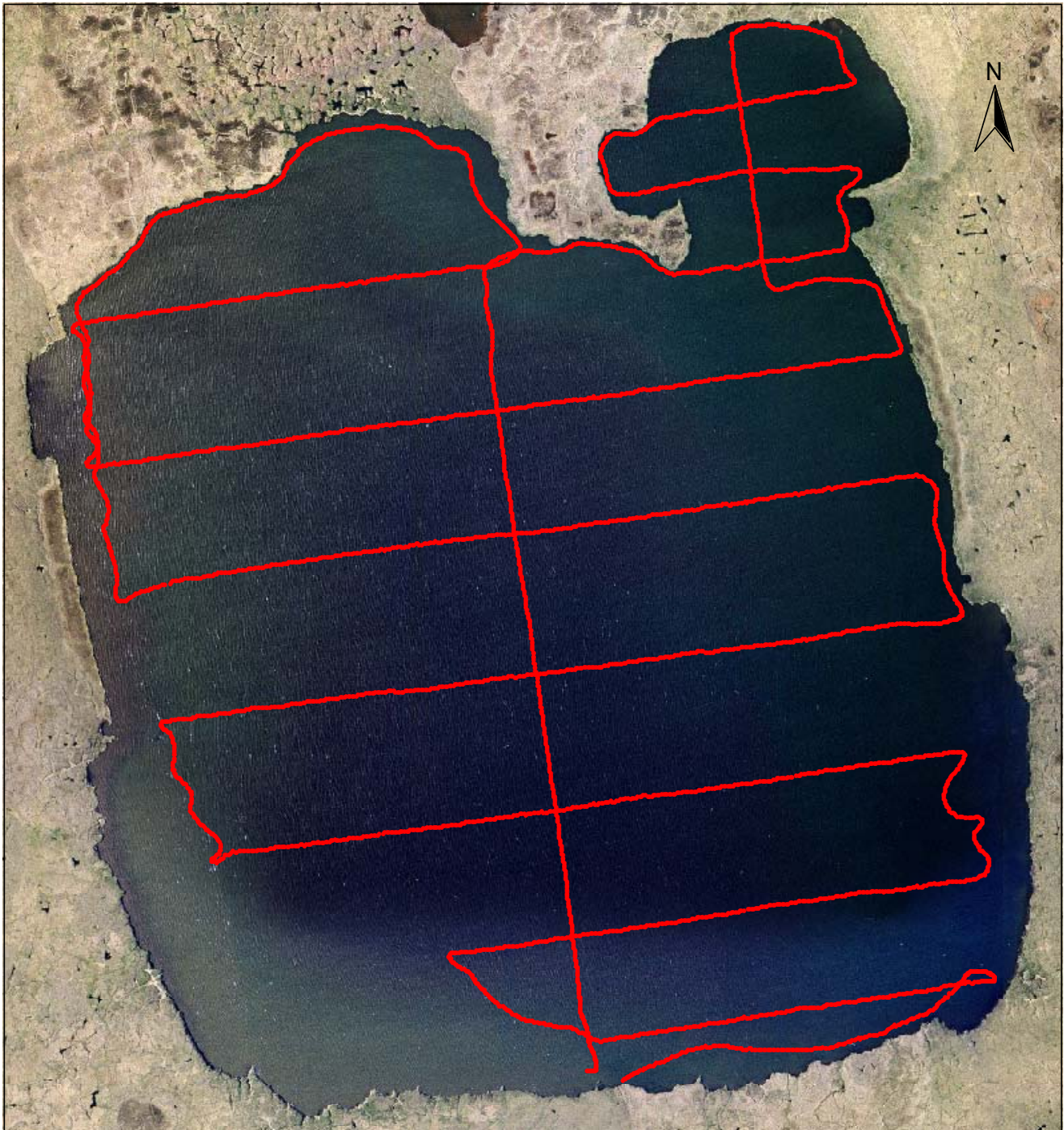
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Fyke Net	Jul 19-21 04	67.8	Ninespine stickleback	611



1000 0 1000 2000 Feet

Regions of lake L9804 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on August 4, 2004



Depth transects surveyed at lake L9804 on August 4, 2004



1000 0 1000 2000 3000 Feet

Depth contours of lake L9805, based on transects surveyed on July 10, 2004
(depth intervals in 1 foot increments)

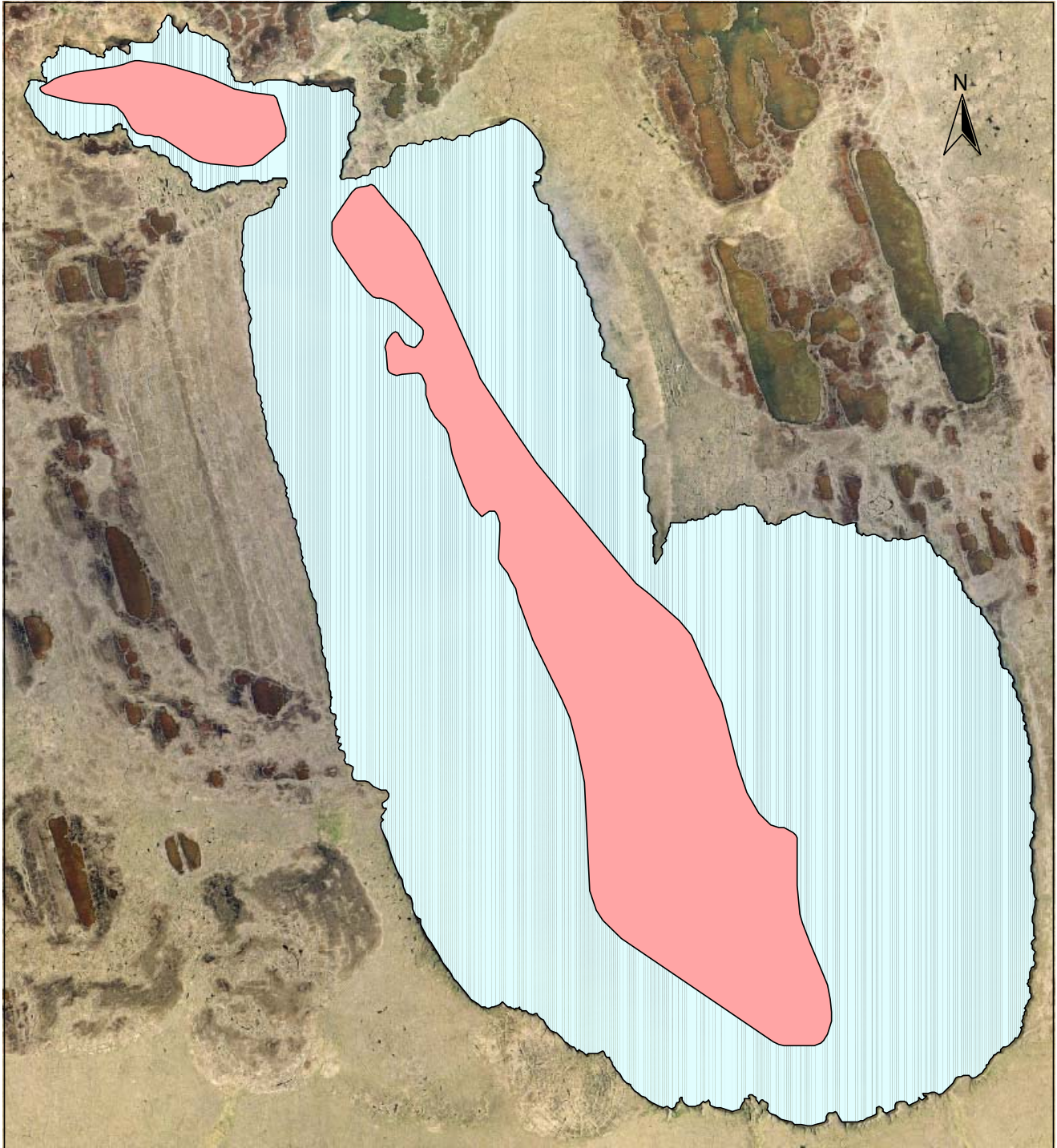
Lake L9805

Other Names:**Location:** 70.23779°N 151.15888°W**USGS Quad Sheet:** Harrison Bay A-2: T10N R4E Sec. 5/8/9**Habitat:** Tundra Lake**Area:** 439 acres**Maximum Depth:** 5.7 feet**Active Outlet:** No**Calculated Volume:** 430.0 million gallons**Permittable Volume:** 0.01 million gallons**Potential Aggregate:** 336.6 acres (water depth 4 ft or less)**Water Quality:**

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
Jul 10 04						126	1.9	7.72	this study
Jul 18 04						141	3.5	7.85	this study
Jul 19 04						143	4.1	7.88	this study
Jul 20 04						145	3.5	8.01	this study
Jul 21 04						146	2.4	7.96	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Fyke Net	Jul 19-21 04	69.7	Ninespine stickleback	592



Regions of lake L9805 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on July 10, 2004



1000 0 1000 2000 3000 Feet

Depth transects surveyed at lake L9805 on July 10, 2004



1000 0 1000 2000 3000 Feet

Depth contours of lake L9806, based on transects surveyed on July 10, 2004
(depth intervals in 1 foot increments)

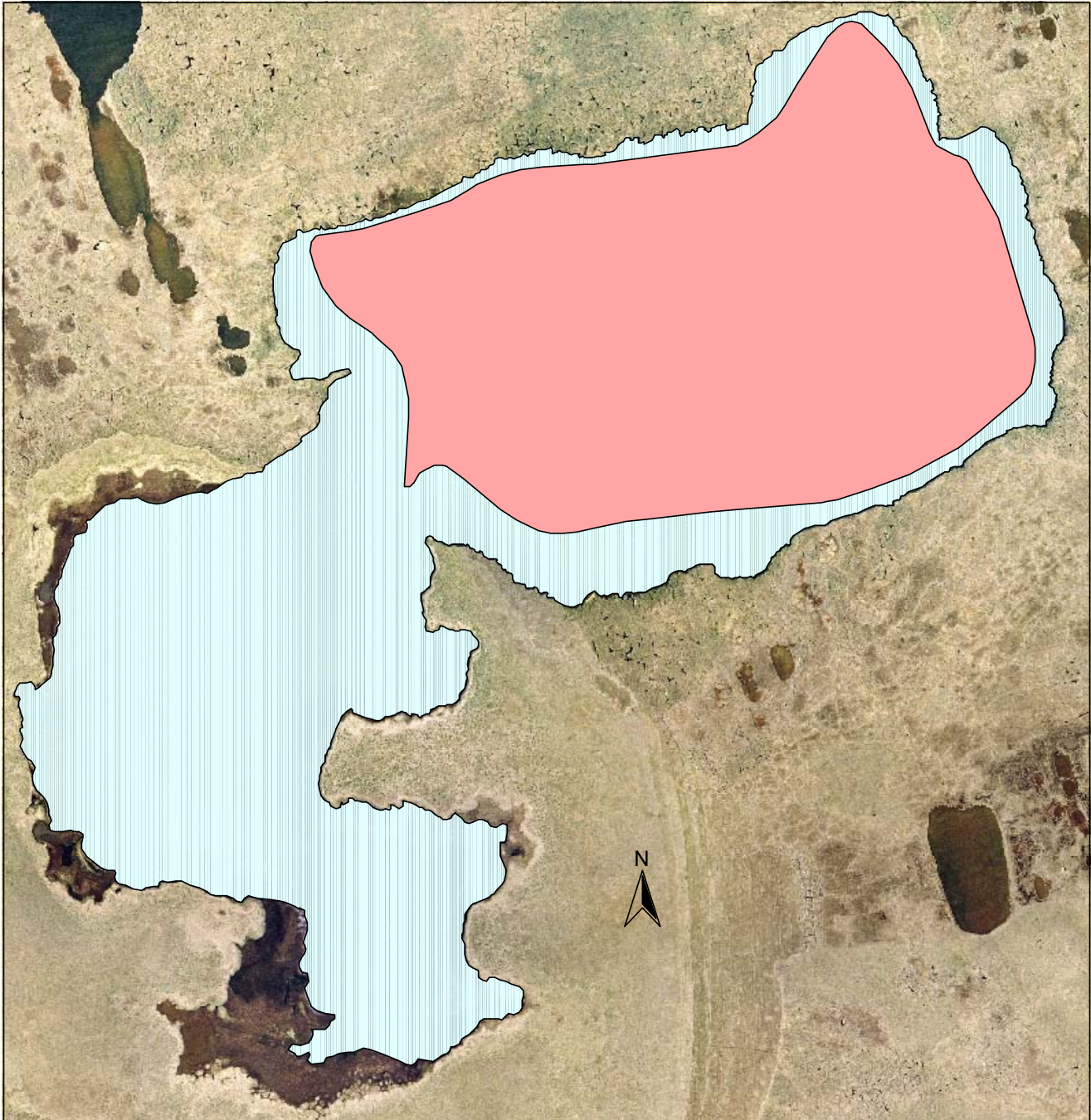
Lake L9806

Other Names:**Location:** 70.24957°N 151.09729°W**USGS Quad Sheet:** Harrison Bay A-2/B-2: T10N R4E Sec. 3/4/10**Habitat:** Tundra Lake**Area:** 362 acres**Maximum Depth:** 6.8 feet**Active Outlet:** No**Calculated Volume:** 423.1 million gallons**Permittable Volume:** 14.63 million gallons**Potential Aggregate** 189.6 acres (water depth 4 ft or less)**Water Quality:**

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
Jul 10 04						159	3.1	7.74	this study
Jul 13 04						164	23.3	7.74	this study
Jul 14 04						162	1.7	7.85	this study
Jul 15 04						165	3.2	7.98	this study
Jul 16 04						167	3.9	7.82	this study
Jul 17 04						166	1.7	7.95	this study

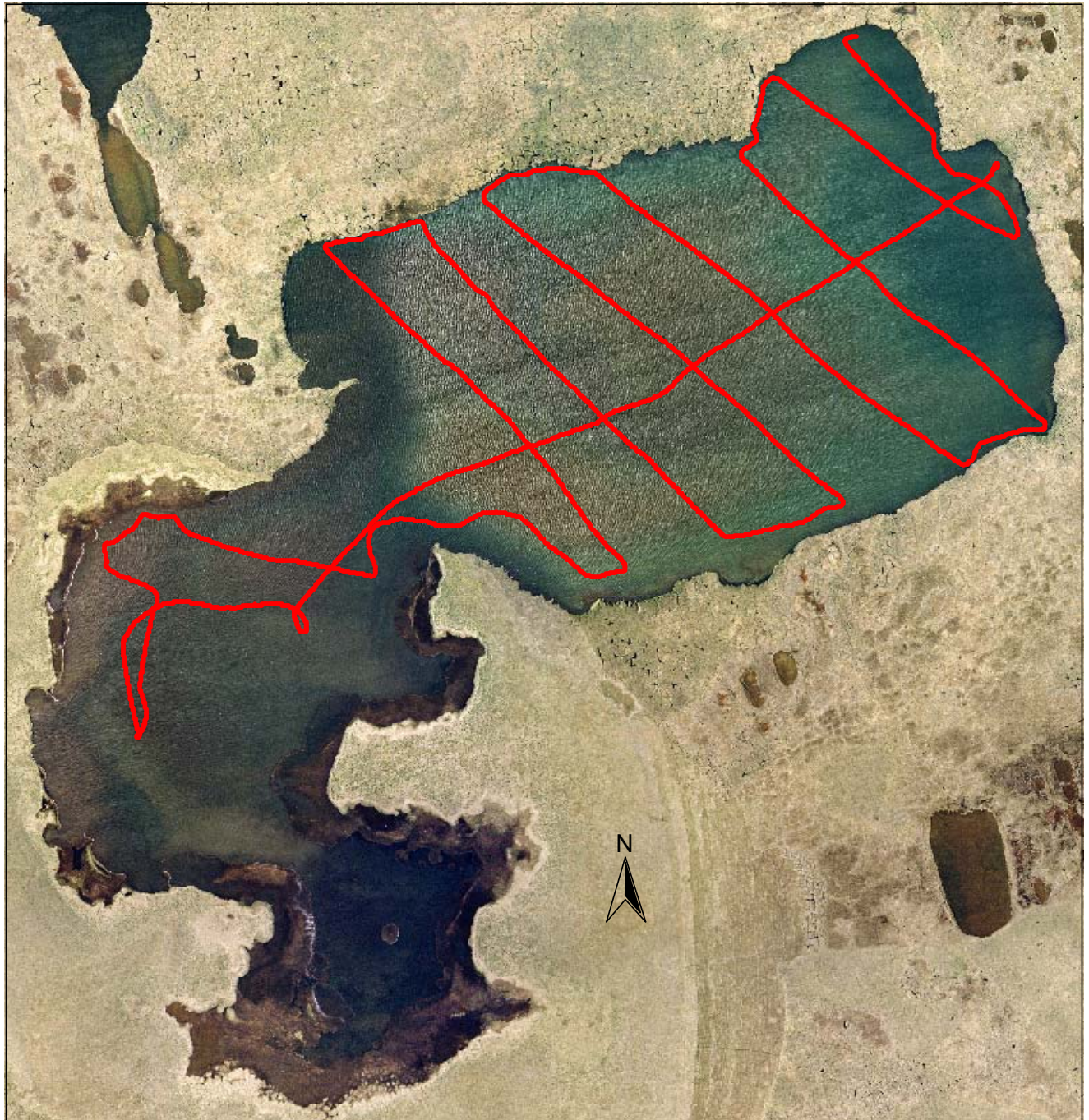
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Fyke Net	Jul 14-17 04	91.6	Ninespine stickleback	3

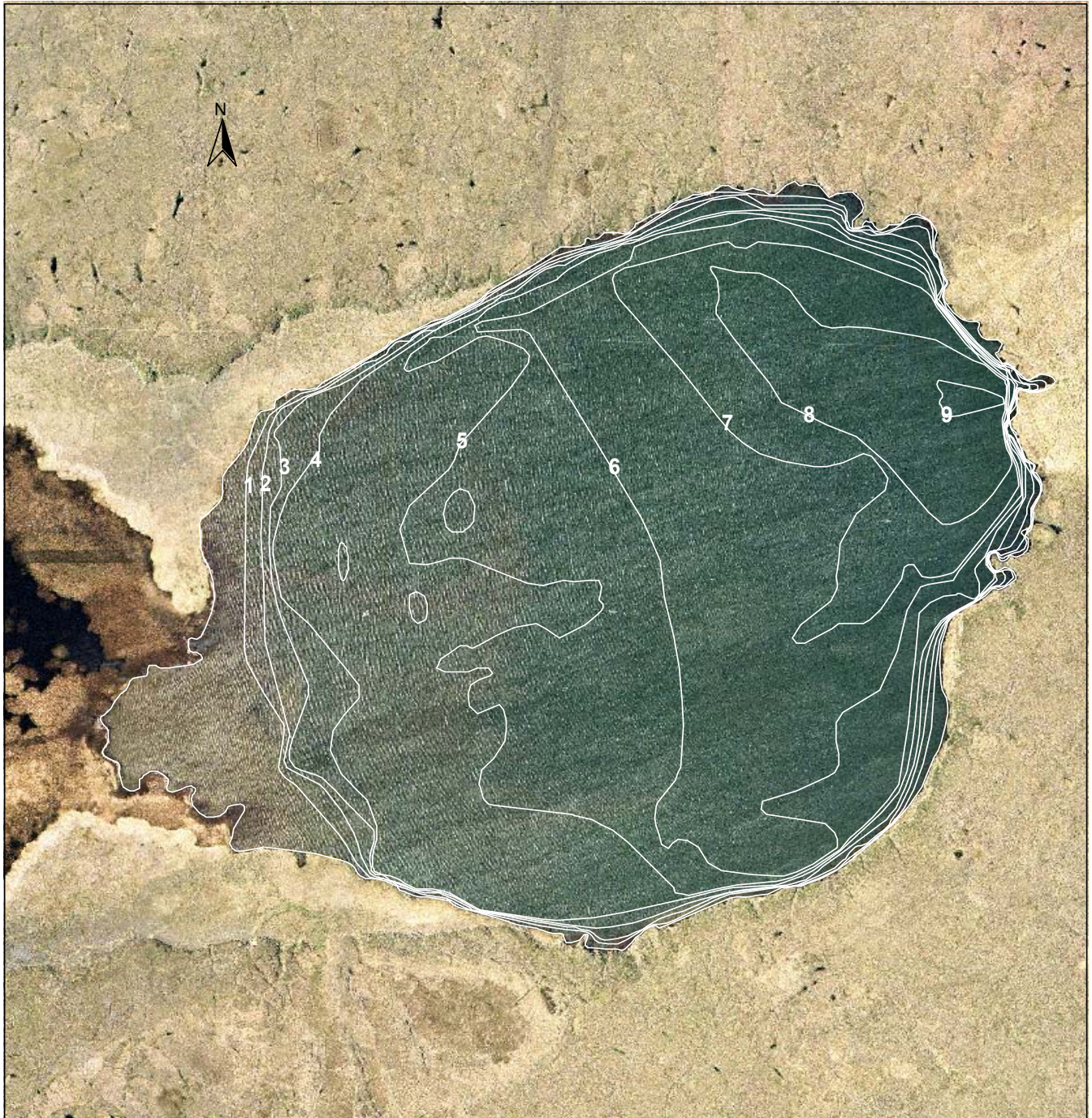


1000 0 1000 2000 3000 Feet

Regions of lake L9806 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on July 10, 2004



Depth transects surveyed at lake L9806 on July 10, 2004



500 0 500 1000 Feet

Depth contours of lake L9817, based on transects surveyed on July 28, 2004
(depth intervals in 1 foot increments)

Lake L9817

Other Names:

Location: 70.23310°N 151.34001°W
USGS Quad Sheet: Harrison Bay A-3: T10N R3E Sec. 10
Habitat: Tundra Lake
Area: 62 acres
Maximum Depth: 9.3 feet

Estimated Water Volume:

Total Volume (mil. gals)	Volume Under 4 ft of Ice (mil. gals)	Volume Under 5 ft of Ice (mil. gals)	Volume Under 7 ft of Ice (mil. gals)
104.88	32.55	18.32	3.02

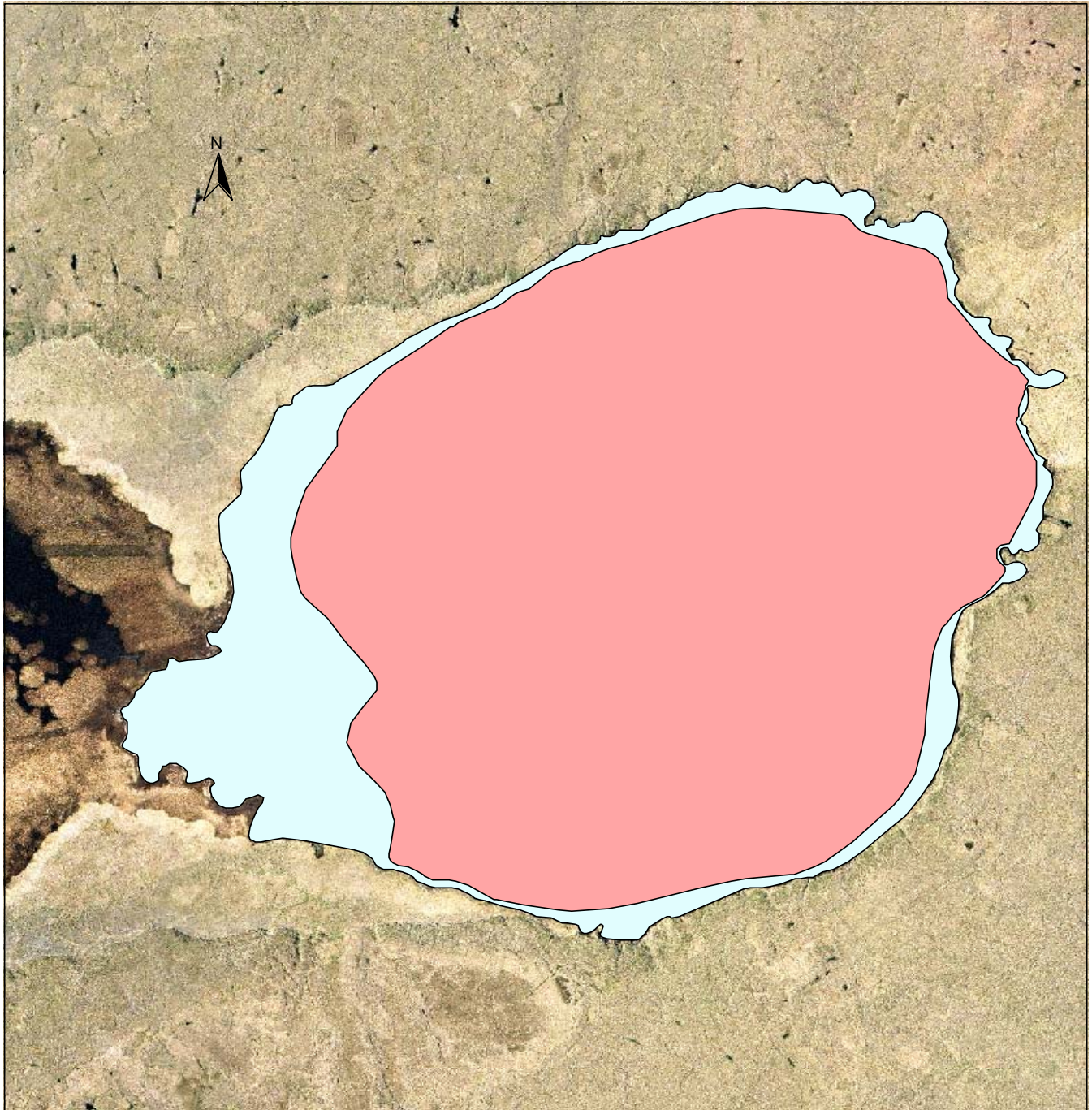
(based on 2004 bathymetry)

Water Chemistry:

Date	Specific Conductance (microS/cm)	Turbidity (NTU)	pH
Jul 30 02	222	1.3	8.21
Jul 31 02	237	1.2	8.10
Aug 01 02	238	1.3	8.25
Aug 02 02	239	1.2	8.15
Aug 03 02	241	1.3	8.26
Aug 04 02	244	1.5	8.04
Jul 15 04	221	1.0	7.05
Jul 16 04	224	0.8	7.60
Jul 17 04	224	0.7	7.72
Jul 18 04	226	0.8	7.70
Jul 19 04	228	0.8	7.74
Jul 28 04	236	0.6	7.79

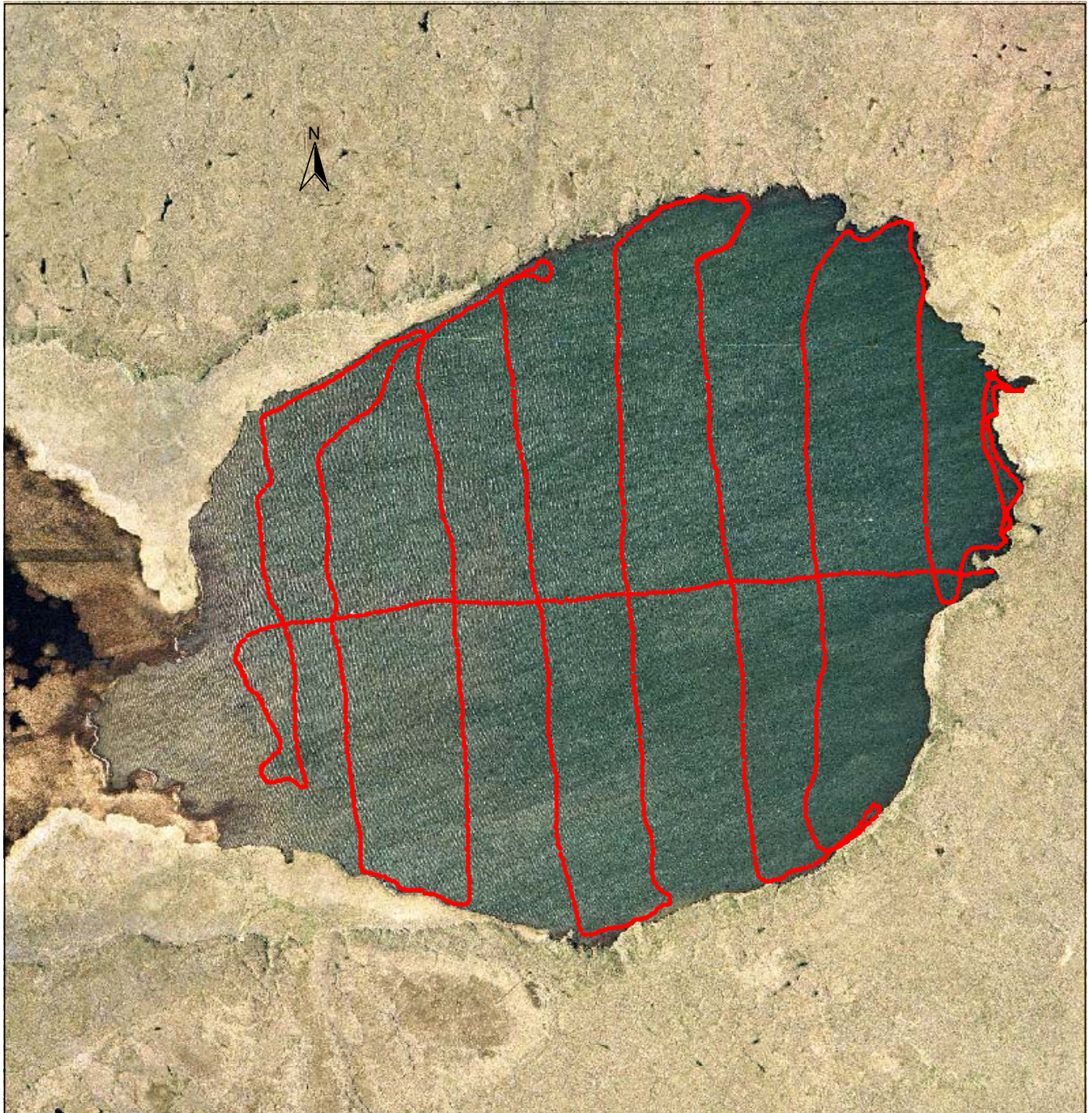
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 17 99	7.5	None	0
Fyke Net	Jul 30 02	25.1	Ninespine stickleback	100
	Jul 31 02	19.5	Ninespine stickleback	154
	Aug 01 02	22.5	Ninespine stickleback	6,000
	Aug 02 02	25.2	Ninespine stickleback	3,000
	Aug 03 02	22.7	Ninespine stickleback	15,000
	Aug 04 02	25.6	Ninespine stickleback	7,500
	Jul 16 04	26.7	None	0
	Jul 17 04	24.4	Ninespine stickleback	1
	Jul 18 04	20.3	None	0
	Jul 19 04	24.5	None	0



500 0 500 1000 Feet

Regions of lake L9817 less than 4 feet deep (light shaded) , and likely to be available for ice chips, based on transects surveyed on July 28, 2004.



500 0 500 1000 Feet

Depth transects surveyed at lake L9817 on July 28, 2004.



Depth contours of lake M9910, based on transects surveyed on August 3, 2004
(depth intervals in 1 foot increments)

Lake M9910

Other Names:

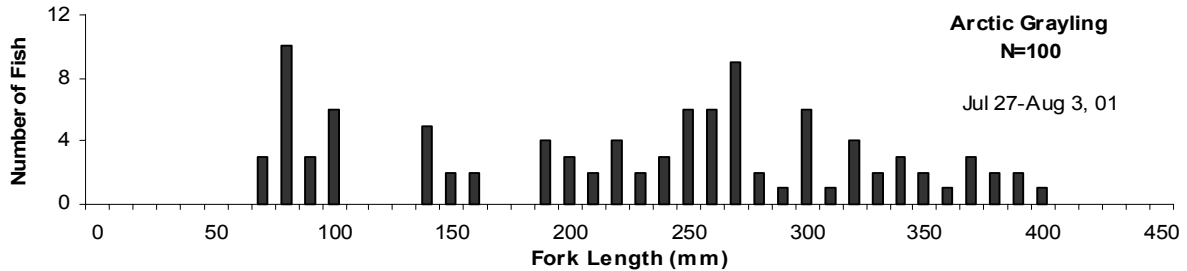
Location: 70.25340°N 151.71385°W
USGS Quad Sheet: Harrison Bay B-3: T10N R2E Sec. 6
Habitat: Perched Lake
Area: 162 acres
Maximum Depth: 9.0 feet
Active Outlet: Yes
Calculated Volume: 301.6 million gallons
Permittable Volume: 1.44 million gallons
Potential Aggregate: 33.2 acres (water depth 4 ft or less)

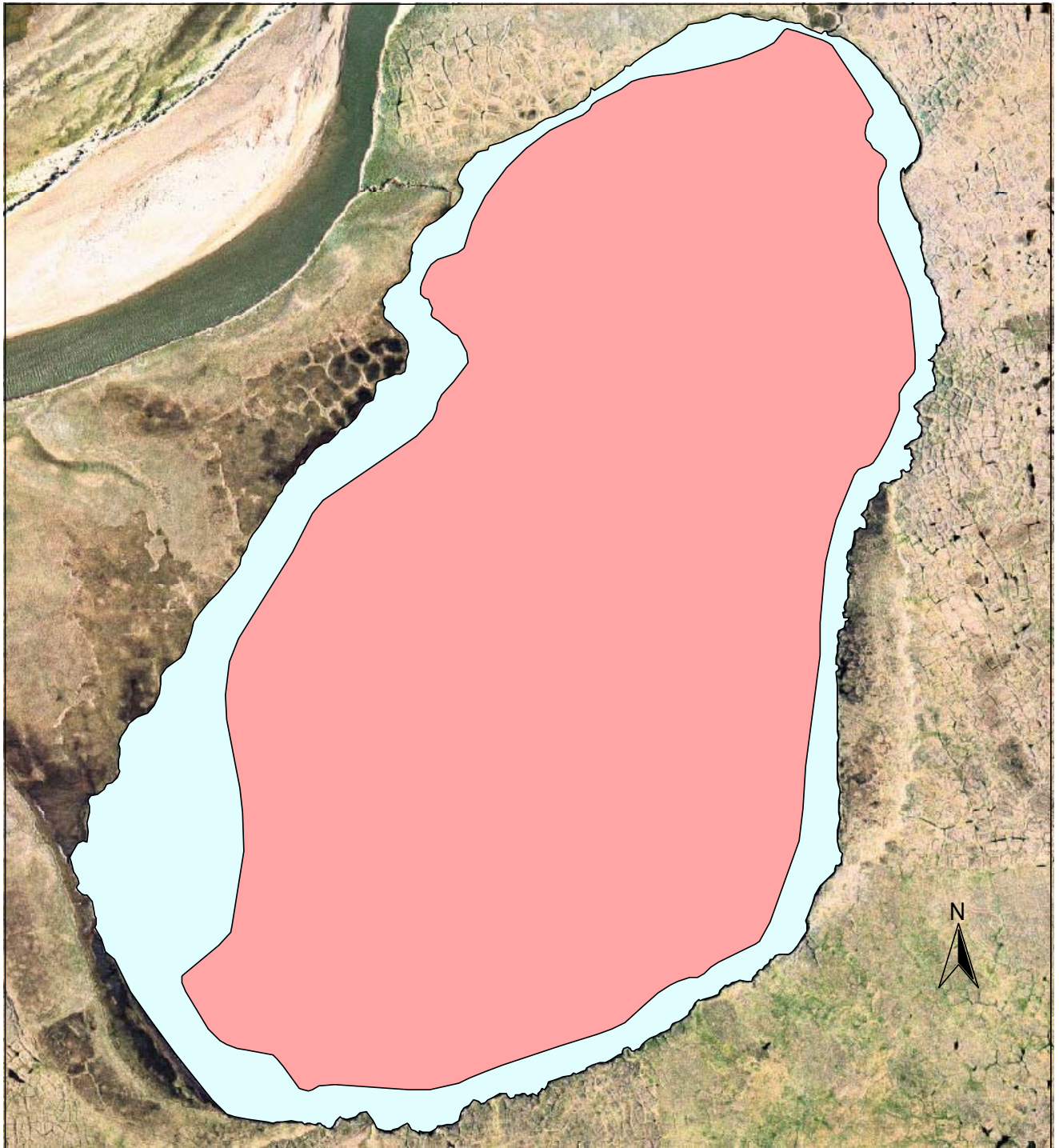
Water Quality:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
1999	17.2	3.0	8.7	3.1	54.9				Moulton (02)
2004	12.1	2.2	5.1	2.7	39.3	86.8	1.4	7.61	this study

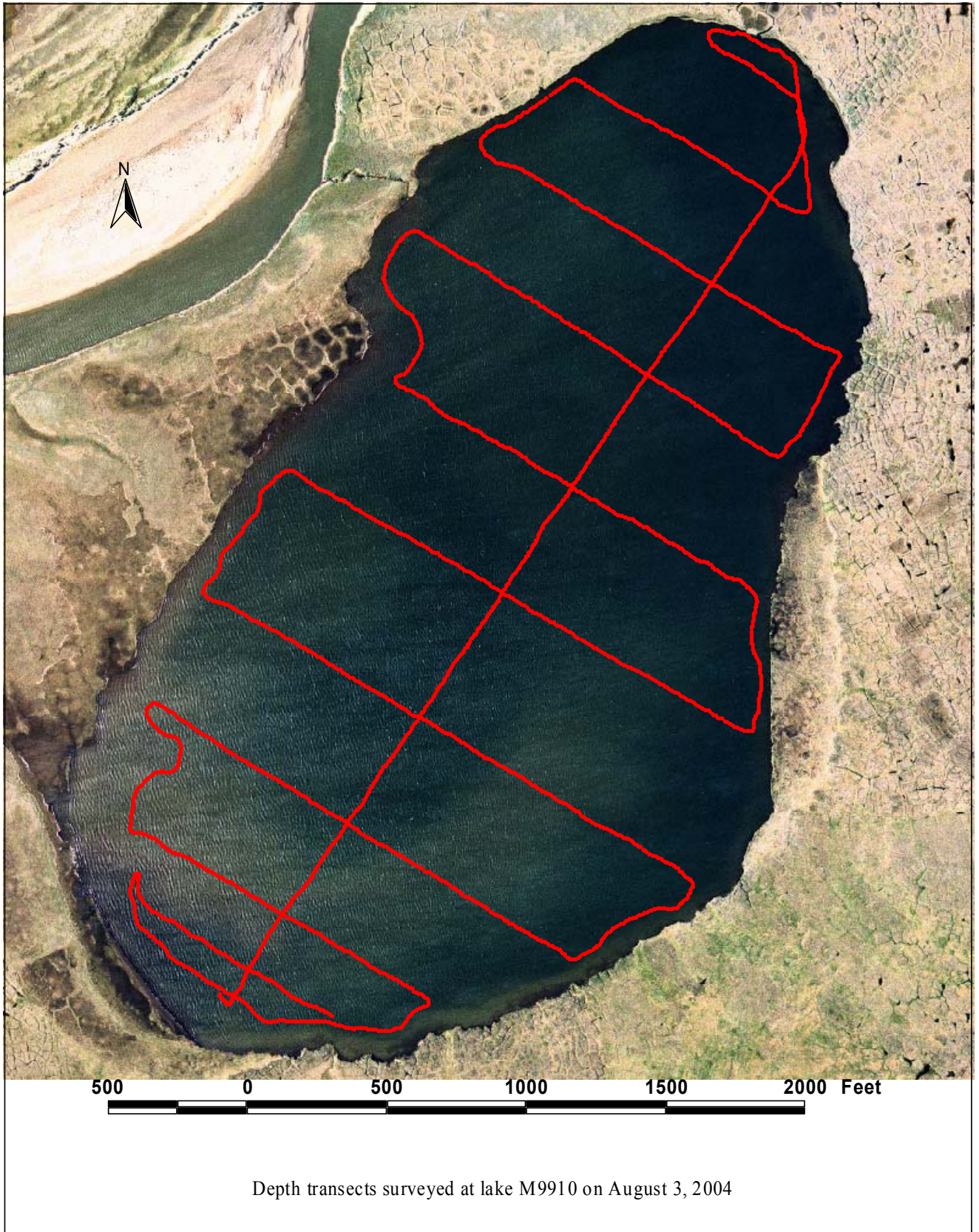
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught	Fork Length (mm)
Gill Net	Jul 11 99	1.2	Arctic grayling	4	279-289
Fyke Net	Jul 27-Aug 3 01	376.0	Humpback whitefish	4	300-316
			Least cisco	1	298
			Arctic grayling	100	77-407
			Alaska blackfish	1	54
			Ninespine stickleback	247	





Regions of lake M9910 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on August 3, 2004



Depth transects surveyed at lake M9910 on August 3, 2004



Depth contours of lake M0009, based on transects surveyed on August 2, 2004
(depth intervals in 1 foot increments)

Lake M0009

Other Names:

Location: 70.27871°N 151.83024°W

USGS Quad Sheet: Harrison Bay B-4: T11N R1E Sec. 26

Habitat: Tundra Lake

Area: 51 acres

Maximum Depth: 10.1 feet

Active Outlet: Yes

Calculated Volume: 52.1 million gallons

Permittable Volume: 0.54 million gallons

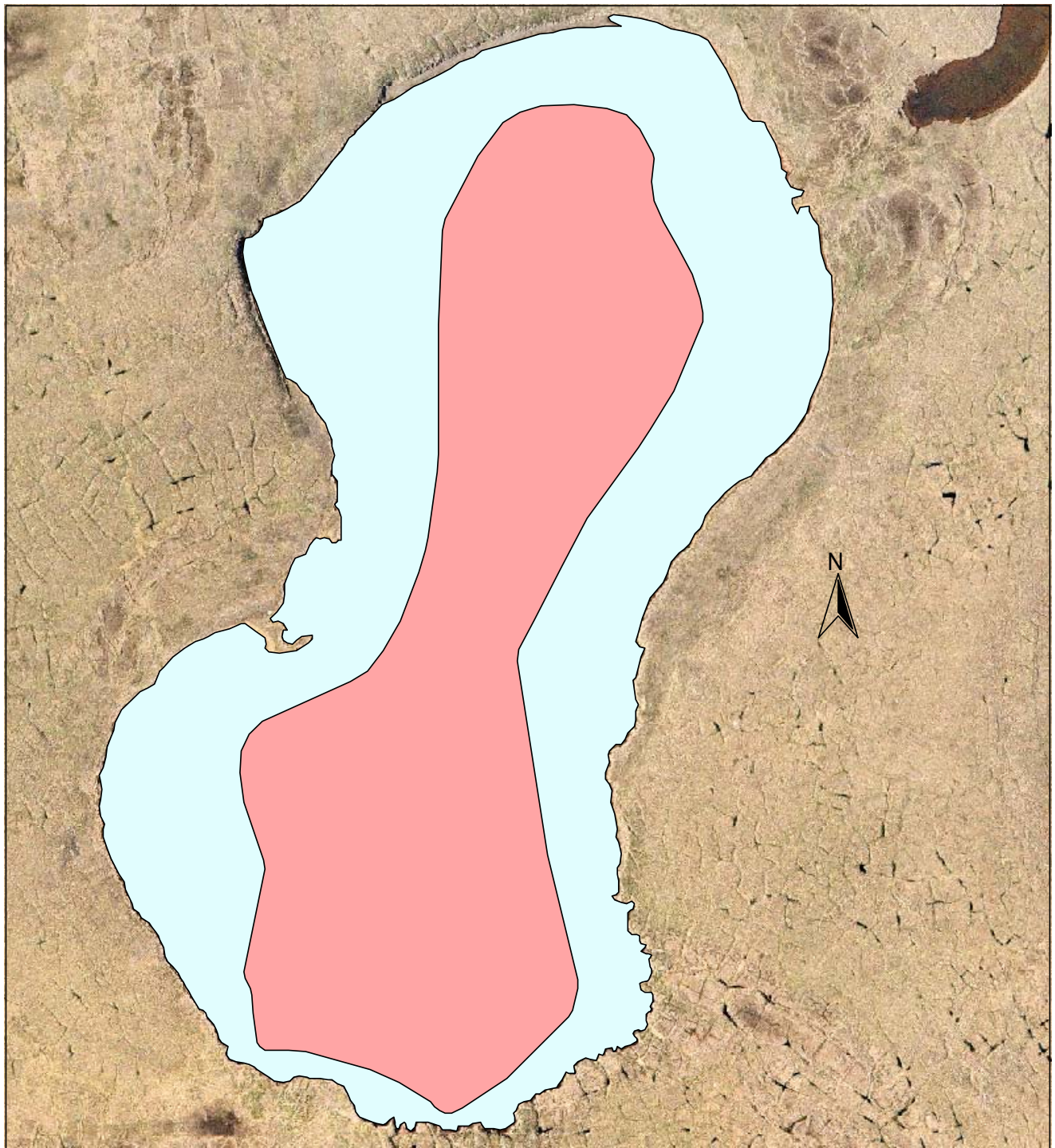
Potential Aggregate 27.4 acres (water depth 4 ft or less)

Water Quality:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2000	7.6	1.5	7.7	3.1	25				Moulton (02)
Jul 25 04						61	2.1	7.47	this study
Jul 26 04						61	1.6	7.26	this study
Jul 27 04						63	3.3	7.47	this study
Jul 28 04						63	2.2	7.53	this study
8/2/2004						65	1.8	7.39	this study

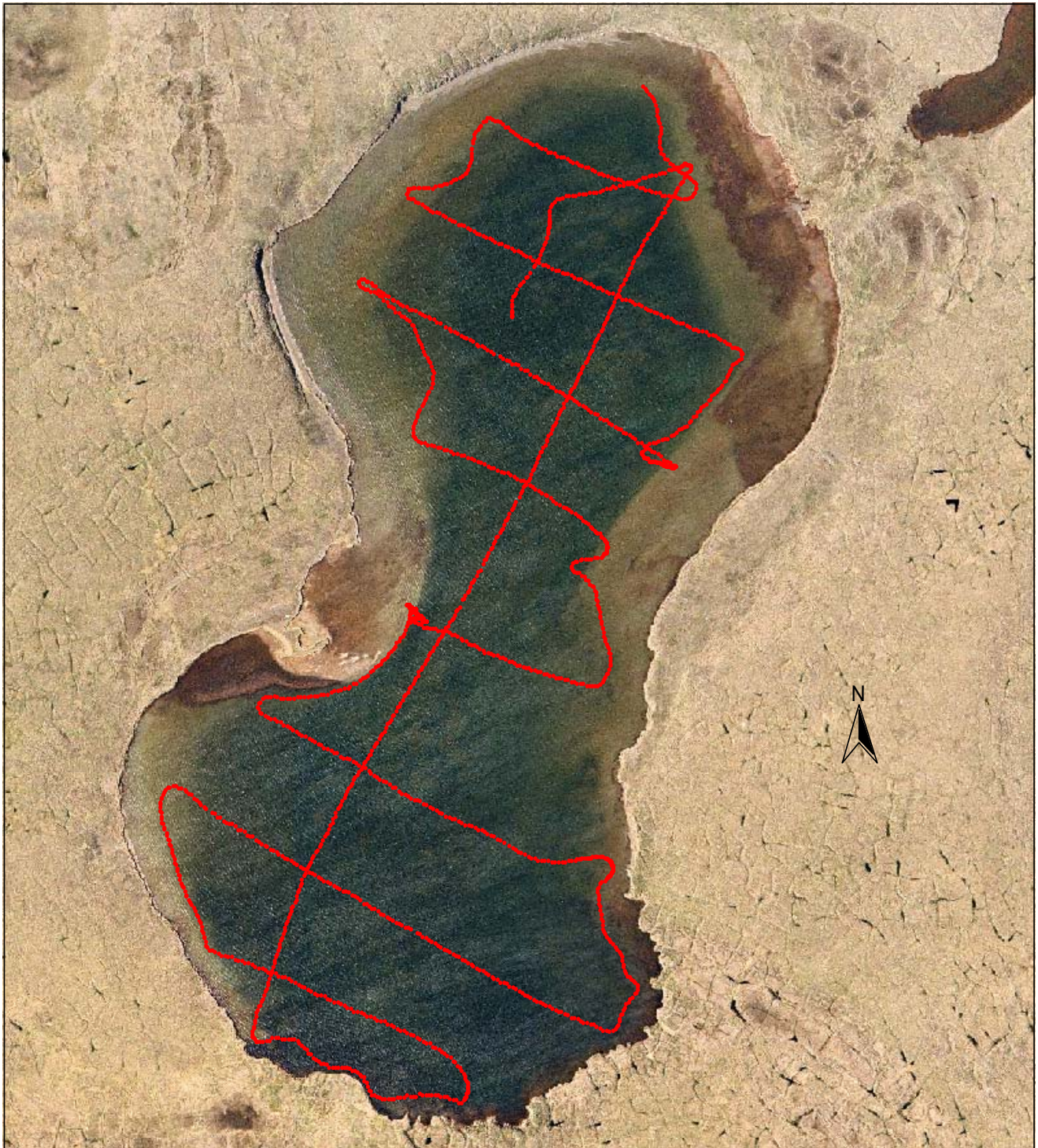
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 17 00	6.8	None	0
Fyke Net	Jul 26-28 04	71.3	Ninespine stickleback	95



500 0 500 1000 Feet

Regions of lake M0009 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on August 2, 2004



Depth transects surveyed at lake M0009 on August 2, 2004



1000 0 1000 2000 3000 Feet

Depth contours of lake M0020, based on transects surveyed on August 4, 2004
(depth intervals in 2 foot increments)

Lake M0020

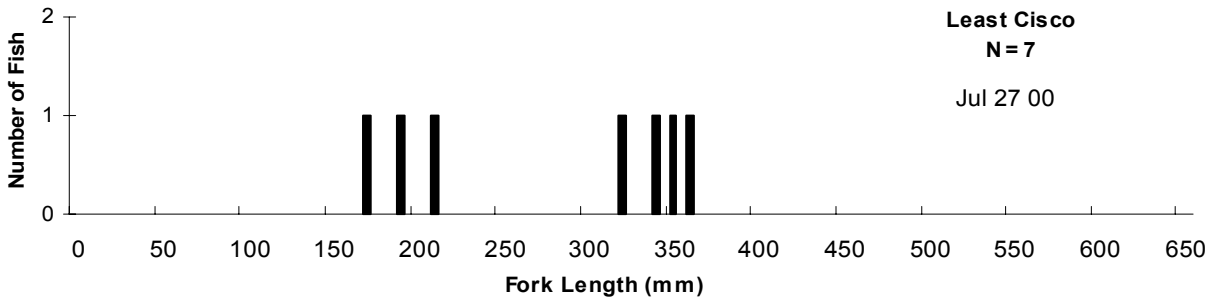
Other Names:
Location: 70.27144°N 151.72814°W
USGS Quad Sheet: Harrison Bay B-3: T11N R2E Sec. 30
Habitat: Oxbow Lake
Area: 120 acres
Maximum Depth: 18.5 feet
Active Outlet: No
Calculated Volume: 310.9 million gallons
Permittable Volume: 14.98 million gallons
Potential Aggregate: 31.7 acres (water depth 4 ft or less)

Water Quality:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2000	18.4	3.2	11.1	4.9	59				Moulton (02)

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught	Fork Length (mm)
Gill Net	Jul 27 00	1.8	Least cisco	7	173-369
Minnow Traps	Jul 27 00	1.9	None	0	





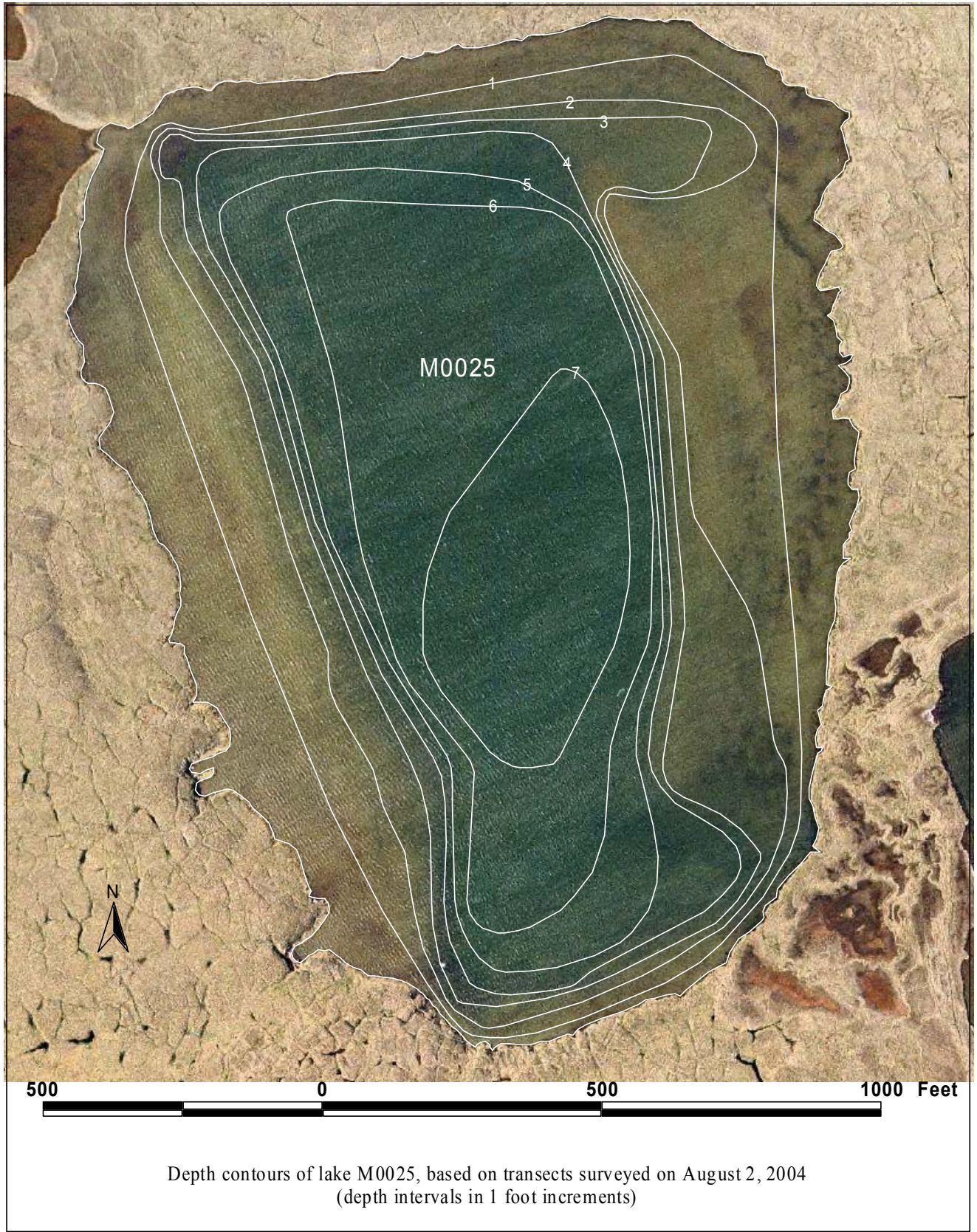
1000 0 1000 2000 3000 Feet

Regions of lake M0020 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on August 4, 2004



1000 0 1000 2000 3000 Feet

Depth transects surveyed at lake M0020 on August 4, 2004



Lake M0025

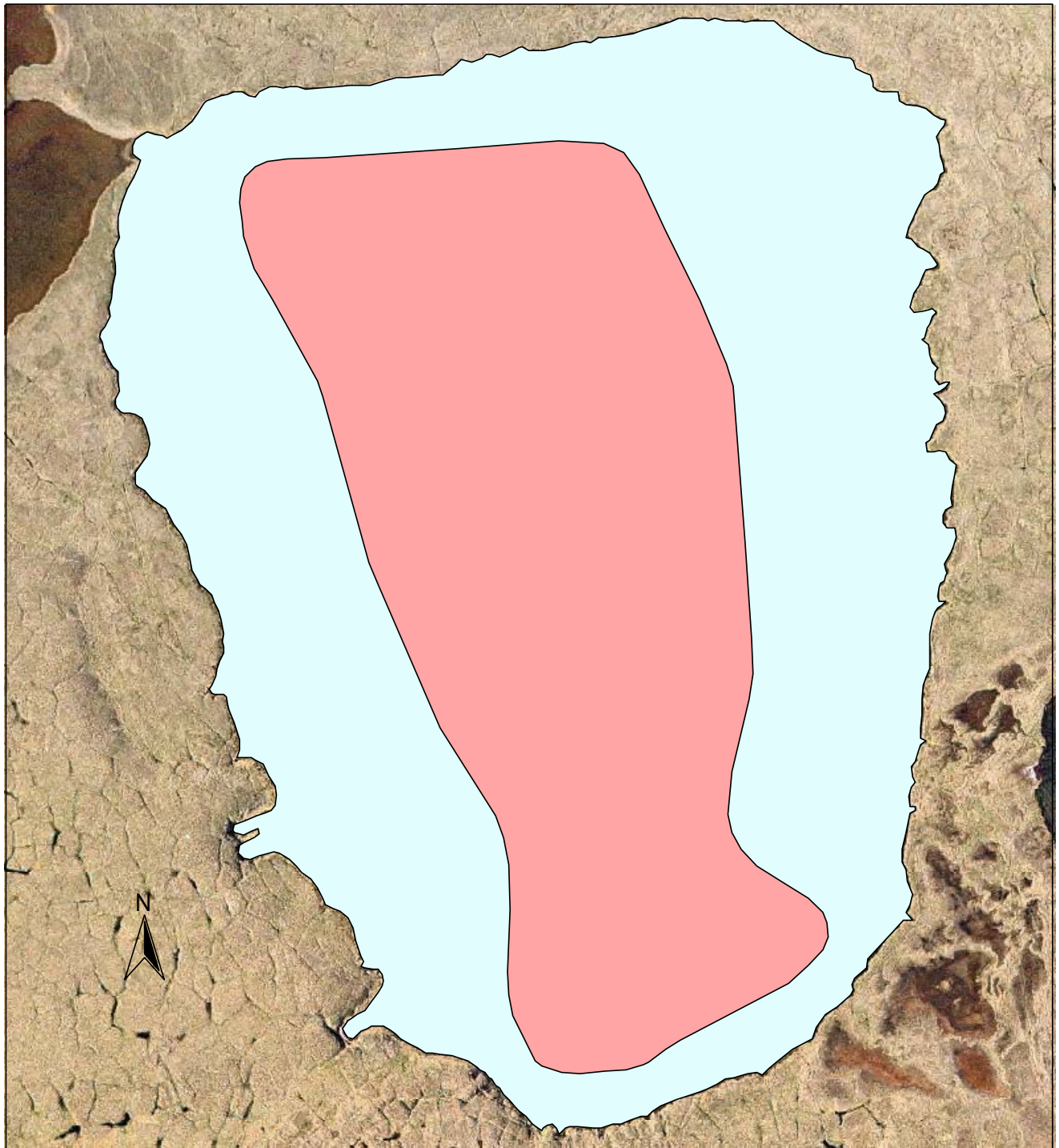
Other Names:
Location: 70.28070°N 151.79700°W
USGS Quad Sheet: Harrison Bay B-3: T11N R1E Sec. 26
Habitat: Tundra Lake
Area: 46 acres
Maximum Depth: 8.2 feet
Active Outlet: No
Calculated Volume: 53.3 million gallons
Permittable Volume: 2.40 million gallons
Potential Aggregate 26.1 acres (water depth 4 ft or less)

Water Quality:

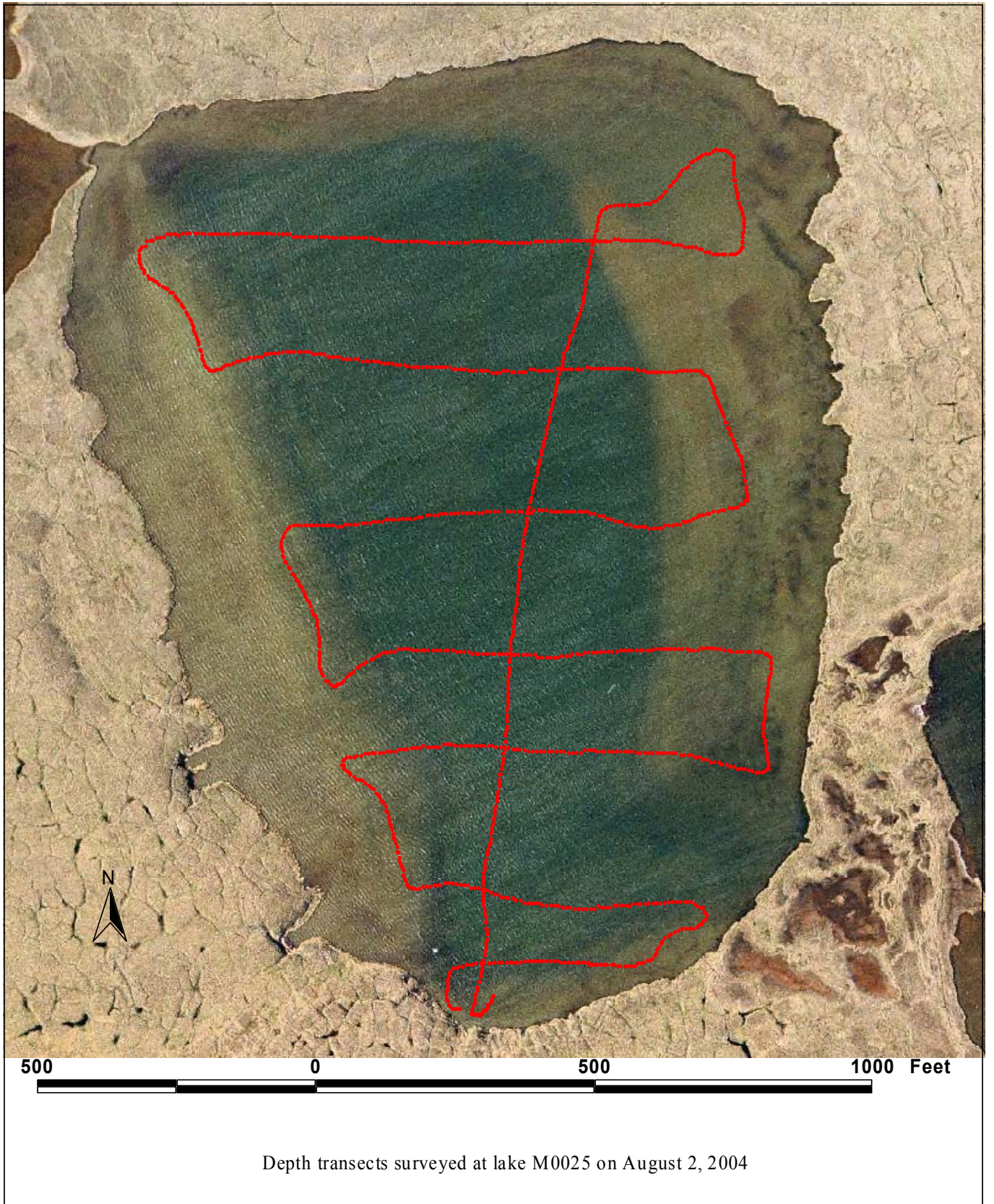
Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2000	10.5	2.6	10.7	4.9	37				Moulton (02)
Jul 23 04						82	2.1	7.73	this study
Jul 24 04						83	1.4	7.68	this study
Jul 25 04						83	1.5	7.60	this study
Jul 26 04						84	1.5	7.37	this study
Jul 27 04						84	1.3	7.56	this study
Aug 2 04						86	1.7	7.44	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 31 00	8.0	None	0
Minnow Traps	Jul 31 00	9.5	None	0
Fyke Net	Jul 24-27 04	92.1	Ninespine stickleback	2,143



Regions of lake M0025 less than 4 ft deep (light shaded), and likely to be available for ice chips, based on transects surveyed on August 2, 2004





Lake R0076

Other Names:
Location: 70.29379°N 151.83276°W
USGS Quad Sheet: Harrison Bay B-4: T11N R1E Sec. 22/23
Habitat: Tundra Lake
Area: 336 acres
Maximum Depth: 8.0 feet
Active Outlet: No
Calculated Volume: 404.1 million gallons
Permittable Volume: 17.67 million gallons
Potential Aggregate 182.5 acres (water depth 4 ft or less)

Water Quality:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Sodium (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2004	11.5	2.4	7.9	3.5	38	86.3	2.4	7.50	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Aug 4 04	6.4	None	0
Minnow trap	Aug 4 04	6.8	Ninespine stickleback	1

