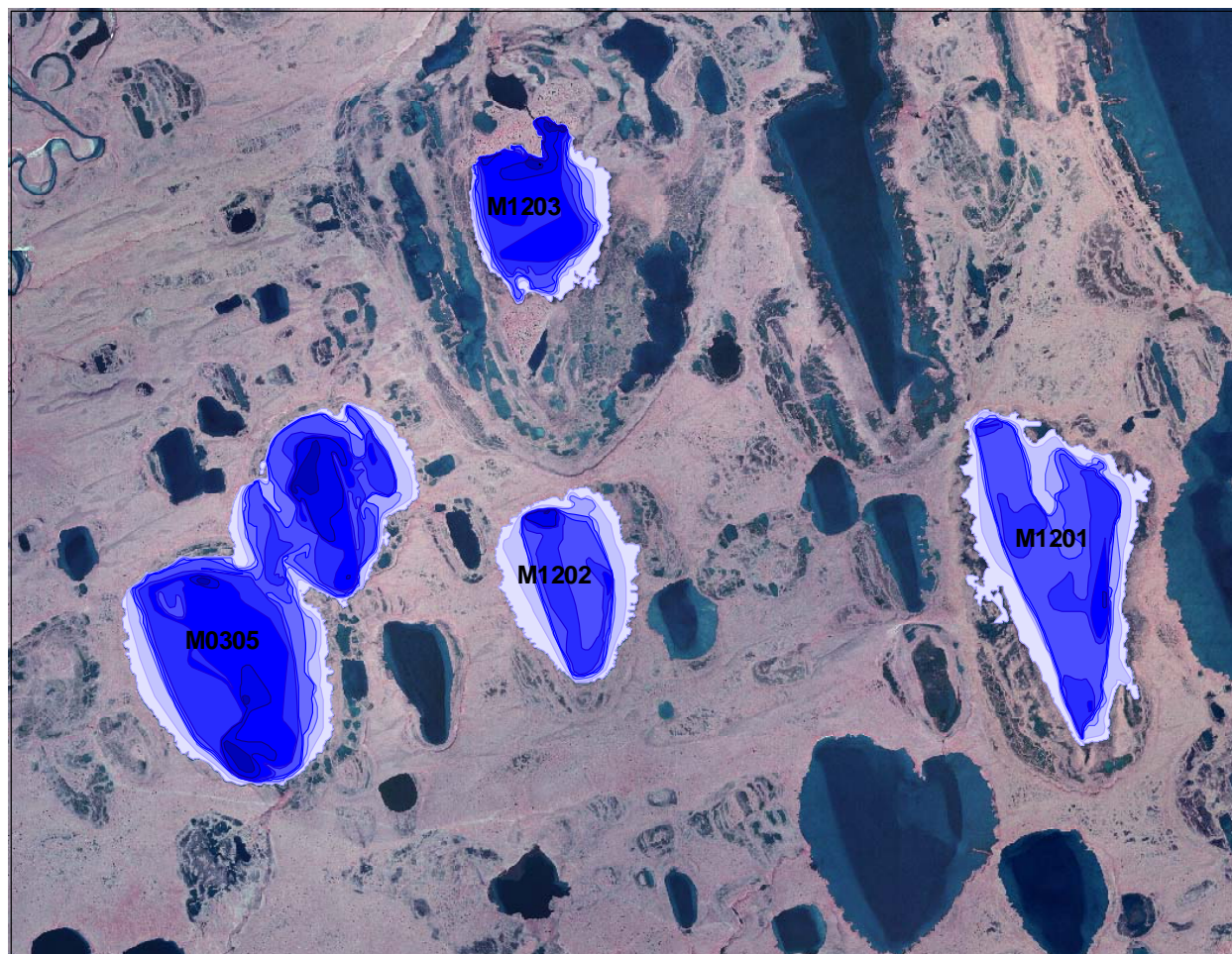


SURVEY OF LAKES IN THE CASSIN EXPLORATION AREA – 2012

Final Report

November 2012



Prepared by:

**MJM Research
1012 Shoreland Drive
Lopez Island, WA**

Prepared for:

**ConocoPhillips Alaska, Inc.
700 G Street
Anchorage, AK**

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INTRODUCTION

This 2012 lake survey sampled 4 lakes for potential use as water sources during winter exploration in the Cassin Exploration Area (Table 1). Goals of this study were to conduct surveys of selected lakes to estimate the volume of water available for use, and to document fish presence and habitat use in lakes that may be used to support exploration activities.

Objectives of the survey were to:

- 1) obtain lake bathymetry and estimate water volumes for selected lakes,
- 2) identify fish species present in selected lakes within the project study area, and
- 3) measure water chemistry parameters to assess suitability of water for potential uses.

The selected lakes may be used as sources of freshwater during oil exploration and development 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.

METHODS

The biological survey consisted of sampling with:

- gill nets for sensitive species,
- minnow traps,
- 20 ft beach seine, and
- visual survey for resistant species.

Lakes were sampled with short-duration gill net sets (typically 7 to 9 hours of total soak time). 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 North Slope for similar surveys. 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 placed in habitats expected to be used by fish for feeding or moving between feeding areas, and were pulled after fish were detected. 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 at the edge of surveyed lakes in areas expected to provide cover or feeding areas for ninespine stickleback. The traps were set and retrieved in concert with the gill net sampling.

At lakes where bottom contours allowed, a 20 ft beach seine was pulled through vegetation beds or detritus deposits along the lakeshore to detect small fishes.

When conditions were appropriate, a visual survey was conducted. Ninespine stickleback are often observed in shallow water along the lake shore. The length of the visual survey was measured with a handheld GPS. If stickleback were observed, minnow traps and seines were not used.

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 a Lamotte 2020 turbidity meter.

Bathymetric data were collected to allow estimating lake volume. 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 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 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. In 2007, Alaska Department of Natural Resources initiated a limit of 20% of the total lake volume if fish are not present. This amount may or may not be present at the time of withdrawal, depending on ice thickness at the time water is needed.

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.

RESULTS AND DISCUSSION

Biological Observations

Fish species considered to be sensitive to effects associated with water withdrawal were not caught in any of the 4 sampled lakes (Table 2). Ninespine stickleback were detected at all 4 lakes.

Water Chemistry Measurements

Water chemistry parameters measured in the studied lakes are presented Table 3. Surface water temperature during the July 11-13 sampling in 2012 averaged 15.4°C, ranging from 14.5°C to 16.0°C. Specific conductance ranged from 50 to 146 microSiemens/cm.

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.

Because all 4 lakes surveyed in the Cassin area during 2012 contained nines[pine sticklebacks, they should provide 74.285 million gallons of water for under-ice withdrawal during winter.

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). Based on the above analysis, the surveyed lakes may provide up to 639 acres of ice chips from lakes surveyed for the exploration use, depending on the thickness of ice at the time of need. This area is equivalent to 189.7 million gallons of water in the top 1 foot of ice.

LITERATURE CITED

- Armstrong, R.H. 1994. Alaska blackfish. ADF&G's Wildlife Notebook Series. Alaska Dept. Fish and Game. Juneau, AK.
- Lewis, D.B., M. Walkey, and H.J.G. Dartnall. 1972. Some effects of low oxygen tensions on the distribution of the three-spined stickleback *Gasterosteus aculeatus* L. and the nine-spined stickleback *Pungitius pungitius* (L). J. Fish. Biol. 4: 103-108.

Table 1. Summary of lakes sampled during 2012 to support support activities in the Cassin Exploration Area.

Lake Name	Latitude (NAD83)	Longitude	Umiat Meridian			Surface Area (acres)	Max. Depth (feet)	Lake Volume (mill. gals)
			Town	Range	Section			
M1201	N70.29292	W152.04280	11N	1W	13/14/23/24/25	452.4	7.2	483.45
M1202	N70.29133	W152.13297	11N	1W	21/22	235.5	8.1	239.53
M1203	N70.31484	W152.13875	11N	1W	9/10/15/16	218.3	9.0	328.22
M0305	N70.29663	W152.17797	11N	1W	16/17/20/21/29	740.3	9.1	1,111.38

Table 2. Catches of fish from lakes sampled during 2012 to support activities in the Cassin Exploration Area.

Lake Name	Sample Date	Gill Nets		Minnow Traps		Seine		Visual Survey	
		Set Duration (hours)	Fish Species ¹	Set Duration (hours)	Fish Species ¹	Effort (hauls)	Fish Species ¹	Distance (yards)	Fish Species ¹
M1201	Jul 11 12	12.4	None	20.7	1 NSSB	3	None	0	--
M1202	Jul 12 12	6.1	None	8.1	None	0	--	253	10 NSSB
M1203	Jul 13 12	7.6	None	0.0	--	0	--	1	52 NSSB
M0305	Jul 03 03	6.0	None	6.0	3 NSSB	0	--	0.0	--
	Jul 12 12	10.0	None	0.0	--	0	--	5	25 NSSB

¹ NSSB = ninespine stickleback

Table 3. Water chemistry parameters measured in conjunction with lake sampling during 2011 to support activities in the Cassin Exploration Area.

Lake	Date	Water Temp (°C)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Total Hardness [CaCO₃] (mg/l)
M1201	Jul 11 12	14.5	105	0.0	7.40	11.0	2.6	5.7	13.0	39.0
M1202	Jul 12 12	15.6	129	0.0	7.82	16.0	3.0	5.7	14.0	54.0
M1203	Jul 13 12	16.0	50	0.2	7.30	5.3	1.0	3.0	5.2	17.0
M0305	Jul 03 03	13.9	141	3.4	7.95	18.0	2.8	6.4	15.0	56.0
	Jul 12 12	15.6	146	0.0	7.99	18.0	2.8	7.3	16.0	58.0

Table 4. Recommended maximum water volumes available for under-ice withdrawal from surveyed lakes during 2012 to support activities in the Cassin Exploration Area.

(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 fish are likely to be present, 20% of total lake volume when no fish are present)

Lake	Surface Area (acres)	Max. Depth (feet)	Calculated Volume (mill. gals)	20% of Total Lake Volume (mill. gals)	30% of Water Under 5 ft of Ice (mill. gals)	15% of Water Under 7 ft of Ice (mill. gals)	Sensitive Fish Species Present	Resistant Fish Species Present¹	Recommended Maximum Under-Ice Withdrawal (mill. gals)
M1201	452.4	7.2	483.45	96.69	5.028	0.011	none	NSSB	5.028
M1202	235.5	8.1	239.53	47.91	3.41	0.088	none	NSSB	3.411
M1203	218.3	9.0	328.22	65.64	16.490	0.478	none	NSSB	16.490
M0305	740.3	9.1	1,111.38	222.28	49.357	2.345	none	NSSB	49.357

¹ NSSB = ninespine stickleback

Table 5. Estimated area available for removing ice aggregate, based on the area covered by water shallower than 4 feet, to support activities in the Cassin Exploration Area.

(ice thickness is typically 4 ft by early January)

Lake	Surface Area (acres)	Max. Depth (feet)	Acres covered by Water shallower than 4 feet	Gallons of Water As Chips (mill. gals)
M1201	452.4	7.2	210.8	62.53
M1202	235.5	8.1	119.2	35.36
M1203	218.3	9.0	71.4	21.17
M0305	740.3	9.1	238.1	70.60

(gallons of water available as chips is the water content of the top 1 ft of ice)

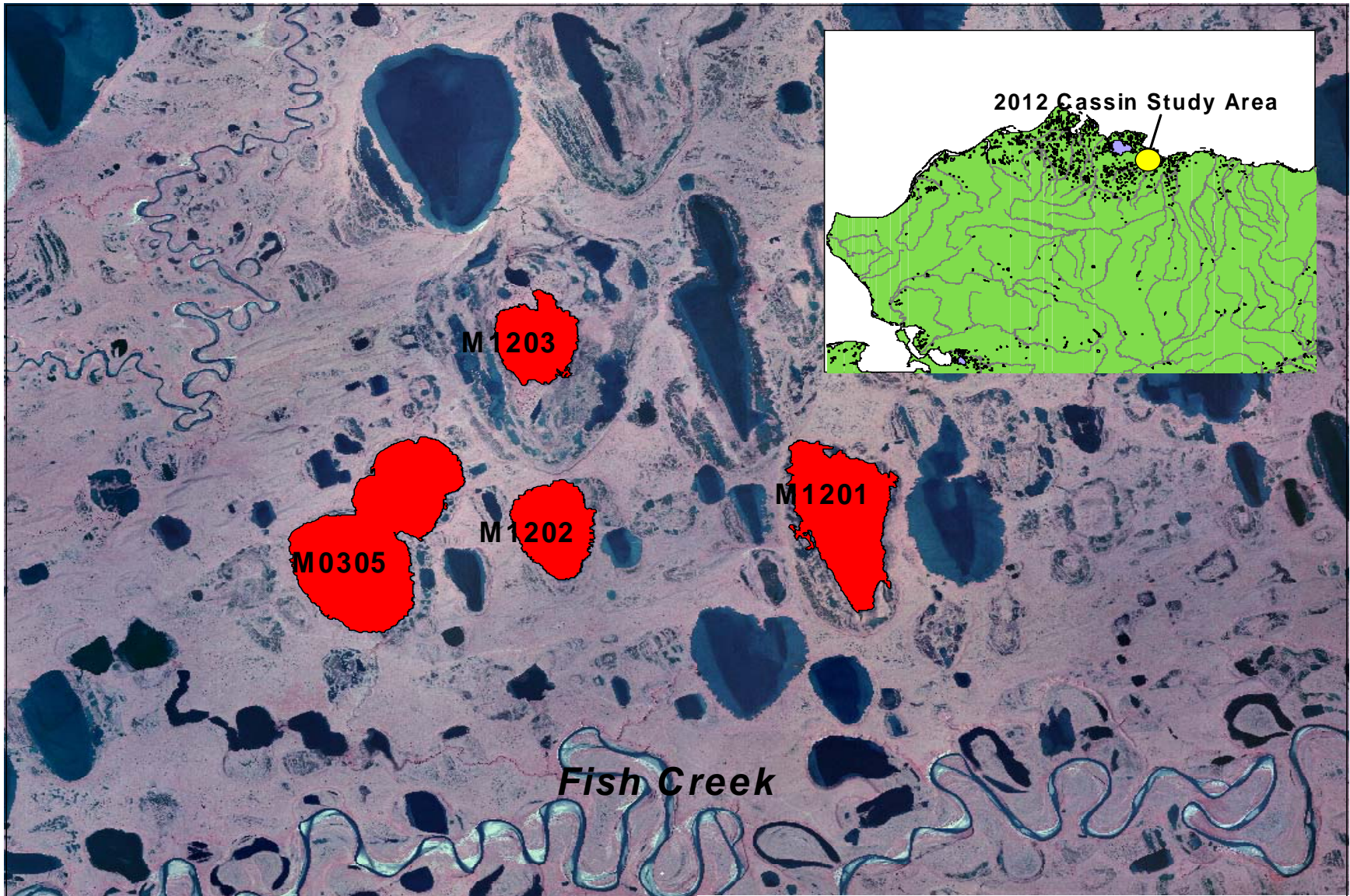
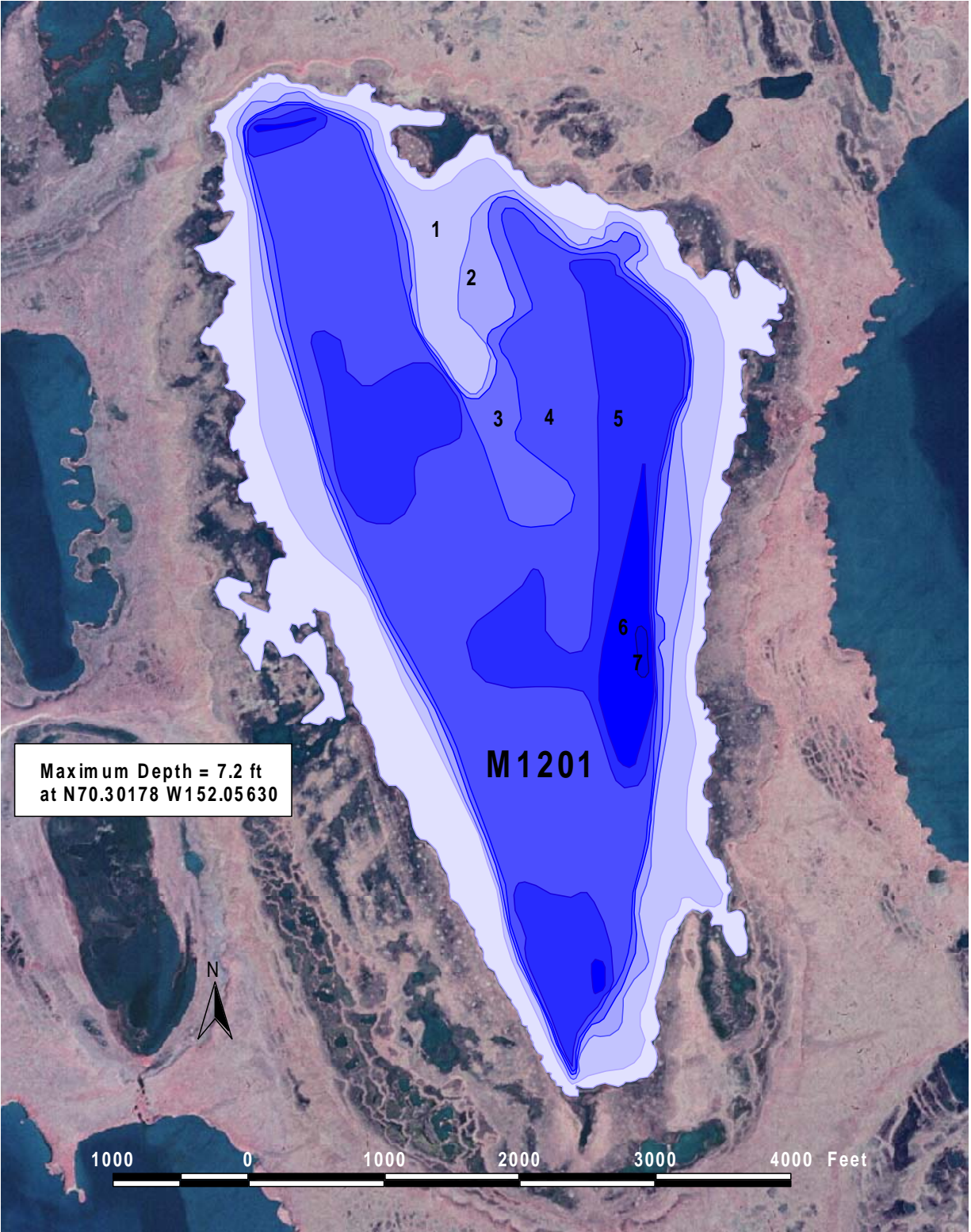


Figure 1. Lakes surveyed in 2012 as potential water sources to support exploration in the Cassin Exploration Area.

Lake Summaries



Depth contours at Lake M1201 based on transects surveyed on July 11, 2012.
(depth in 1 foot intervals)

Lake M1201

Other Names: None Known
Location: 70.29292°N 152.0428°W
USGS Quad Sheet: Harrison Bay B-4: T11N R1W, Sections 13/14/23/24/25
Habitat: Tundra Lake
Area: 452 acres
Maximum Depth: 7.2 feet
Active Outlet: No
Total Lake Volume: 483.45 million gallons (Jul 11 2012 data)
Water Volume Under 4 ft of ice: 68.68 million gallons
Water Volume Under 5 ft of ice: 16.76 million gallons
Water Volume Under 7 ft of ice: 0.07 million gallons

Potential Ice Aggregate: 210.85 acres (water depth 4 ft or less)
62.53 million gallons

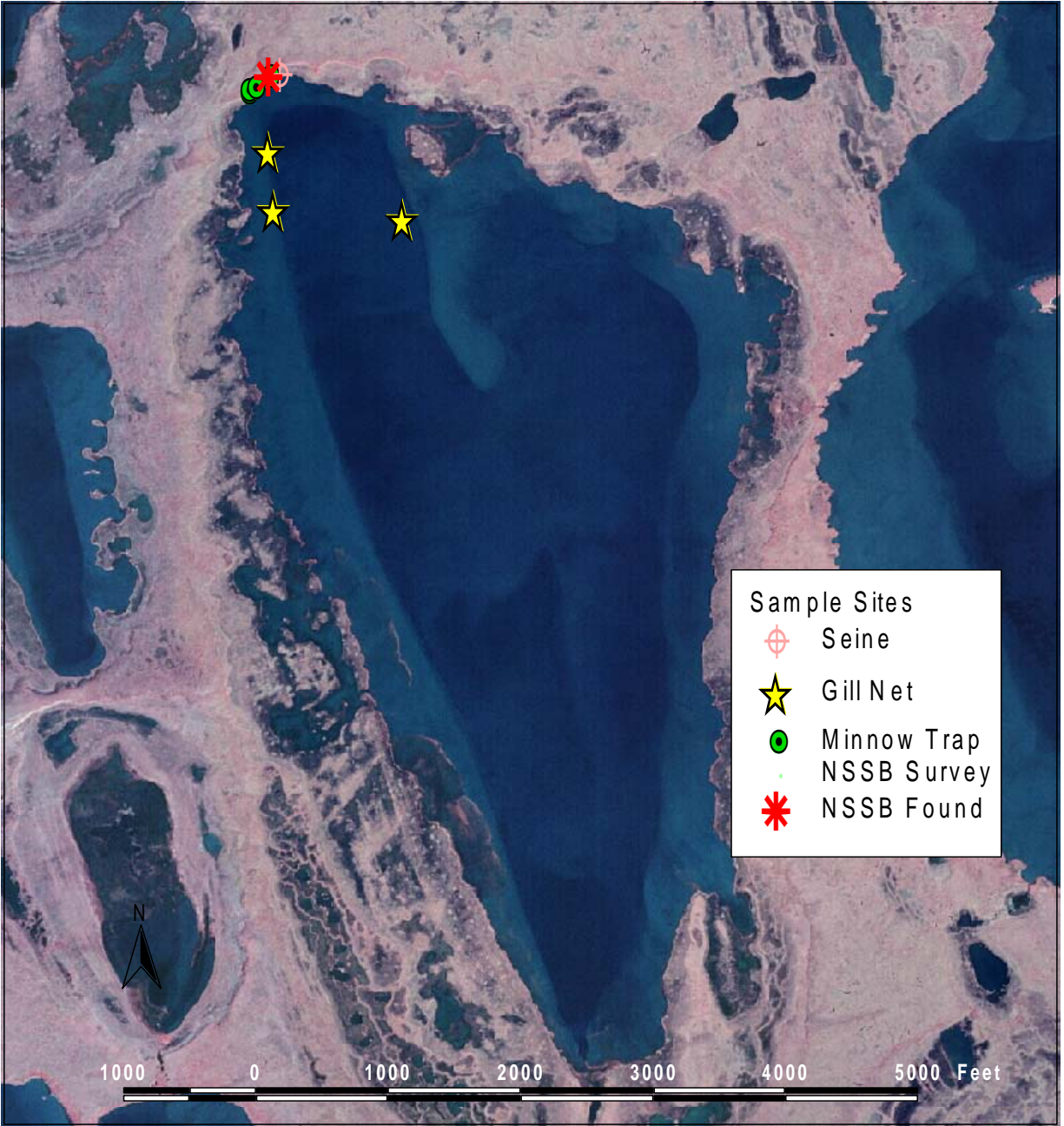
Maximum Recommended Winter Removal: **5.028 million gallons**
(30% of water volume under 5 ft of ice)

Water Chemistry:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2012	11.0	2.6	5.7	13.0	39	105	0.0	7.40	L. Moulton

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 11 12	12.4	none	0
Minnow trap	Jul 11 12	20.7	Ninespine stickleback	1
Seine	Jul 11 12	3 hauls	none	0



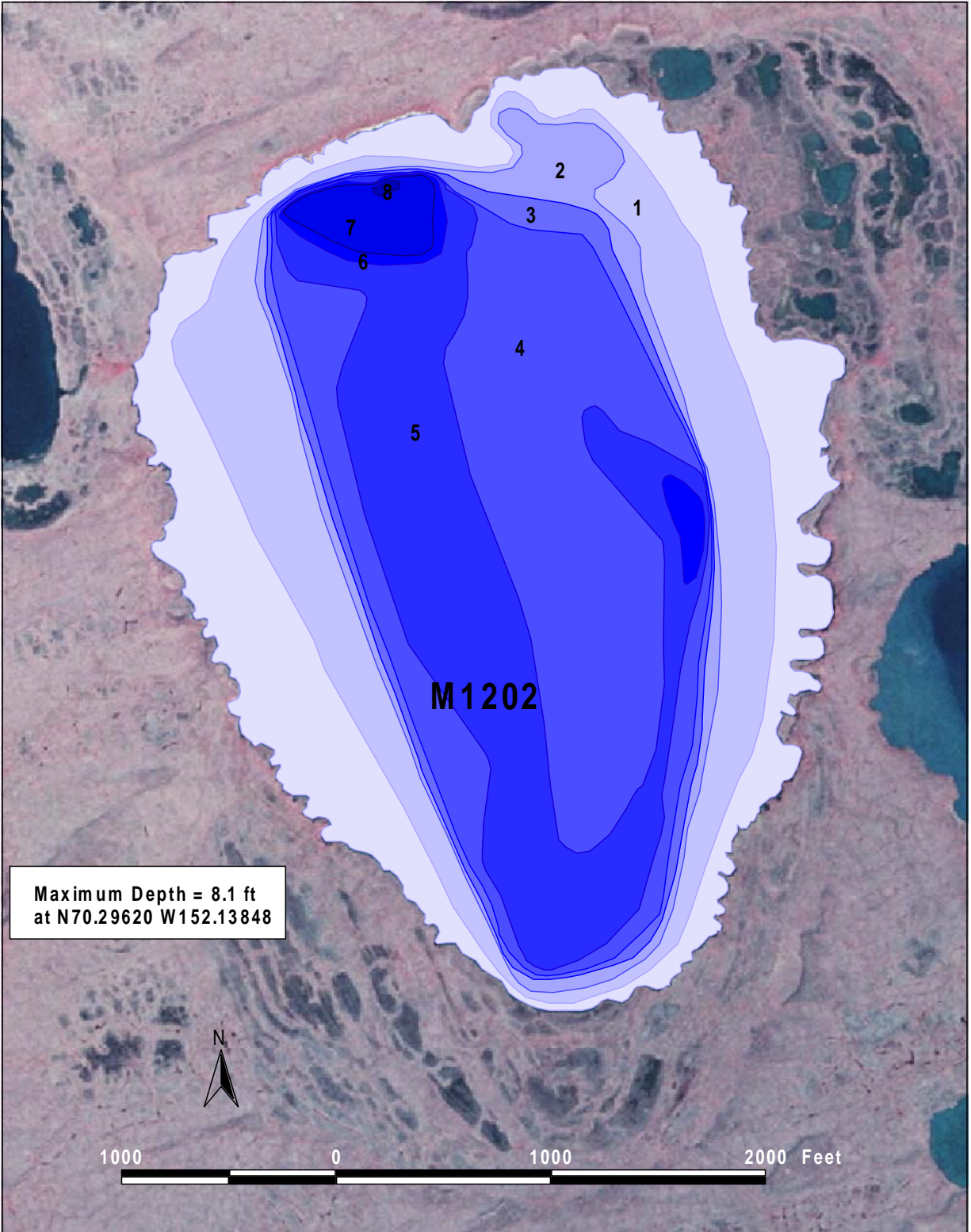
Location of fish sample sites at Lake M1201 on July 11, 2012.
(NSSB = ninespine stickleback)



Regions of Lake M1201 less than 4 feet deep (light blue) and likely to be available for ice chips, based on transects surveyed on July 11, 2012.



Depth transects surveyed at Lake M1201 on July 11, 2012.



Depth contours at Lake M1202 based on transects surveyed on July 12, 2012.
(depth in 1 foot intervals)

Lake M1202

Other Names: None Known
Location: 70.29133°N 152.132970°W
USGS Quad Sheet: Harrison Bay B-4: T11N R1W, Section 21/22
Habitat: Tundra Lake
Area: 236 acres
Maximum Depth: 8.1 feet
Active Outlet: No
Total Lake Volume: 239.53 million gallons (Jul 12 2012 data)
Water Volume Under 4 ft of ice: 38.71 million gallons
Water Volume Under 5 ft of ice: 11.37 million gallons
Water Volume Under 7 ft of ice: 0.59 million gallons

Potential Ice Aggregate: 119.24 acres (water depth 4 ft or less)
35.36 million gallons

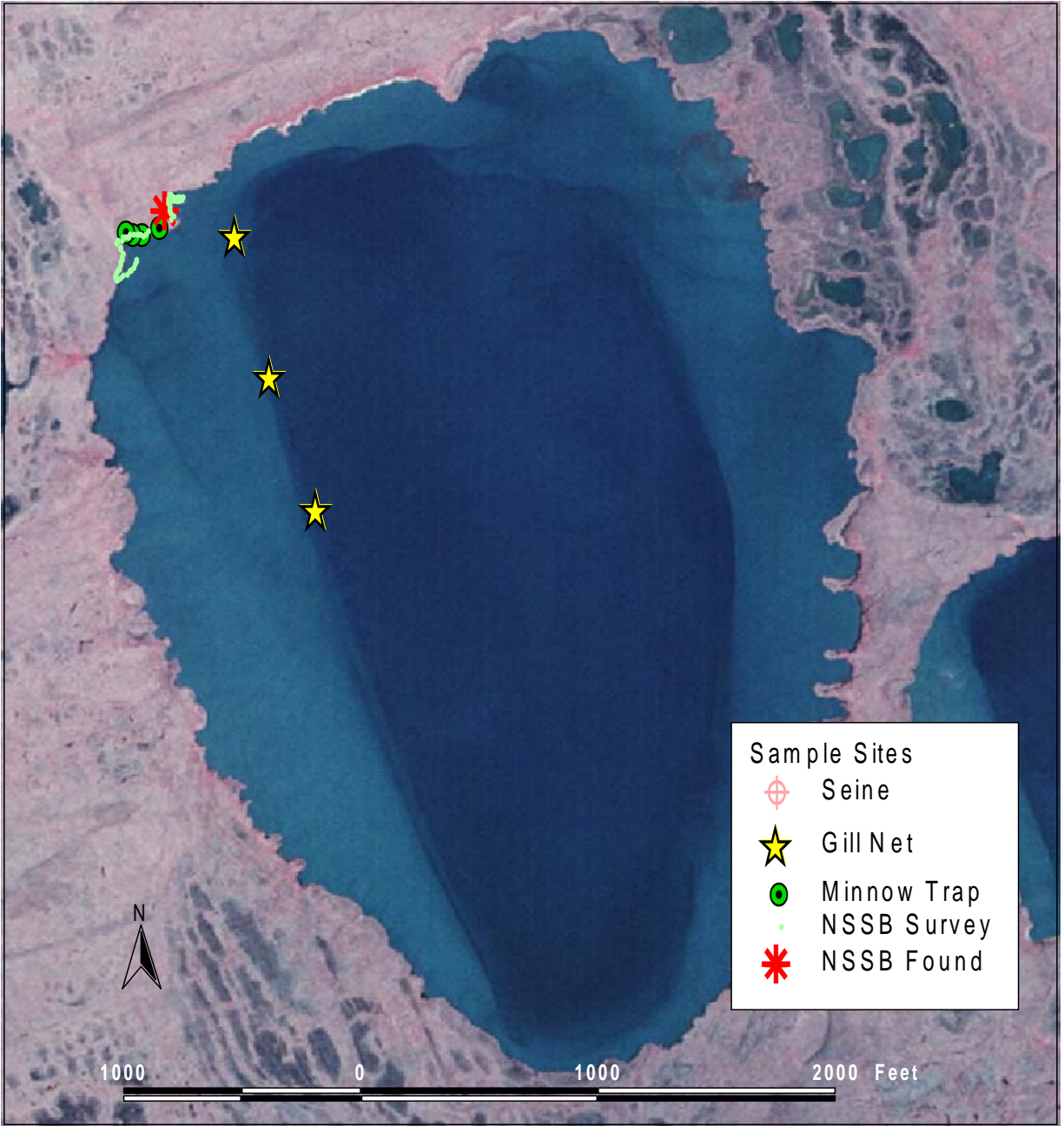
Maximum Recommended Winter Removal: **3.411 million gallons**
(30% of water volume under 5 ft of ice)

Water Chemistry:

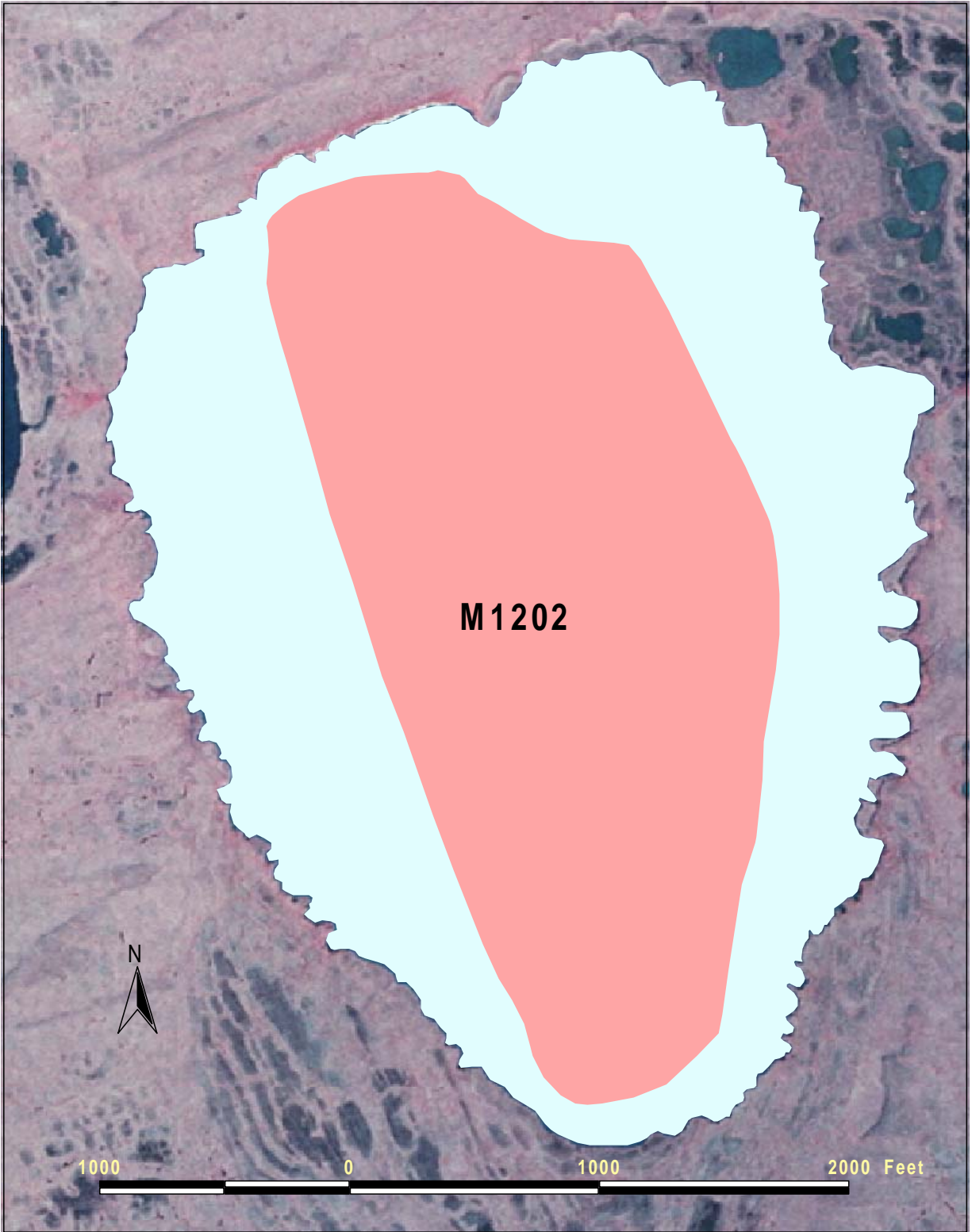
Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2012	16.0	3.0	5.7	14.0	54	129	0.0	7.82	L. Moulton

Catch Record:

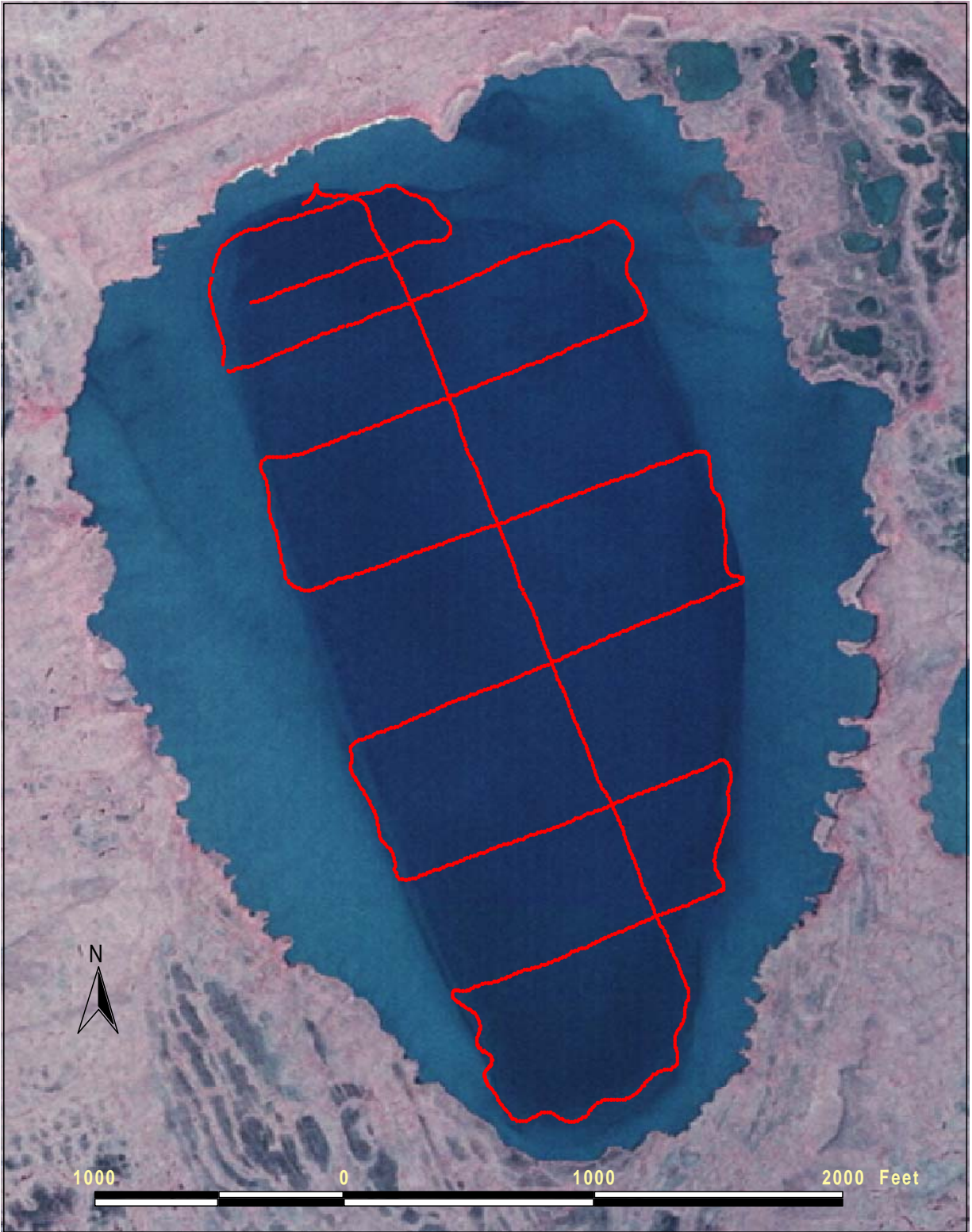
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 12 12	6.1	none	0
Minnow trap	Jul 12 12	8.1	none	0
Visual Survey	Jul 12 12	253 yds	Ninespine stickleback	10



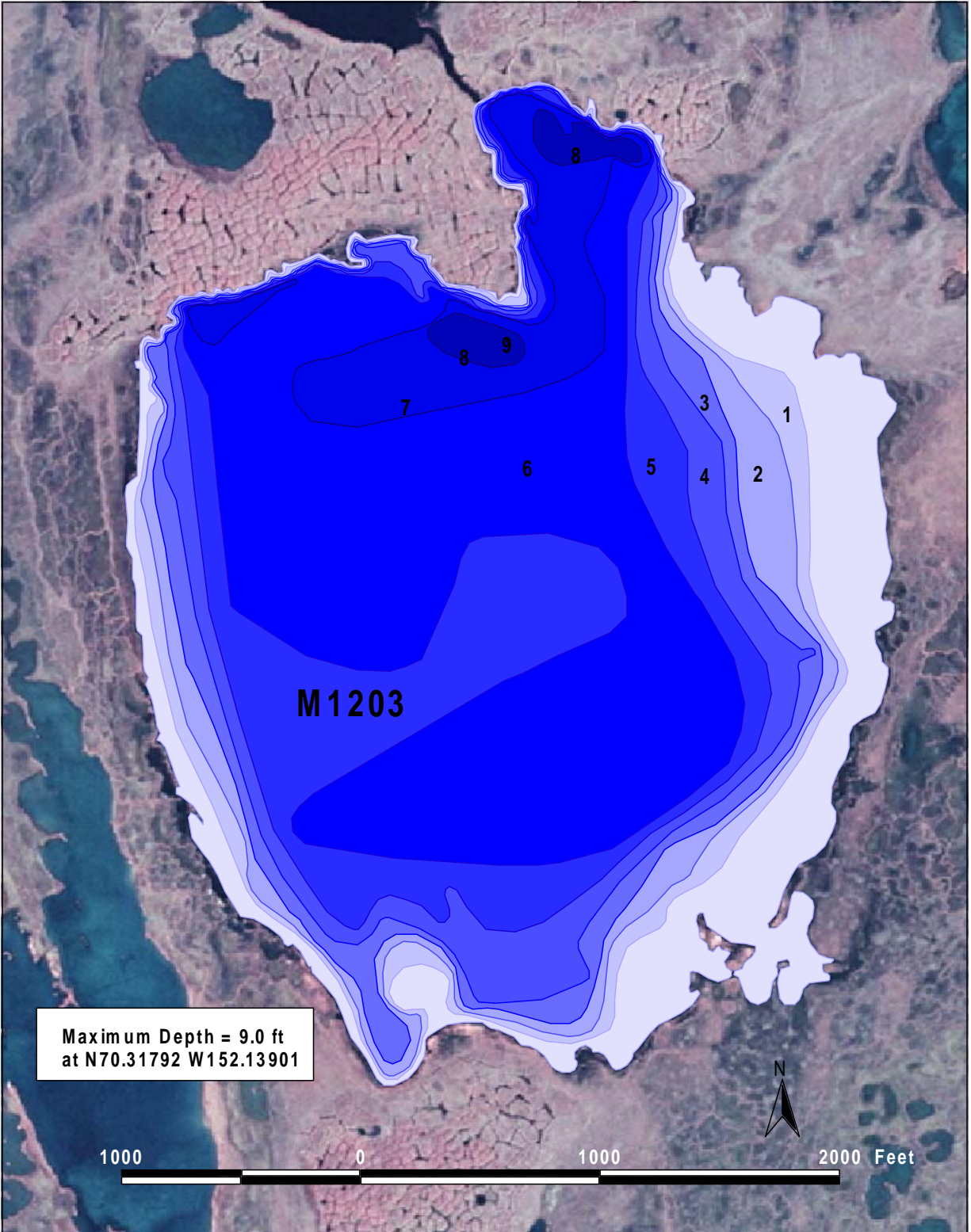
Location of fish sample sites at Lake M1202 on July 12, 2012.
 (NSSB = ninespine stickleback)



Regions of Lake M1202 less than 4 feet deep (light blue) and likely to be available for ice chips, based on transects surveyed on July 12, 2012.



Depth transects surveyed at Lake M1202 on July 12, 2012.



Depth contours at Lake M1203 based on transects surveyed on July 13, 2012.
(depth in 1 foot intervals)

Lake M1203

Other Names: None Known
Location: 70.31484°N 152.13875°W
USGS Quad Sheet: Harrison Bay B-4: T11N R1W, Sections 9/10/15/16
Habitat: Drainage Lake (?)
Area: 218 acres
Maximum Depth: 9.0 feet
Active Outlet: Yes? - appears to be a relict drainage channel
Total Lake Volume: 328.22 million gallons (Jul 13 2012 data)
Water Volume Under 4 ft of ice: 99.86 million gallons
Water Volume Under 5 ft of ice: 54.97 million gallons
Water Volume Under 7 ft of ice: 3.19 million gallons

Potential Ice Aggregate: 71.39 acres (water depth 4 ft or less)
21.17 million gallons

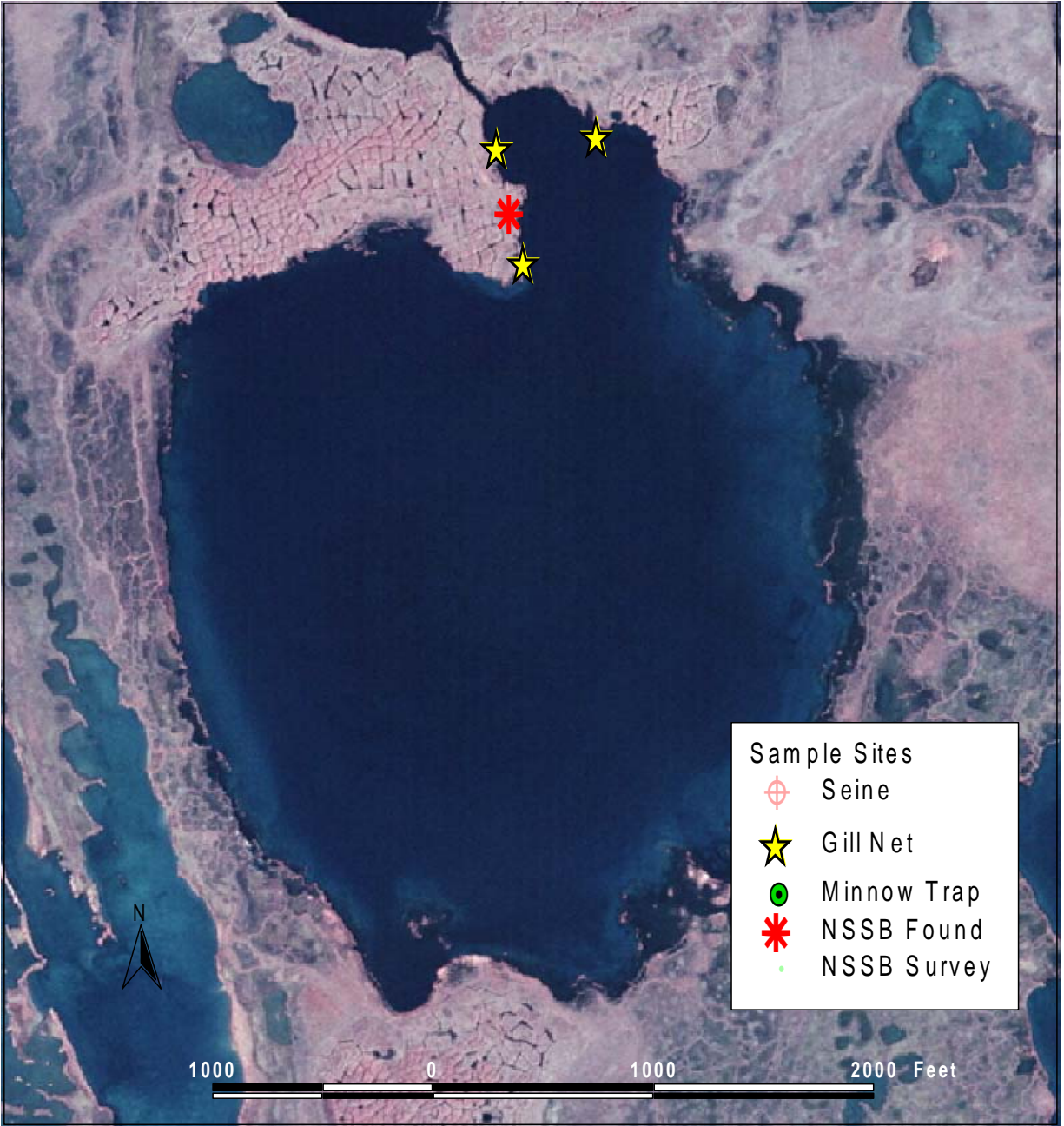
Maximum Recommended Winter Removal: **16.49 million gallons**
(30% of water volume under 5 ft of ice)

Water Chemistry:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Total Hardness [CaCO ₃] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2012	5.3	1.0	3.0	5.2	17.0	50	0.2	7.30	L. Moulton

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 13 12	7.6	none	0
Visual Survey	Jul 13 12	1 yd	Ninespine stickleback	52



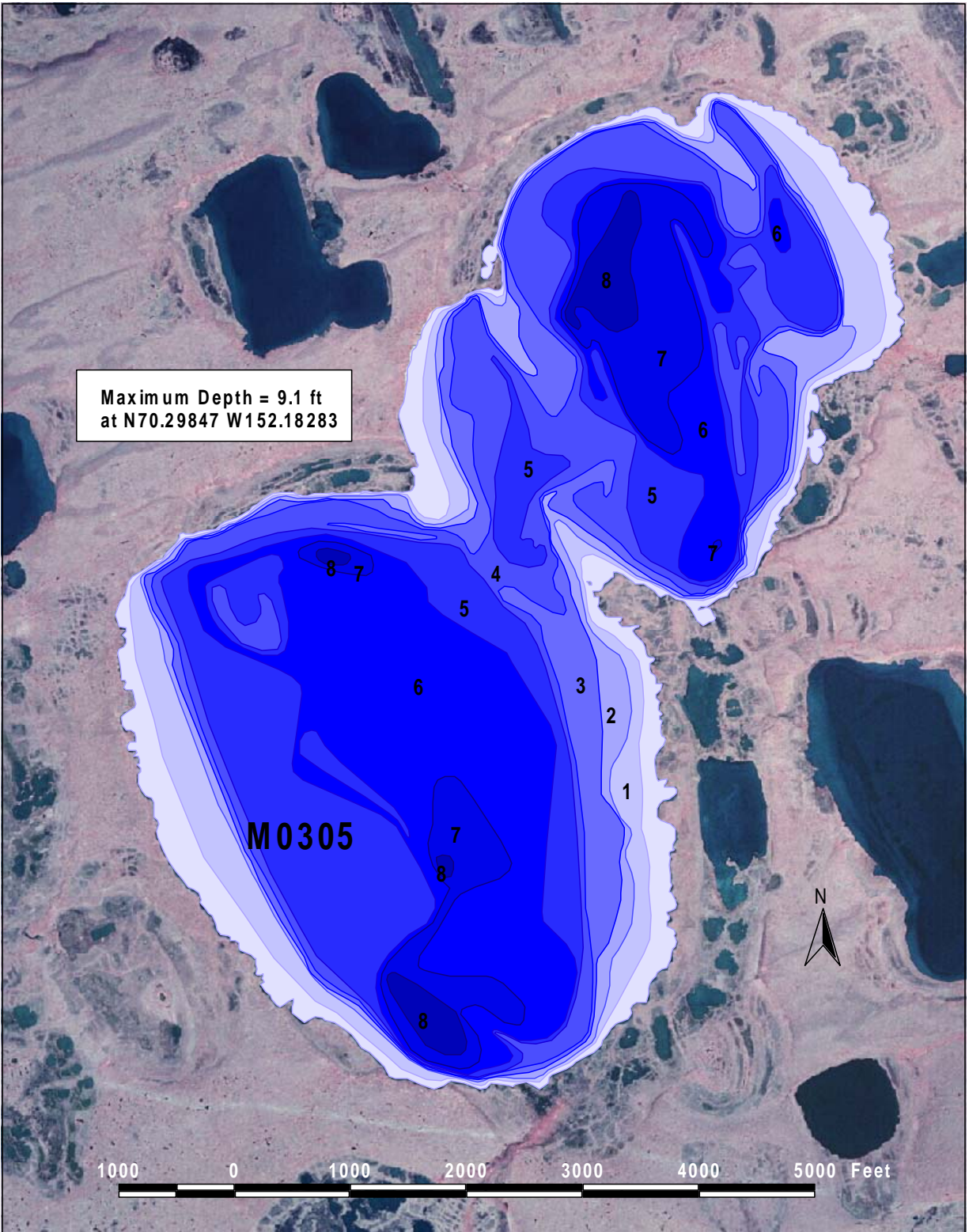
Location of fish sample sites at Lake M1203 on July 13, 2012.
(NSSB = ninespine stickleback)



Regions of Lake M1203 less than 4 feet deep (light blue) and likely to be available for ice chips, based on transects surveyed on July 13, 2012.



Depth transects surveyed at Lake M1203 on July 13, 2012.



Depth contours at Lake M0305 based on transects surveyed on July 24, 2003 and July 13, 2012.
(depth in 1 foot intervals)

Lake M0305

Other Names: None Known
Location: 70.28695°N 152.19686°W
USGS Quad Sheet: Harrison Bay B-4: T11N R1W Sec. 16/17/20/21/29
Habitat: Tundra Lake
Area: 740 acres
Maximum Depth: 9.1 feet
Active Outlet: No
Total Lake Volume: 1,111.38 million gallons (July 24, 2003 and
Water Volume Under 4 ft of ice: 310.27 million gallons July 12, 2012 data)
Water Volume Under 5 ft of ice: 164.52 million gallons
Water Volume Under 7 ft of ice: 15.64 million gallons

Potential Aggregate: 238.1 acres (water depth 4 ft or less)
 18.63 million gallons

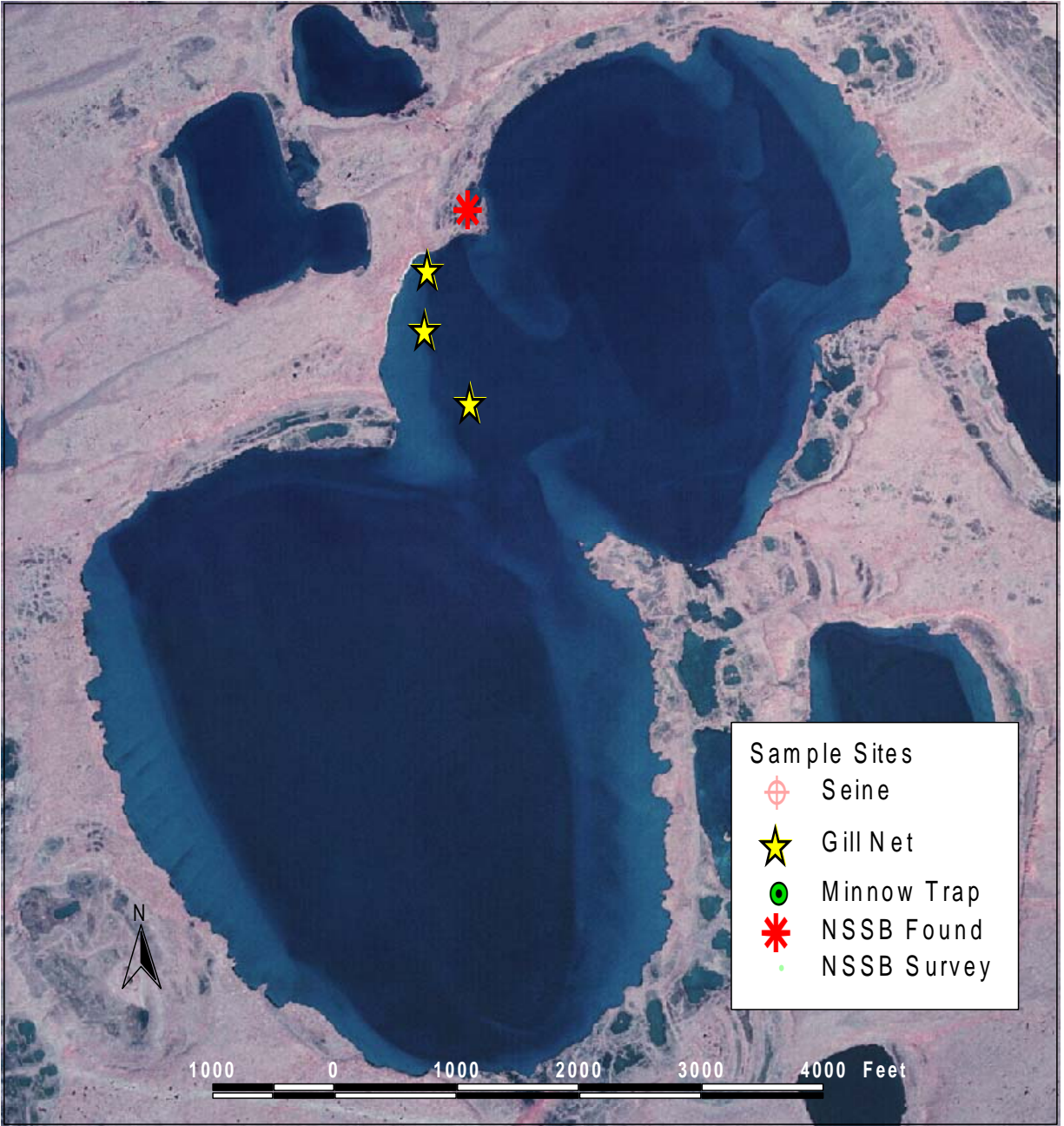
Maximum Recommended Winter Removal: **49.36 million gallons**
 (30% of volume under 5 feet of ice)
 (does not include volume associated with ice aggregate)

Water Chemistry:

Year of Test	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Total Hardness [CaCO3] (mg/l)	Specific Conductance (microS/cm)	Turbidity (NTU)	pH	Source
2003	18.0	2.8	6.4	15	56	141	3.4	7.95	L. Moulton
2012	18.0	2.8	7.3	16	58	146	0.0	7.99	L. Moulton

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 24 03	6.0	None	0
	Jul 12 1	10	No	0
Minnow Trap	Jul 24 03	6.0	Ninespine stickleback	3
Visual Survey	Jul 12 12	5 yds	Ninespine sticklebac	5



Location of fish sample sites at Lake M0305 on July 12, 2012.
(NSSB = ninespine stickleback)



Regions of Lake M0305 less than 4 feet deep (light blue) and likely to be available for ice chips, based on transects surveyed on July 24, 2003 and July 12, 2012.



Depth transects surveyed at Lake M0305 on July 24, 2003 (green) and July 12, 2012 (red).