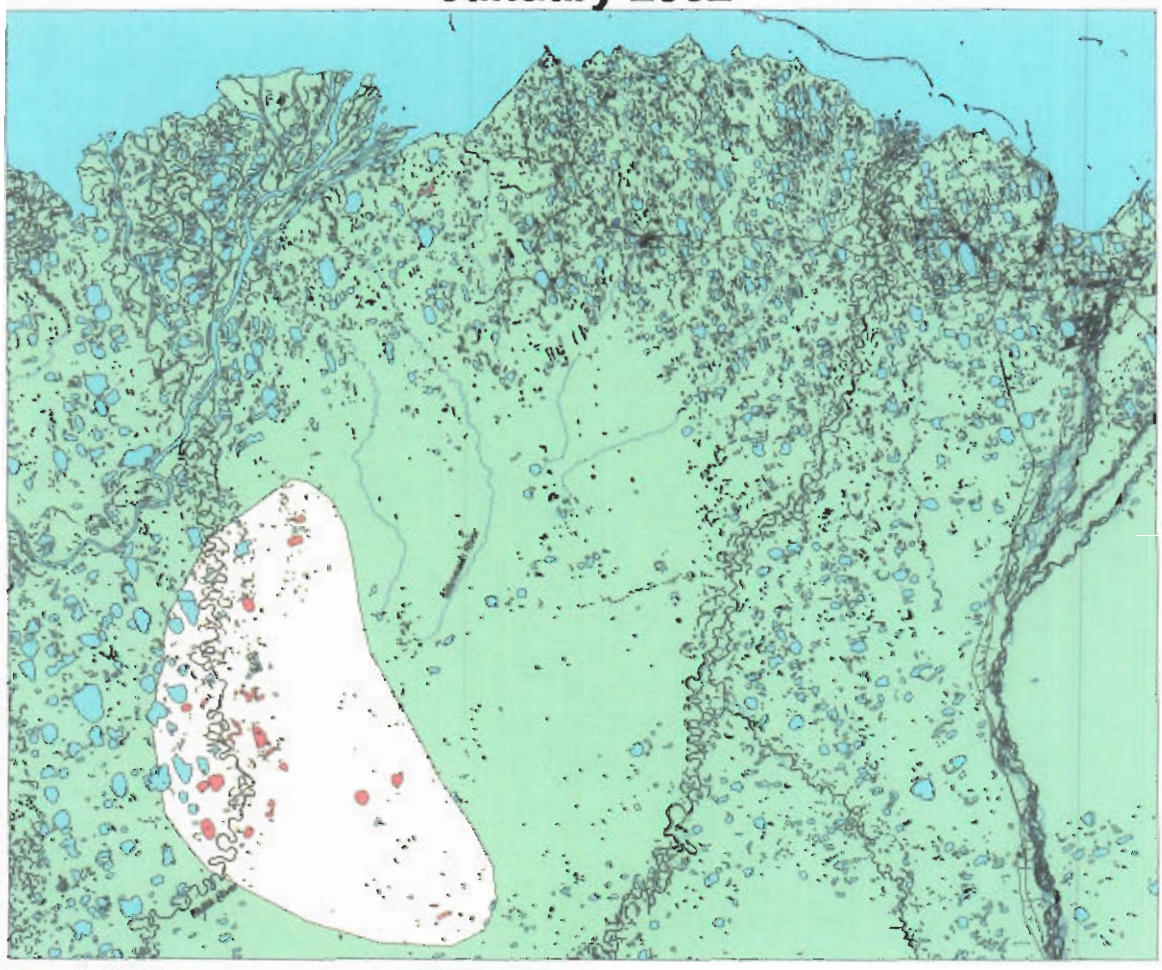
EVALUATION OF POTENTIAL FISH HABITAT IN LAKES IN THE GRIZZLY/HEAVENLY/SUPERCUB REGION - 2001

Final Data Report

January 2002



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INTRODUCTION

Phillips Alaska Inc. is interested in exploring for oil and gas in several prospects south of the Kuparuk Field and east of the Itkillik River. 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.

The objectives of the study are to document fish presence and habitat use in the prospect areas known as Grizzly, Heavenly and Supercub. Selected lakes include those that may be used to support exploration. The area surveyed during 2001 lies between the Itkillik River, a tributary of the Colville River, and the Kuparuk River, and south of Meltwater (Figure 1).

A few of the lakes in the northern end of the study area were surveyed in conjunction with exploration of the Meltwater field, but all were shallow tundra lakes and did not represent fish habitat.

The objectives of the survey were to:

1) inventory fish species in the various lakes within the project study areas (sampling area identified in Figure 1),

2) measure lake depths to estimate lake volumes, and

3) measure water chemistry parameters to assess suitability of water for potential uses.

METHODS

The biological survey consisted of sampling with gill nets and minnow traps combined with physical measurements. Lakes were sampled with short-duration gill net sets (typically 4 to 6 hours) using a multimesh gill net (120 feet long, 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. The 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. Fish captured were measured and released if not severely injured. Duration of each set was recorded to allow calculation of catch rates.

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 in 2001, 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 either a Coning pH meter or an Oaktron pH Tester III. Turbidity was measured with an H.F. Scientific DRT15CE turbidity meter. At many of the lakes, a water sample was taken and sent to Northern Test Labs for laboratory determination of chloride, sodium, calcium, magnesium, hardness (as $CaCO_3$) and total dissolved solids (TDS).

Bathymetric data were collected to allow estimating lake volume. Depths were taken with an Eagle SupraPro ID depth sounder. Individual depth measurements were located with a hand-held Garmin III+ GPS receiver while traversing the lake with a boat. Transect positions were determined by entering the GPS positions into Arcview 3.2 GIS software and plotting the positions on maps of the surveyed lakes.

Lake volume was estimated by applying the formula for the volume of a cone to the surface area and maximum depth of each lake. The surface area was obtained from a GIS base map using USGS 1:63,360 scale quadrangle sheets. The amount allowed for winter water withdrawal was estimated as 15% of the volume of the lake deeper than 7 feet. The volume estimation is a rough estimate, but is currently accepted as an initial estimate for a one-time use. For lakes that are proposed for long-term use, volume is estimated based on contour maps of the lake.

Lake Summaries

This report uses lake numbering based on 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 and Burr (1986); sampling in 1985
L = Lobdell; water chemistry sampling in 1991-1999
M = Moulton; fish sampling in 1999

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.

Five 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).

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 29 lakes were evaluated as fish habitat in the Grizzly/Heavenly/Supercub region in 2001 (Table 1). No fish were captured in over 149 hours of gill net sampling. Arctic grayling and ninespine stickleback were observed in one lake (M0133). The lack of fish was surprising for lakes in the Itkillik River valley, because some lakes were near the river and deep enough to winter fish. The lack of fish was particularly surprising for two oxbow lakes, M0121 and M0123. Oxbow lakes typically support fish, but these two failed to yield any catch in over 24 combined hours of netting.

Water Chemistry Measurements

Water chemistry parameters measured in the studied lakes are presented Table 3. Mean water temperatures during the survey average 11.3°C (range: 8.0-16.4 °C). Dissolved oxygen was high, averaging 96.3% saturation (range: 86-110%). The observed frequency of specific conductance and pH values from surveyed lakes are graphed in Figure 8.

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 or seen during 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 broad whitefish, least cisco and arctic grayling, while Alaska blackfish and ninespine stickleback are more resistant. 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.

Based on the above lake evaluation, 1 lake was confirmed to contain fish, another 3 have potential to be fish-bearing, and 25 likely do not represent fish habitat.

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Table 1. Summary of lakes sampled near the Grizzly/Heavenly/Supercub prospects in 2001.

Area	Lake Name	Latitude (NAD27)	Longitude (NAD27)	Town	Range	Section	Surface Area (acres)	Maximum Depth (feet)	Calculated Volume (mill. gals)
Grizzly									
	M9801	70.05361	150.63333	8N	6E	15/16	266	6.0	171.59
	M9803	70.07361	150.61333	8N	6E	3	127	6.5	88.75
	M0115	69.82359	150.91383	5N	5E	4/5	243	7.4	193.51
	M0116	69.82705	150.87563	6N	5E	33/34	523	9.6	539.78
	M0121	69.87196	150.81165	6N	5E	14	230	12.2	301.86
	M0122	69.77819	150.79315	5N	5E	23/24	197	5.9	124.84
	M0123	69.84457	150.77336	6N	5E	25	48	8.8	45.24
	M0124	69.79417	150.73520	5N	6E	18	90	6.5	62.83
	M0125	69.80448	150.72878	5N	6E	7	96	6.3	65.15
	M0131	70.00358	150.77089	7N	5E	1	321	6.9	237.87
	M0132	69.83901	150.69221	6N	6E	29/32	129	4.4	61.03
	M0133	69.78166	150.89960	5N	5E	16/21	546	9.9	581.19
	M0134	69.89804	150.95119	6N	5E	5/6	160	6.2	106.39
	M0135	69.90337	150.89890	6N	5E	4	84	10.2	91.85
	M0136	69.91069	150.81394	6N/7N	5E	2/35	23	<4	
	M0137	69.90722	150.78116	6N	5E	1	149	<4	
	M0138	69.91127	150.76477	6N/7N	5E	1/36	106	<4	
	M0139	69.90505	150.74838	6N	6E	6	83	<4	
	M0140	69.86689	150.75175	6N	5E/6E	13/24/18/19	527	<4	
	M0141	69.85344	150.72905	6N	6E	19/30	113	<4	
Heavenly									
	L9828	69.95067	150.25750	7N	7E	25/36	28	8	23.65
	L9830	69.97747	150.41136	7N	7E	9	94	8	80.87
	L9831	70.00416	150.42438	8N	7E	32/33	71	8	60.71
	M0126	69.69391	150.27902	4N	8E	19	127	6.4	87.36
	M0127	69.70148	150.29608	4N	7E	13	39	7.0	29.52
	M0128	69.71014	150.35921	4N	7E	11	27	9.0	25.83
	M0129	69.71111	150.25731	4N	8E	7	6	10.0	6.23
Supercub									
	M0119	69.80681	150.48080	5N	7E	7	402	6.8	293.77
	M0120	69.82180	150.38429	5N	7E	3/4	292	6.4	201.06

Table 2. Catches of fish from lakes sampled near the Grizzly/Heavenly/Supercub prospects in 2001.

Area	Lake Name	Sample Date	Set Duration (hours)	Fish Species	Number
Grizzly	M9801	7/25/2001	13.9	None	0
	M9803	7/25/2001	7.2	None	0
	M0115	7/24/2001	15.2	None	0
	M0116	7/24/2001	14.7	None	0
	M0121	7/28/2001	16.3	None	0
	M0122	7/28/2001	6.5	None	0
	M0123	7/29/2001	8.2	None	0
	M0124	7/31/2001	14.2	None	0
	M0125	7/31/2001	7.5	None	0
	M0126	8/1/2001	8.3	None	0
	M0132	8/3/2001	2.6	None	0
	M0133	8/30/2001	seen	GRAY, NSSB	3
Heavenly	M0131	8/3/2001	13.1	None	0
Supercub	M0119	7/27/2001	15.0	None	0
	M0120	7/27/2001	6.3	None	0
Total:			149.1		

GRAY = arctic grayling
NSSB = ninespine stickleback

Table 3. Water chemistry parameters measured in conjunction with lake sampling in the Grizzly/Heavenly/Supercub area, 2001.

Area	Lake	Date	Water Temp (oC)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	Specific Conductance (microS/cm)	pH	Turbidity (NTU)	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l	Magnesium (mg/l)	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)
Grizzly														
	M9801	Jul 24 01	13.2	9.2	88	197	8.2	2.8	11.0	3.9	36	2.3	98	94
	M9803	Jul 24 01	14.5	9.7	95	163	8.3	1.1	7.5	2.2	29	1.9	81	54
	M0115	Jul 25 01	15.8	9.1	92	246	8.2	1.1	13.0	5.3	35	5.9	110	140
	M0116	Jul 25 01	16.4	9.8	100	199	8.2	1.0	5.4	2.5	31	3.7	92	100
	M0121	Jul 28 01	14.2	10.2	100	121	7.9	1.9	3.8	1.5	21	2.6	63	92
	M0122	Jul 28 01	13.1	9.8	93	134	8.0	3.0	3.1	1.8	23	2.9	69	110
	M0123	Jul 29 01	9.4	9.9	86	110	8.0	1.4	3.1	1.4	20	2.3	60	84
	M0124	Jul 31 01	8.2	10.4	88	115	7.9	1.8	5.0	1.5	20	3.2	63	94
	M0125	Jul 31 01	9.6	11.0	96	95	7.7	4.7	2.8	1.1	16	2.0	49	82
	M0131	Aug 03 01	8.0	11.0	93	193	8.2	1.4	7.6	3.6	37	2.7	100	114
	M0132	Aug 03 01	8.7	11.9	101	233	8.2	20.4	5.9	2.1	45	4.4	130	144
	M0133	Aug 30 01	7.7	meter not functioning		147	8.1	0.7	2.9	1.6	25	3.0	75	60
	M0134	Aug 30 01	8.7	meter not functioning		275	8.3	1.4	11.0	7.3	43	4.4	130	140
	M0135	Aug 30 01	8.8	meter not functioning		141	8.1	1.1	3.8	2.1	22	2.9	68	70
Heavenly														
	L9828								10.0	2.2	47.4	4.3	136	189
	M0126	Aug 01 01	9.9	11.8	104	236	8.1	3.7	12.0	1.9	46	5.2	140	138
	M0127	Aug 01 01	10.3	10.9	98	148	8.9	2.5	2.9	0.76	30	2.8	86	88
	M0128	Aug 01 01	10.6	11.4	102	150	8.0	2.3	2.8	0.9	30	2.9	88	104
	M0129	Aug 01 01	11.5	12.0	110	209	8.1	1.2	3.6	0.96	45	3.6	130	142
Supercub														
	M0119	Jul 27 01	13.3	9.8	94	200	8.2	2.0	6.9	1.5	37	3.4	110	82
	M0120	Jul 27 01	13.5	10.1	97	176	8.2	1.5	3.5	1.0	33	2.1	92	86

Table 4. Estimated water volumes available for winter withdrawal from surveyed lakes near the Grizzly/Heavenly/Supercub prospects in 2001

Region	Lake	Habitat[1]	Surface Area (acres)	Max. Depth (feet)	Calculated Volume (mil. gals)	15% of Winter Volume (mil. gals)	Sensitive Fish Species Present[2]	Resistant Fish Species Present[3]	Fish Concern[4]	Available Water (mil. gals)
Grizzly										
	M9801	Tundra	266	6.0	171.59		none	none		171.59
	M9803	Tundra	127	6.5	88.75		none	none		88.75
	M0115	Tundra	243	7.4	193.51		none	none		193.51
	M0116	Tundra	523	9.6	539.78		none	none		539.78
	M0121	Oxbow	230	12.2	301.86	19.3	none	none	Yes?	19.3
	M0122	Tundra	197	5.9	124.84		none	none		124.84
	M0123	Oxbow	48	8.8	45.24	1.4	none	none	Yes?	1.4
	M0124	Tundra	90	6.5	62.83		none	none		62.83
	M0125	Tundra	96	6.3	65.15		none	none		65.15
	M0131	Tundra	321	6.9	237.87		none	none		237.87
	M0132	Tundra	129	4.4	61.03		none	none		61.03
	M0133	Perched?	546	9.9	581.19	25.54	GRAY	NSSB	Yes	25.54
	M0134	Tundra	160	6.2	106.39		ns	ns		106.39
	M0135	Oxbow	84	10.2	91.85	4.32	ns	ns	Yes?	4.32
	M0136	Tundra	23	<4			ns	ns		too shallow
	M0137	Tundra	149	<4			ns	ns		too shallow
	M0138	Tundra	106	<4			ns	ns		too shallow
	M0139	Tundra	83	<4			ns	ns		too shallow
	M0140	Tundra	527	<4			ns	ns		too shallow
	M0141	Tundra	113	<4			ns	ns		too shallow
Heavenly										
	L9828	Tundra	28	8	23.65		ns	ns		23.65
	L9830	Tundra	94	8	80.87		ns	ns		80.87
	L9831	Tundra	71	8	60.71		ns	ns		60.71
	M0126	Tundra	127	6.4	87.36		none	none		87.36
	M0127	Tundra	39	7.0	29.52		ns	ns		29.52
	M0128	Tundra	27	9.0	25.83		ns	ns		25.83
	M0129	Tundra	6	10.0	6.23		ns	ns		6.23
Supercub										
	M0119	Tundra	402	6.8	293.77		none	none		293.77
	M0120	Tundra	292	6.4	201.06		none	none		201.06

[1] FF = frequent flooding (every 1 to 5 years); IF = infrequent flooding (less than once every 5 years)

[2] GRAY = arctic grayling

[3] NSSB = ninespine stickleback

[4] No = lake does not represent fish habitat, Yes = fish present during survey, Y? = fish not caught but lake has potential to be fish habitat.

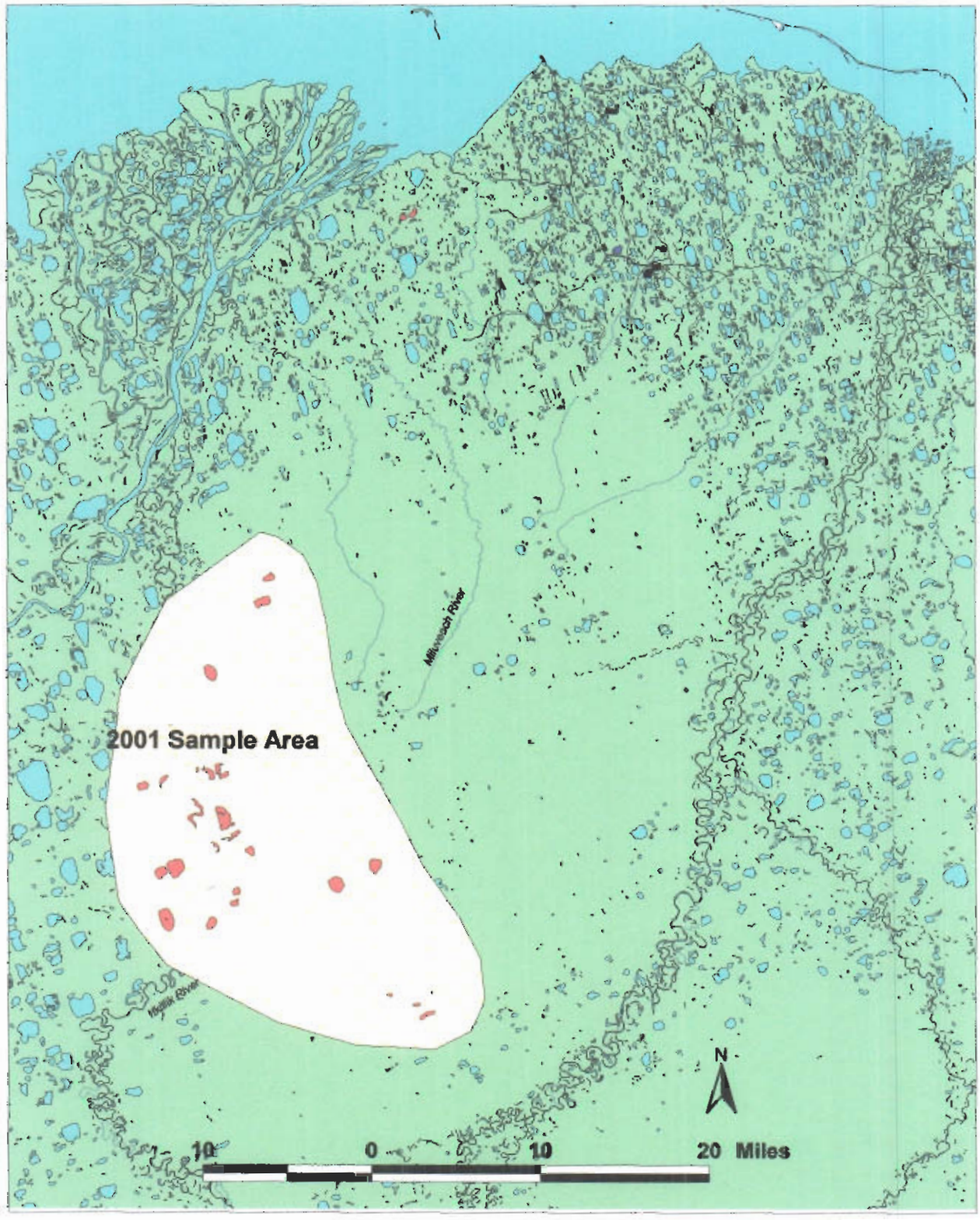


Figure 1. Location of Grizzly/Heavenly/Supercub area of interest, 2001.

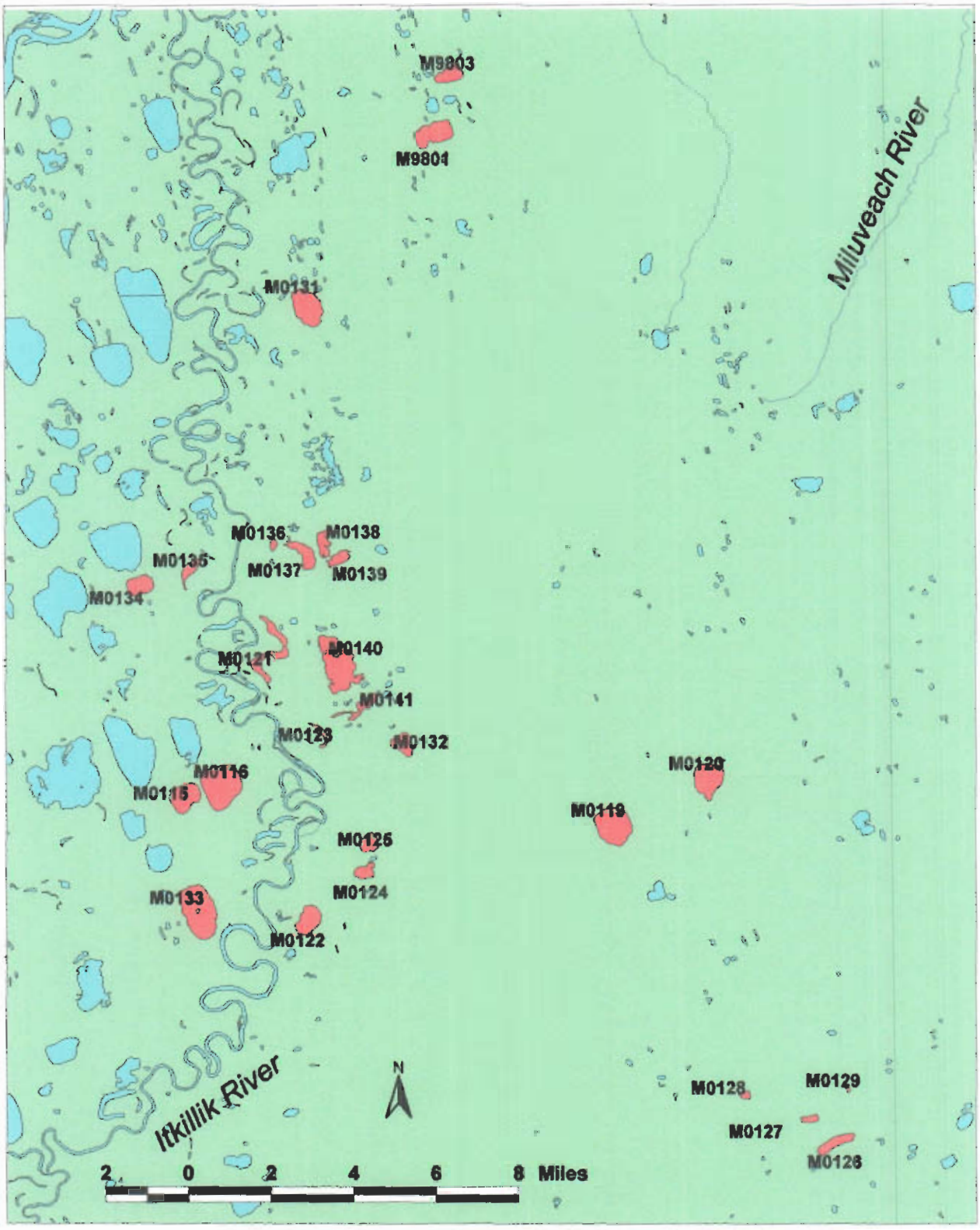


Figure 2. Lakes near the Grizzly,Heavenly and Supercub prospects evaluated as fish habitat during the 2001 summer field season

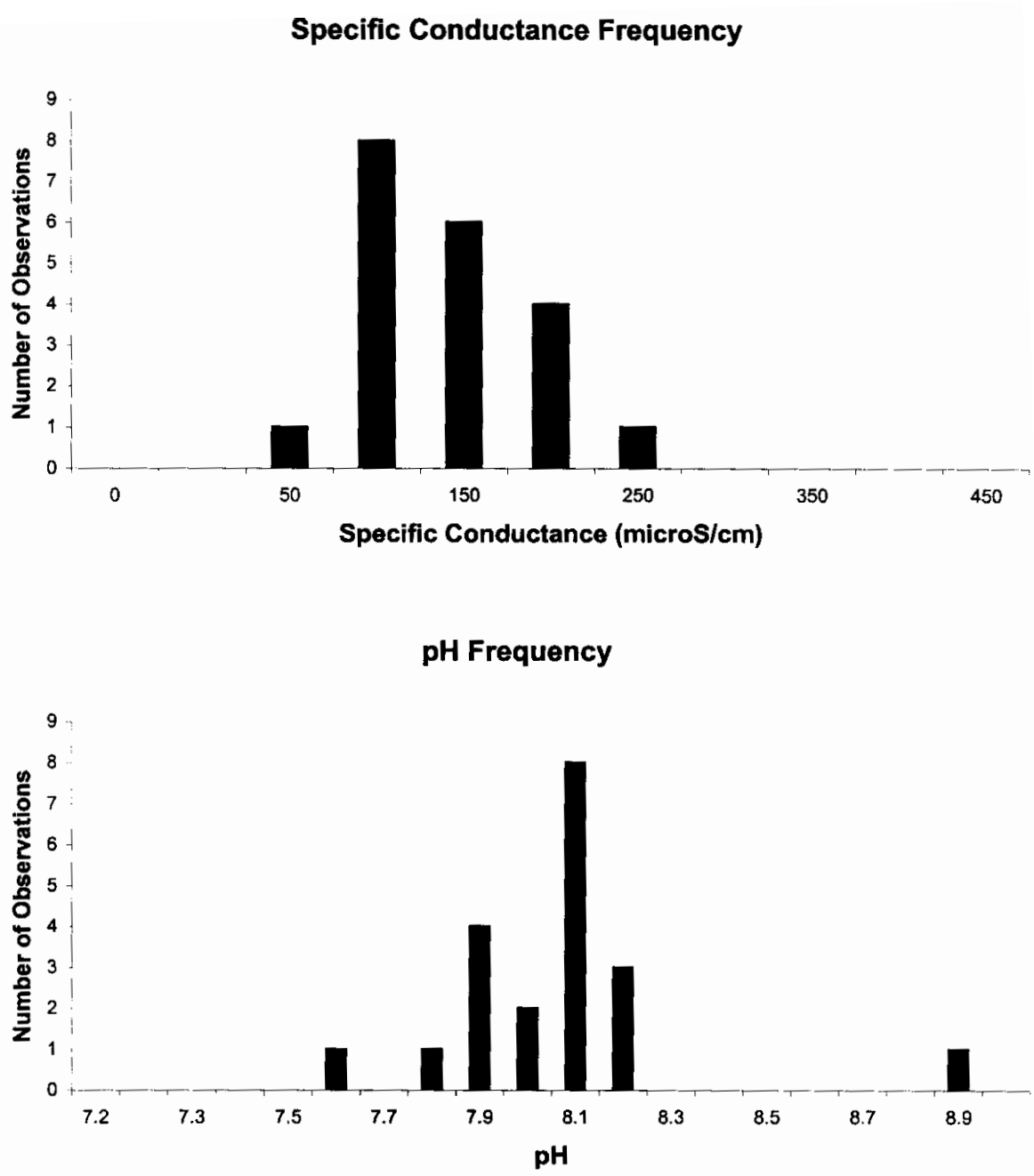
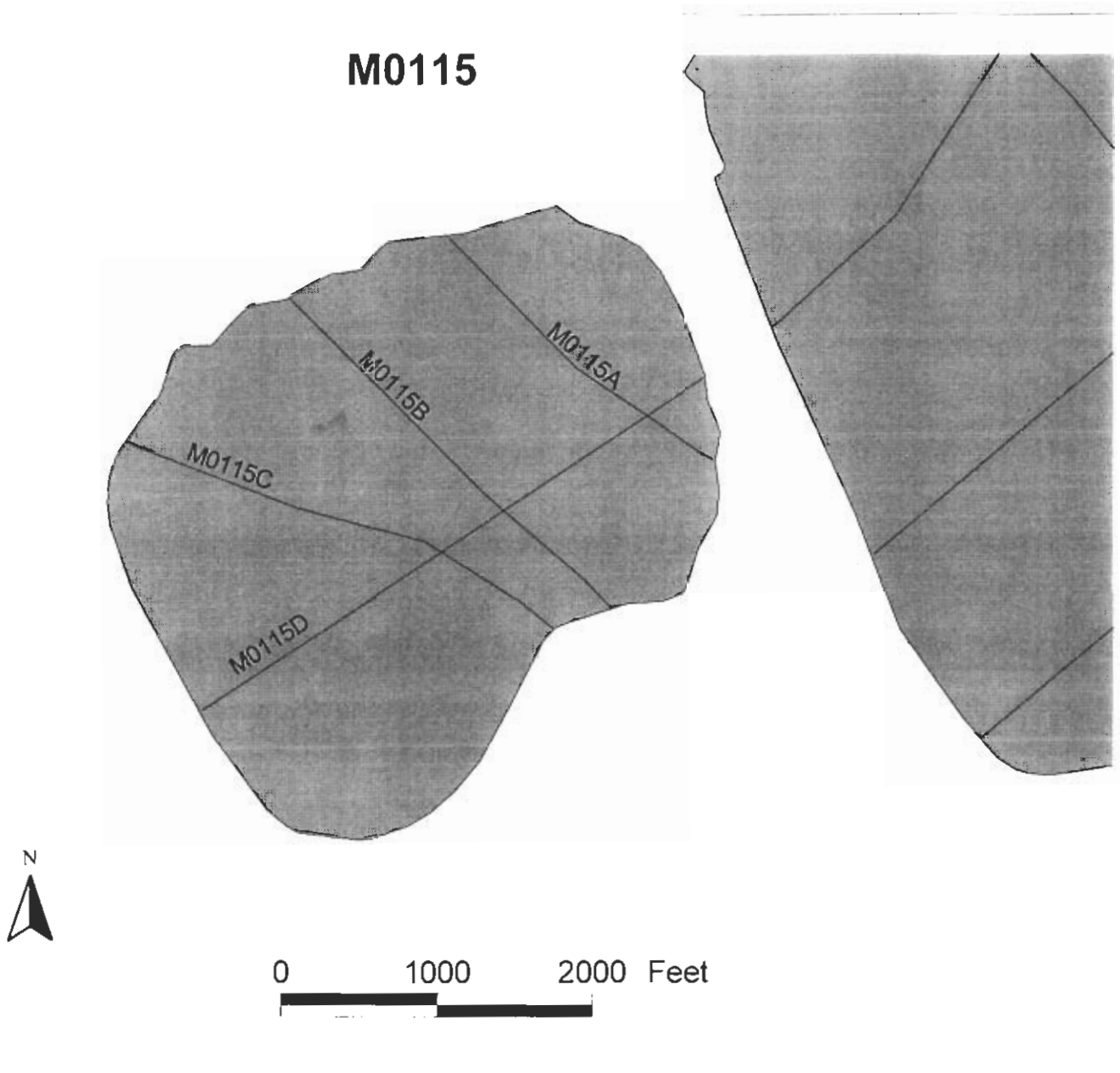


Figure 3 Frequency distribution of specific conductance and pH measurements taken during summer from 20 lakes in the Grizzly/Heavenly/Supercub regions, 2001.

PHILLIPS 2001 EXPLORATION
LAKE SUMMARIES


M0115
M0115A
M0115B
M0115C
M0115D
N
0
1000
2000 Feet

Lake M0115

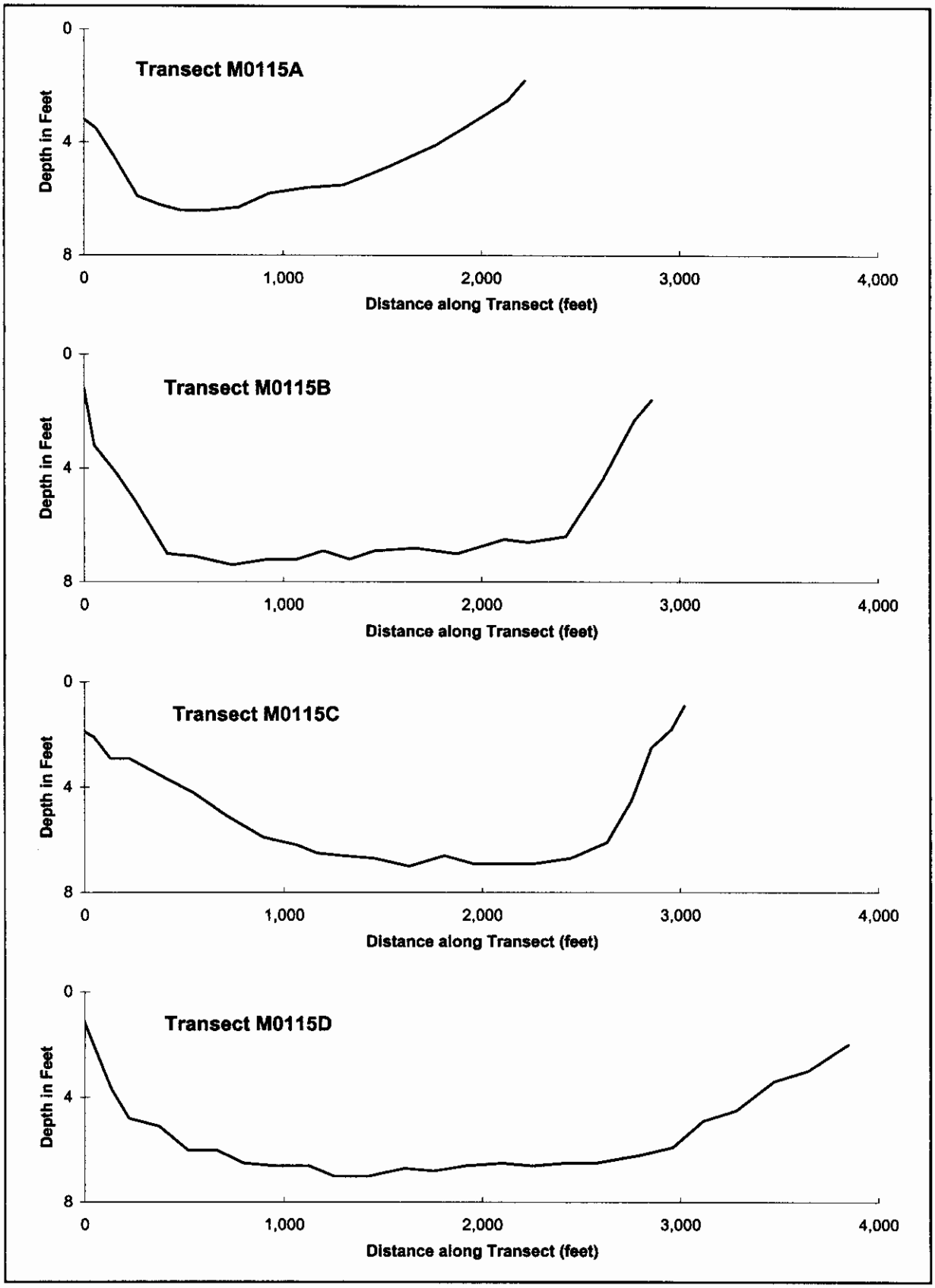
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R5E, Section 4/5
Habitat:
Area: 243 acres
Maximum Depth: 7.4 feet
Active Outlet:
Turbidity: 1.1 NTU
Spec. Conductance: 246 µS/cm
pH: 8.2
Calculated Volume: 193.5 million gallons
Permittable Volume: No fish concern

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	13.0	5.3	35.0	5.9	110	140	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 24 01	15.2	None	0


Transect M0115A
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0115B
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0115C
Depth in Feet
0
4
8
0
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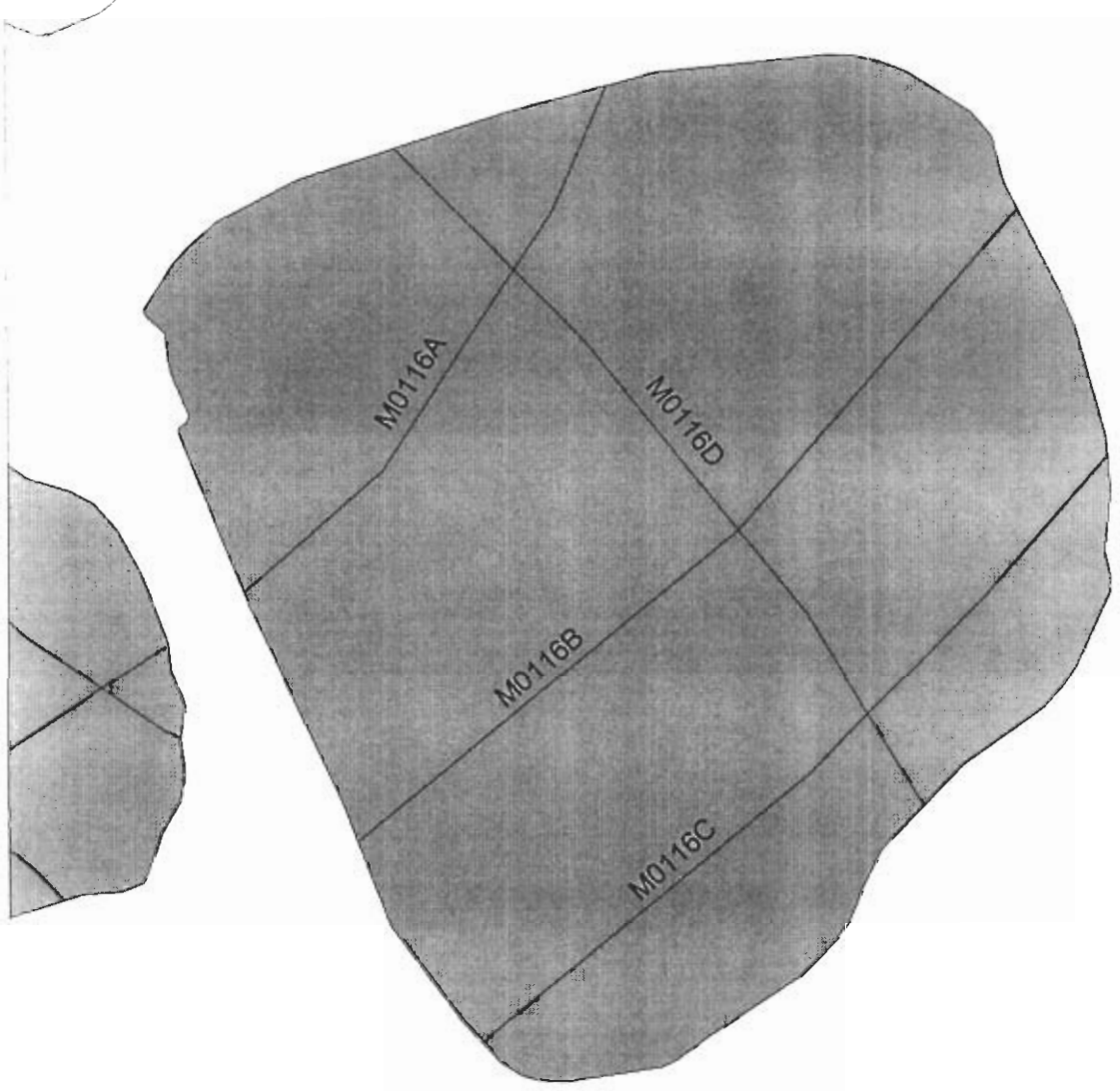
Distance along Transect (feet)

M0116



Lake M0116

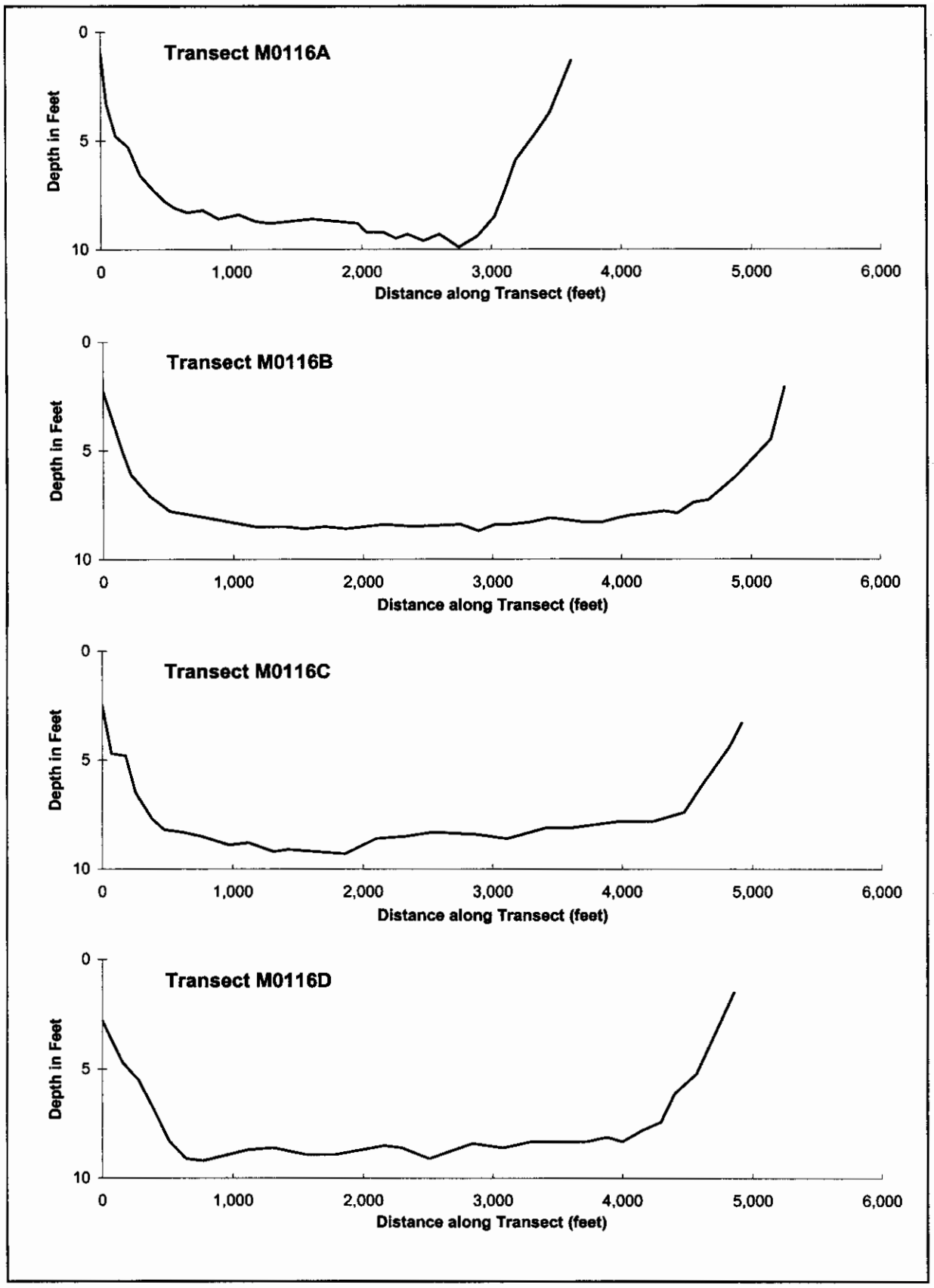
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R5E, Section 33/34
Habitat:
Area: 523 acres
Maximum Depth: 9.6 feet
Active Outlet:
Turbidity: 1.0 NTU
Spec. Conductance: 199 µS/cm
pH: 8.2
Calculated Volume: 539.8 million gallons
Permittable Volume: No fish concern

Water Quality:

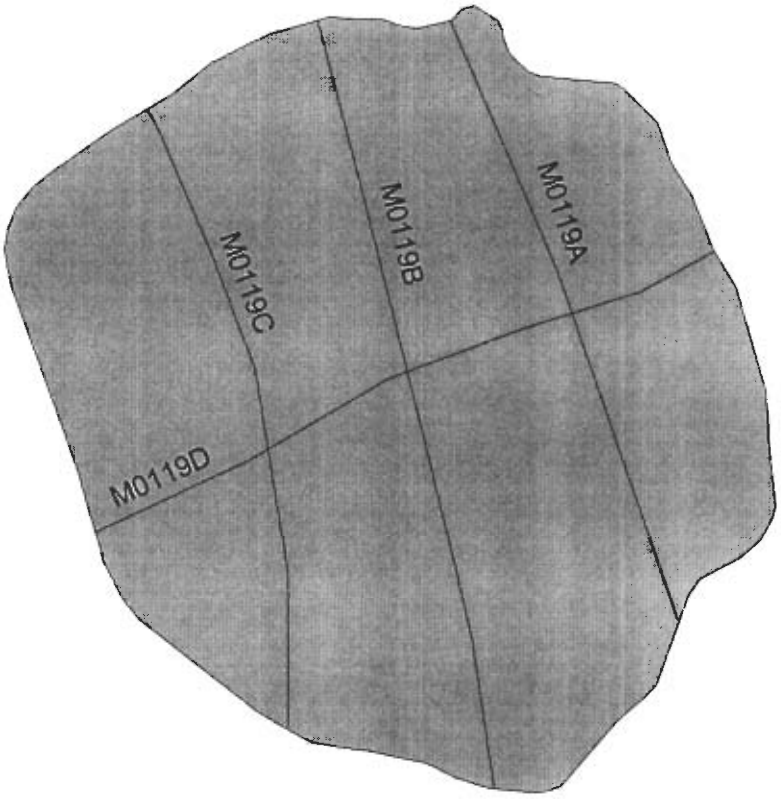
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.8	1.5	21.0	2.6	63	92	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 24 01	14.7	None	0


Transect M0116A
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0116B
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0116C
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0116D
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)

M0119


M0119A
M0119B
M0119C
M0119D


N


0
1000
2000
3000
4000
5000
Feet

Lake M0119

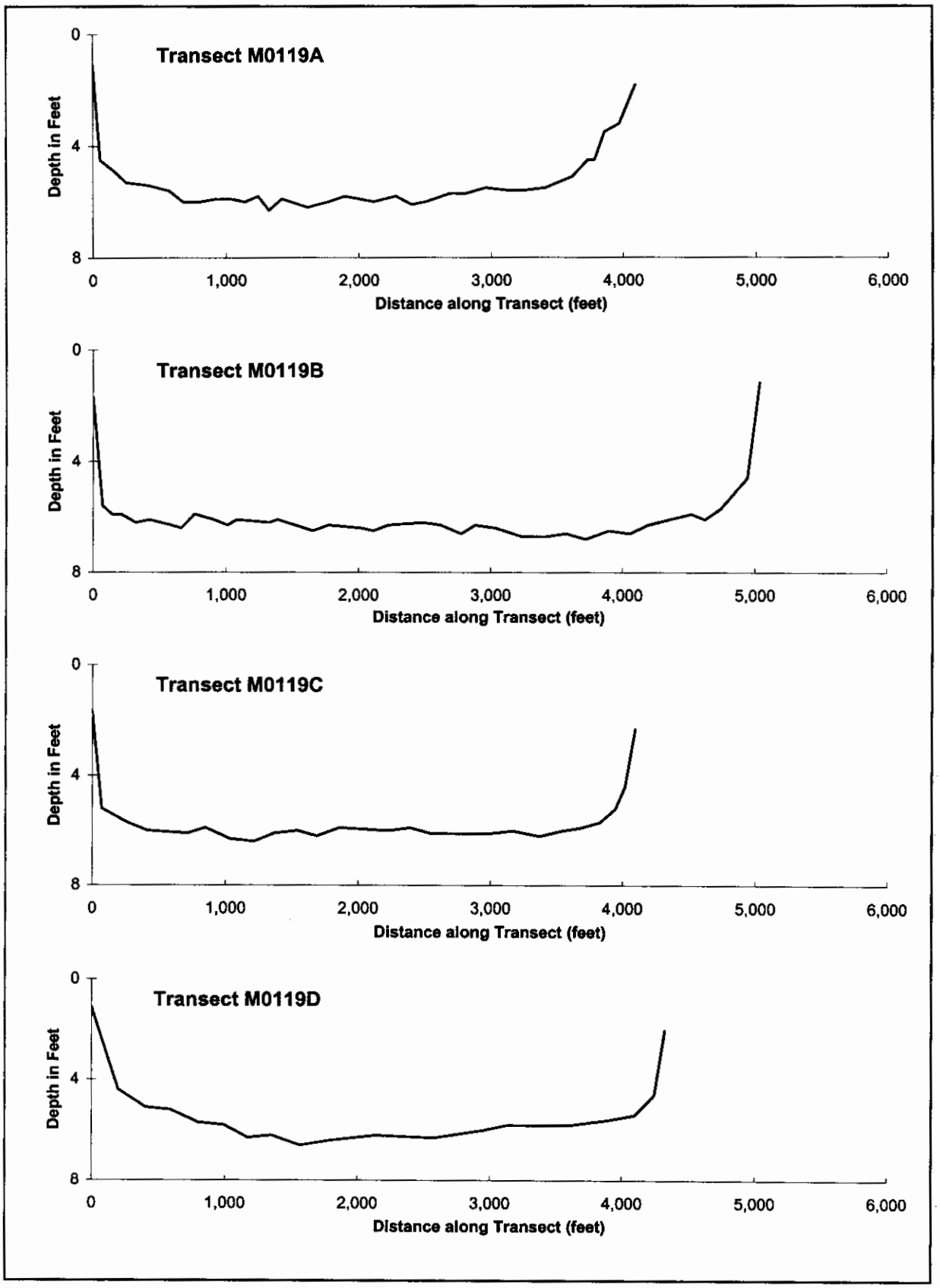
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R7E, Section 7
Habitat:
Area: 402 acres
Maximum Depth: 6.8 feet
Active Outlet:
Turbidity: 2.0 NTU
Spec. Conductance: 199.735 µS/cm
pH: 8.2
Calculated Volume: 293.8 million gallons
Permittable Volume: No fish concern

Water Quality:

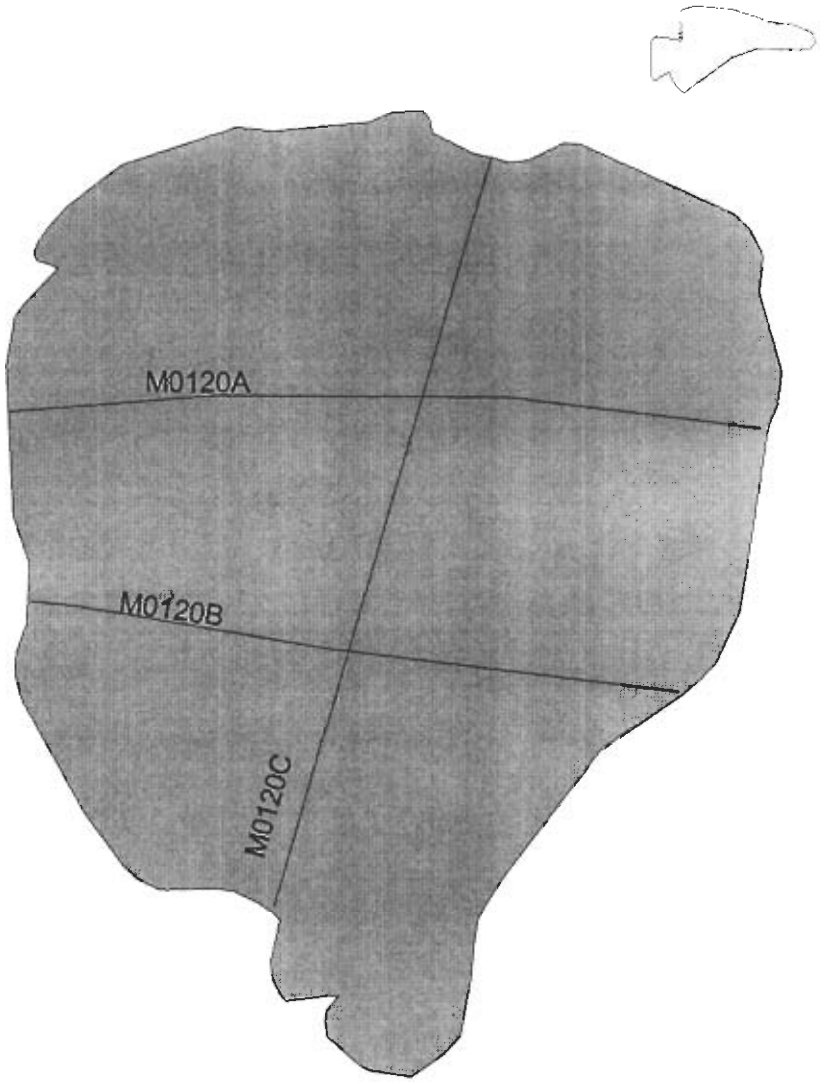
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	6.9	1.5	37.0	3.4	110	82	this study

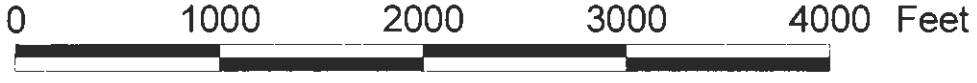
Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 27 01	15.0	None	0


Transect M0119A
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0119B
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0119C
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)
Transect M0119D
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
5,000
6,000
Distance along Transect (feet)

M0120





Lake M0120

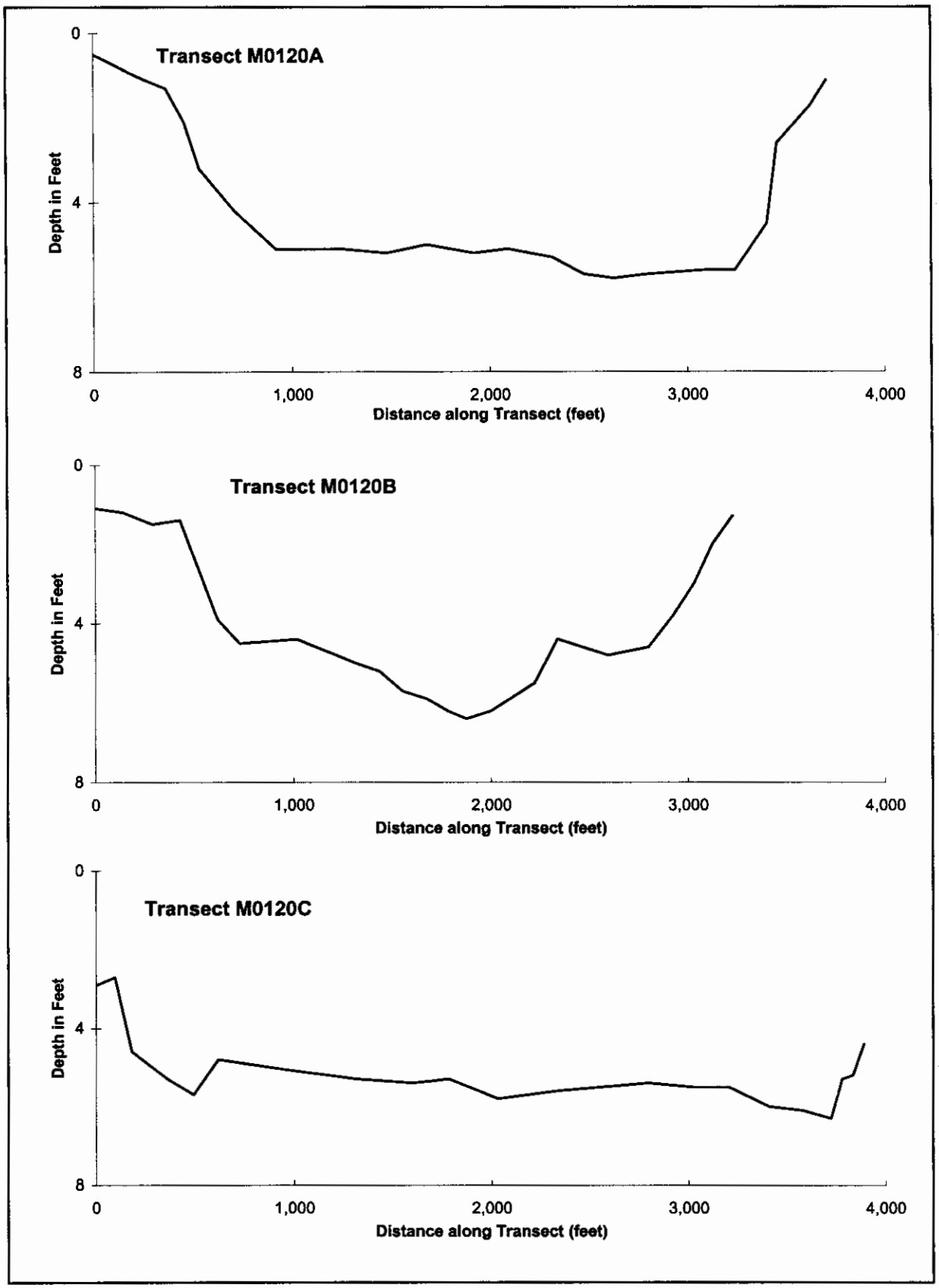
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R7E, Section 3/4
Habitat:
Area: 292 acres
Maximum Depth: 6.4 feet
Active Outlet:
Turbidity: 1.5 NTU
Spec. Conductance: 176.33113 µS/cm
pH: 8.2
Calculated Volume: 201.1 million gallons
Permittable Volume: No fish concern

Water Quality:

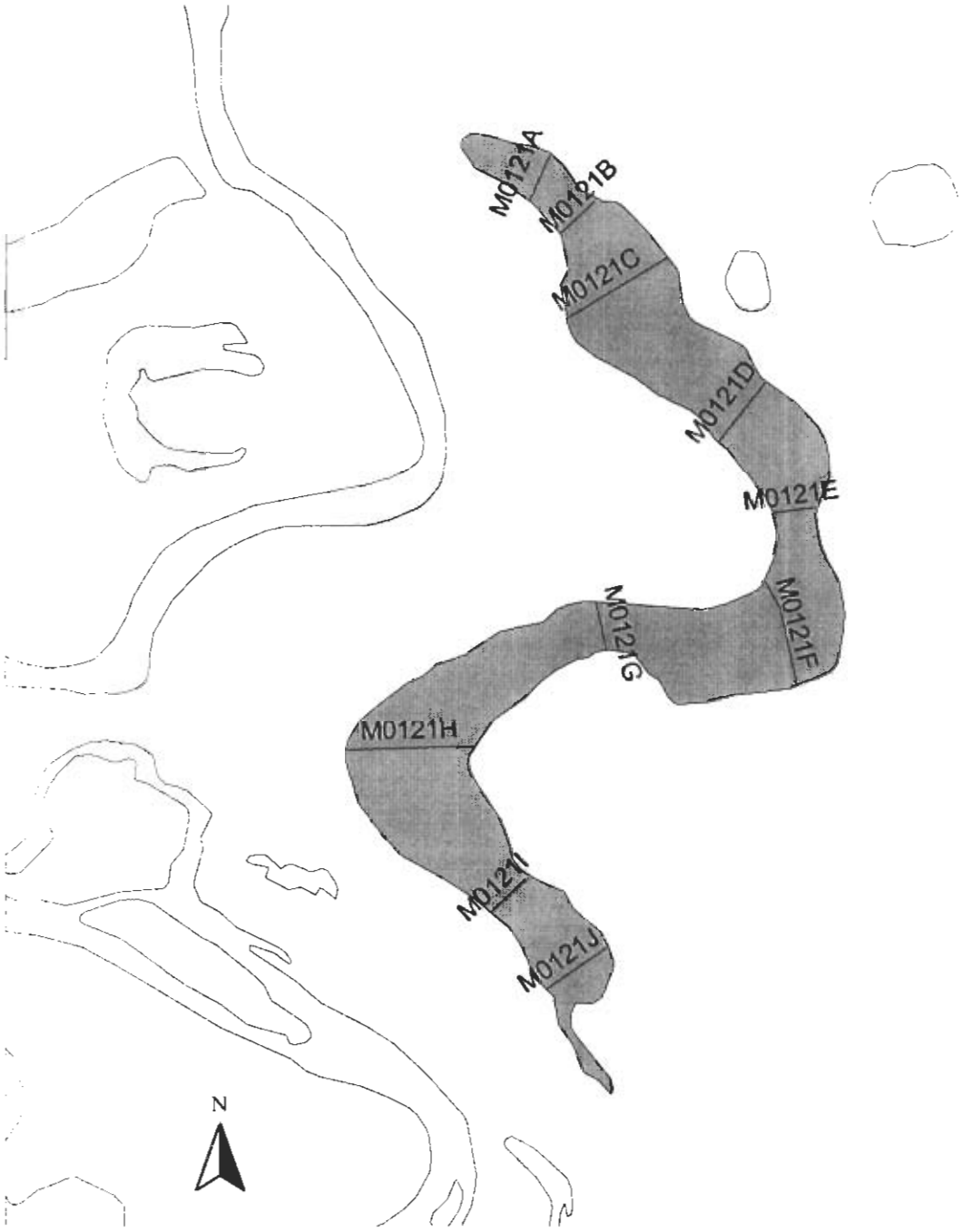
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.5	1.0	33.0	2.1	92	86	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 27 01	6.3	None	0


Transect M0120A
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0120B
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0120C
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)

M0121


M0121A
M0121B
M0121C
M0121D
M0121E
M0121F
M0121G
M0121H
M0121I
M0121J
N
0 1000 2000 3000 4000 5000 Feet

Lake M0121

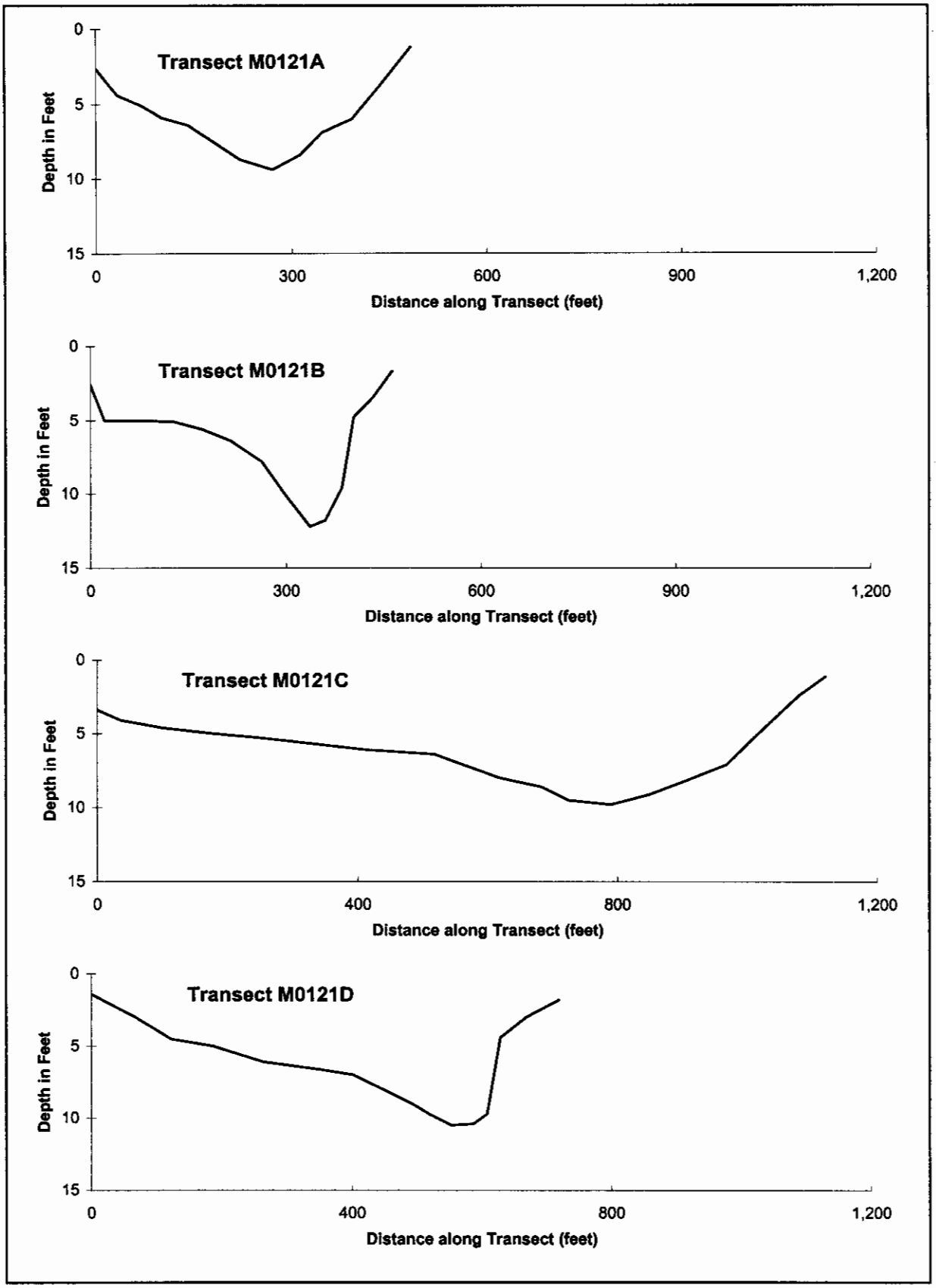
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R5E, Section 14
Habitat:
Area: 230 acres
Maximum Depth: 12.2 feet
Active Outlet:
Turbidity: 1.9 NTU
Spec. Conductance: 121.20143 µS/cm
pH: 7.9
Calculated Volume: 301.9 million gallons
Permittable Volume: No fish concern

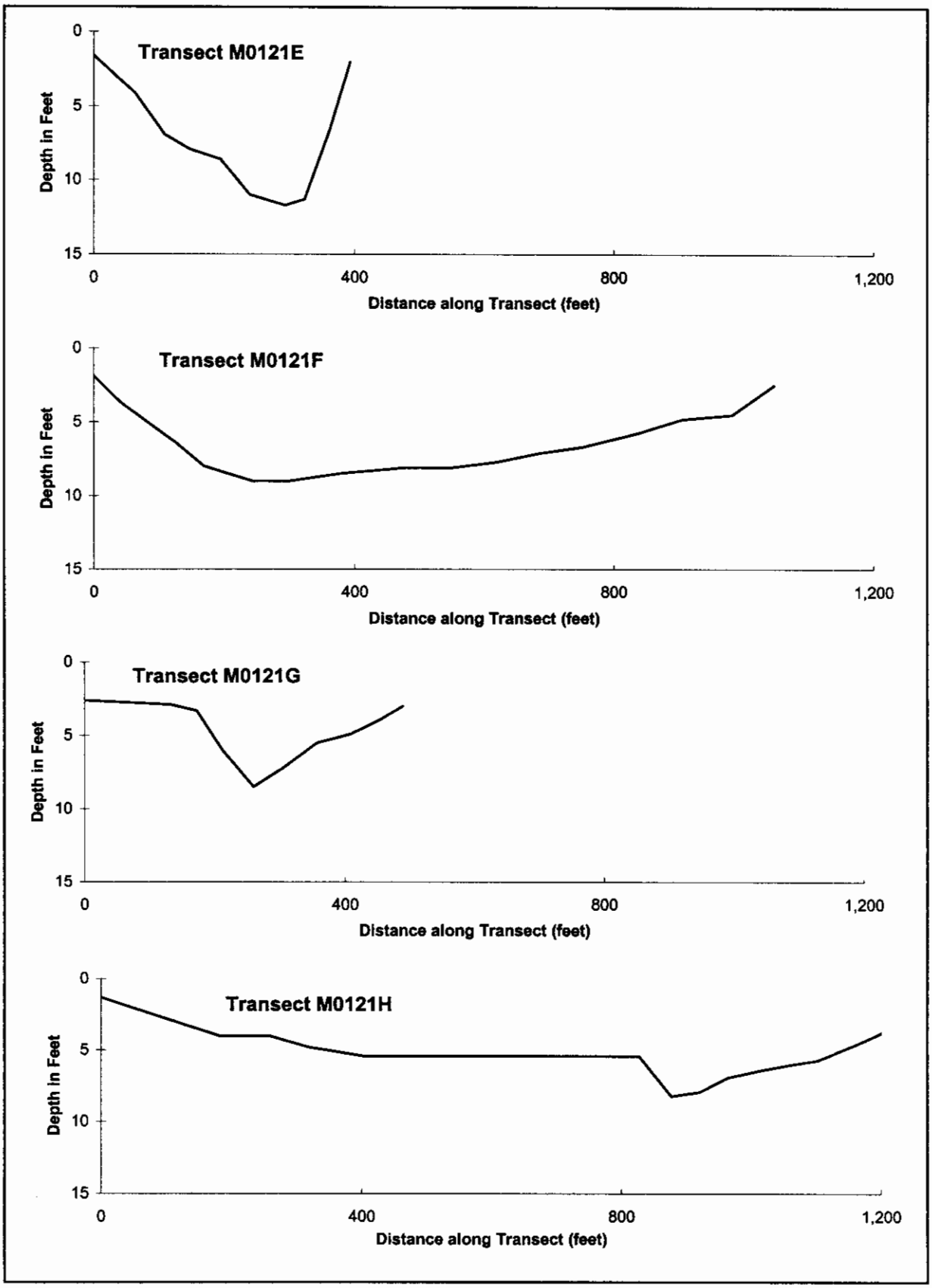
Water Quality:

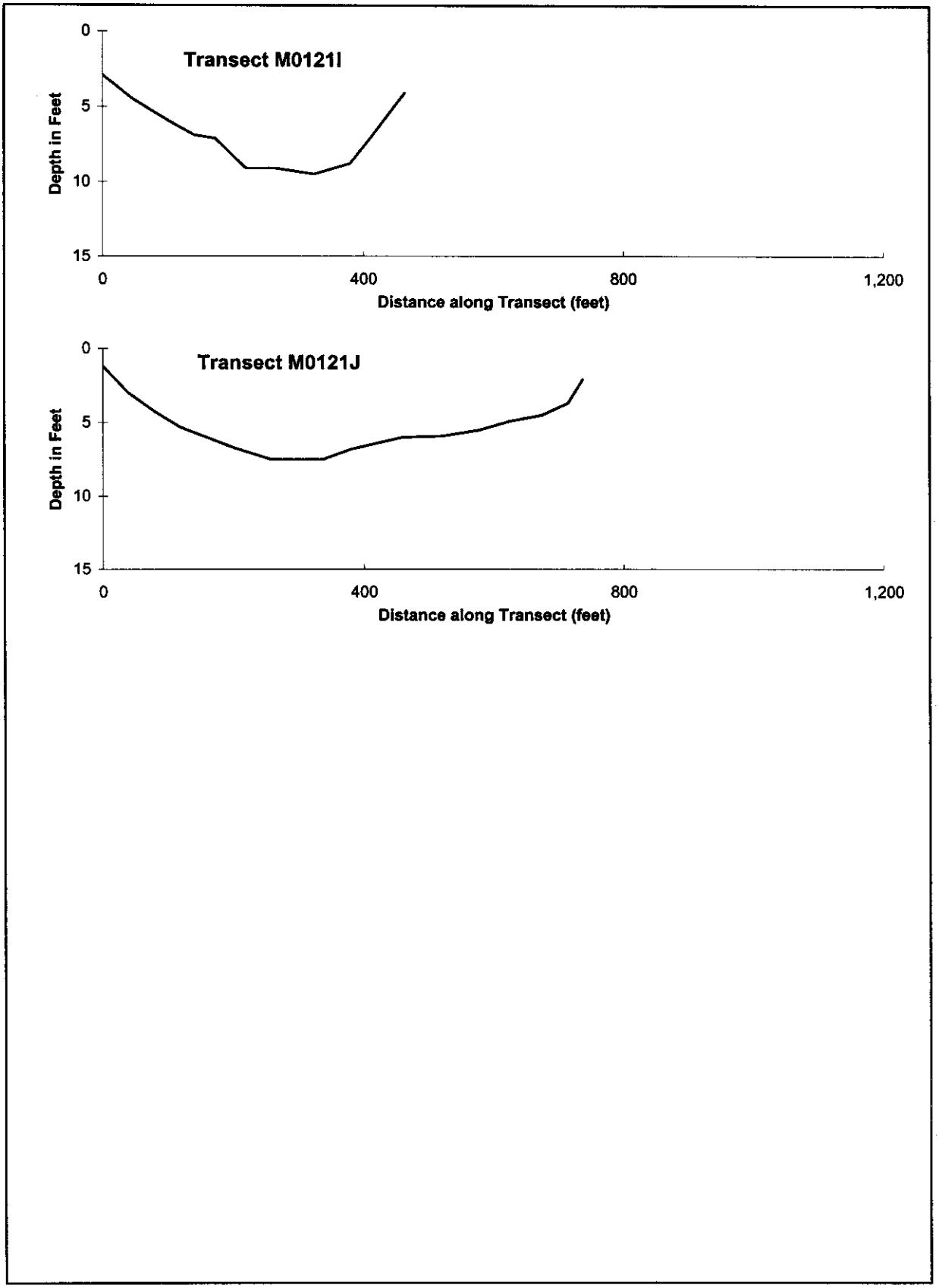
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.8	1.5	21.0	2.6	63	92	this study

Catch Record:

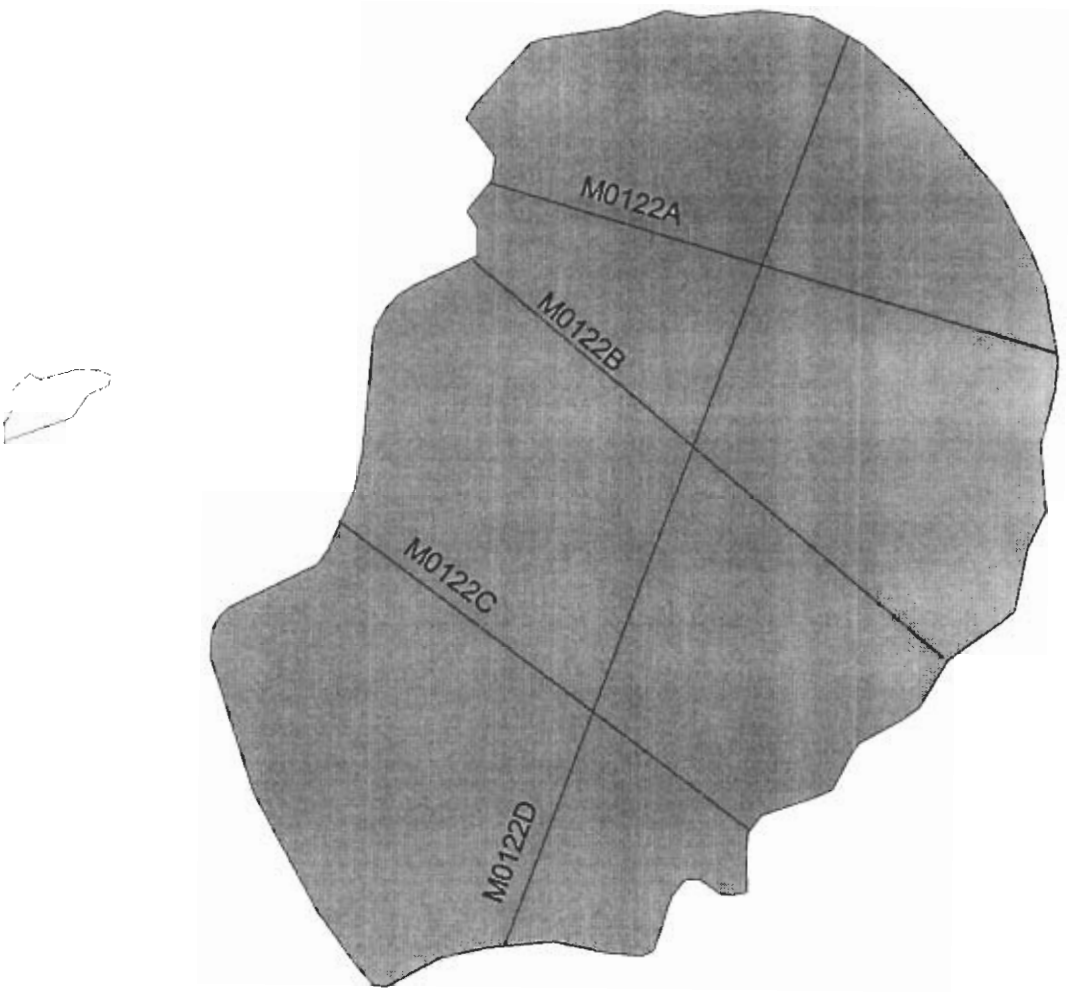
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 28 01	16.3	None	0


Transect M0121A
Depth in Feet
0
5
10
15
0
300
600
900
1,200
Distance along Transect (feet)
Transect M0121B
Depth in Feet
0
5
10
15
0
300
600
900
1,200
Distance along Transect (feet)
Transect M0121C
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)
Transect M0121D
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)


Transect M0121E
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)
Transect M0121F
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)
Transect M0121G
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)
Transect M0121H
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)


Transect M0121I
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)
Transect M0121J
Depth in Feet
0
5
10
15
0
400
800
1,200
Distance along Transect (feet)

M0122



Lake M0122

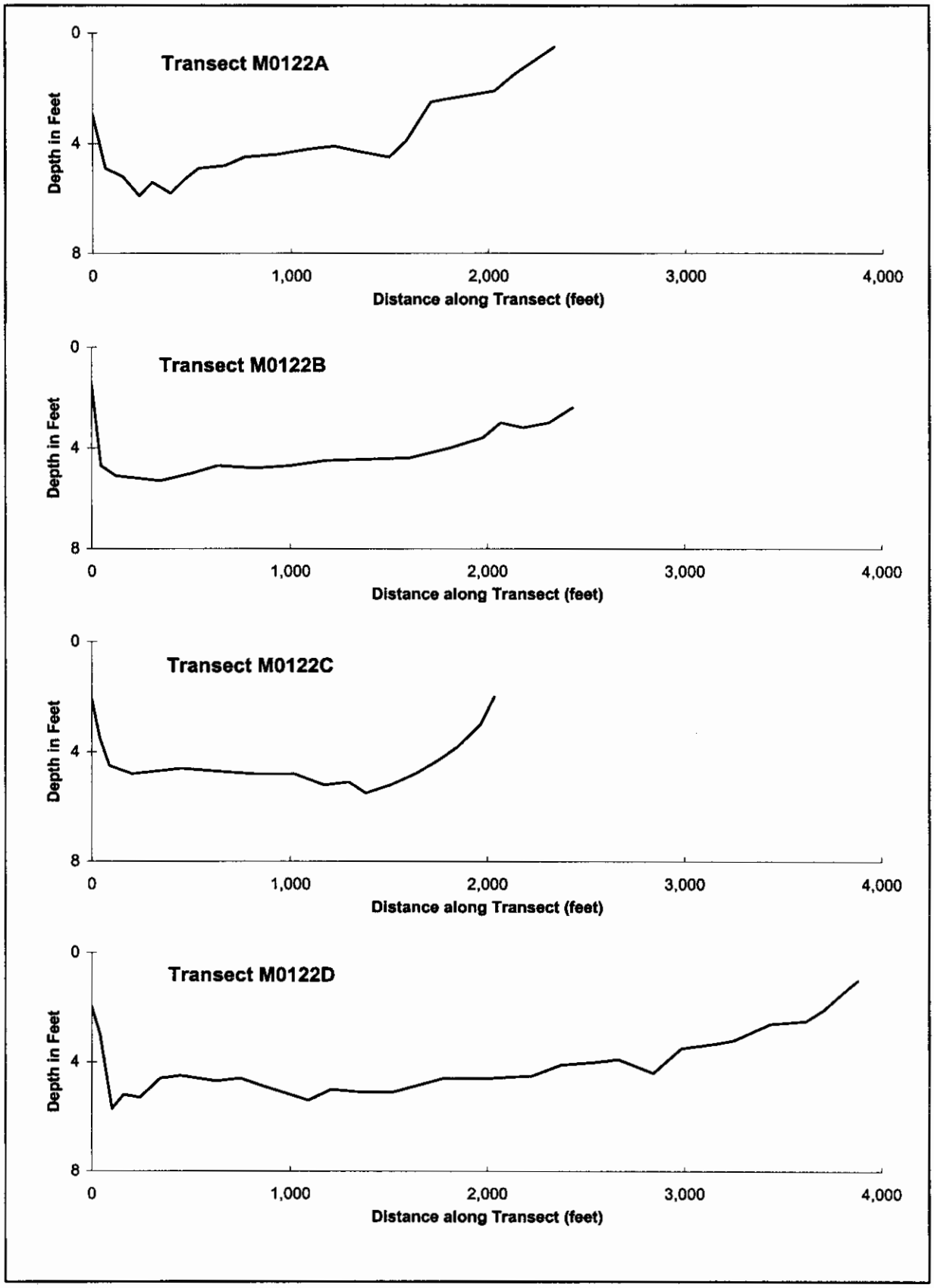
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R5E, Section 23/24
Habitat:
Area: 197 acres
Maximum Depth: 5.9 feet
Active Outlet:
Turbidity: 3.0 NTU
Spec. Conductance: 134.203 µS/cm
pH: 8.0
Calculated Volume: 124.8 million gallons
Permittable Volume: No fish concern

Water Quality:

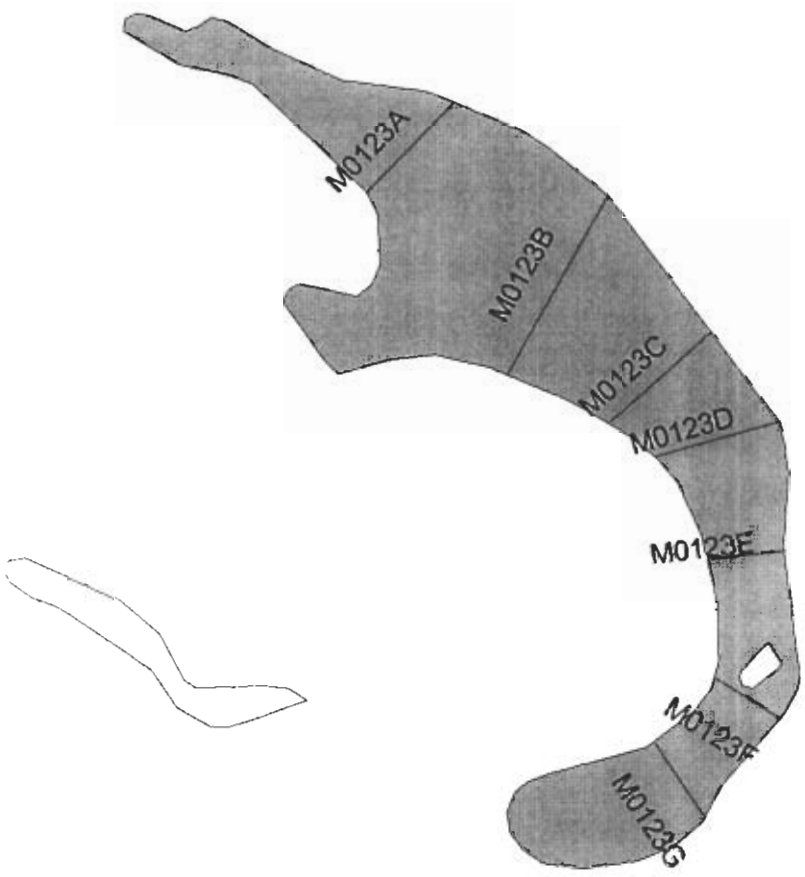
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.1	1.8	23.0	2.9	69	110	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 28 01	6.5	None	0


Transect M0122A
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0122B
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0122C
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0122D
Depth in Feet
0
4
8
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)

M0123


M0123A
M0123B
M0123C
M0123D
M0123E
M0123F
M0123G


N


0
1000
2000
3000 Feet

Lake M0123

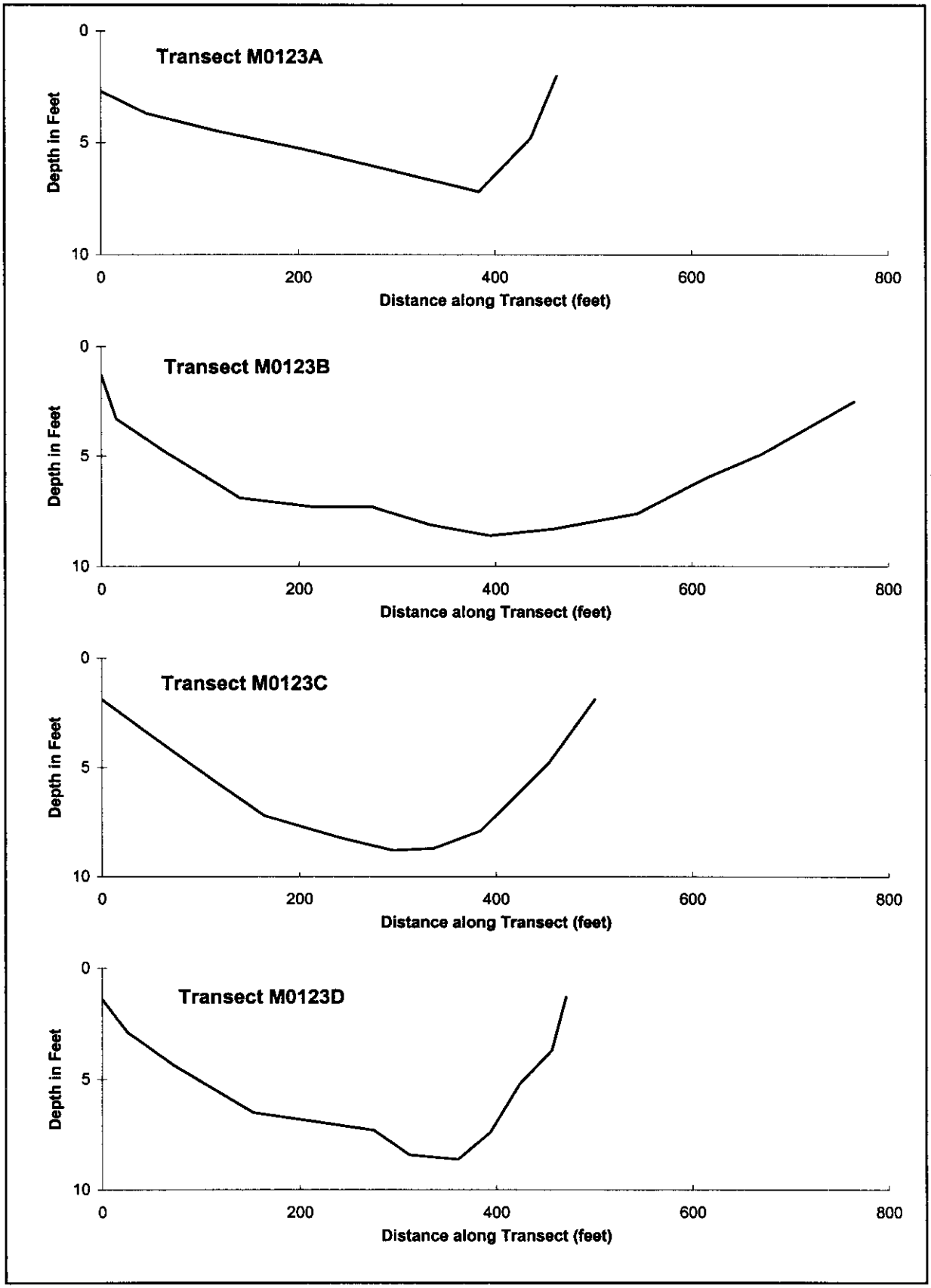
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R5E, Section 25
Habitat:
Area: 48 acres
Maximum Depth: 8.8 feet
Active Outlet:
Turbidity: 1.4 NTU
Spec. Conductance: 109.8228 µS/cm
pH: 7.96
Calculated Volume: 45.2 million gallons
Permittable Volume: No fish concern

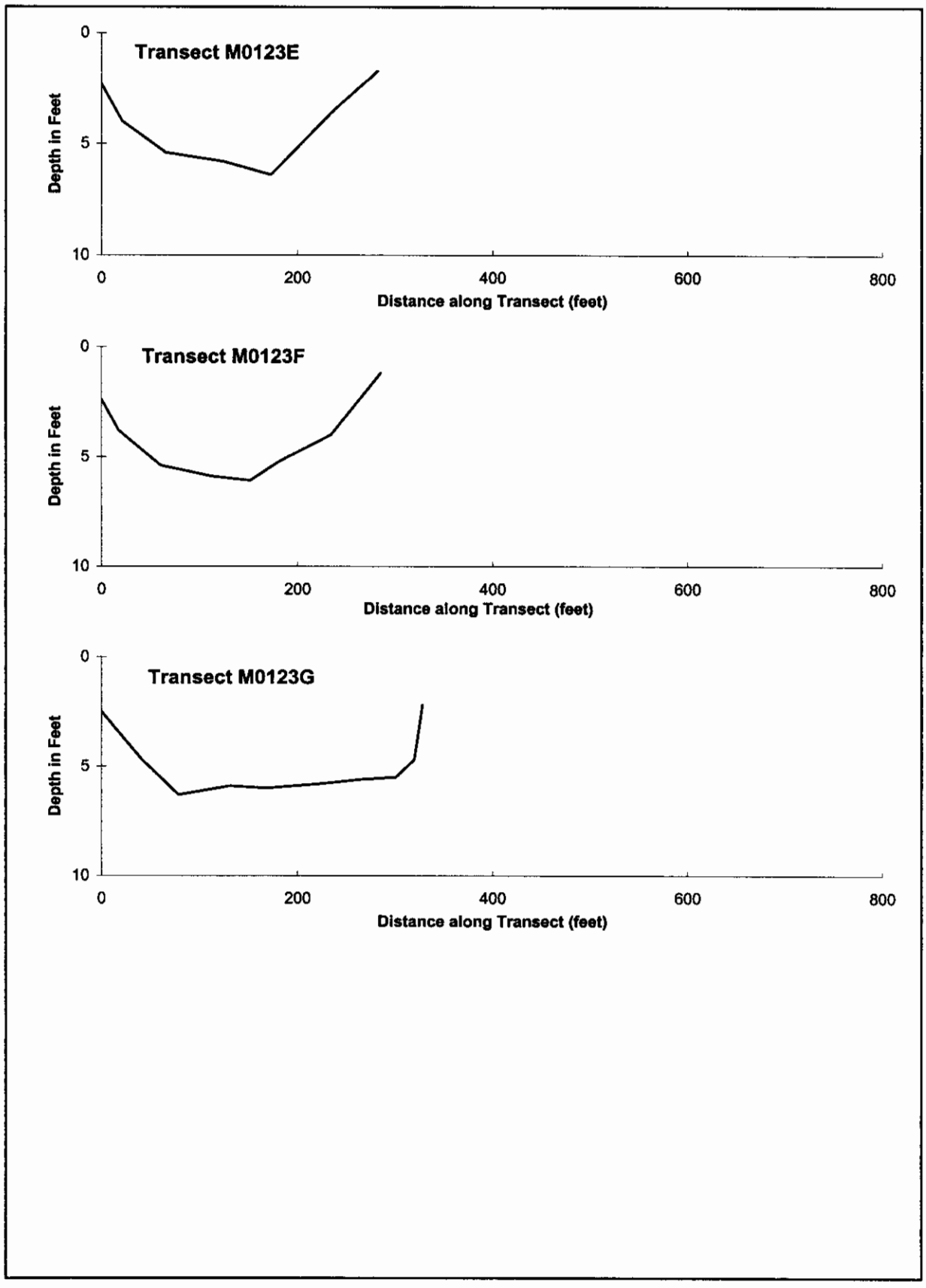
Water Quality:

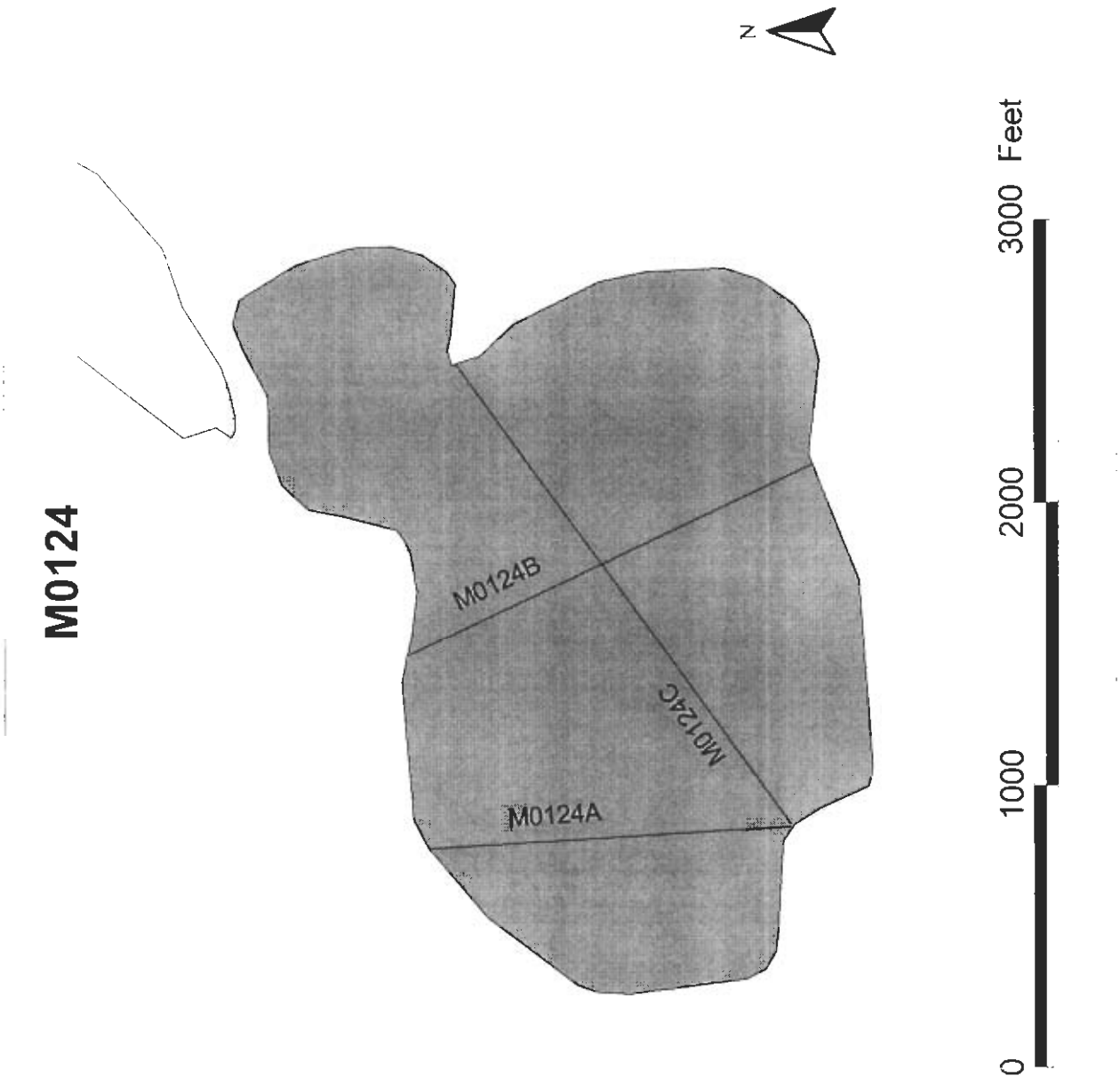
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.1	1.4	20.0	2.3	60	84	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 29 01	8.2	None	0


Transect M0123A
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)
Transect M0123B
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)
Transect M0123C
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)
Transect M0123D
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)


Transect M0123E
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)
Transect M0123F
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)
Transect M0123G
Depth in Feet
0
5
10
0
200
400
600
800
Distance along Transect (feet)


M0124
N
M0124B
M0124C
M0124A
0
1000
2000
3000 Feet

Lake M0124

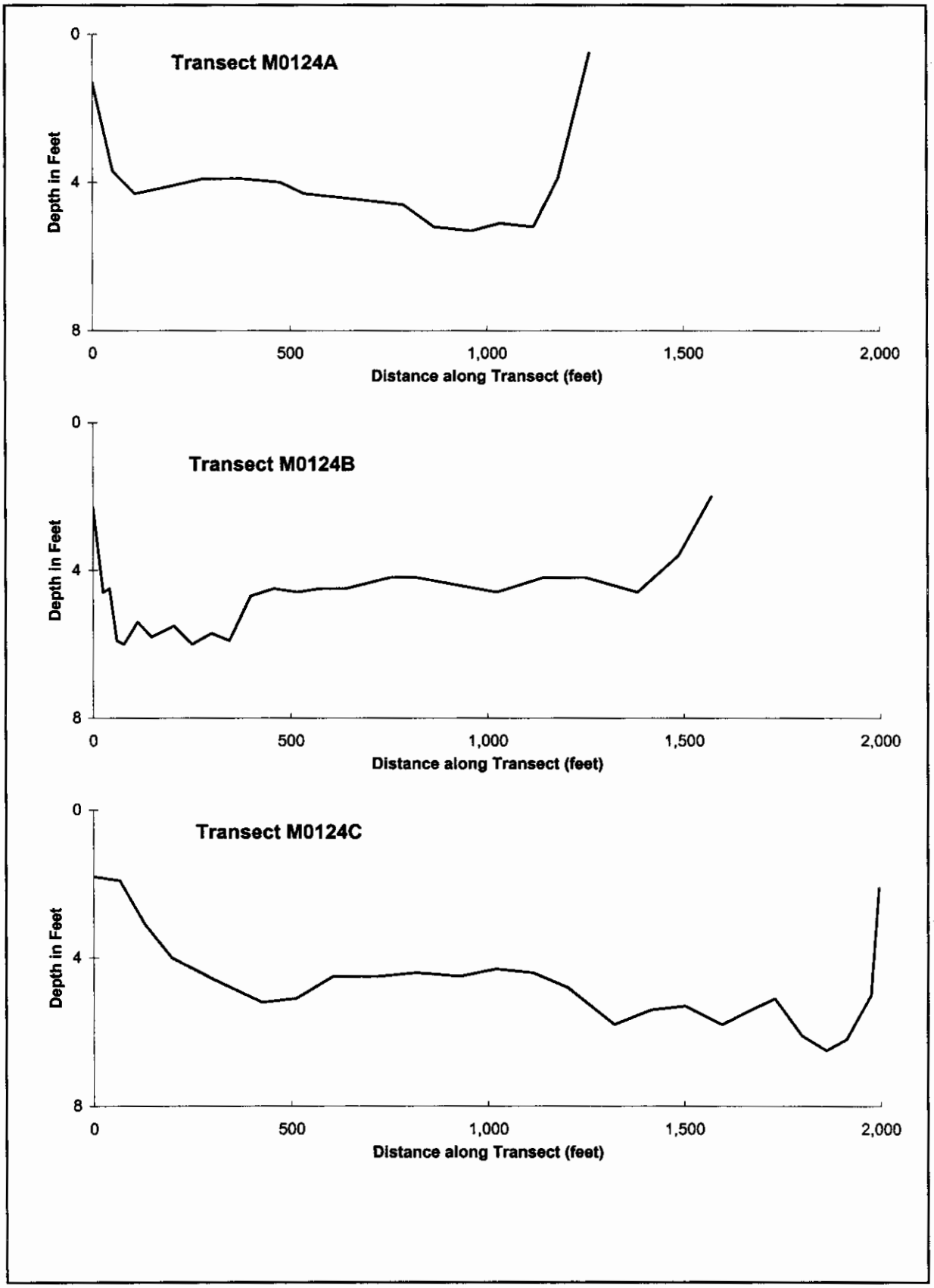
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R6E, Section 18
Habitat:
Area: 90 acres
Maximum Depth: 6.5 feet
Active Outlet:
Turbidity: 1.8 NTU
Spec. Conductance: 114.70727 µS/cm
pH: 7.9
Calculated Volume: 62.8 million gallons
Permittable Volume: No fish concern

Water Quality:

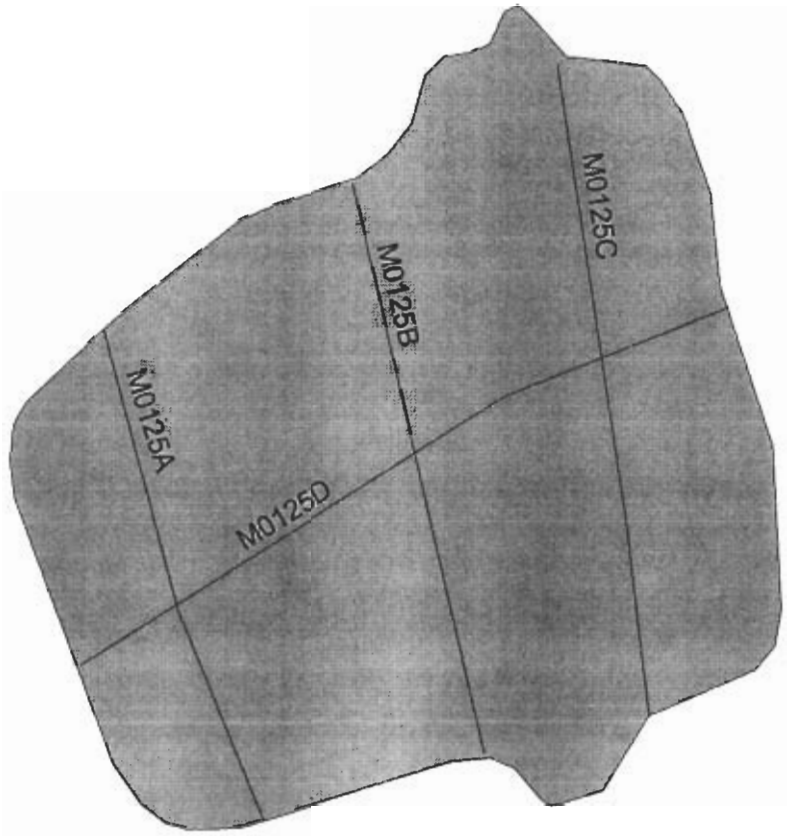
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	5.0	1.5	20.0	3.2	63	94	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 31 01	14.2	None	0


Transect M0124A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
Distance along Transect (feet)
Transect M0124B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
Distance along Transect (feet)
Transect M0124C
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
Distance along Transect (feet)

M0125



Lake M0125

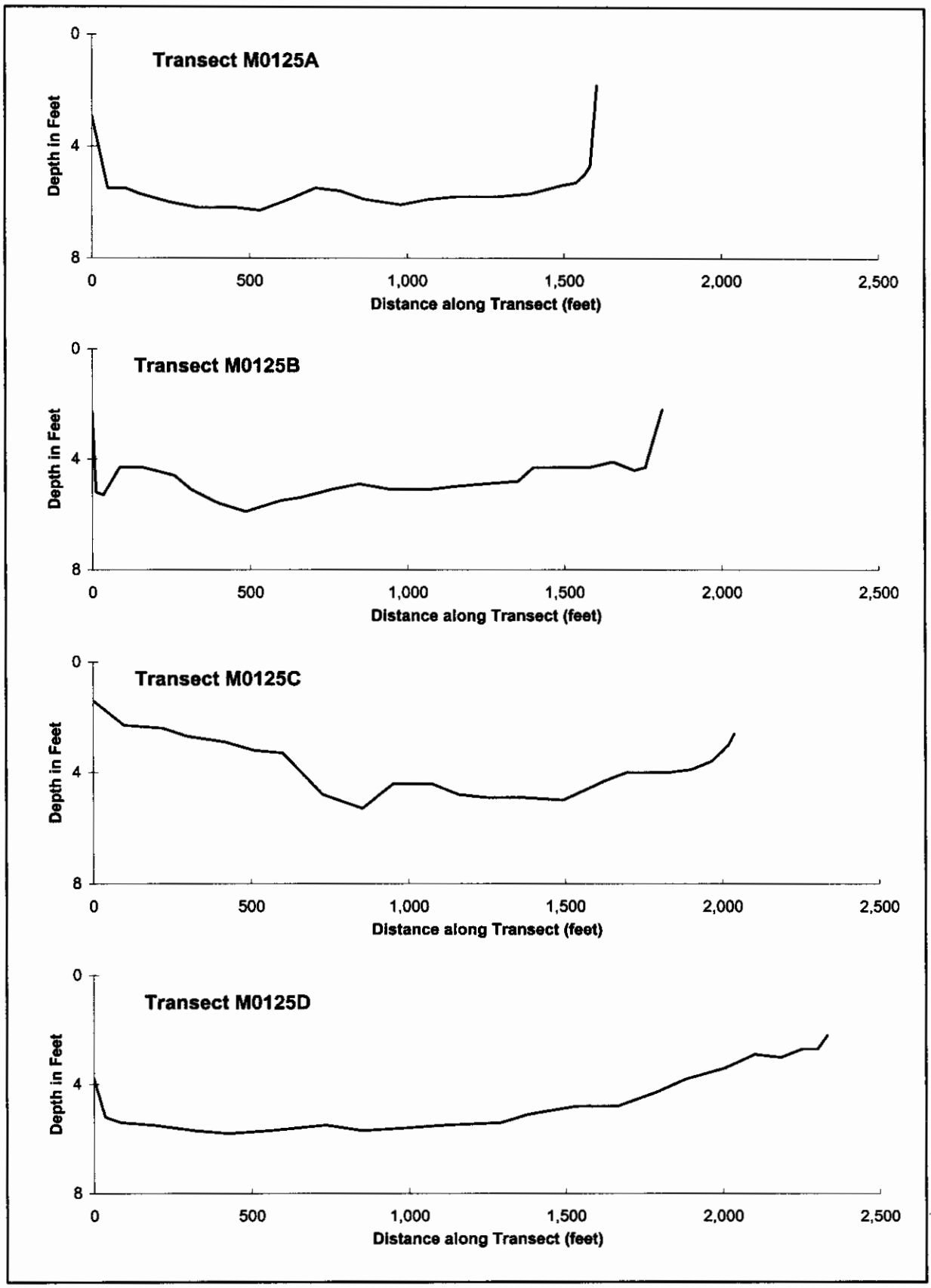
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R6E, Section 7
Habitat:
Area: 96 acres
Maximum Depth: 6.3 feet
Active Outlet:
Turbidity: 4.7 NTU
Spec. Conductance: 94.63633 µS/cm
pH: 7.7
Calculated Volume: 65.2 million gallons
Permittable Volume: No fish concern

Water Quality:

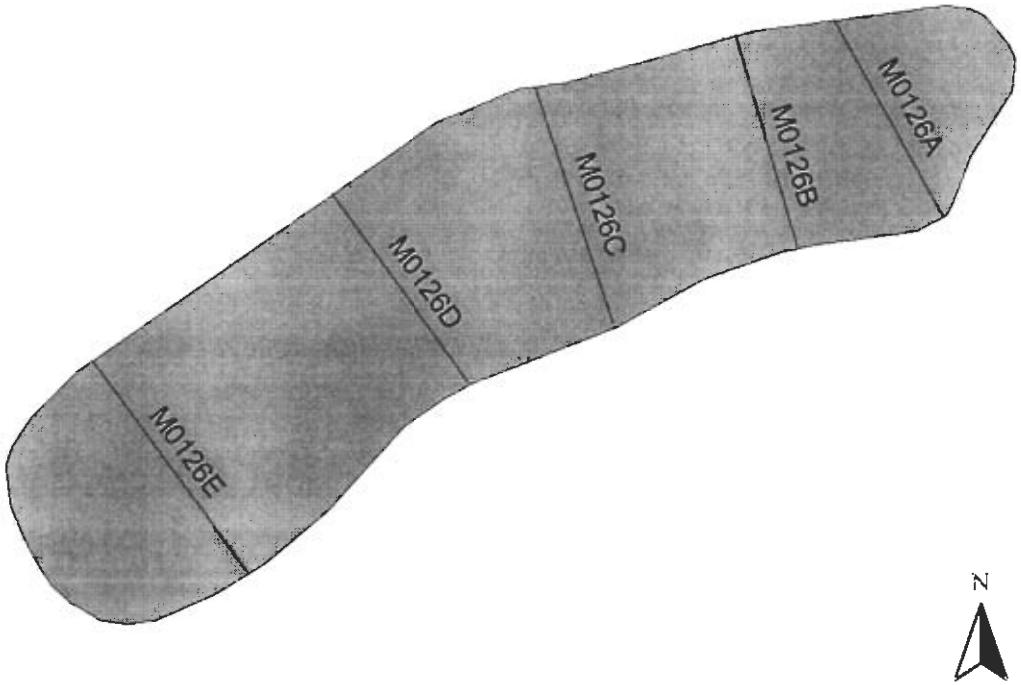
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	2.8	1.1	16.0	2.0	49	82	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 31 01	7.5	None	0


Transect M0125A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M0125B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M0125C
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M0125D
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)

M0126



Lake M0126

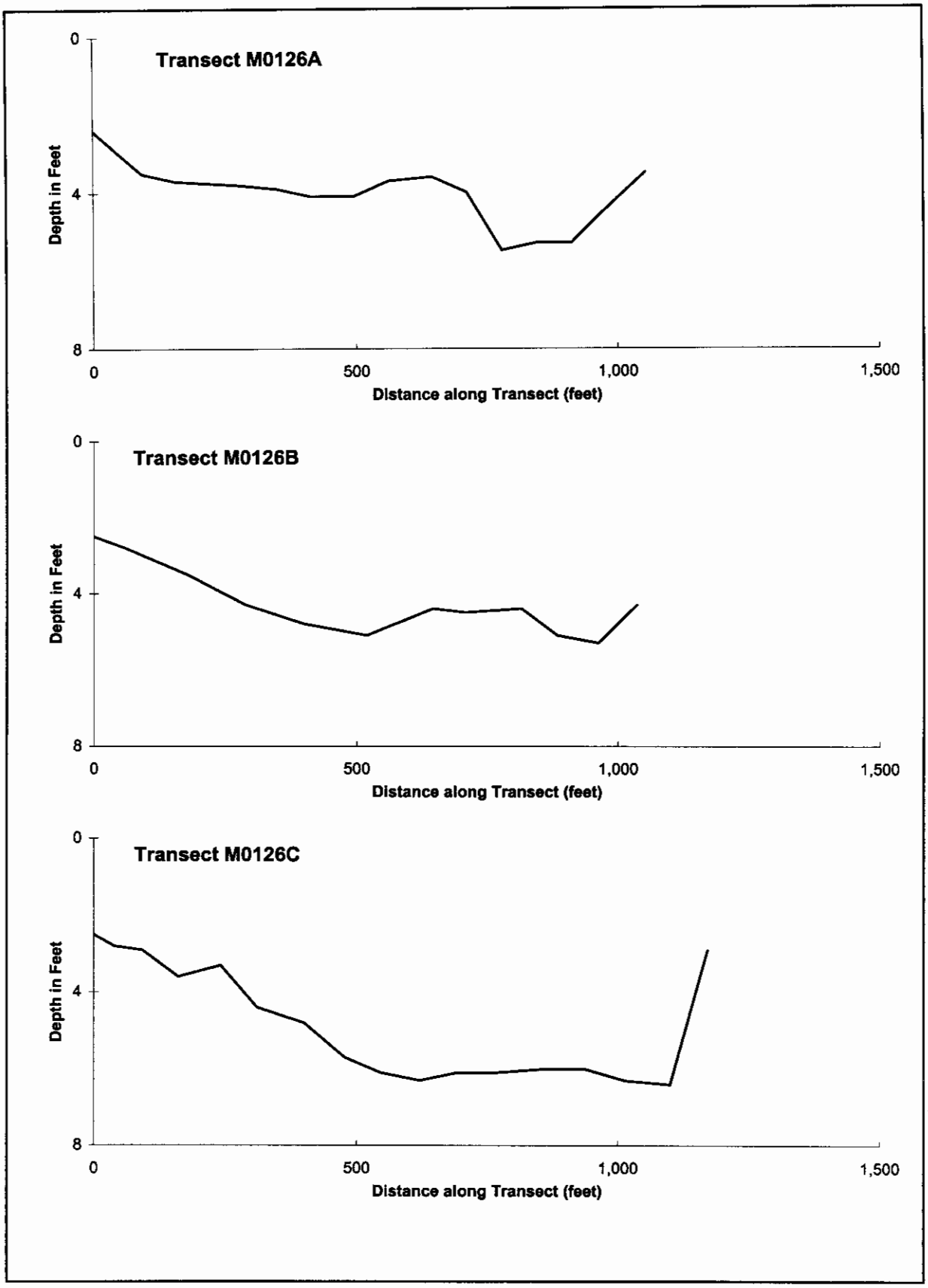
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T4N R8E, Section 19
Habitat:
Area: 127 acres
Maximum Depth: 6.4 feet
Active Outlet:
Turbidity: 3.7 NTU
Spec. Conductance: 236.23154 µS/cm
pH: 8.1
Calculated Volume: 87.4 million gallons
Permittable Volume: No fish concern

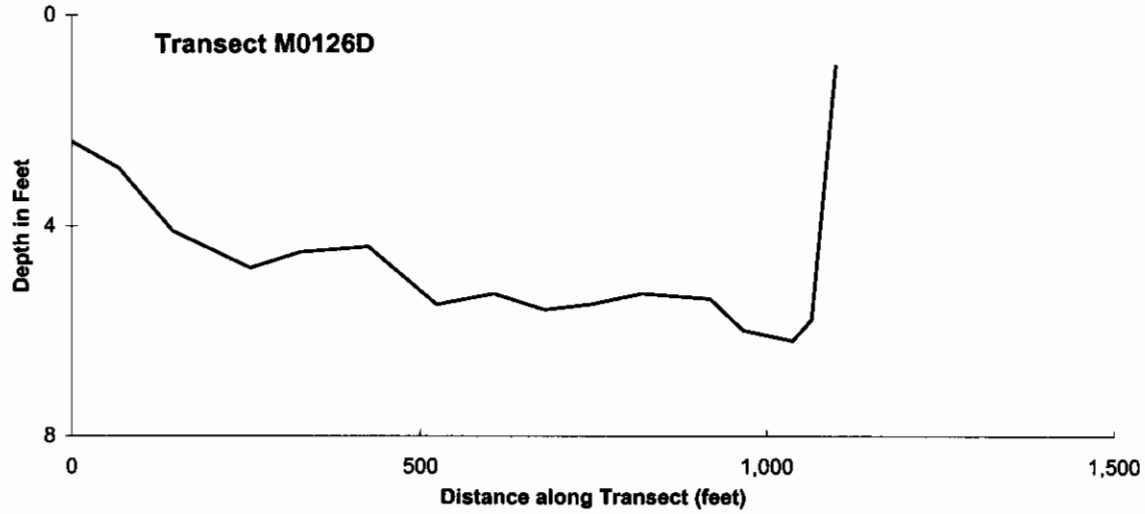
Water Quality:

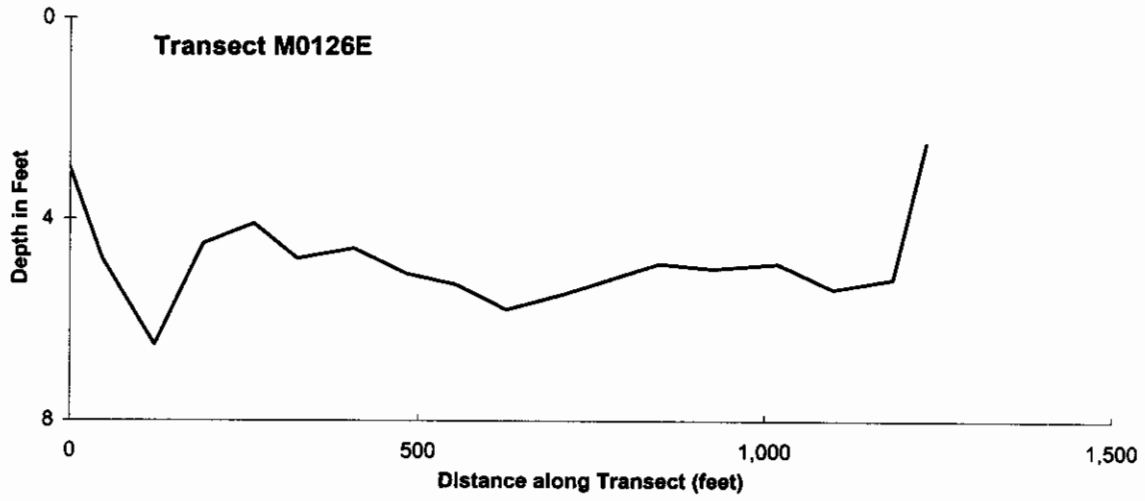
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	12.0	1.9	46.0	5.2	140	138	this study

Catch Record:

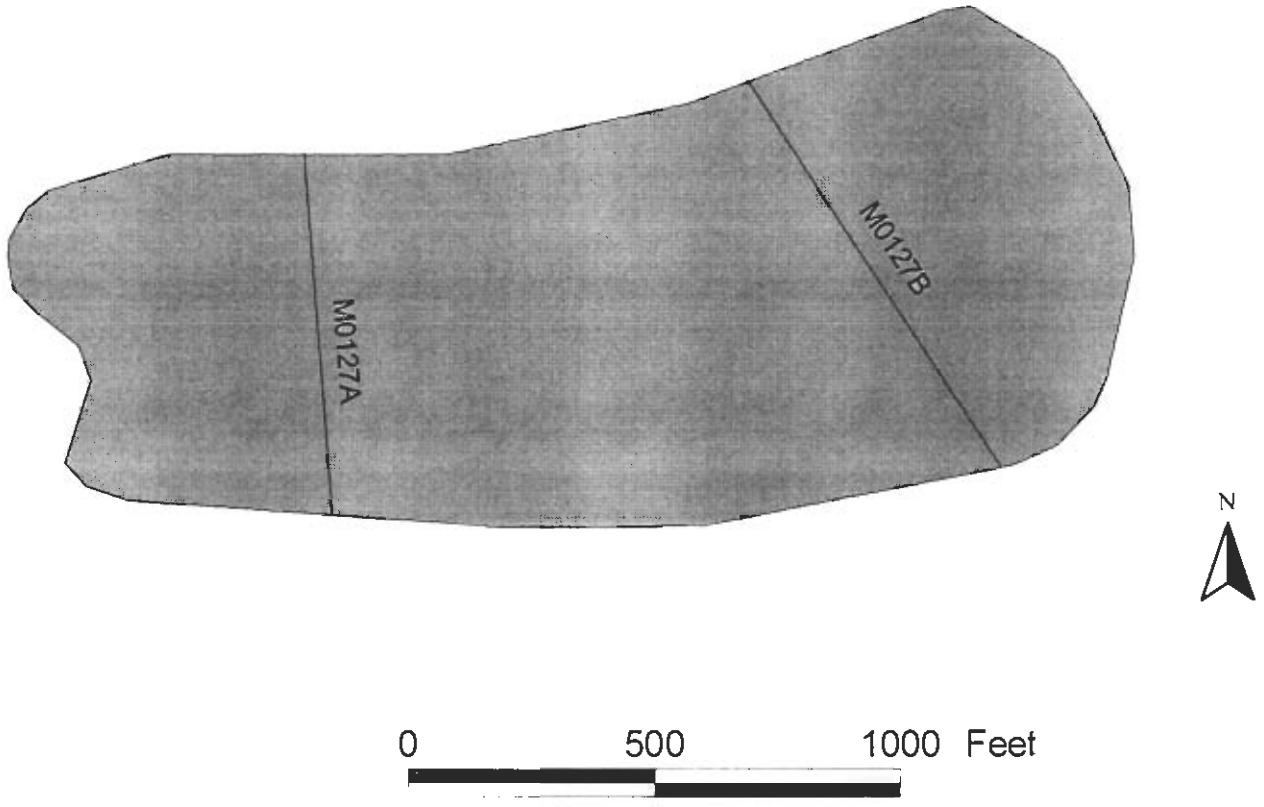
Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Aug 1 01	8.3	None	0


Transect M0126A
Depth in Feet
0
4
8
0
500
1,000
1,500
Distance along Transect (feet)
Transect M0126B
Depth in Feet
0
4
8
0
500
1,000
1,500
Distance along Transect (feet)
Transect M0126C
Depth in Feet
0
4
8
0
500
1,000
1,500
Distance along Transect (feet)


Transect M0126D
Depth in Feet
0
4
8
0
500
1,000
1,500
Distance along Transect (feet)


Transect M0126E
Depth in Feet
0
4
8
0
500
1,000
1,500
Distance along Transect (feet)

M0127

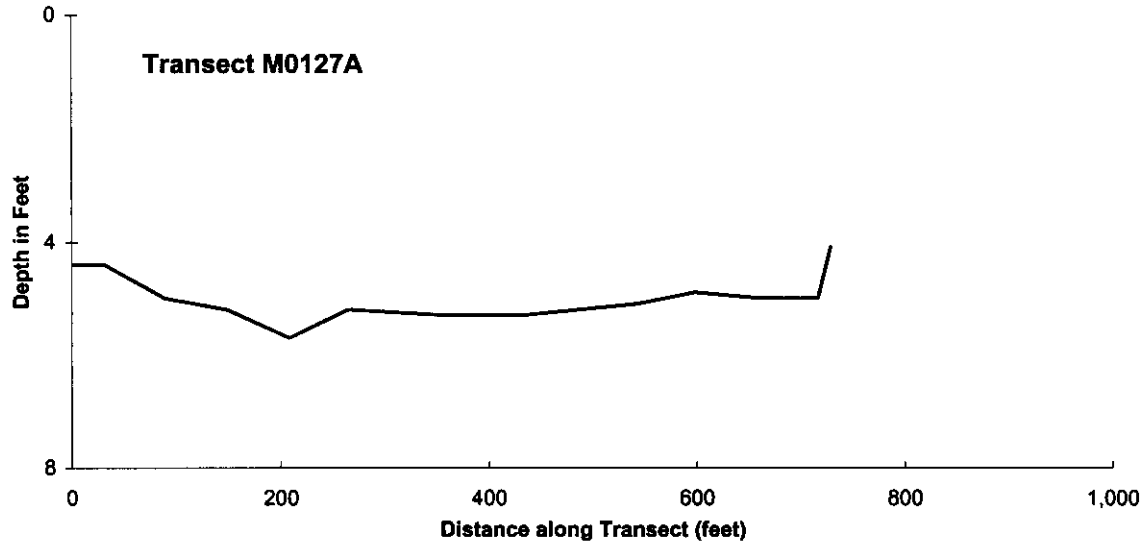


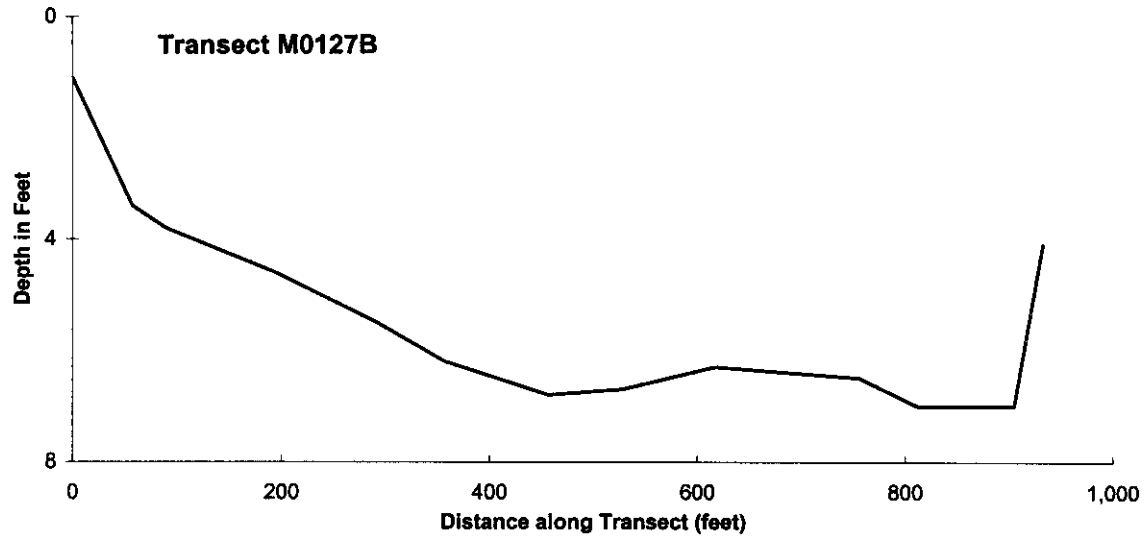
Lake M0127

Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T4N R7E, Section 13
Habitat:
Area: 39 acres
Maximum Depth: 7.0 feet
Active Outlet:
Turbidity: 2.5 NTU
Spec. Conductance: 148 µS/cm
pH: 8.9
Calculated Volume: 29.5 million gallons
Permittable Volume: No fish concern

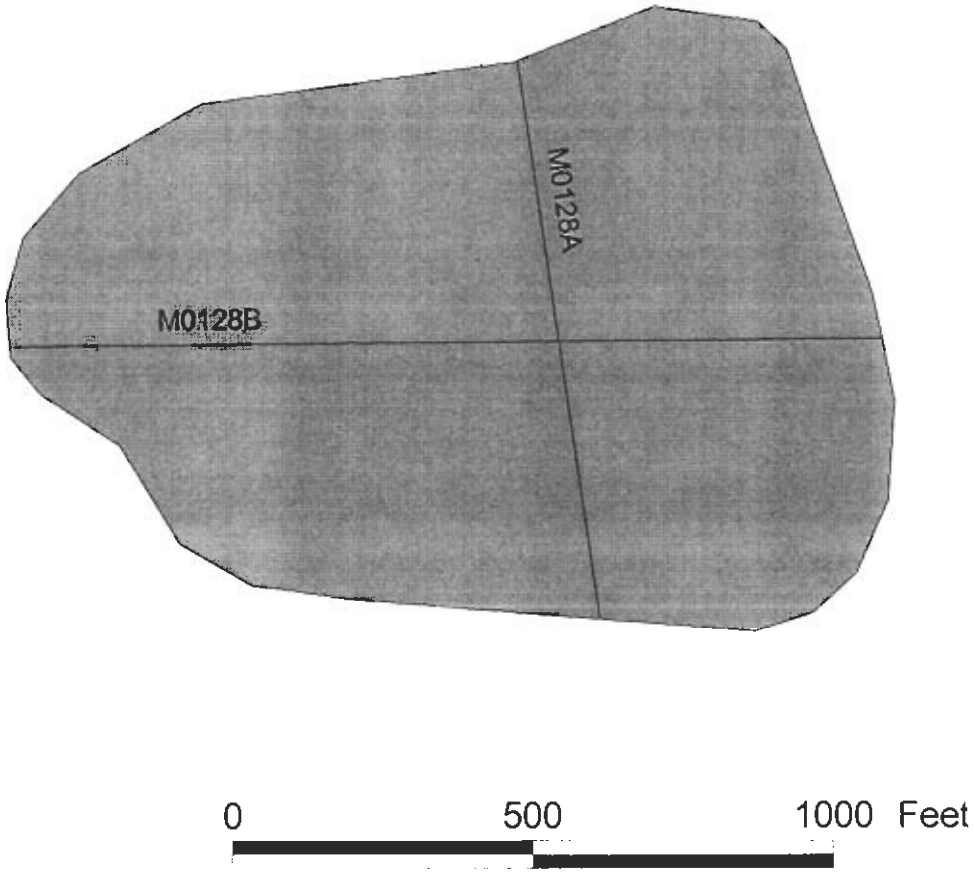
Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	2.9	0.8	30.0	2.8	86	88	this study


Transect M0127A
Depth in Feet
0
4
8
0
200
400
600
800
1,000
Distance along Transect (feet)


Transect M0127B
Depth in Feet
0
4
8
0
200
400
600
800
1,000
Distance along Transect (feet)

M0128

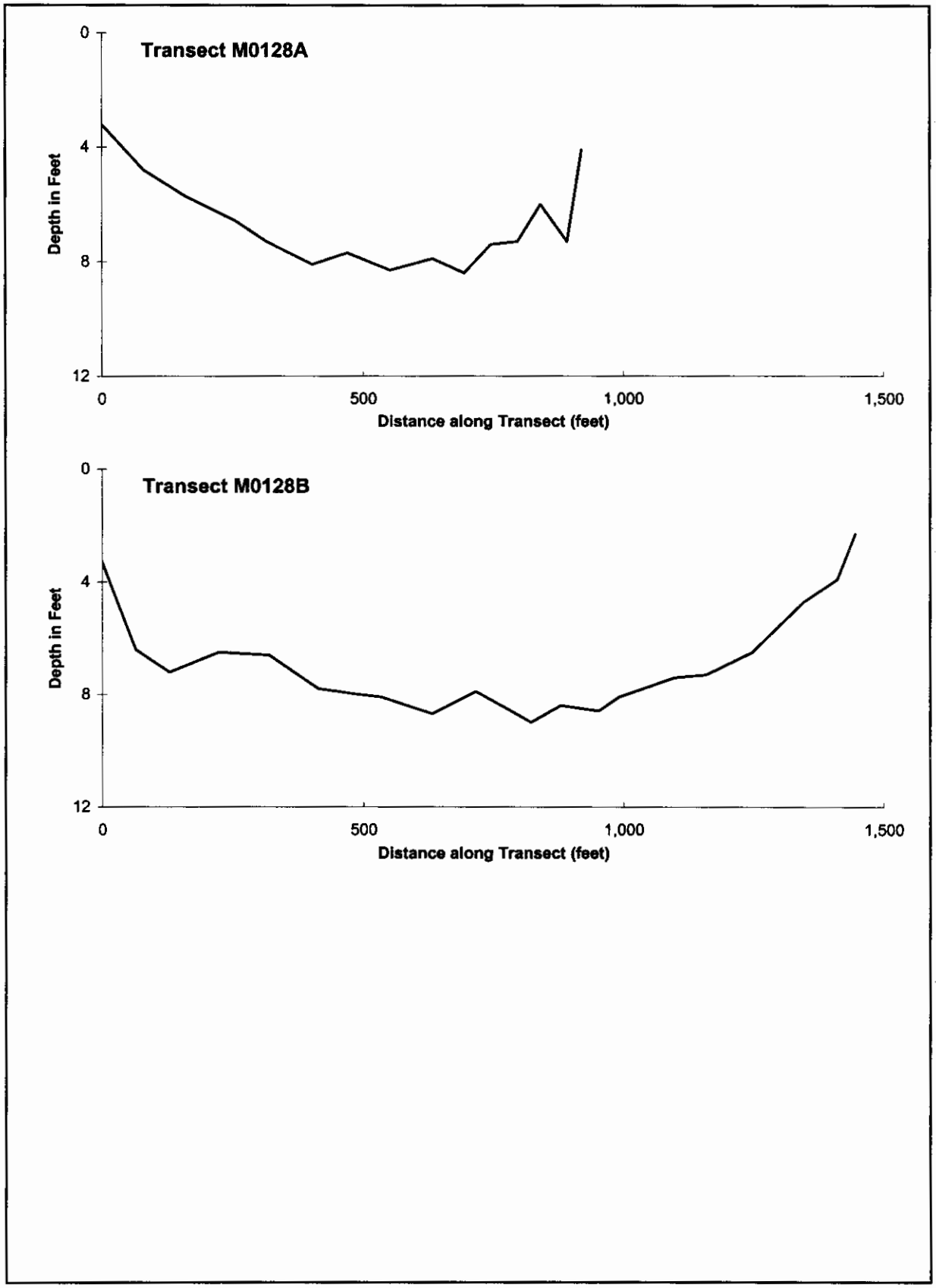


Lake M0128

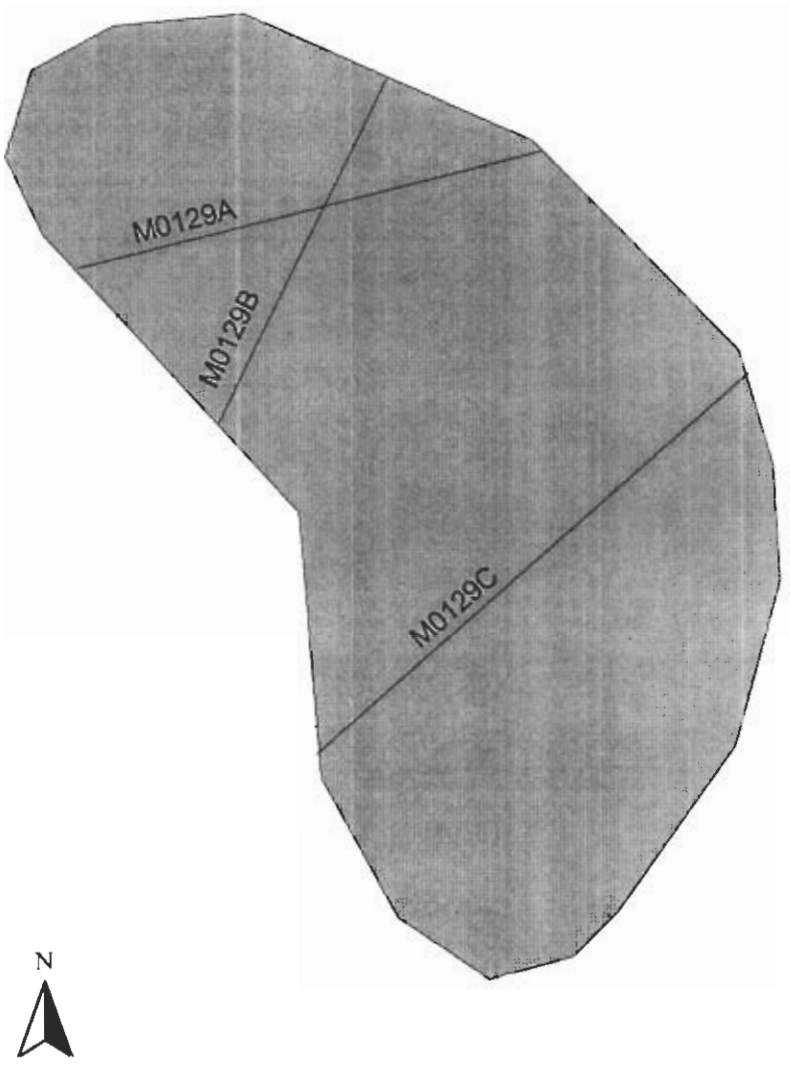
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T4N R7E, Section 11
Habitat:
Area: 27 acres
Maximum Depth: 9.0 feet
Active Outlet:
Turbidity: 2.3 NTU
Spec. Conductance: 150 µS/cm
pH: 8.0
Calculated Volume: 25.8 million gallons
Permittable Volume: No fish concern

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	2.8	0.9	30.0	2.9	88	104	this study


Transect M0128A
Depth in Feet
0
4
8
12
0
500
1,000
1,500
Distance along Transect (feet)
Transect M0128B
Depth in Feet
0
4
8
12
0
500
1,000
1,500
Distance along Transect (feet)

M0129



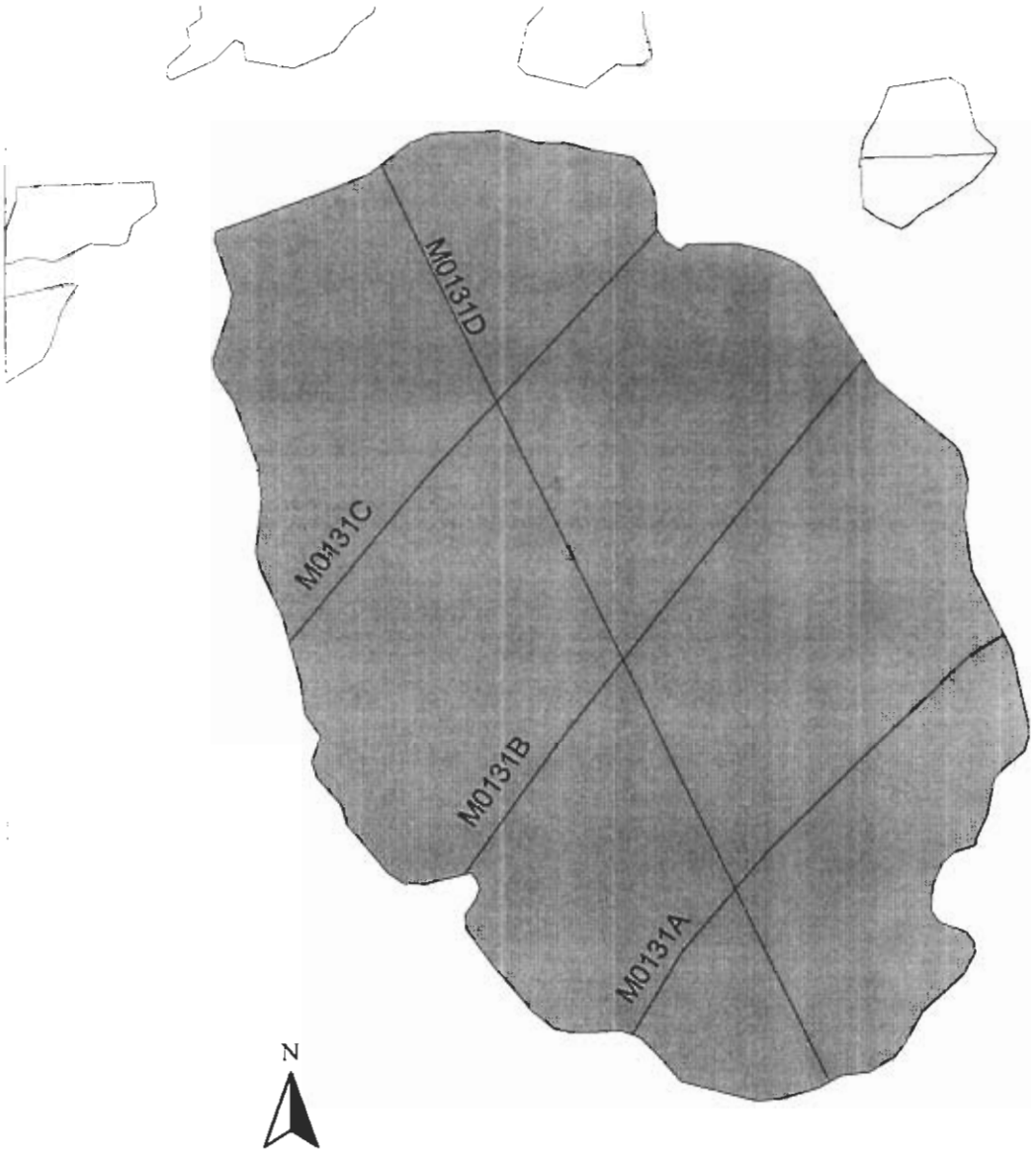
Lake M0129

Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T4N R8E, Section 7
Habitat:
Area: 6 acres
Maximum Depth: 10.0 feet
Active Outlet:
Turbidity: 1.2 NTU
Spec. Conductance: 209 µS/cm
pH: 8.1
Calculated Volume: 6.2 million gallons
Permittable Volume: No fish concern

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.6	1.0	45.0	3.6	130	142	this study

M0131



Lake M0131

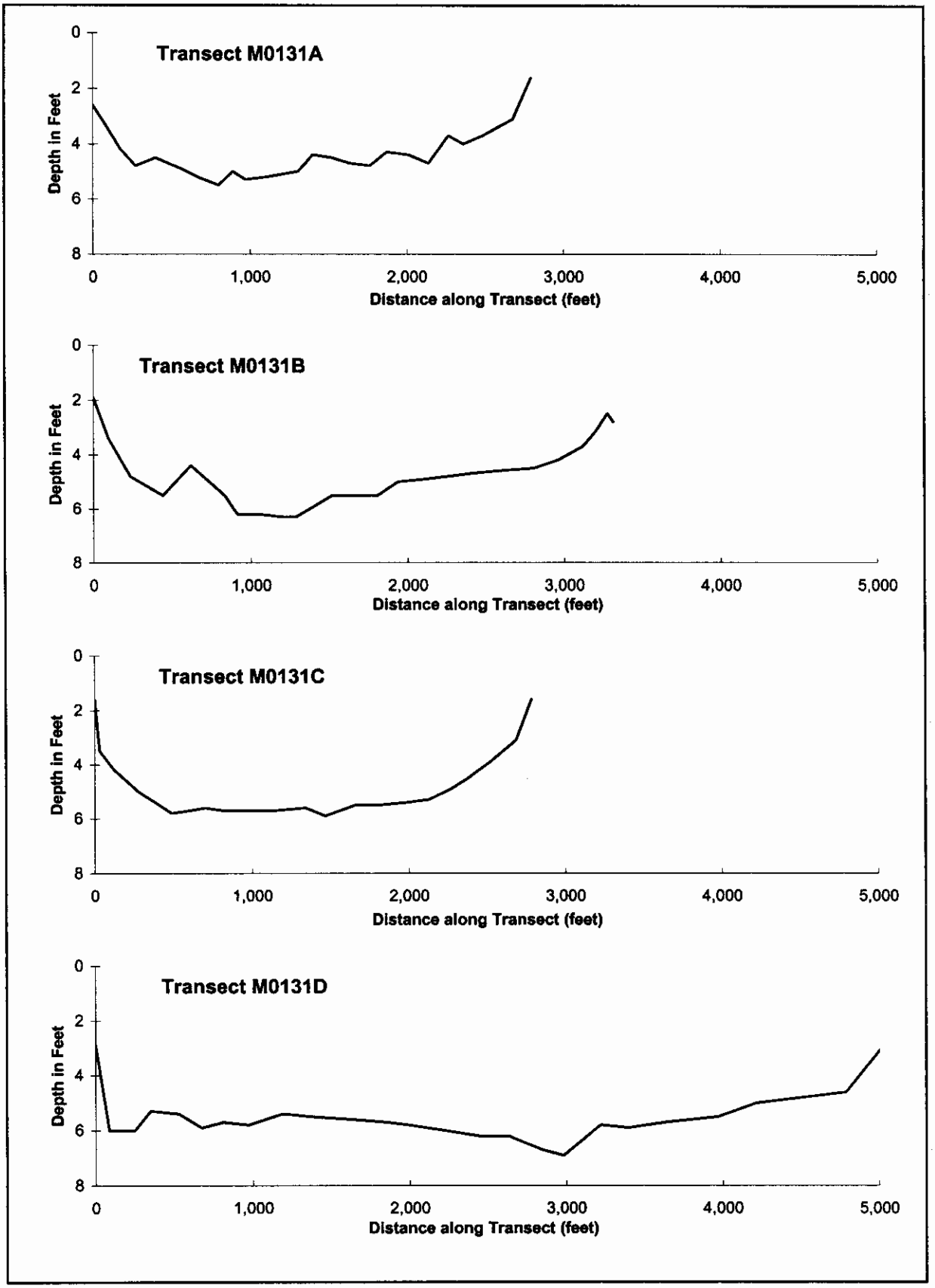
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T7N R5E, Section 1
Habitat:
Area: 321 acres
Maximum Depth: 6.9 feet
Active Outlet:
Turbidity: 1.4 NTU
Spec. Conductance: 193 µS/cm
pH: 8.2
Calculated Volume: 237.9 million gallons
Permittable Volume: No fish concern

Water Quality:

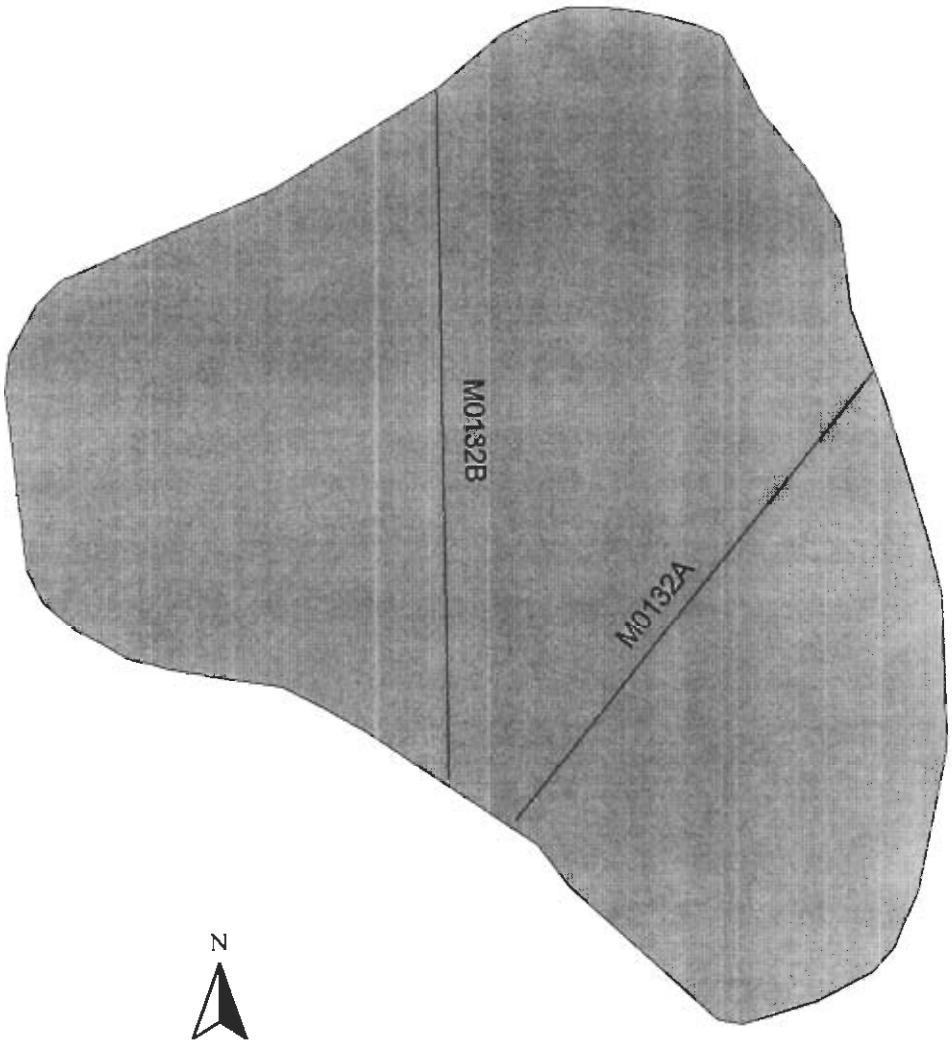
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	7.6	3.6	37.0	2.7	100	114	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Aug 3 01	13.1	None	0


Transect M0131A
Depth in Feet
0
2
4
6
8
0
1,000
2,000
3,000
4,000
5,000
Distance along Transect (feet)
Transect M0131B
Depth in Feet
Distance along Transect (feet)
Transect M0131C
Depth in Feet
Distance along Transect (feet)
Transect M0131D
Depth in Feet
Distance along Transect (feet)

M0132



0 500 1000 1500 2000 Feet

Lake M0132

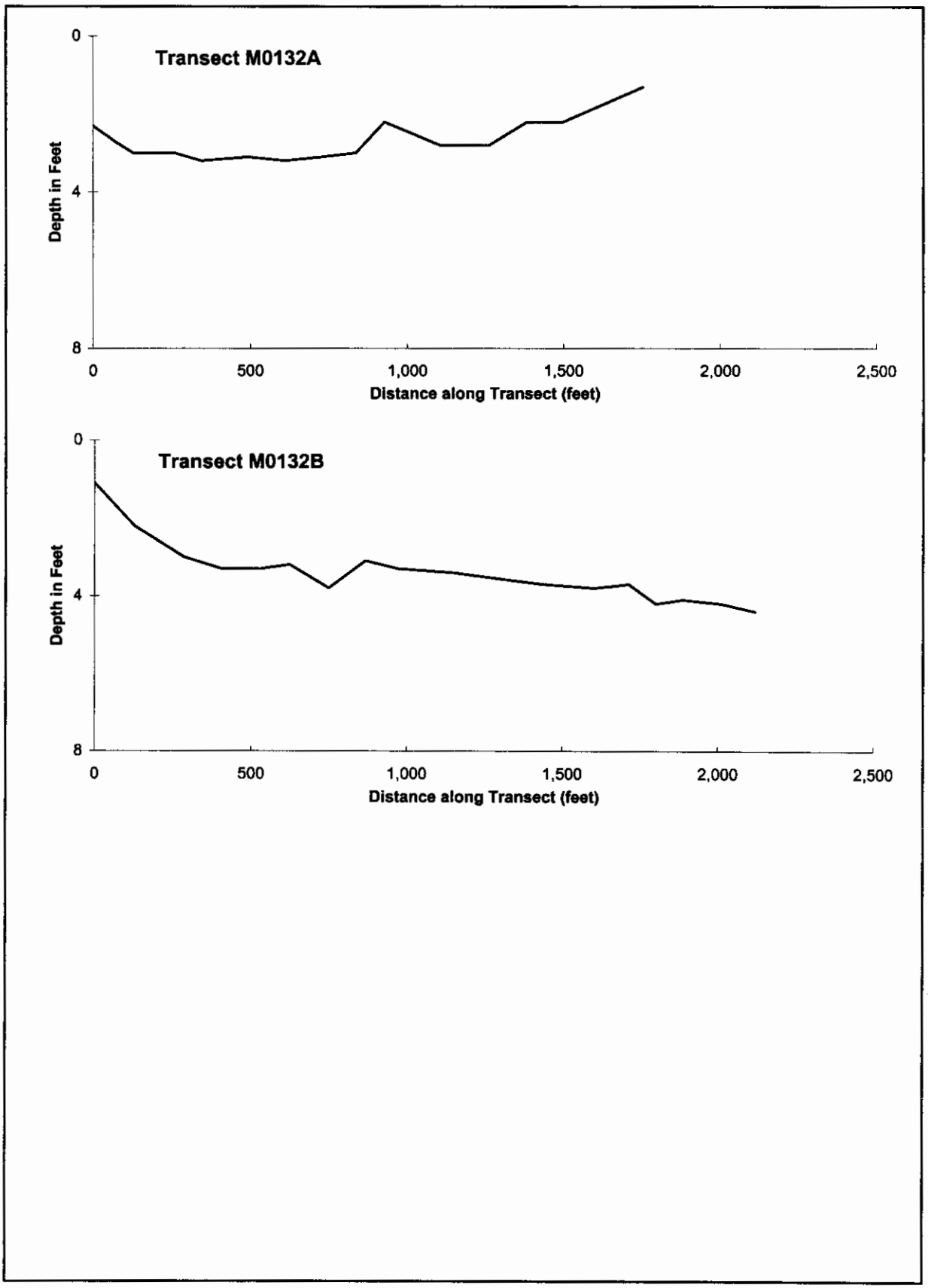
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R6E, Section 29/32
Habitat:
Area: 129 acres
Maximum Depth: 4.4 feet
Active Outlet:
Turbidity: 20.4 NTU
Spec. Conductance: 233 µS/cm
pH: 8.2
Calculated Volume: 61.0 million gallons
Permittable Volume: No fish concern

Water Quality:

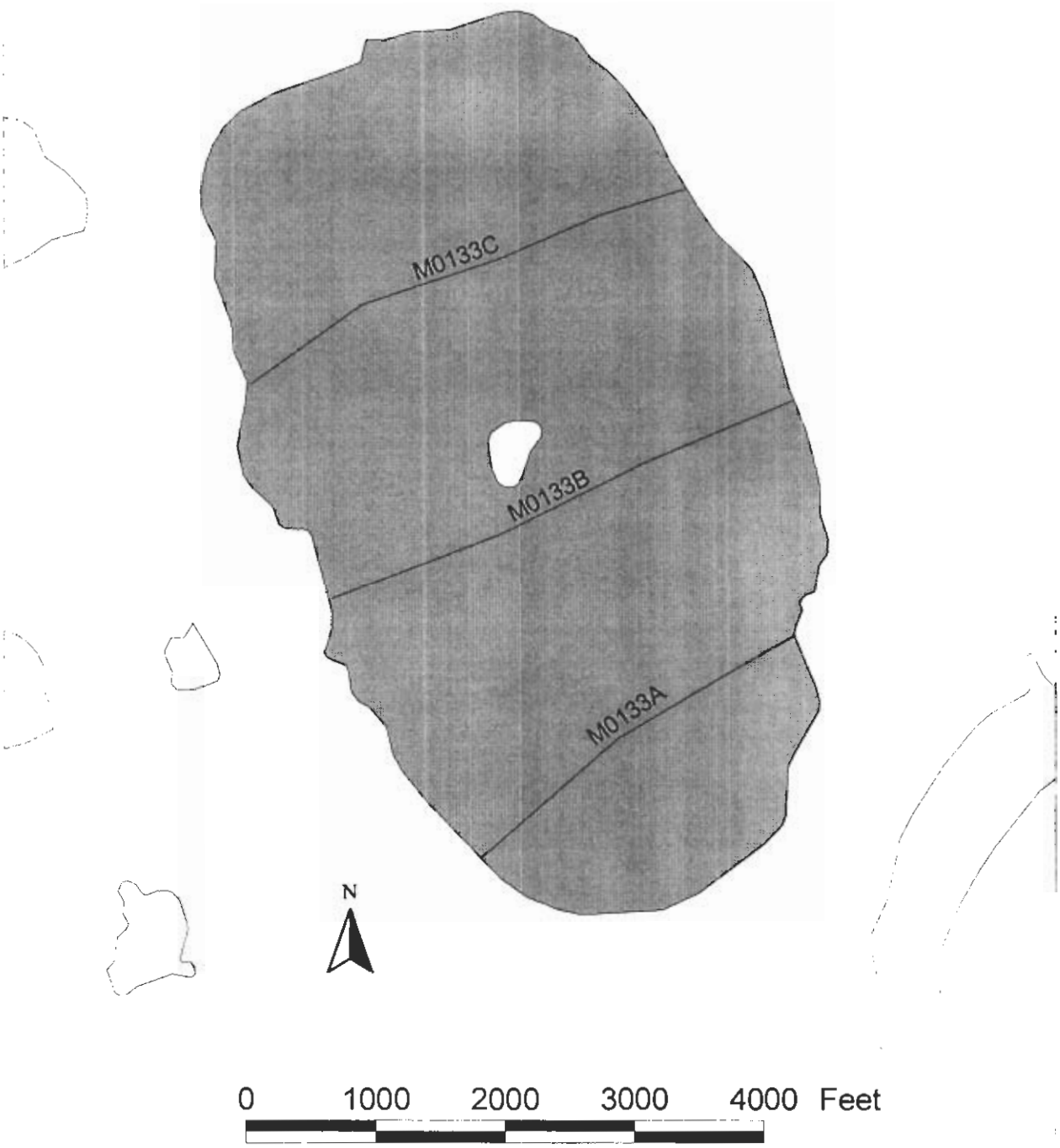
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	5.9	2.1	45.0	4.4	130	144	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Aug 3 01	2.6	None	0


Transect M0132A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M0132B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)

M0133



Lake M0133

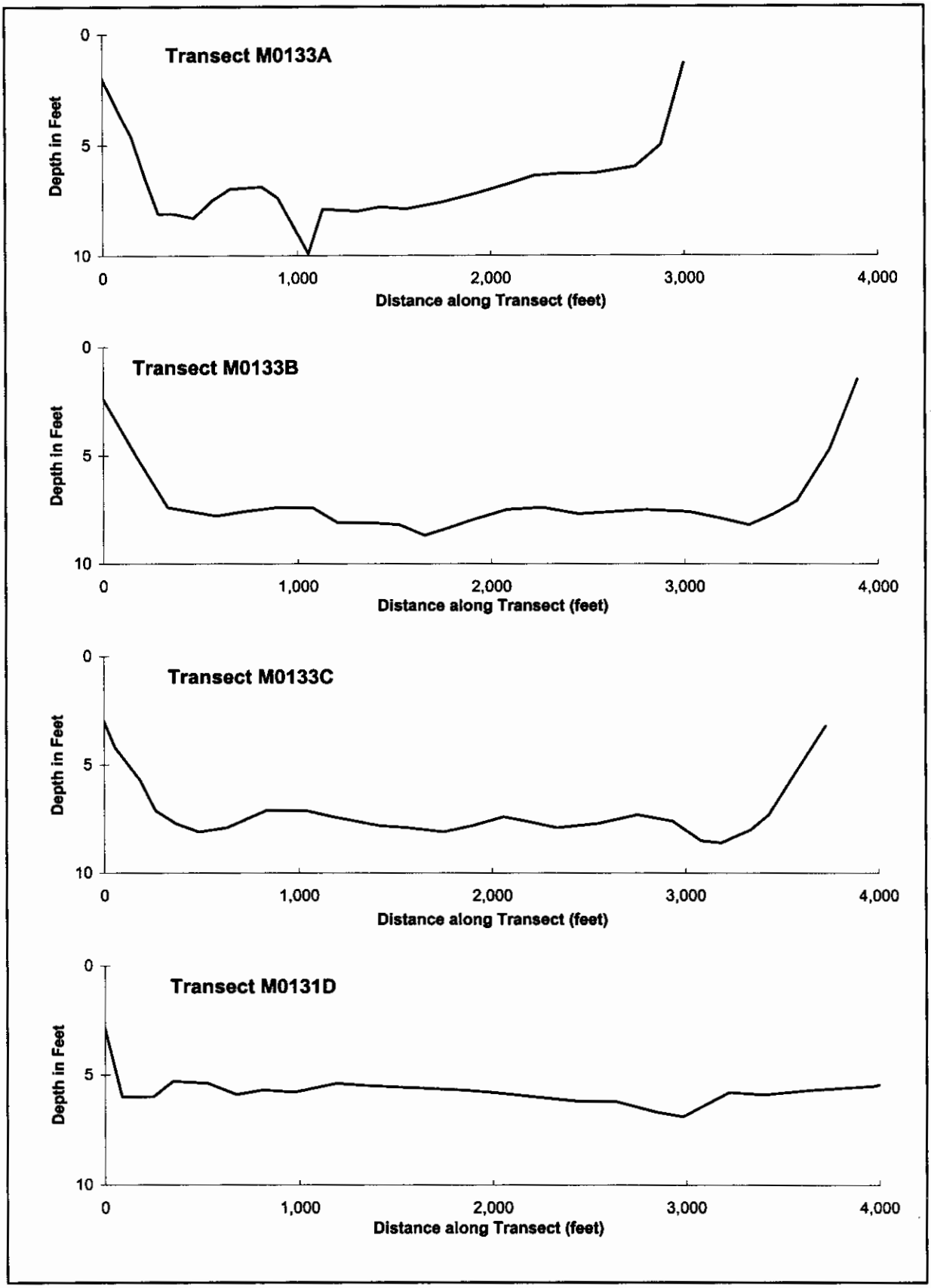
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T5N R5E, Section 16/21
Habitat:
Area: 546 acres
Maximum Depth: 9.9 feet
Active Outlet:
Turbidity: 0.7 NTU
Spec. Conductance: 147 µS/cm
pH: 8.1
Calculated Volume: 581.2 million gallons
Permittable Volume: 25.5 million gallons

Water Quality:

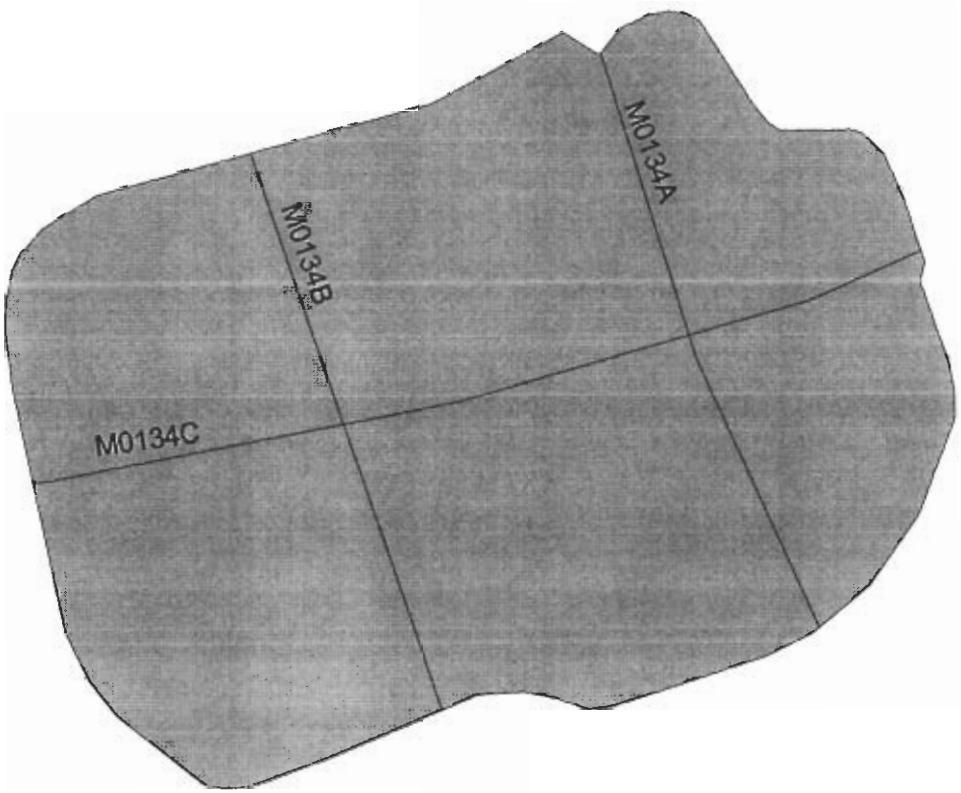
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	2.9	1.6	25.0	3.0	75	60	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Seen
Visual	Aug 30 01		Arctic grayling	3


Transect M0133A
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0133B
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0133C
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)
Transect M0131D
Depth in Feet
0
5
10
0
1,000
2,000
3,000
4,000
Distance along Transect (feet)

M0134

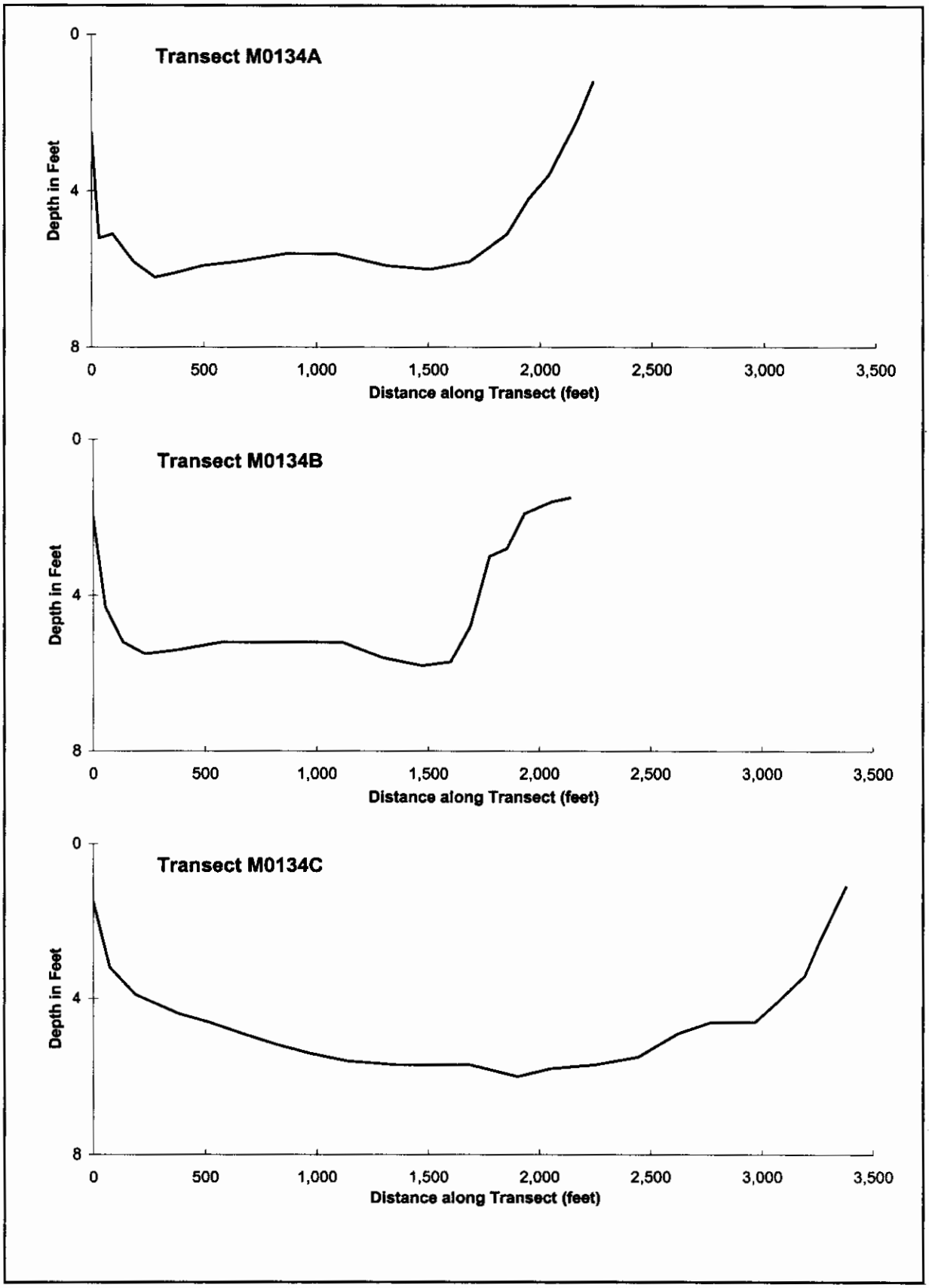


Lake M0134

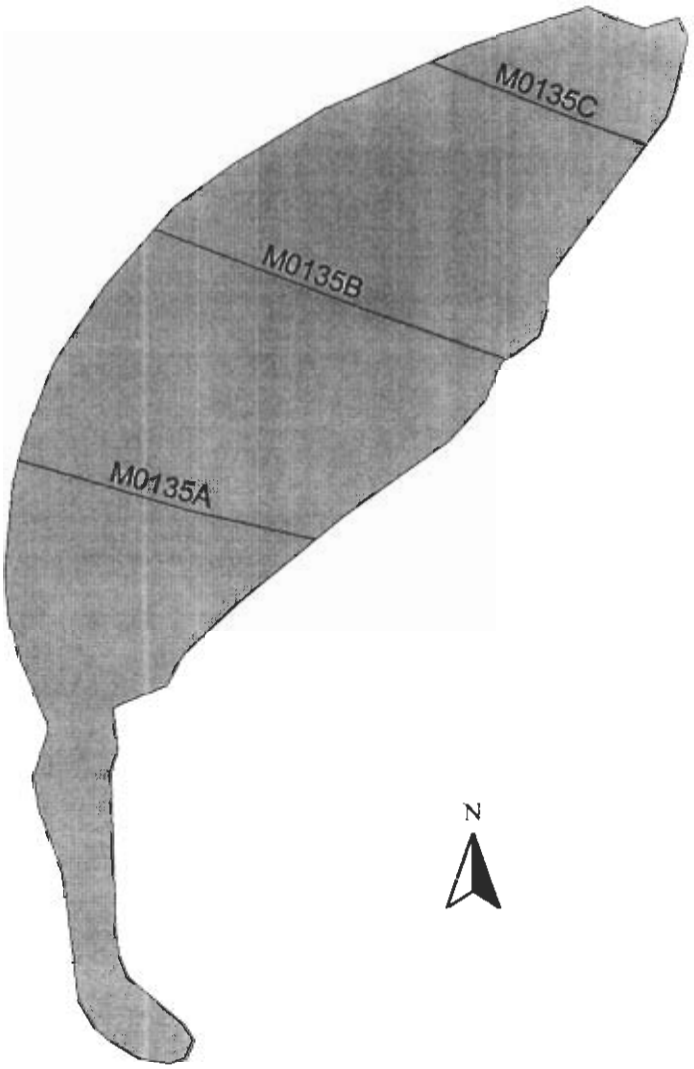
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R5E, Section 5/6
Habitat:
Area: 160 acres
Maximum Depth: 6.2 feet
Active Outlet:
Turbidity: 1.4 NTU
Spec. Conductance: 275 µS/cm
pH: 8.3
Calculated Volume: 106.4 million gallons
Permittable Volume: No fish concern

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	11.0	7.3	43.0	4.4	130	140	this study


Transect M0134A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)
Transect M0134B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)
Transect M0134C
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)

M0135



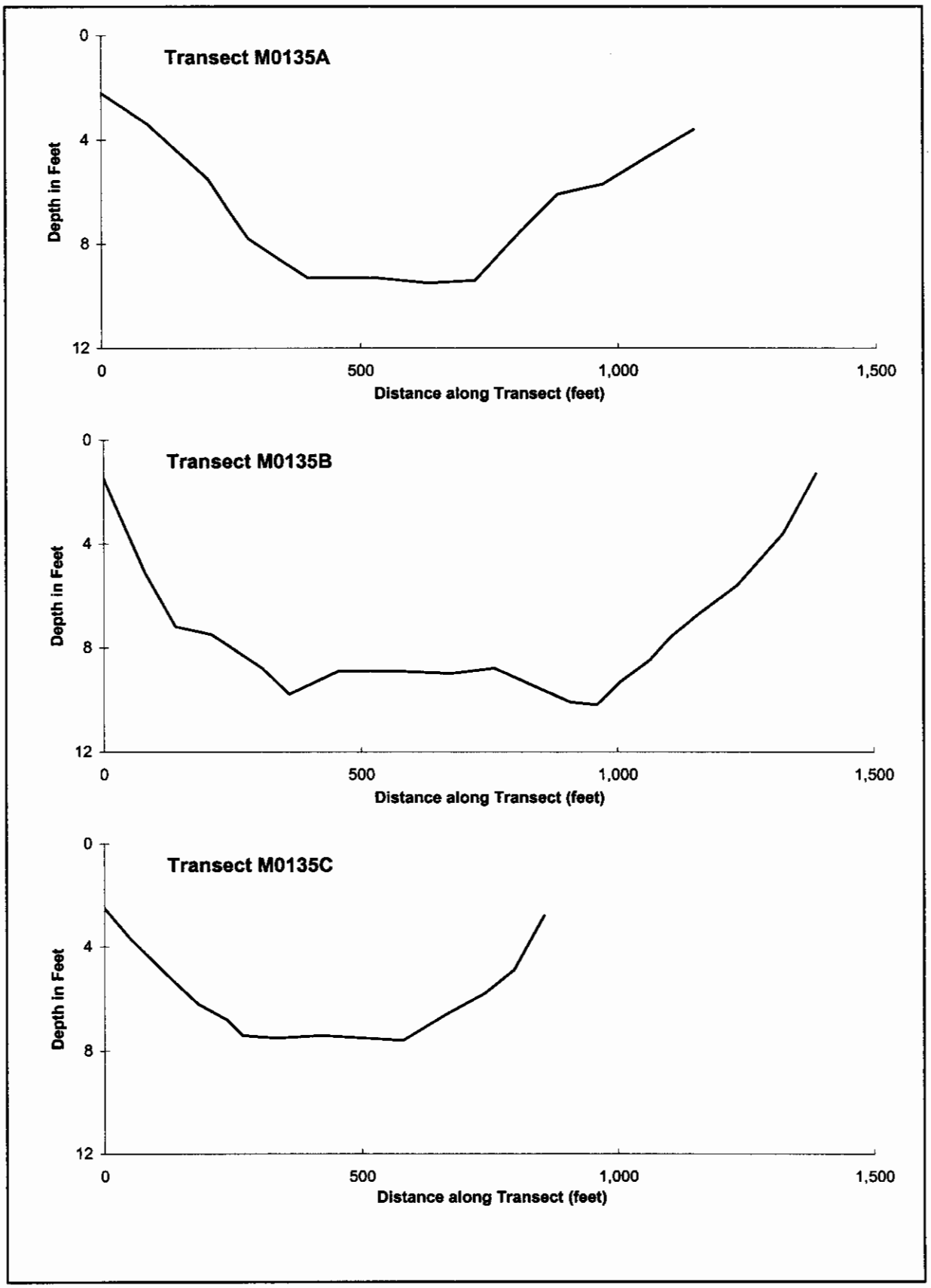
0 1000 2000 3000 Feet

Lake M0135

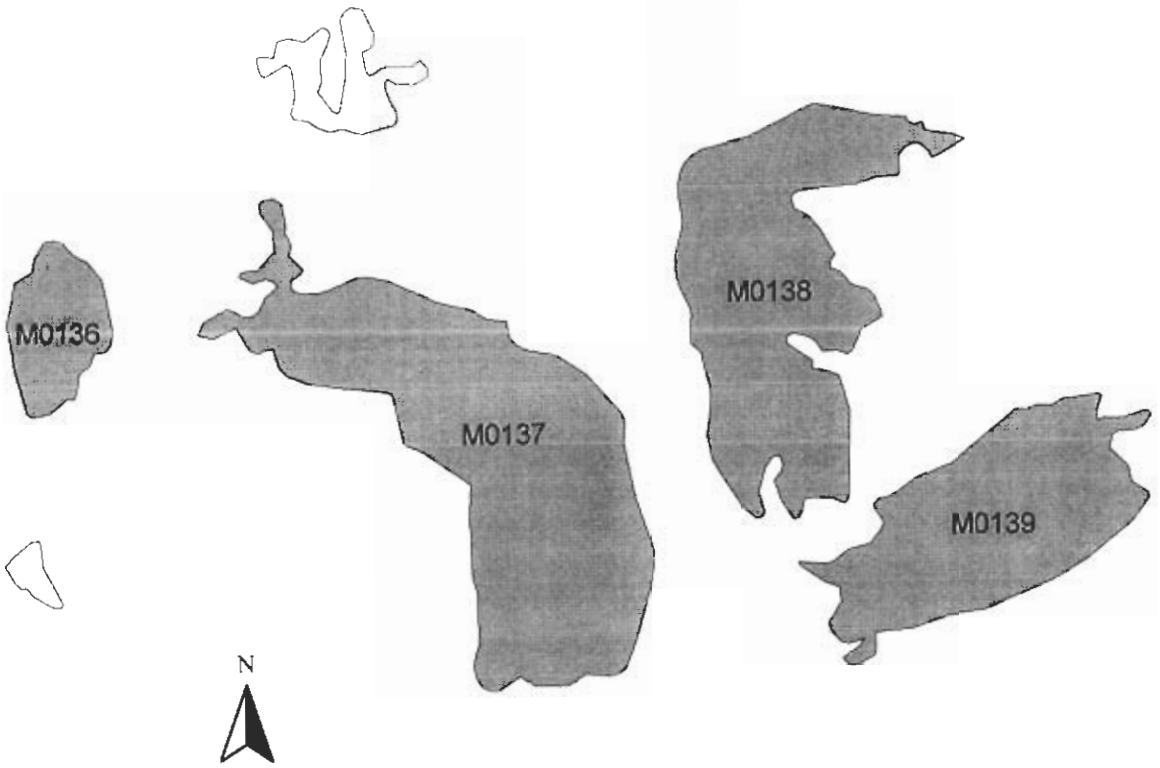
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T6N R5E, Section 4
Habitat:
Area: 84 acres
Maximum Depth: 10.2 feet
Active Outlet:
Turbidity: 1.1 NTU
Spec. Conductance: 141 µS/cm
pH: 8.1
Calculated Volume: 91.8 million gallons
Permittable Volume: 4.3 million gallons

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	3.8	2.1	22.0	2.9	68	70	this study


Transect M0135A
Depth in Feet
0
4
8
12
0
500
1,000
1,500
Distance along Transect (feet)
Transect M0135B
Depth in Feet
0
4
8
12
0
500
1,000
1,500
Distance along Transect (feet)
Transect M0135C
Depth in Feet
0
4
8
12
0
500
1,000
1,500
Distance along Transect (feet)

M0136-M0139



Lake M0136

Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N/7N R5E, Section 2/35
Habitat:	
Area:	23 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	NTU
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

Lake M0137

Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N R5E, Section 1
Habitat:	
Area:	149 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

Lake M0138

Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N/7N R5E, Section 1/36
Habitat:	
Area:	106 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

Lake M0139

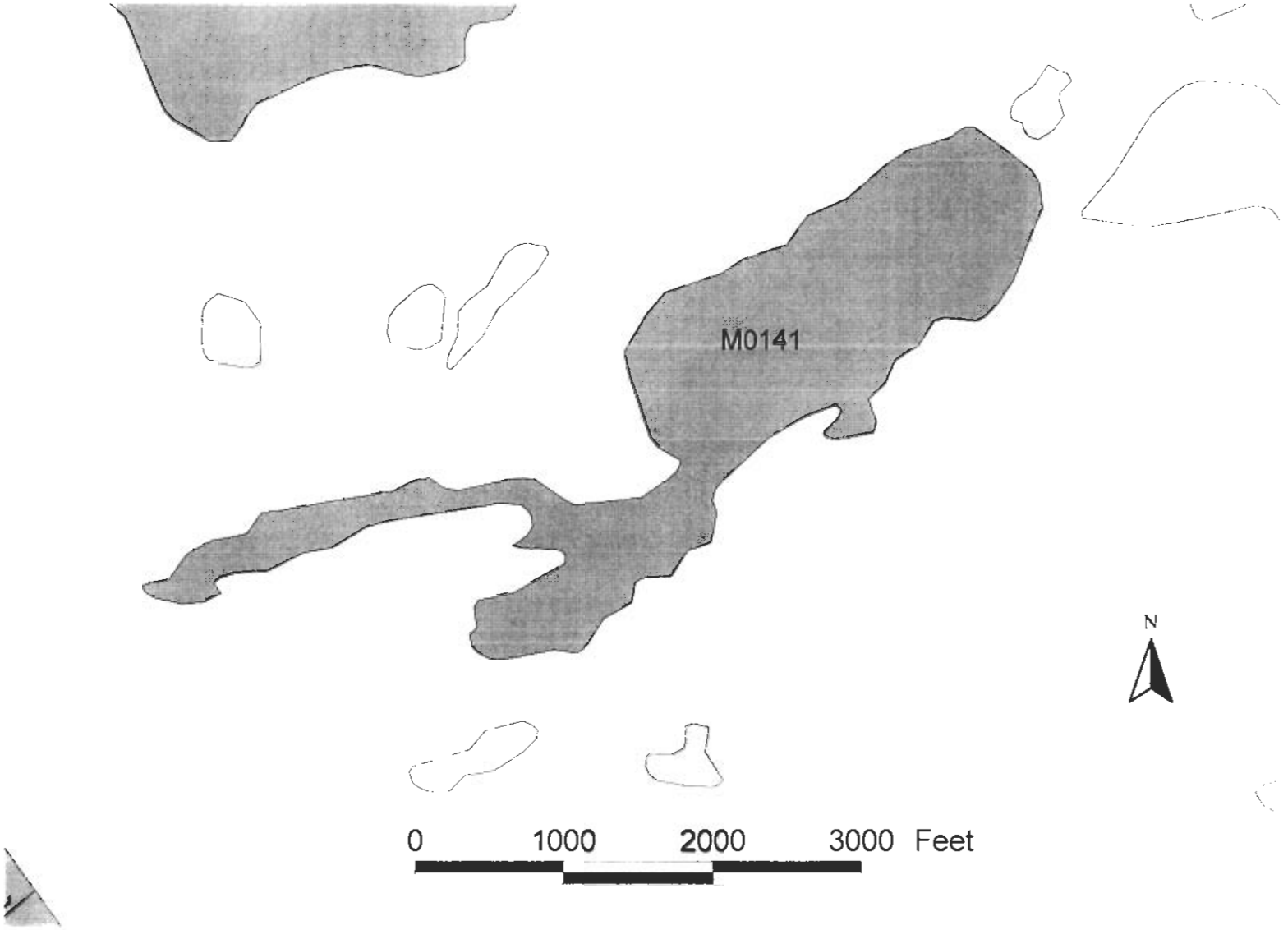
Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N R6E, Section 6
Habitat:	
Area:	83 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

M0140

Lake M0140

Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N R5E/6E, Section 13/24/18/19
Habitat:	
Area:	527 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

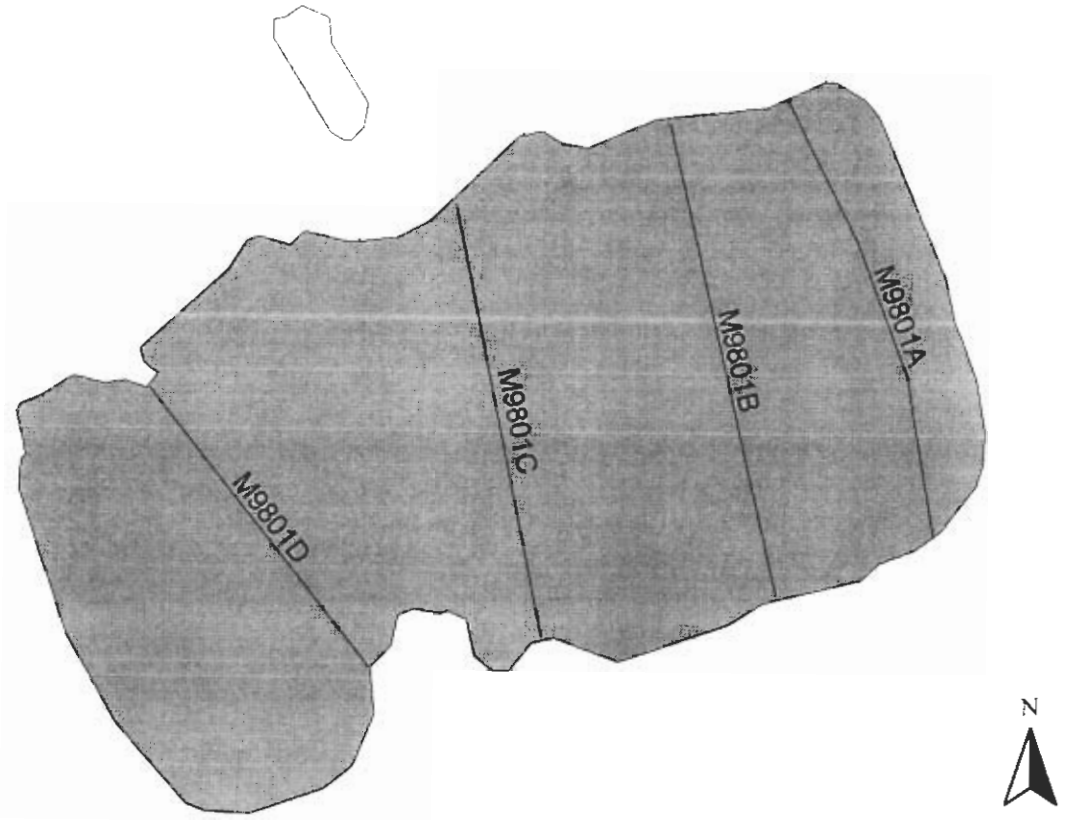
M0141



Lake M0141

Other Names:	
Location:	70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet:	T6N R6E, Section 19/30
Habitat:	
Area:	113 acres
Maximum Depth:	<4 feet
Active Outlet:	
Turbidity:	
Spec. Conductance:	
pH:	
Calculated Volume:	
Permittable Volume:	No fish concern

M9801



Lake M9801

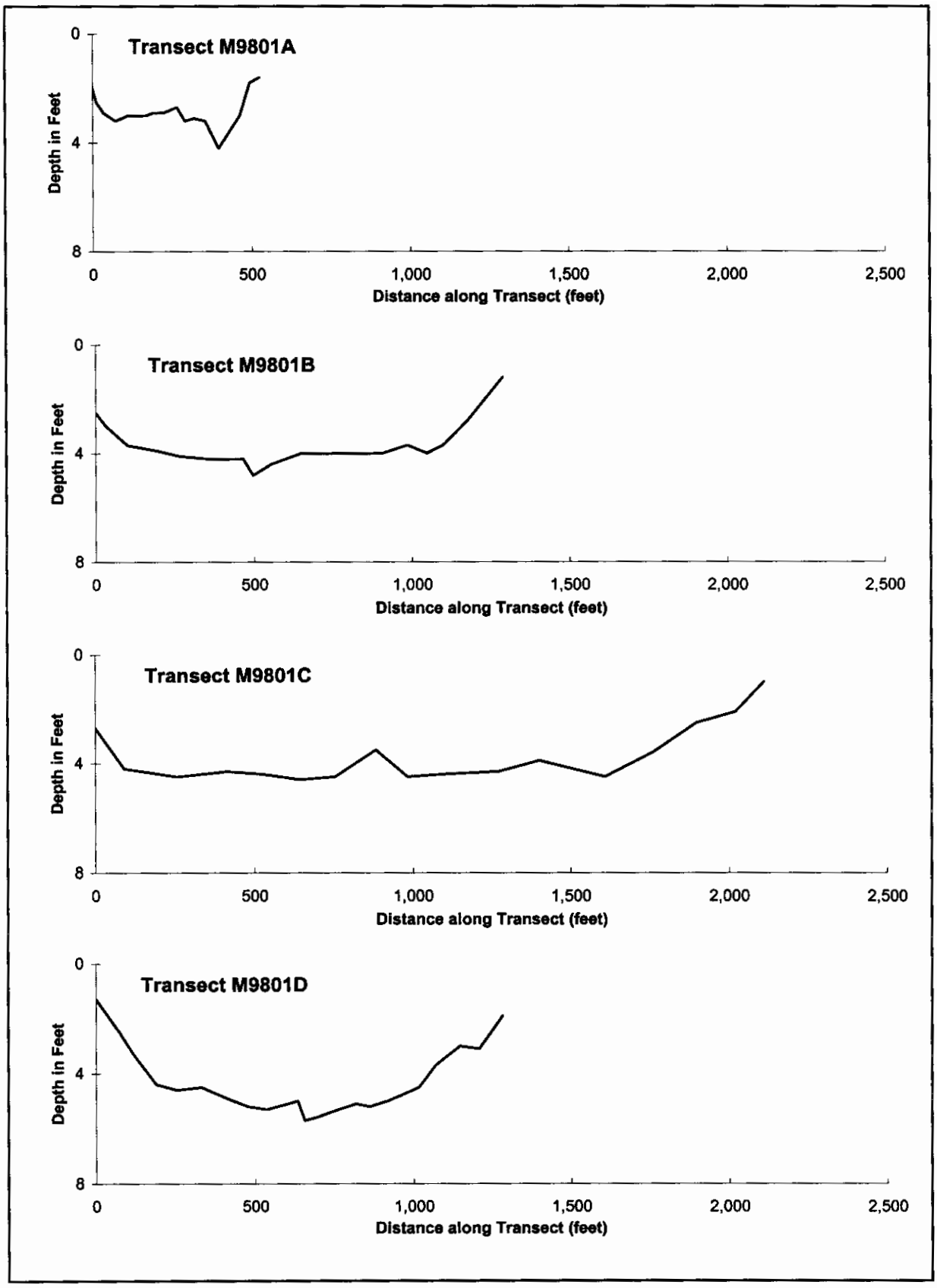
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T8N R6E, Section 15/16
Habitat: Tundra Lake
Area: 266 acres
Maximum Depth: 6.0 feet
Active Outlet:
Turbidity: 2.8 NTU
Spec. Conductance: 197 µS/cm
pH: 8.2
Calculated Volume: 171.6 million gallons
Permittable Volume: No fish concern

Water Quality:

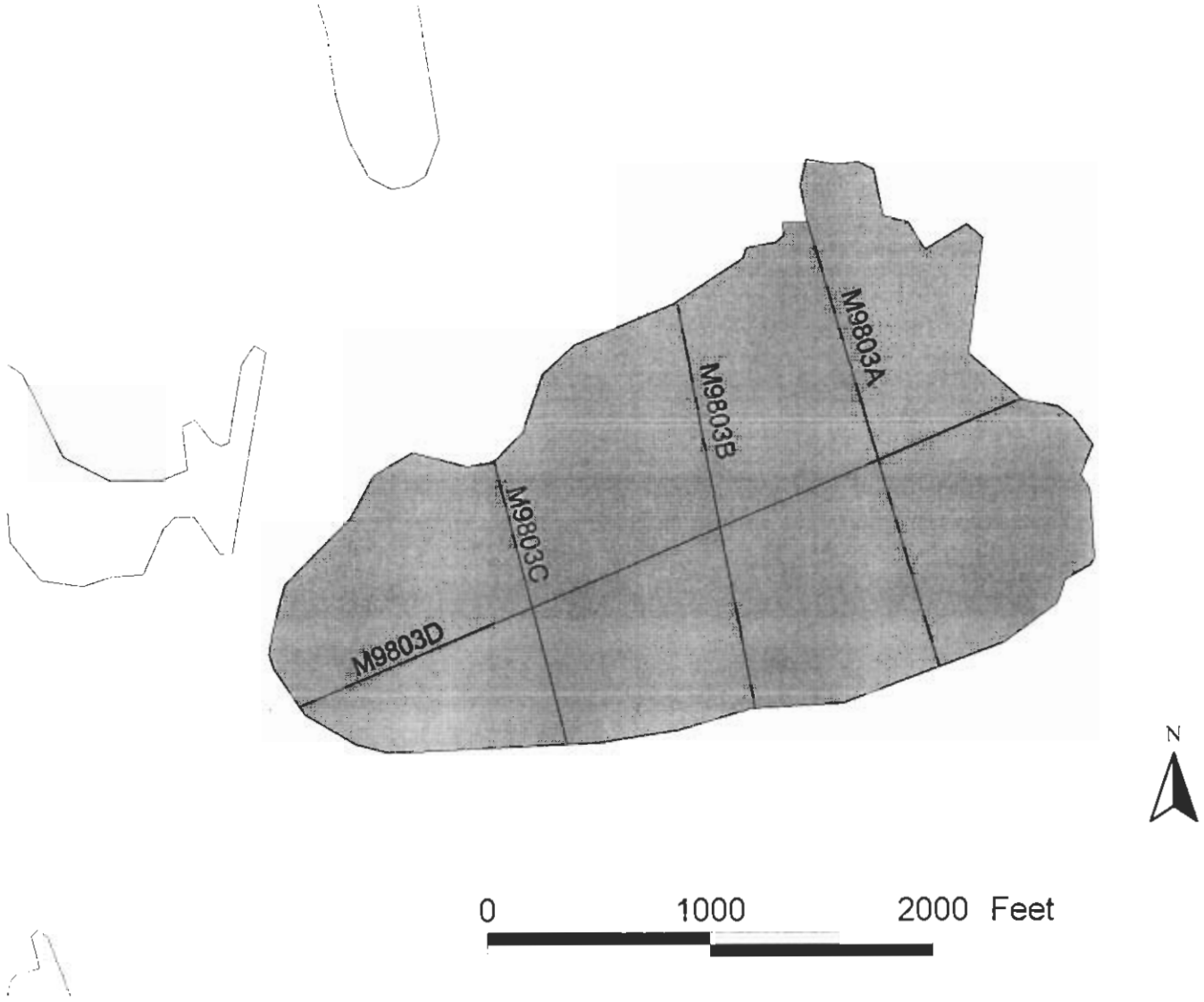
Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	11.0	3.9	36.0	2.3	98	94	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 25 01	13.9	None	0


Transect M9801A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M9801B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M9801C
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)
Transect M9801D
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
Distance along Transect (feet)

M9803



Lake M9803

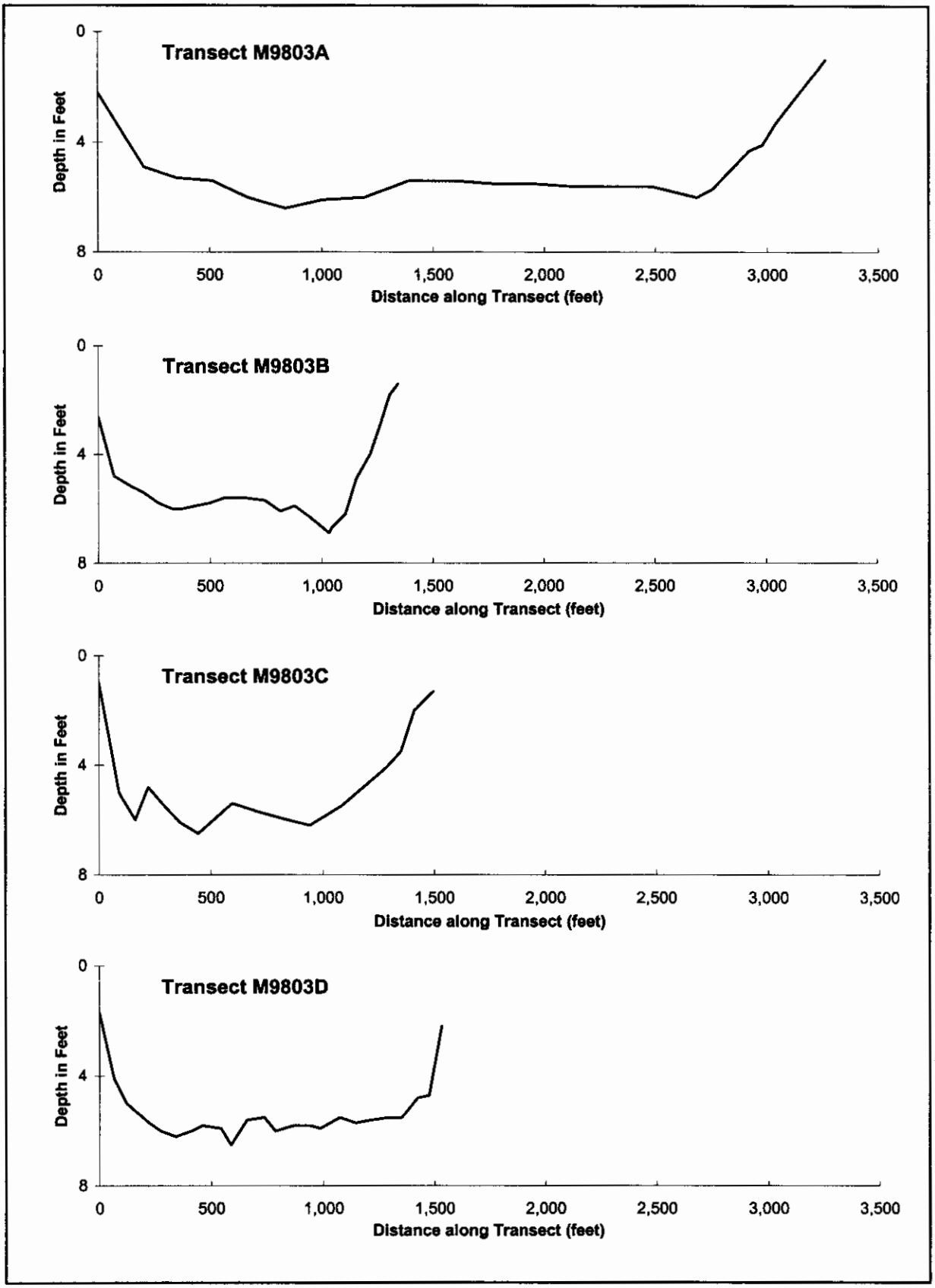
Other Names:
Location: 70° 16' 42.5"N 151° 40' 59.0"W
USGS Quad Sheet: T8N R6E, Section 3
Habitat: Tundra Lake
Area: 127 acres
Maximum Depth: 6.5 feet
Active Outlet:
Turbidity: 1.1 NTU
Spec. Conductance: 163 µS/cm
pH: 8.3
Calculated Volume: 88.8 million gallons
Permittable Volume: No fish concern

Water Quality:

Year of Test	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l	Total Hardness [CaCO3] (mg/l)	Total Dissolved Solids (mg/l)	Source
2001	7.5	2.2	29.0	1.9	81	54	this study

Catch Record:

Gear	Date	Effort (hours)	Species	Number Caught
Gill Net	Jul 25 01	7.2	None	0


Transect M9803A
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)
Transect M9803B
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)
Transect M9803C
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)
Transect M9803D
Depth in Feet
0
4
8
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance along Transect (feet)