Lake Name: Boot	**Survey Type: Targeted Survey**
DOW Number: 03-0030-00	**Survey ID Date: 08/12/2020**

Lake Identification

Alternate Lake Name:	N/A	DNR Sounding Map Number:	C0737
Primary Lake Class ID:	23	Alternate Lake Class ID:	N/A

Lake Location

Primary County:	Becker	Nearest Town:	Two Inlets

Legal Descriptions

Lake Center:	Township - 142N	Range - 36W	Section - 32
PLS Section Lake Center:	14203632		

All Legal Descriptions:

Becker County:	Township - 141N	Range - 36W	Sections - 5, 6
	Township - 142N	Range - 36W	Sections - 29, 32

Area Office

Area Name:	Park Rapids	ORG Code:	F117
Region Name:	Northwest	Region Number:	1

Lake Access

(Information based on Population Assessment dated 08/16/2011)

Station ID	Ownership	Public Use	Type	Location / Comments
AC - 1	DNR	Open to Public use	Concrete	DNR access located on the north shore.

Lake Characteristics

Lake Area (planimetered acres):	348.00		GIS Shoreline Length (miles):	6.78
GIS Lake Area (acres):	385.10		Maximum Fetch (miles):	1.80
DOW Lake Area (acres):	401.00		Fetch Orientation (degrees):	45
Littoral Area (acres):	81.00		USGS Quad Map Number:	J08d
Area in MN (acres):	385.10		USGS Quad 24K GIS Index:	1916
Maximum Depth (feet):	109.0			
Mean Depth (feet):	N/A			

Watershed Characteristics

Major Watershed		**Minor Watershed**	
Name:	Crow Wing River	Name:	Basswood Cr
Watershed Number:	12	Watershed Number:	54
Watershed size (acres):	1,268,954	Watershed size (acres):	20,109

Surveys and Investigations

Initial Survey:	09/06/1951.
Re-Survey:	08/05/1991, 07/29/1974.
Population Assessment:	08/16/2011, 08/14/2006, 08/08/2001, 08/05/1996, 08/04/1986, 08/12/1981.
Special Assessment:	09/04/2008, 05/31/2006, 08/16/2004, 05/27/2004, 06/05/2002.
Standard Survey:	08/15/2016.
Targeted Survey:	08/12/2020, 09/27/2018, 07/12/2016.

Water Level History - Readings

Station ID	Date	Level	Reading (feet)	Reading Type
BM - 1	08/15/2016	Normal	-3.40	Above or below Benchmark
	08/11/2011	Normal	-3.34	Above or below Benchmark
	08/14/2006	Low	-3.95	Above or below Benchmark
BM - 2	08/17/2016	Normal	-1.15	Above or below Benchmark
	08/11/2011	Normal	-0.95	Above or below Benchmark
	08/16/2006	Low	-1.20	Above or below Benchmark
BM - 3	08/11/2011	Normal	-2.43	Above or below Benchmark
	08/14/2006	Low	-3.05	Above or below Benchmark

Water Level History - Station Summary

Station ID	Minimum Level		Maximum Level		Range (feet)	Average Level (feet)	Reading Type (and number of readings)
	Feet	**Date**	**Feet**	**Date**			
BM - 1	-3.95	08/14/2006	-3.34	08/11/2011	0.61	-3.56	Above or below Benchmark (3)
BM - 2	-1.20	08/16/2006	-0.95	08/11/2011	0.25	-1.10	Above or below Benchmark (3)
BM - 3	-3.05	08/14/2006	-2.43	08/11/2011	0.62	-2.74	Above or below Benchmark (2)

Survey Crew Notes

VGN survey to confirm Cisco presence.

Discussion

A vertical gill net (VGN) survey was conducted by Index of Biological Integrity (IBI) program staff on Boot Lake (DOW# 03-0034-00) during August 12-13, 2020. A VGN gang consists of seven different sized meshes set side-by-side that extend from the water surface to the bottom over the deepest areas of the lake. A VGN gang is set overnight and is designed to sample pelagic (i.e., open water) species such as Cisco, also known as Tullibee. This sampling was conducted on Boot Lake to confirm Cisco presence, since the species had only been sampled in one of twelve standard gill net (GN) surveys conducted between 1951 and 2016 despite temperature oxygen profiles indicating suitable habitat for the species over that period. Additionally, the morphology of Boot Lake (e.g., maximum depth) may not be conducive to sampling Cisco in GNs but is favorable for VGN sampling.

During the 2020 VGN survey, 43 Cisco were captured in two VGN gangs set in 100 and 71 feet of water (Figure 1). A majority of the Cisco catch (93%) was from VGN gang 1, which was located in the deeper, southern basin. Between VGN gangs, Cisco total length averaged 4.7 inches and varied from 3.9-14.3 inches (Figure 2). Cisco were sampled in waters from 20-43 feet deep, and the average depth at capture was 35 feet (Figures 3 and 4). These waters varied in temperature from 7.1-23.5°C (44.8-74.3°F) and dissolved oxygen concentration from 0.9-11.3 mg/L.

Other fish species that were sampled included Black Crappie (n=1), Bluegill (n=1), Northern Pike (n=10), Walleye (n=9), and Yellow Perch (n=73), and most were sampled at or above the thermocline. Northern Pike were the exception, with several individuals sampled as deep as 36 feet.

The top of the thermocline in Boot Lake was set up at approximately 20 feet at each VGN gang location and dissolved oxygen decreased to below 3.0 mg/L (i.e., TDO3) at 38 feet and 7.7°C (45.9°F; Figure 3) or 30 feet and 10.1°C (50.2°F; Figure 4) at the time of sampling. Dissolved oxygen concentrations below the thermocline indicate that oxythermal habitat was adequate for Cisco at some depths at the time of sampling during the summer of 2020. However, low oxygen conditions (less than 3 mg/L) and warm surface temperatures did limit Cisco distribution within the water column to an extent. When adequate oxythermal habitat is available, Cisco are not squeezed into unfavorable, warmer water conditions and therefore do not experience higher levels of stress.

The Secchi transparency measurements at the time of sampling were 13 and 15 feet whereas total phosphorus and chlorophyll-a have averaged approximately 7 and 1 parts per billion, respectively. These water quality parameters correspond with the sufficient oxythermal habitat observed during this survey.

Factors that can influence oxythermal habitat include eutrophication (excess nutrients) and climate change. Eutrophication can lead to depletion of dissolved oxygen in the deeper, colder waters as a result of increased rates of organic material decomposition and decay. Climate change can lead to extended periods of summer stratification and warming of surface waters. The combination of these factors can contribute to a habitat squeeze that leads to physiological stress and summer kill events for coldwater species such as Cisco.

Status Of The Fishery

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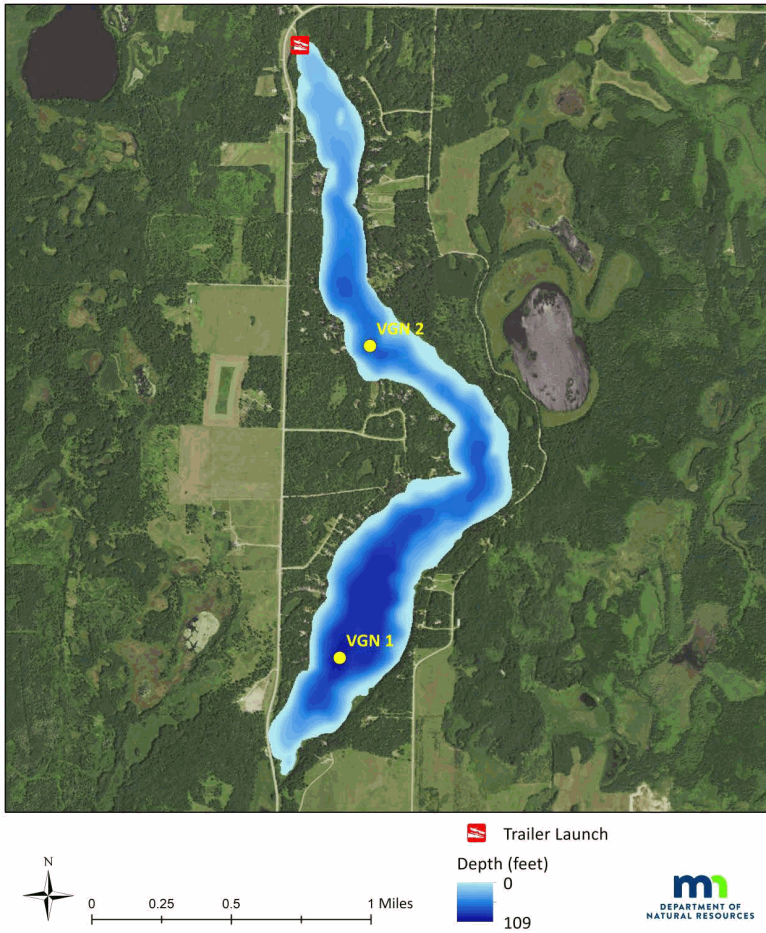
Survey Attachments

Attachment #1: Map   **Title:** Boot Lake VGN Map

Boot Lake (03-0030-00)
2020 Vertical Gill Net Gang Locations

File Name: Boot Figures_Page_1.jpg

UTM Easting: -
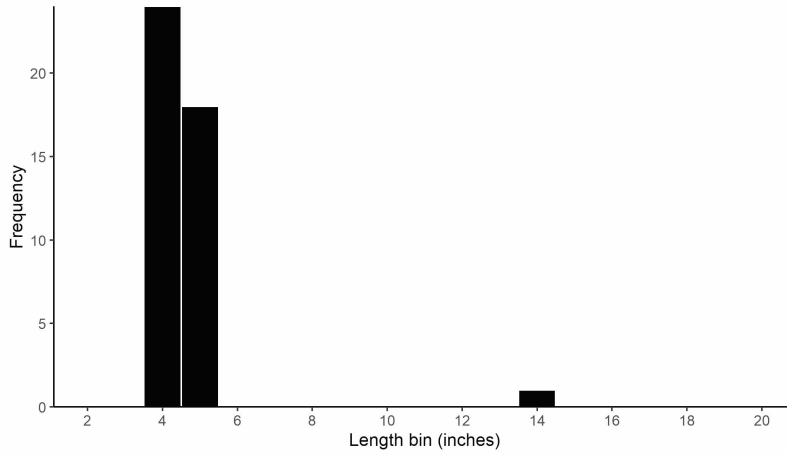**UTM Northing:** -

Date: 03/12/2021
Time: 10:11 am

Notes: Boot Lake VGN Map

Survey Attachments (*Continued*)

Attachment #2: Graph   **Title:** Cisco length frequency histogram

File Name: Boot Figures_Page_2.jpg

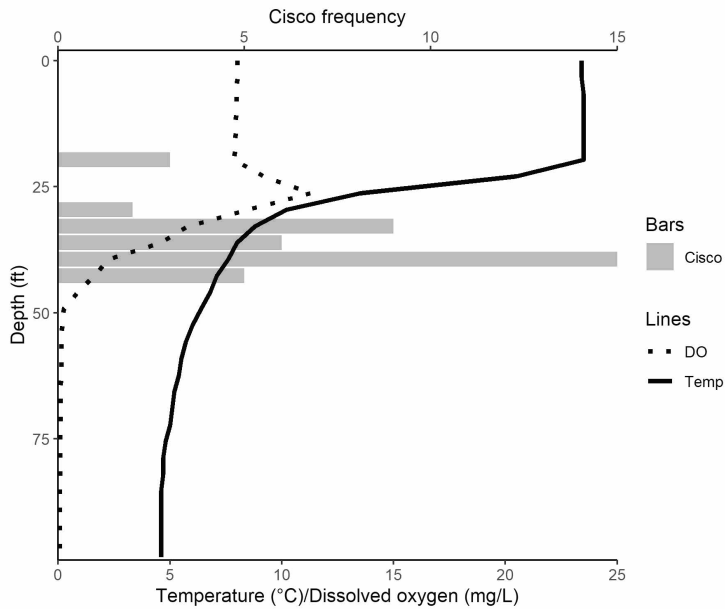**UTM Easting:** -
UTM Northing: -

Date: 03/12/2021
Time: 10:12 am

Notes: Cisco length frequency histogram

Survey Attachments (*Continued*)

Attachment #3: Graph   **Title:** VGN 1 Cisco frequency, temperature, and dissolved oxygen by depth

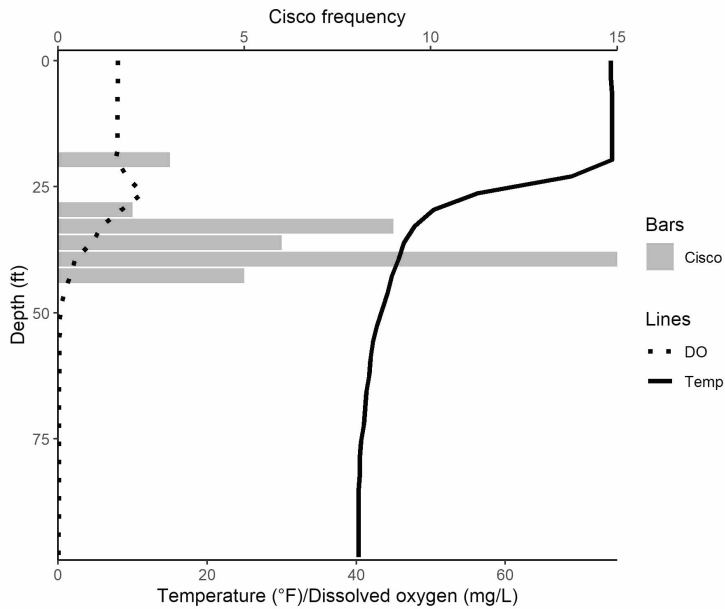**File Name:** Boot Figures_Page_3.jpg

UTM Easting: -
UTM Northing: -

Date: 03/12/2021
Time: 10:16 am

Notes: VGN 1 Cisco frequency, temperature, and dissolved oxygen by depth

Survey Attachments (*Continued*)

Attachment #4: Graph   **Title:** VGN 2 Cisco frequency, temperature, and dissolved oxygen by depth

File Name: Boot Figures_Page_4.jpg

UTM Easting: -
UTM Northing: -

Date: 03/12/2021
Time: 10:17 am

Notes: VGN 2 Cisco frequency, temperature, and dissolved oxygen by depth

Approval Notice

<u>Program Manager Signed</u>

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NATURAL RESOURCES

FISHERIES
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Lake Survey Report revision: 20210209-RJE. Data Date: 03/24/2021 at 1:19 pm .