Fishery responses to hydrologic reconnection of Wolf Lake and Powderhorn Lake

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2021 Annual Progress Report (2020 activities)

Background and Objectives

A hydrologic reconnection of Wolf Lake and Powderhorn Lake has been proposed as part of a plan to restore ecologically significant habitats and improve hydrology within the Calumet Region along the south shore of Lake Michigan. Powderhorn Lake is a 20-hectare lake managed by the Forest Preserves of Cook County (FPCC). Wolf Lake is a 384-hectare lake managed by the Illinois Department of Natural Resources (IDNR). These lakes have been isolated by urban and industrial development but were once connected as part of a large network of marshes and lakes neighboring Lake Michigan. The proposed reconnection would reduce flooding of residential areas and marsh habitats by way of a water control structure that adjusts water levels in Powderhorn Lake and may facilitate fish movement between the lakes and improve spawning and rearing habitat access for adult and juvenile fishes.

During March 2020, the Illinois Natural History Survey (INHS), with input from the FPCC, developed a scope of work (SOW) to assess the outcomes of the hydrologic reconnection of Wolf Lake and Powderhorn Lake. The SOW focused on several responses of interest regarding the status, productivity, and movement of ecologically and economically important fish populations within Wolf Lake and Powderhorn Lake and had five objectives: 1) Assess water quality (i.e., nutrients and chlorophyll-*a*) in both lakes and quantify littoral habitat within Powderhorn Lake before and after hydrologic reconnection, 2) Assess potential changes in status and abundance of zooplankton communities in Wolf Lake and Powderhorn Lake before and after hydrologic reconnection, 3) Assess potential changes to status and abundance of fish communities in Wolf Lake and Powderhorn Lake before and after hydrologic reconnection, 4) Quantify reproductive activity of fish communities in Wolf Lake and Powderhorn Lake before and after hydrologic reconnection, and 5) Quantify fish movement between Powderhorn and Wolf lakes (i.e., functional connectivity) after hydrologic reconnection. This progress report summarizes data collected during 2020 as part of the pre-connection assessment of Wolf Lake and Powderhorn Lake.

2020 Summary of activities

Research staff from the INHS planned to conduct monthly sampling (i.e., one sampling event per month) for water quality, zooplankton, and ichthyoplankton at each lake May – September 2020. University of Illinois COVID-19 safety protocols prevented sampling during May 2020. A regular monthly sampling schedule resumed June through September 2020 and all permitted research activities were completed. Fixed collection sites within each lake were

updated from the proposed SOW to account for site accessibility (e.g., water depth) during the first visit in June 2020 (Figure 1).

Water quality and habitat availability (Objective 1)

Water quality data were collected and analyzed monthly from June through September 2020. Secchi depth (m), temperature (°C), and dissolved oxygen (mg L^{-1}) along with water samples for nutrient analysis and chlorophyll-*a* extraction were collected from a fixed index site within each lake (Figure 1). Temperature and oxygen were measured at 0.5-m depth increments from surface to bottom at the index site using a YSI ProSolo optical field probe. Water samples were collected with an integrated water bottle sampler by lowering a 1.89-L water bottle to the extent of the photic zone (2× Secchi depth) and back to the surface at a rate of 0.5 m s^{-1}. Water samples were analyzed at the Kaskaskia Biological Station for concentrations of chlorophyll-*a* (µg L^{-1}), a surrogate measure for phytoplankton abundance, and total phosphorus (mg L^{-1}). Depth in Powderhorn Lake was mapped each month using side scan sonar where adequate water depths were available (minimum 0.5 m).

Zooplankton community assessment (Objective 2)

Zooplankton are an important food resource for fish early life stages, adult planktivorous fishes, and larger invertebrates that are themselves prey for many sport fish species. Thus, quantification of zooplankton communities is important for assessing the effects of hydrologic reconnection between Powderhorn Lake and Wolf Lake on the aquatic food webs of these lakes. Zooplankton were collected monthly from June through September 2020 with vertical tows at three fixed sites in each lake (Figure 1) using a Wisconsin plankton net (63-µm mesh). Three replicate tows from the extent of the photic zone (2× Secchi depth) were conducted at each site on alternating sides of the boat. Zooplankton were preserved in Lugol's iodine solution and were brought back to the Kaskaskia Biological Station for enumeration and identification using a combination of microscopy and semi-automated methods (FlowCam).

Adult and juvenile fish surveys (Objective 3)

A multi-gear sampling approach is necessary to adequately characterize populations of game and nongame fish species in Wolf and Powderhorn lakes before and after hydrologic reconnection. During June and September 2020, adult and juvenile fishes were sampled using pulsed-DC boat electrofishing (60 Hz, 25% duty cycle) standardized by a power goal (3,000 W) based on water temperature and conductivity. Three boat-electrofishing transects were conducted per lake each month. A fyke net survey was conducted during October 2020 to assess the relative abundance of species (e.g., crappies) difficult to collect with boat electrofishing gear. Fyke nets (1 m x 2 m; 13-mm bar mesh; single 9-m lead line) were set perpendicular to shorelines at depths of 3 m or less. Electrofishing transects and net deployments were conducted at fixed sites (Figure 1) within littoral habitats Powderhorn Lake and Wolf Lake, and these sites will be sampled again after reconnection.

Ichthyoplankton (larval fish) surveys (Objective 4)

Standardized ichthyoplankton collections were conducted monthly from June through September to quantify reproductive activity of fish communities in Wolf Lake and Powderhorn Lake during 2020. Ichthyoplankton push-net transects (approximately 5 min) were conducted at two fixed littoral sites (Figure 1) in each lake using a 0.5-m diameter plankton push net with a 500-µm mesh and a 1:5 width-to-length ratio. Total water volume sampled along each transect was measured with a flow meter mounted in the center of the net, allowing for an estimation of larval fish density ($N \cdot m^{-3}$). This sampling will be used to assess changes in the reproductive output (i.e., densities of larval fishes) of fishes established in Powderhorn Lake and Wolf Lake and indicate whether fish unique to each lake prior to reconnection are spawning in newly available habitats.

Fish passage (Objective 5)

Multiple approaches will be used to assess fish movement between Powderhorn Lake and Wolf Lake after hydrologic reconnection. Target species will be collected and PIT-tagged (PIT tags are passive integrated transponders with unique codes and implanted internally) during future boat electrofishing surveys, allowing for recapture and identification of individuals that may move between Powderhorn Lake and Wolf Lake. All fish collected in subsequent sampling events will be scanned for presence of a PIT tag. Recapture of tagged individuals during repeated sampling efforts through time will allow for quantification of movement rates of different species within and between lakes.

In addition to mark-recapture methods, the INHS will deploy antenna receivers at four connection points between Powderhorn Lake, Wolf Lake, and the intervening marsh habitat to assess emigration and immigration rates. PIT-tagged fish moving into and out of pipe connections will be detected and recorded via construction of a radio frequency identification antenna connected to a tuner and single antenna reader and datalogger (up to 10 scans per second). Each antenna will be powered with two 12-V batteries that will be secured with the reader in a water-proof and tamper-proof case. Solar panels will be used to maintain continuous power for each system's batteries. Frequency of detection downloads and battery maintenance will be coordinated with IDNR and FPCC biologists. For both methods of assessing fish movement, rates of movement, immigration, and emigration will be compared between tagged species and modelled as a function of seasonal conditions (e.g., water temperature).

Results and sample processing

Water quality and habitat availability (Objective 1)

All water quality samples and data collected during 2020 have been processed (Tables 1-2 and Figure 2). Data from vertical profiles collected at the index site in each lake indicate that suitable temperature and oxygen conditions were available for fish during June-September 2020 in Wolf and Powderhorn lakes (Figure 2). Powderhorn Lake displayed a typical summer stratification of temperature and oxygen, followed by turnover in the fall (Figure 2). Stratification was not observed at the index site in the lowermost basin of Wolf Lake, near the proposed connection. As a result, temperature and oxygen conditions were similar from surface to bottom each month. Both lakes are eutrophic based on chlorophyll-*a* and total phosphorus concentrations. Chlorophyll-*a* was highest during July in Wolf Lake and during August in

Powderhorn Lake (Table 1). In general, the chlorophyll-*a* concentrations recorded throughout the year indicate high algal biomass in both lakes during the summer months. Maximum depth recorded in Powderhorn was 5.64 m (18.5 ft) and occurred during July 2020 sampling (Table 3). Bathymetric maps created using sonar recordings are provided in Figures 3-6.

Zooplankton community assessment (Objective 2)

Zooplankton samples collected during 2020 have been processed. Mean densities ($N \cdot L^{-1}$) of all taxa collected at each lake during each month are presented in Tables 4-5. These data support that there are differences in the zooplankton communities within each lake. For example, Daphnia were rarely collected in Wolf Lake, but were present in Powderhorn Lake during each sampling event. Another notable difference is that the microzooplankton within Wolf Lake was often dominated by nauplii, the larval stage of several copepod species. In contrast, microzoplankon samples from Powderhorn Lake were more often characterized by lower densities of nauplii and higher densities of rotifers. Additional data on the zooplankton communities in Wolf and Powderhorn lakes will be provided in future reports.

Adult and juvenile fish surveys (Objective 3)

Across all sampling methods and events, a total of 22 fish species were captured, 13 in Powderhorn Lake and 21 in Wolf Lake (Table 6, Table 7). This diversity difference arose from the lack of Catastomidae (suckers), Atherinidae (silversides), Clupeidae (shad), and walleye detections in Powderhorn compared to Wolf Lake, as well as lower cyprinid and *Lepomis* diversity (Table 6, Table 7). The only unique species record from Powderhorn Lake across the 2020 sampling events was the yellow bullhead. A total of 870 fish were captured in 2020, divided relatively evenly between the two lakes (Table 6, Table 7). In Powderhorn Lake, bluegill and grass pickerel were consistently among the top three most abundant species captured during electrofishing surveys (Table 8). Other species with high relative abundance in Powderhorn Lake included yellow perch, which increased in abundance from June to September, and black crappie, a species captured at much higher rates in September than June surveys (Table 8). Wolf Lake electrofishing catches were dominated by bluegill and yellow perch in both months, with largemouth bass having a high relative abundance in September (Table 8). Fyke net catch per unit effort (CPUE) in both lakes was dominated by bluegill (Table 9). Black crappie were also relatively abundant during fyke-net surveys in Powderhorn Lake, while redear sunfish had the next highest fyke-net CPUE in Wolf Lake (Table 9).

All surveys indicated that size structure of sunfishes and yellow perch in both lakes is poor. The length distribution of bluegill and yellow perch collected with electrofishing is provided in Figure 7; however, the length distribution of bluegill and yellow perch collected in fyke nets was similar to electrofishing. A total of only seven "quality" length (≥ 150 mm or 6 in) individual bluegill were collected from both Wolf and Powderhorn lakes during June and September electrofishing surveys combined. Only one of these fish, a 174 mm (6.9 in) bluegill, was collected from Powderhorn Lake during June 2020. No quality length yellow perch (≥ 200 mm or 8 in) were collected from either lake during the electrofishing surveys or fyke net survey. Small bluegill and perch, however, may benefit larger piscivorous sportfish populations in both

lakes through increased prey availability. Although low in relative abundance, we collected ten black crappie (range 200-300 mm), two largemouth bass (415 and 436 mm), and one northern pike (694 mm; Powderhorn Lake) that were quality length or greater among all surveys. Additional surveys required to PIT tag sportfish and monitor fish movement between lakes will continue to provide more information on the relative abundance and size structure of fish populations within Wolf Lake and Powderhorn Lake.

Ichthyoplankton (larval fish) surveys (Objective 4)

Reproductive activity of fishes in Wolf and Powderhorn lakes was highest during June 2020 (Tables 10-11). Similar to electrofishing surveys, ichthyoplankton collections support that Wolf Lake contains a more diverse fish community than Powderhorn Lake. Larval fish collections during June 2020 in Wolf Lake were dominated by brook silverside and *Lepomis* sunfishes, but also included largemouth bass and individuals from the family Percidae (perches) (Table 10). *Lepomis* sunfish reproductive activity occurred over a longer time period in Wolf Lake than in Powderhorn Lake (Tables 10-11). No larval fish were collected from either lake during September. Data from Powderhorn Lake indicate low reproductive output compared to other fishing lakes within the FPCC.

Fish passage (Objective 5)

Monitoring for potential fish passage between Wolf Lake and Powderhorn Lake will begin once construction of the water control structure and hydrologic reconnection is complete. Targeted fish surveys will be conducted to implant PIT-tags into target fish species as the reconnection project nears completion. No fish were tagged during 2020 because of the potential for natural and fishing mortality (i.e., harvest by anglers) to deplete the number of tagged fish prior to the hydrologic reconnection. Staff from the Kaskaskia Biological Station plan to visit Powderhorn Lake during fall 2020/spring 2022 to deploy antenna systems and conduct fish tagging surveys. Target species and numbers of fish PIT-tagged will be the focus of further discussions with IDNR and FPCC biologists.

Tables and Figures

Table 1. Chlorophyll-*a* concentrations in Powderhorn Lake and Wolf Lake from June-September 2020. All values are in µg L^{-1}.

Lake	June	July	August	September
Powderhorn Lake	3.6	5.9	11.5	3.6
Wolf Lake	1.2	26.3	9.2	2.1

Table 2. Total phosphorus concentrations in Powderhorn Lake and Wolf Lake from June-September 2020. All values are in mg L^{-1}.

Lake	June	July	August	September
Powderhorn Lake	0.341	0.255	0.031	0.217
Wolf Lake	0.082	0.174	0.022	0.104

Table 3. Mean and maximum water depth (m) in Powderhorn Lake during 2020.

Month	Mean	Maximum
June	3.08	5.00
July	3.60	5.64
August	3.78	5.55
September	3.72	5.36

Table 4. Mean density ($N \cdot L^{-1}$) ± 1 standard error of zooplankton collected in Wolf Lake during 2020.

Taxa	June	July	August	September
Chaoboridae	0	0.5 ± 0.5	0.06 ± 0.06	0
Cladocerans				
Bosminidae	3 ± 1.6	9 ± 4.0	19 ± 13.5	5 ± 3.1
Ceriodaphnia	0.2 ± 0.1	5 ± 2.5	5 ± 2.2	11 ± 4.3
Chydoridae	0	0.9 ± 0.9	0.9 ± 0.5	0.3 ± 0.2
Daphnia	0.1 ± 0.1	0	0	0
Sididae	0.2 ± 0.2	19 ± 8.6	15 ± 4.7	0.2 ± 0.1
Copepods				
Calanoida	2 ± 1.3	6 ± 2.5	8 ± 1.2	14 ± 4.8
Cyclopoida	1 ± 0.3	1 ± 0.4	8 ± 2.3	16 ± 5.4
Ostracoda	0.04 ± 0.04	0.2 ± 0.2	0	0
Rotifera	26 ± 21.0	75 ± 20.8	26 ± 9.9	121 ± 31.8
Nauplii	74 ± 49.4	66 ± 35.5	66 ± 12.0	108 ± 54.1

Table 5. Mean density ($N \cdot L^{-1}$) ± 1 standard error of zooplankton collected in Powderhorn Lake during 2020.

Taxa	June	July	August	September
Chaoboridae	0	0	0	0.03 ± 0.03
Cladocerans				
Bosminidae	8 ± 4.2	8 ± 7.7	9 ± 4.2	1 ± 0.7
Ceriodaphnia	33 ± 18.0	0	0.1 ± 0.1	0
Chydoridae	0.3 ± 0.2	0.3 ± 0.2	0.1 ± 0.1	0.03 ± 0.03
Daphnia	3 ± 1.2	2 ± 0.4	3 ± 0.2	2 ± 0.2
Sididae	0.8 ± 0.7	4 ± 2.8	17 ± 2.1	13 ± 0.3
Copepods				
Calanoida	10 ± 3.4	2 ± 0.7	14 ± 1.6	4 ± 0.4
Cyclopoida	9 ± 7.3	4 ± 0.3	2 ± 0.1	7 ± 0.7
Ostracoda	0.6 ± 0.6	0.1 ± 0.1	1 ± 0.5	0
Rotifera	264 ± 108	69 ± 43.3	72 ± 32.8	34 ± 5.2
Nauplii	43 ± 6.8	29 ± 7.9	36 ± 6.5	28 ± 3.6

Table 6. Total number of fish captured per species in Powderhorn Lake during DC boat-electrofishing surveys (EF) in June and September and fyke-net surveys in October.

Family	Species	Common name	June EF	Sept. EF	Oct. fyke	Total
Atherinopsidae	*Labidesthes sicculus*	Brook Silverside	0	0	0	0
Catastomidae	*Erimyzon sucetta*	Lake Chubsucker	0	0	0	0
	Ictiobus bubalus	Smallmouth Buffalo	0	0	0	0
Centrarchidae	*Ambloplites rupestris*	Rock bass	0	0	0	0
	Lepomis cyanellus	Green Sunfish	0	0	0	0
	Lepomis gulosus	Warmouth	5	1	7	13
	Lepoms macrochirus	Bluegill	24	25	145	194
	Lepomis megalotis	Longear Sunfish	0	0	0	0
	Lepomis microlophus	Redear Sunfish	3	1	41	45
	Lepomis hybrid	Hybrid sunfish	2	5	24	31
	Micropterus salmoides	Largemouth Bass	1	8	4	13
	Pomoxis nigromaculatus	Black Crappie	0	13	77	90
Clupeidae	*Dorosoma cepedianum*	Gizzard Shad	0	0	0	0
Cyprinidae	*Cyprinus carpio*	Common Carp*	1	5	3	9
	Notemigonus crysoleucas	Golden Shiner	0	1	0	1
	Pimephales notatus	Bluntnose Minnow	0	0	0	0
Esocidae	*Esox americanus*	Grass Pickerel	8	19	1	28
	Esox lucius	Northern Pike	0	0	1	1
Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	0	1	0	1
	Ameiurus nebulosus	Brown Bullhead	1	1	0	2
Percidae	*Perca flavescens*	Yellow Perch	19	5	9	33
	Sander vitreus	Walleye	0	0	0	0
		Total fish	64	85	312	461

Notes: *nonnative species

Table 7. Total number of fish captured per species in Wolf Lake during DC boat-electrofishing surveys (EF) in June and September and fyke-net surveys in October.

Family	Species	Common name	June EF	Sept. EF	Oct. fyke	Total
Atherinopsidae	*Labidesthes sicculus*	Brook Silverside	1	0	0	1
Catastomidae	*Erimyzon sucetta*	Lake Chubsucker	2	0	0	2
	Ictiobus bubalus	Smallmouth Buffalo	0	2	0	2
Centrarchidae	*Ambloplites rupestris*	Rock bass	7	4	2	13
	Lepomis cyanellus	Green Sunfish	1	0	1	2
	Lepomis gulosus	Warmouth	3	2	20	25
	Lepoms macrochirus	Bluegill	13	30	95	138
	Lepomis megalotis	Longear Sunfish	1	0	0	1
	Lepomis microlophus	Redear Sunfish	0	6	59	65
	Lepomis hybrid	Hybrid sunfish	2	3	1	6
	Micropterus salmoides	Largemouth Bass	7	14	0	21
	Pomoxis nigromaculatus	Black Crappie	0	2	7	9
Clupeidae	*Dorosoma cepedianum*	Gizzard Shad	0	0	1	1
Cyprinidae	*Cyprinus carpio*	Common Carp*	0	3	0	3
	Notemigonus crysoleucas	Golden Shiner	0	2	2	4
	Pimephales notatus	Bluntnose Minnow	1	5	0	6
Esocidae	*Esox americanus*	Grass Pickerel	1	4	0	5
	Esox lucius	Northern Pike	0	1	0	1
Ictaluridae	*Ameiurus natalis*	Yellow Bullhead	0	0	0	0
	Ameiurus nebulosus	Brown Bullhead	1	0	0	1
Percidae	*Perca flavescens*	Yellow Perch	30	51	20	101
	Sander vitreus	Walleye	0	0	2	2
		Total fish	70	129	210	409

Notes: *nonnative species

Table 8. Electrofishing mean catch per unit effort ($N \cdot hr^{-1} \pm 1$ standard error) during June and September surveys in Powderhorn Lake and Wolf Lake.

	Powderhorn		Wolf	
Fish species	June	September	June	September
Brook Silverside	0	0	1 ± 1.3	0
Lake Chubsucker	0	0	3 ± 2.7	0
Smallmouth Buffalo	0	0	0	3 ± 2.7
Rock bass	0	0	9 ± 4.8	5 ± 3.5
Green Sunfish	0	0	1 ± 1.3	0
Warmouth	7 ± 1.3	1 ± 1.3	4 ± 4	1 ± 1.3
Bluegill	32 ± 2.3	33 ± 3.5	17 ± 4.8	40 ± 16.2
Longear Sunfish	0	0	3 ± 1.3	0
Redear Sunfish	4 ± 4	1 ± 1.3	0	8 ± 6.1
Hybrid sunfish	3 ± 1.3	7 ± 4.8	3 ± 1.3	4 ± 2.3
Largemouth Bass	1 ± 1.3	11 ± 5.8	3 ± 3.5	19 ± 2.7
Black Crappie	0	17 ± 7.1	0	3 ± 2.7
Gizzard Shad	0	0	0	0
Common Carp*	1 ± 1.3	7 ± 6.7	0	4 ± 4
Golden Shiner	0	1 ± 1.3	0	3 ± 2.7
Bluntnose Minnow	0	0	1 ± 1.3	7 ± 4.8
Grass Pickerel	11 ± 10.7	25 ± 2.7	1 ± 1.3	5 ± 3.5
Northern Pike	0	0	0	1 ± 1.3
Yellow Bullhead	0	1 ± 1.3	0	0
Brown Bullhead	1 ± 1.3	1 ± 1.3	1 ± 1.3	0
Yellow Perch	25 ± 4.8	7 ± 3.5	40 ± 16.2	33 ± 33.3
Walleye	0	0	0	0

Notes: *nonnative species

Table 9. Fyke-net mean catch per unit effort (N per net-night ± 1 standard error) during June and September surveys in Powderhorn Lake and Wolf Lake.

Fish species	Powderhorn Lake	Wolf Lake
Brook Silverside	0	0
Lake Chubsucker	0	0
Smallmouth Buffalo	0	0
Rock bass	0	0.2 ± 0.1
Green Sunfish	0	0.1 ± 0.1
Warmouth	1 ± 0.3	2 ± 1.1
Bluegill	15 ± 5.5	10 ± 5
Longear Sunfish	0	0
Redear Sunfish	4 ± 1.9	6 ± 3.3
Hybrid sunfish	2 ± 1.1	0.1 ± 0.1
Largemouth Bass	0.4 ± 0.2	0
Black Crappie	8 ± 3.8	1 ± 0.5
Gizzard Shad	0	0.1 ± 0.1
Common Carp	0.3 ± 0.2	0
Golden Shiner	0	0.2 ± 0.2
Bluntnose Minnow	0	0
Grass Pickerel	0.1 ± 0.1	0
Northern Pike	0.1 ± 0.1	0
Yellow Bullhead	0	0
Brown Bullhead	0	0
Yellow Perch	1 ± 0.5	2 ± 0.9
Walleye	0	0.2 ± 0.1

Table 10. Mean Density (individuals m^{-3}) ± 1 standard error of larval fish collected in Wolf Lake during June- September 2020.

ID	June	July	August	September
Brook Silverside	0.21 ± 0.21	0.05 ± 0.02	0	0
Lepomis sunfishes	0.17 ± 0.17	0.34 ± 0.31	0.14 ± 0.06	0
Largemouth bass	0.02 ± 0.02	0	0	0
Percidae	0.09 ± 0.07	0	0	0

Table 11. Mean Density (individuals m^{-3}) ± 1 standard error of larval fish collected in Powderhorn Lake during June- September 2020.

ID	June	July	August	September
Cyprinidae	0.01 ± 0.01	0	0	0
Lepomis sunfishes	0.09 ± 0.05	0.02 ± 0.02	0	0

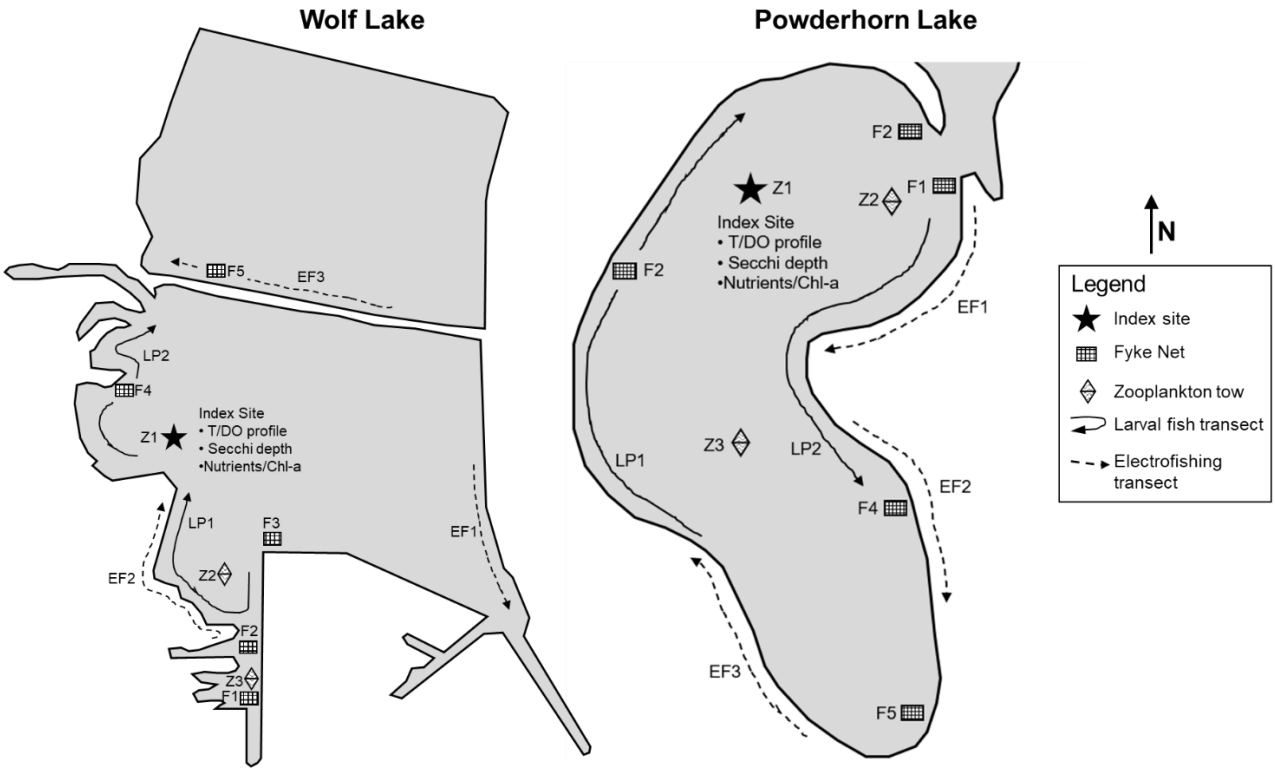

Figure 1. Distribution of data collection points in Wolf Lake and Powderhorn Lake, including Secchi depth, water temperature and dissolved oxygen vertical profiles (T/DO profile), and water samples for nutrient analysis and chlorophyll-*a* extraction (nutrients/Chl-*a*) collected from a fixed index site within each lake.

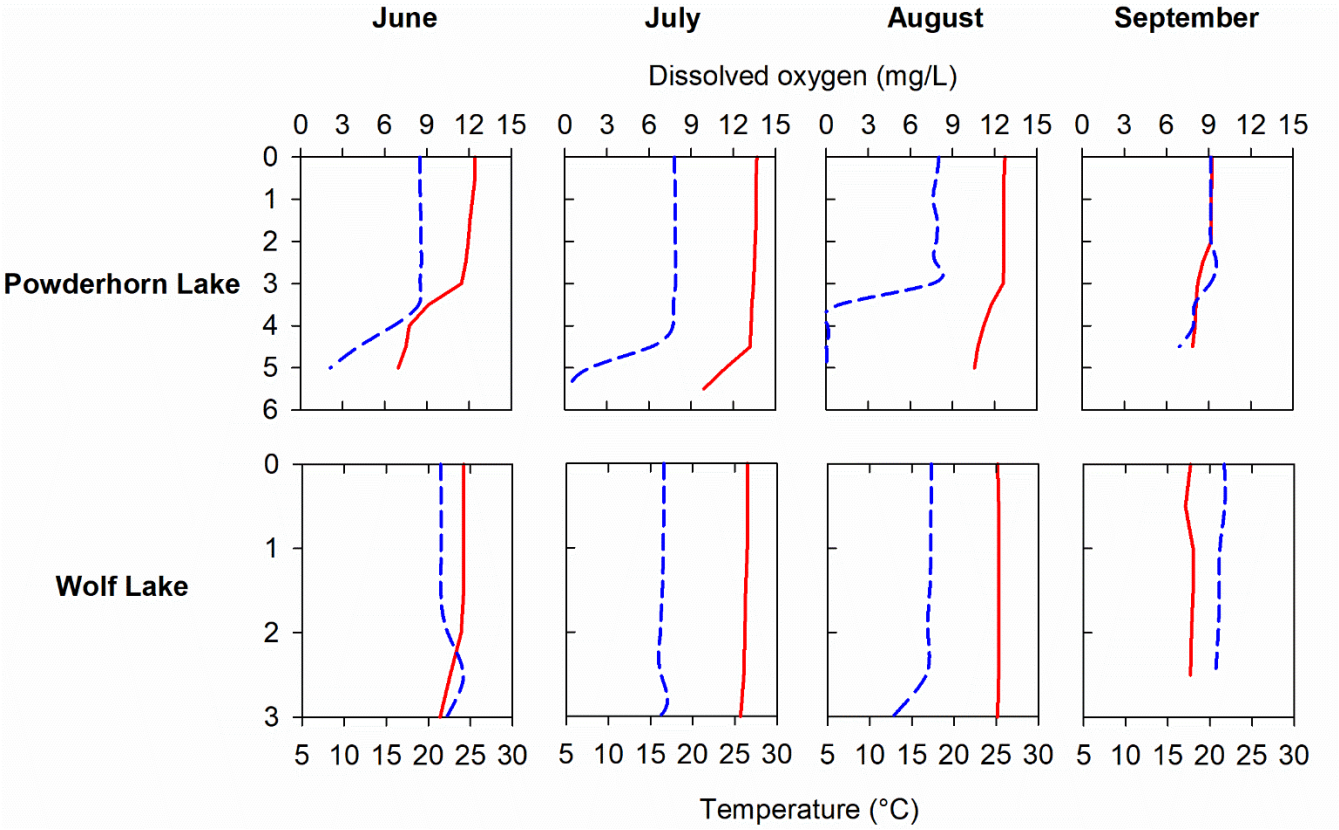

Figure 2. Temperature (°C; red line) and oxygen (mg·L^{-1}; dashed blue line) vertical profiles measured at index sites in Powderhorn Lake and Wolf Lake from June-September.

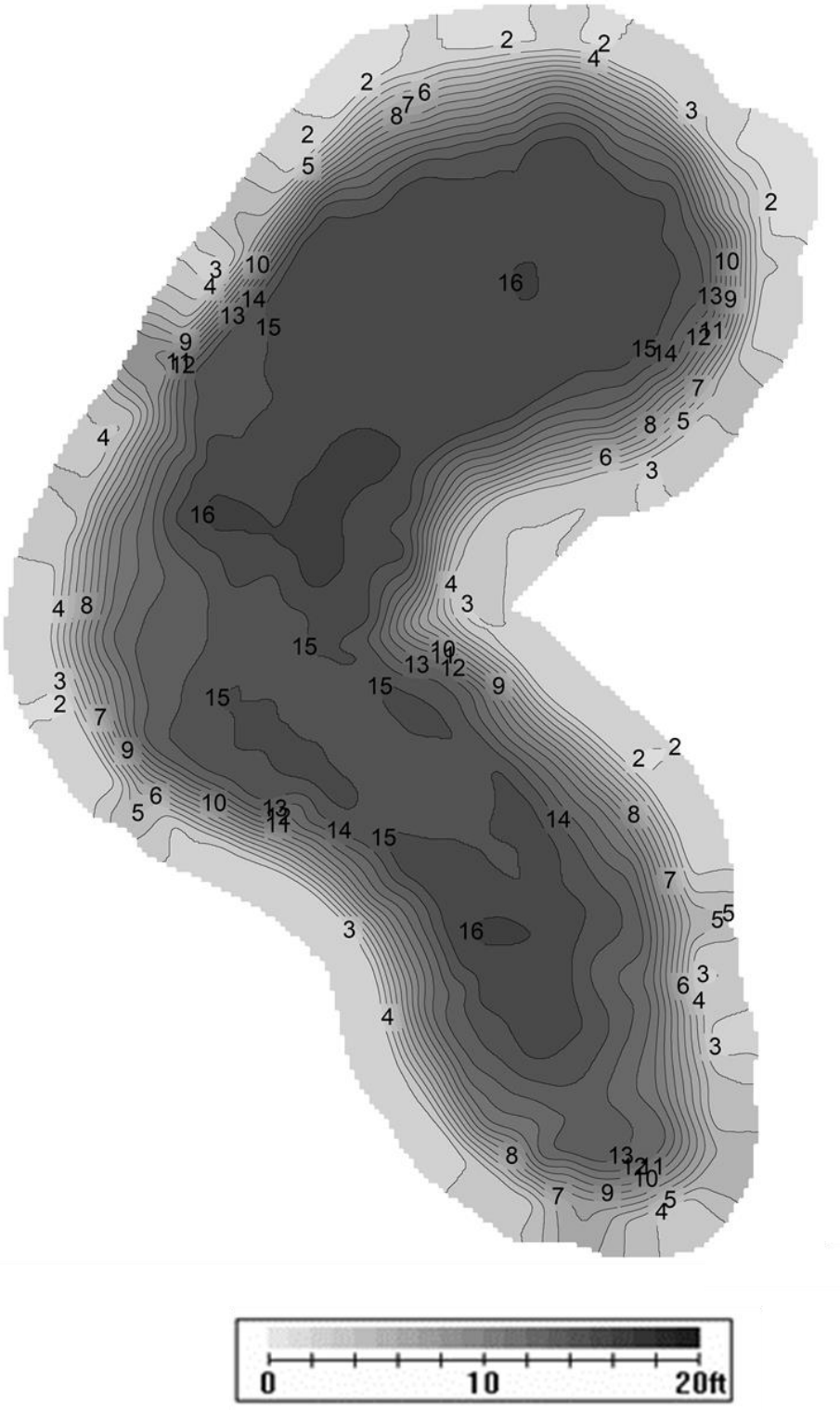

Figure 3. Sonar collected bathymetry of Powderhorn Lake in June 2020.

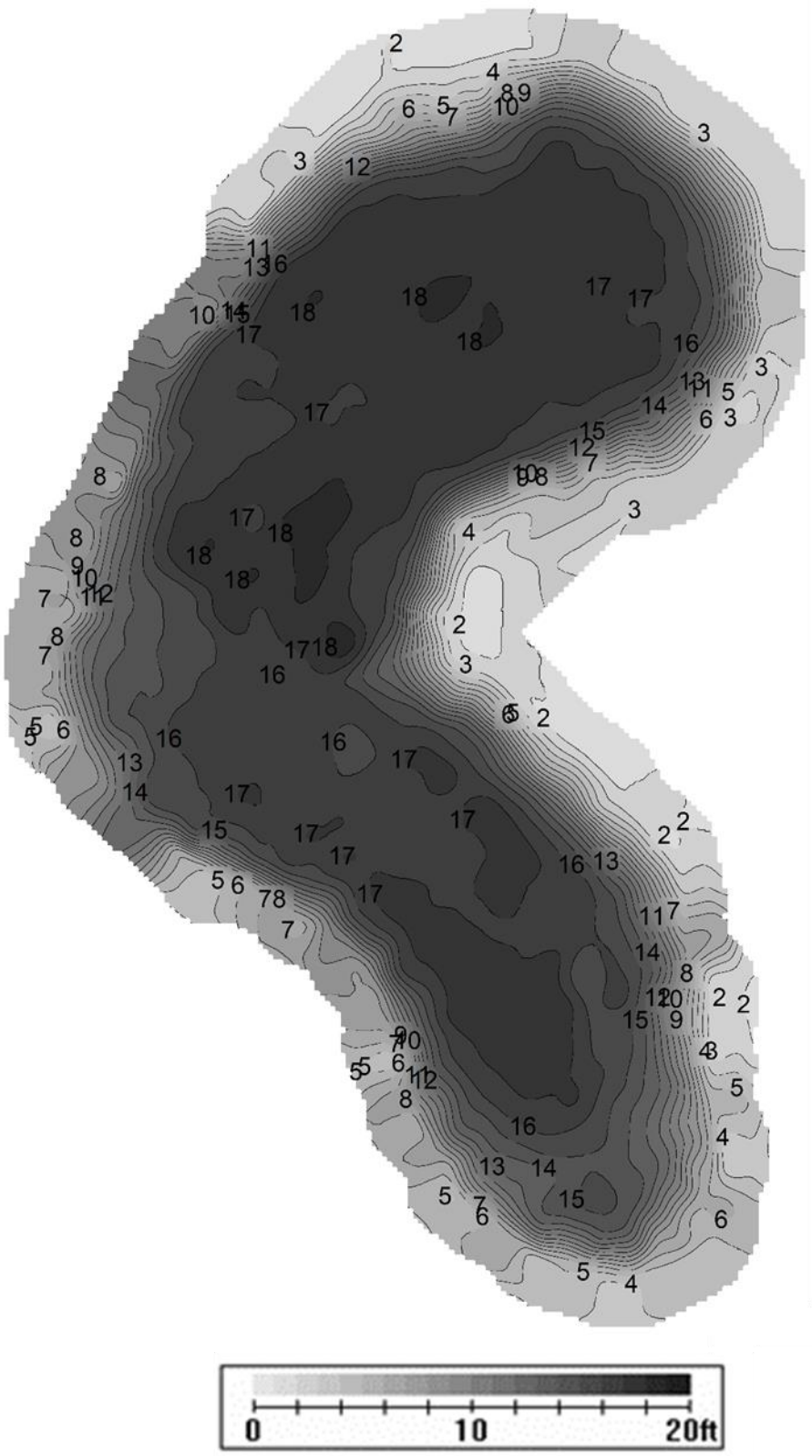

Figure 4. Sonar collected bathymetry of Powderhorn Lake in July 2020.

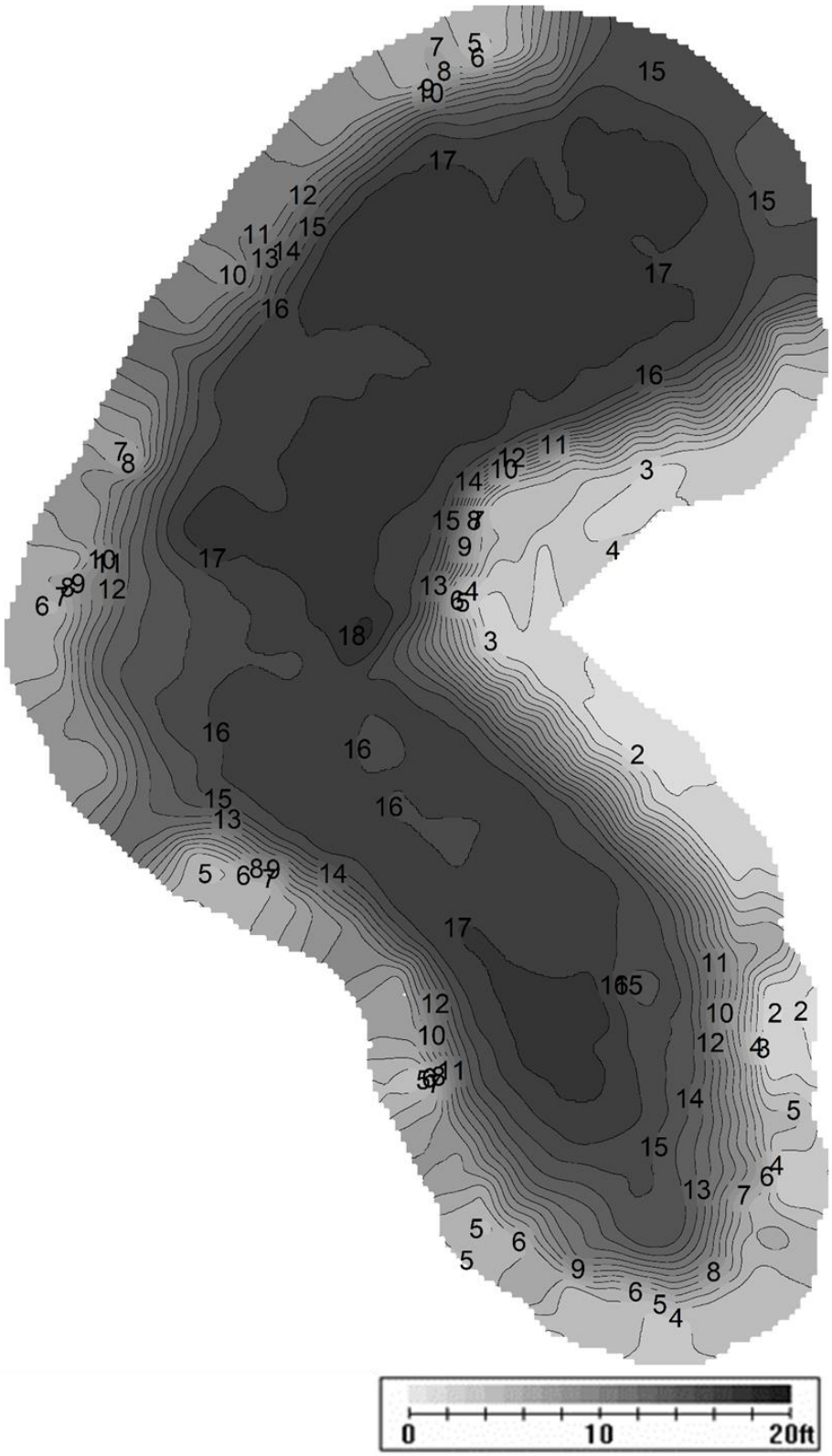

Figure 5. Sonar collected bathymetry of Powderhorn Lake in August 2020.

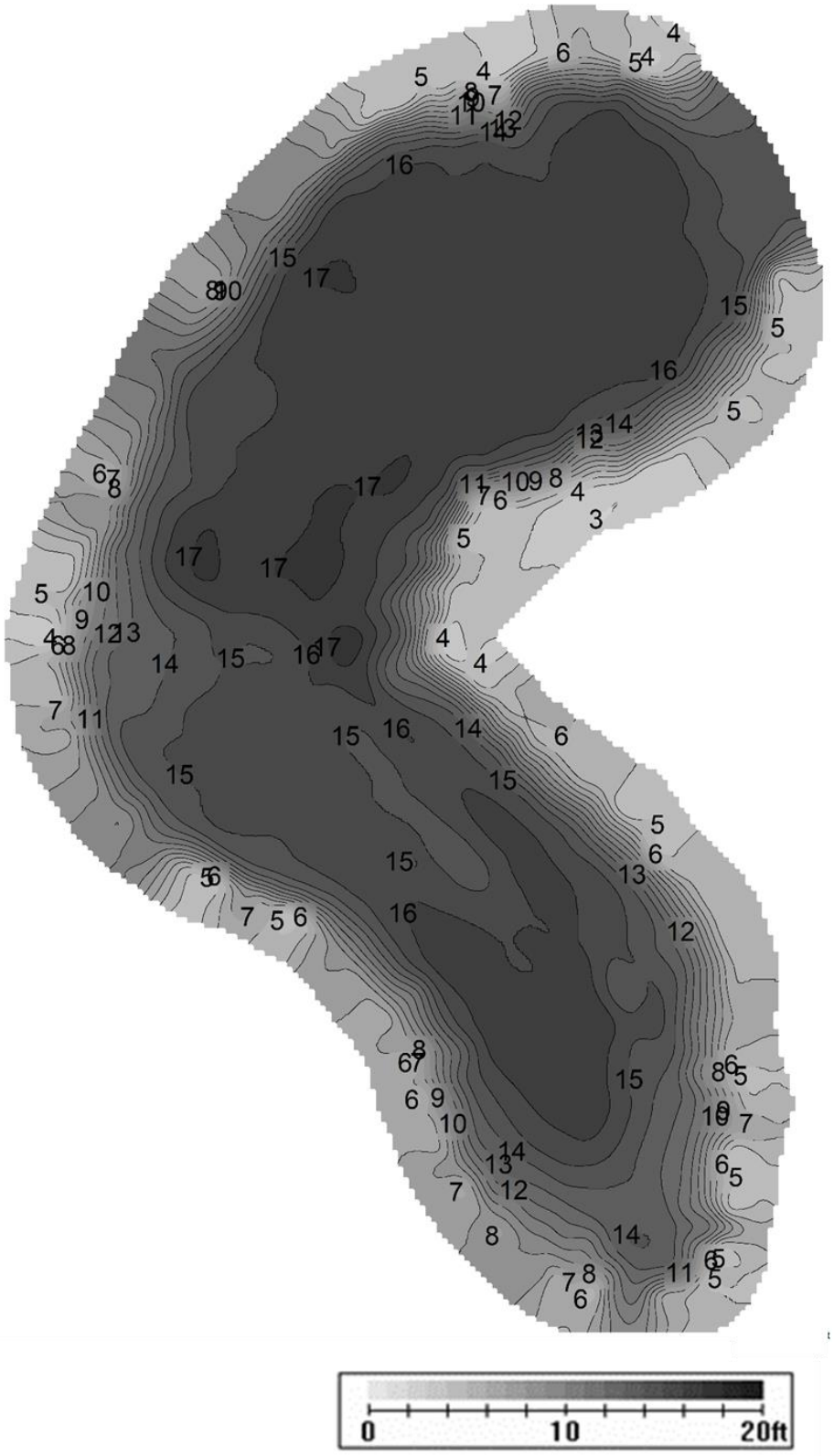

Figure 6. Sonar collected bathymetry of Powderhorn Lake in September 2020.

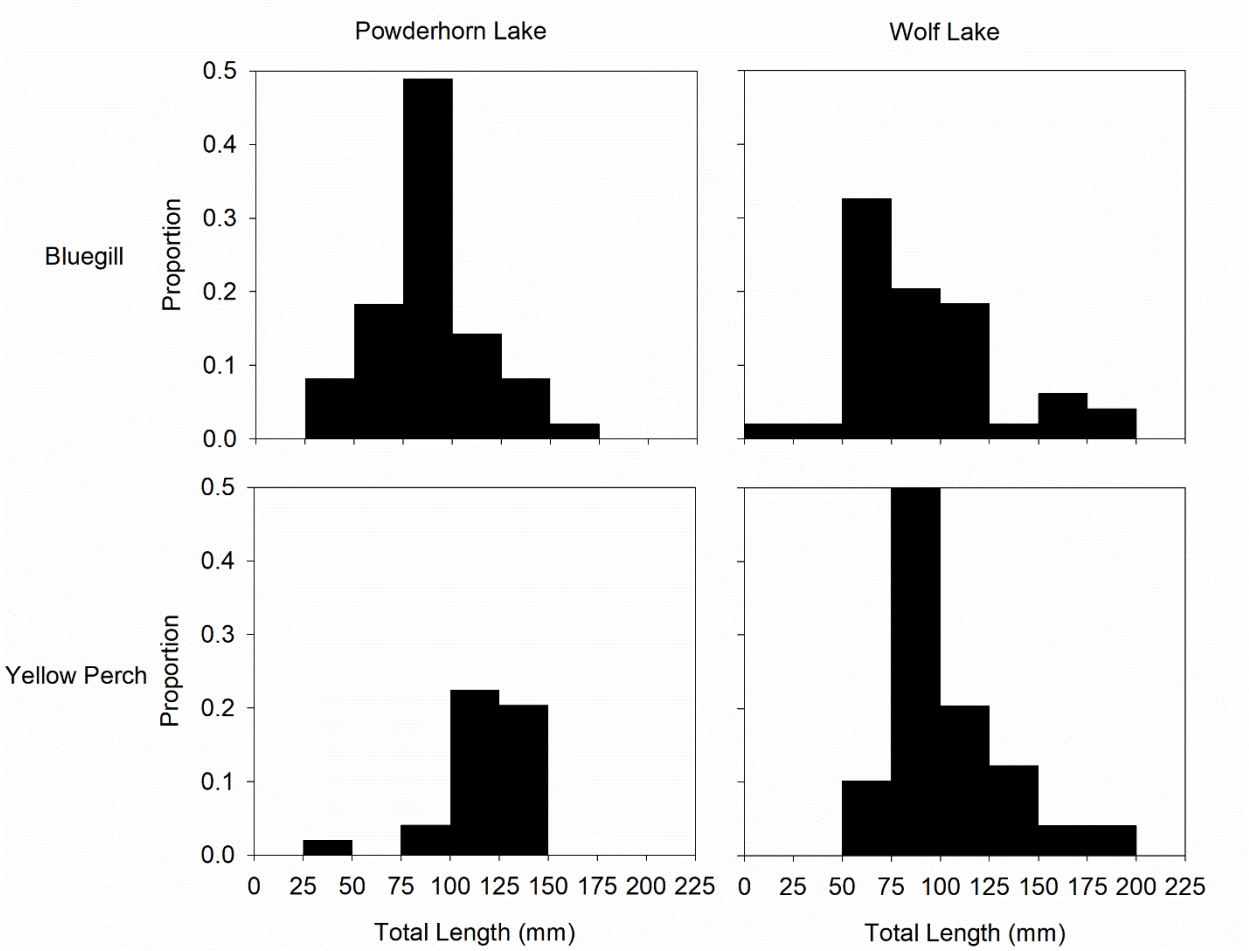

Figure 7. Length frequency distribution for bluegill and yellow perch collected from Powderhorn Lake and Wolf Lake using boat electrofishing during June and September 2020.