Department of Planning, Design and Natural Resources
Division of Natural Resources
Division of Planning

Department of Park Operations
Division of Outdoor Education
Division of Parks

NATURAL RESOURCES MANAGEMENT PLAN: SHADOW LAKE, SOUTH CHAGRIN RESERVATION v.1.0

Cleveland Metroparks Technical Report 2012/NR-06

Shadow Lake offers the most popular lake fishing venue on the east side of Cleveland Metroparks (photo C. Batule).

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Executive Summary

Shadow Lake is a 3.74 acre impoundment created from the damming of two headwater streams in South Chagrin Reservation in 1968. Since that time, the lake has been an important recreation area in Cleveland Metroparks for fishing and nature watching activities. The overarching management goal of the lake is to maintain its "fishable" status (there is no swimming permitted in this waterbody) per Federal Clean Water Act (CWA) objectives, which is accomplished through active fisheries management activities in the lake.

In winter 2011, low dissolved oxygen under the ice caused a fish kill. The source was tracked back to excessive vegetative growth and subsequent winter die-off caused by nutrient input from a composting operation on an adjacent property. The cause of the issue was promptly addressed and the lake was back to normal water quality conditions by spring 2011. Otherwise, no other water quality issues have been documented at the lake. The lake serves a watershed role as a stormwater buffer between adjacent lands and Tinker's Creek.

The lake offers a fair to moderate quality, but popular, recreational fishery. There are currently at least 10 species of fish known to inhabit Shadow Lake, most of which are of interest to anglers. The fish community is currently dominated by stunted bluegill (*Lepomis macrochirus*), pumpkinseed sunfish (*L. gibbosus*), and white crappie (*Pomoxis annularis*). Stockings of rainbow trout (*Oncorhynchus mykiss*) in winter and spring offer a highly popular seasonal fishery that complements the native fishery of the lake.

A fish community survey conducted on 17 August 2011 revealed low numbers of largemouth bass (*Micropterus salmoides*), which reflects a serious predator/prey

imbalance, which is in large part the reason for the overpopulation of stunted sunfish. The reason for the lack of bass is under investigation, but is likely a combination of limitations of habitat, such as low dissolved oxygen (DO) under the ice in winter as aquatic vegetation decomposes, and historic overharvest by anglers. Lack of appropriate spawning areas could be another limitation in the waterbody, which could be addressed by installing spawning structures. Largemouth bass have been stocked in recent years and will likely continue to be stocked over the next several years in an attempt to reestablish a year-round predator population. Follow-up sampling in the future (likely summer 2016) will determine the success of this effort. In the meantime, DO will be monitored under the ice when conditions permit. If future results indicate overharvest of bass is a significant issue, changes in regulations for bass could be discussed in this fishing area. Current regulations allow the harvest of 2 largemouth bass $\geq$12" per angler per day. Reestablishing a healthy predator population would have a top-down effect on the prey species in the lake, namely improving growth rates of stunted sunfish species. If bass cannot be reasonably established in the lake, the reasonable alternative will be to accept the waterbody as offering a limited quality fishery.

The lake does provide function as wildlife habitat. Although no rare species are known to inhabit the waterbody or immediate surrounding area, it does offer a typical regional assemblage of common waterfowl, wading birds, reptiles, amphibians, invertebrates, and aquatic macrophytes.

Historic Overview and Background

Shadow Lake is a 3.74 acre impoundment which was created in 1968 through construction of a dam which impounded two headwater streams in South Chagrin Reservation. The lake has a relatively small watershed of 0.22 miles^2 per USGS StreamStats program (with boundaries slightly amended in StreamStats as a result of hydrologic modification in the watershed due to infrastructure), with drainage mostly from the east up to Cochran Road (Figure 1). Historically, the deepest area is at the southwestern end of the lake at approximately 13 feet, with depths progressively becoming shallower towards the eastern basin of the waterbody, grading to less than 4 foot deep along the eastern shoreline. Wooden fishing platforms are located on the north-central and south-western shorelines of the lake to facilitate angler access. The lake is situated in a former stream valley bordered immediately to the north, east (albeit a narrow corridor in this direction, with industrial development beyond), and south by parkland and to the west by Hawthorn Parkway. The lake is surrounded by natural surface trails and Shadow Lake Picnic Area is situated approximately 400 feet north of the lake. A Waste Management landfill facility is located approximately 300 feet east of the lake within the watershed (Figures 2 and 3). Despite fairly intensive park development in the area, the lake retains a mostly scenic quality and is largely surrounded by tree canopy and mowed grass along the shoreline. Ever since its creation, the lake has been part of an intensively used recreation area which features fishing, picnicking, hiking, and sledding recreational activities, both organized and impromptu in nature. Activities are overall most intense during the late spring through summer months.

The overarching goal for management of Shadow Lake is to maintain, and improve where possible, the chemical, physical, and biological integrity of the waterbody as reflected in the national water quality objective as contained in the Federal Clean Water Act (CWA). The CWA objective is often referred to as the "fishable/swimmable goal," and the foremost goal for the lake is its continued management as a fishing area. This is currently conducted through management activities focused on the fishery. Swimming is prohibited at this location.

Water Quality Overview

Shadow Lake experienced the most significant water quality incident in its 44 year history in winter 2011(Table 1). The issue first became apparent due to a series of angler (ice fishing) complaints of no fish activity for two straight weeks between mid to late January 2011, despite recent stockings of rainbow trout. An investigation revealed critically low dissolved oxygen levels under the ice (< 3.0 ppm) at various locations around the lake, an uncharacteristically heavy phytoplankton (algae) stain in the water, and strong odor and discoloration of the south feeder creek at the east end of the lake. It was also found that the north feeder creek at the east of the lake had exceptionally high conductivity (13,000 mS/cm). Interview with local anglers familiar with the lake also revealed a number of reports that significantly more aquatic vegetation than normal was noted in the east end of the lake during late summer 2010.

Initially, sanitary waste was suspected as the nutrient source of this issue, but it was quickly ruled out based on analysis for coliform bacteria and other parameters characteristic of sanitary discharge. At this point, Waste Management (owners of the

adjacent CLI landfill) and the City of Solon also became involved in the investigation due to their facility locations on a major portion of the lake's watershed (Figure 1). Ohio EPA and the Cuyhahoga County Board of Health were also involved, with the former agency deciding to treat the situation as an emergency response and ordering the entirety of the flow of the southern creek pumped to the local Solon POTW during further investigation. The decision was made by Cleveland Metroparks to close the lake to public use during the investigation and signs were clearly posted around the lake indicating this to be the case.

Waste Management contracted Eagon and Associates to perform a full environmental investigation of the situation, and they found that nutrients were entering the southern feeder creek from a clay tile beneath a retention pond that had a heavy layer of organic muck which was damaged during construction activities onsite (Eagon and Associates 2011). The source of the organic material concentrated in this pond was determined to be a chronic leak at a nearby industrial composting facility on the City of Solon property. The source of the high conductivity in the northern stream was determined to be due to run-off of road salt on this same property due to poor housekeeping practices. Both problems were promptly addressed by the City of Solon. At this time, as a good faith gesture, Waste Management offered to pay to restock the lake (approximately $6,000) at a time when it was determined to be prudent. Cleveland Metroparks indicated this would likely be in spring or fall 2012 after the lake was deemed to be back to normal from a water quality standpoint.

As the ice thawed on the lake in spring 2011 a major fish kill, dominated by hundreds of dead trout, was confirmed. Park Operations staff removed many of these

fish and disposed of them at a location away from public use. The decision was made to re-open the lake in early spring 2011 and ODNR stocked trout without incident. Aquatic weed and algal growth were back to normal levels in summer 2011. It was determined that the fish kill was caused by a nutrient induced classic winter fish kill in which organic material (algae and aquatic macrophytes) under the ice consumed oxygen as it decomposed (Austin el al. 1996). A fish assessment conducted in late summer 2011 revealed a poor fish community lacking predator/prey balance. Trout stocking in December 2011 and January 2012 were conducted without incident and the fish have been healthy and conducive to angler capture. The DO levels under ice cover in the lake were scheduled to be monitored throughout winter 2011-12, but lack of ice formation due to an uncharacteristically warm winter has made this unfeasible. Follow-up sampling for conductivity on 9 February 2012 in the northern stream (3520 uS/cm) and at the southern basin of the lake (2370 uS/cm) revealed that, although conductivity readings were still moderately elevated versus most regional streams and lakes, the stream conductivity was reduced to just over one-quarter of the level it was a year ago at the same location. A complete timeline of the incident is outlined in Table 1.

The situation will continue to be monitored, but at the time of this writing it appears that the situation has been effectively addressed and that the lake is back to normal. If this continues to be the case through summer 2012, the lake will be ready for restocking of native warm-water species like largemouth bass, bluegill, and channel catfish in fall 2012.

Water transparency varies, being clearer during the colder seasons, due to seasonal variation in phytoplankton and zooplankton communities in the lake (Wetzel

1983). No other water quality issues have otherwise been observed in the lake over at least the past 7 years, beyond which point records are limited.

Fisheries Resource Overview

In an effort to obtain current data on the fish community in Shadow Lake, electrofishing was performed on 17 August 2011 in two sampling runs totaling 80 minutes. Electrofishing is a well established method utilized by fisheries managers to accurately assess fish population dynamics, abundance, and structure (Neilsen and Johnson 1983, Reynolds 1993, Smith-Root 2007). A Smith Root GPP 5.0 electrofishing unit and customized Alweld commercial johnboat, including booms constructed by Ashcraft Machine and Supply, Inc., of Newark, Ohio, were used. One person maneuvered the boat and operated the electrofishing unit control box while two assistants collected stunned fish, which were retained in an aerated 90 gallon onboard livewell for later processing. Fish lengths (mm) were obtained using a custom measuring board and weights (g) were obtained using a digital scale. Data was recorded onsite and all fish were released afterwards. Datasheets from the sampling activity are available in Appendix A.

Shadow Lake offers a typical fish assemblage for a small lake in Ohio. Fish species of importance (albeit to varying degrees) to anglers include largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus*), bluegill (*Lepomis mahrochirus*), pumpkinseed sunfish (*L. gibbosus*), channel catfish (*Ictalurus punctatus*), bullhead catfishes (*Ameriurus* spp.), common carp (*Cyprinus carpio*), and seasonally stocked rainbow trout (*Onchorynchus mykiss*). Other

fish species known to be present, but of lesser immediate interest to anglers, include golden shiner (*Notemigonus crysoleucas).* The fish community composition, overall, is typical for a small Ohio lake. Considering the location of the lake in a heavily utilized urban setting, the fishery would be characterized overall as "good" for seasonally stocked rainbow trout and "fair" for all other species.

The fish community, overall, is notable in lacking a healthy predator population (Table 2, Figure 4). Largemouth bass should be the dominant year-round predator in Shadow Lake given the habitat available and, as such, have a marked influence over the fish community (Anderson 1976, Carlander 1977, Austin 1996). The reason for this lack of largemouth bass in the recent sampling may be due to habitat limitations (low dissolved oxygen in harsh winters and/or lack of suitable spawning areas) and/or overharvest by anglers. Lack of prey species is not a limiting factor in this waterbody. Due to this scenario predator proportional stock densities and predator/prey ratio could not be calculated and analyzed (Table 3). Future plans include working to re-establish largemouth bass to the lake and also to determine limiting factors influencing sustainability of their populations in the waterbody, as will be covered in more detail in an upcoming section.

Bluegill and pumpkinseed sunfish are the most dominant forage fish in Shadow Lake. Sampling yielded 95 total sunfish weighing a total of 1.86 kg (4.1 lbs) (Table 1). Based on plotting length against frequency, there appears to be as many as six year classes of sunfish in the sample (Figure 5). Both black and white crappie, also stunted in size, make up a significant component of the sunfish community in the lake, with four apparent year classes present (Figure 6). Note that the smallest size classes of sunfish are

less susceptible to electrofishing and netting than larger specimens due to less surface area exposed to the electric field, hence the lower frequency of the smallest size class in the sample. Given a lack of "quality" size sunfish of 15 cm or greater in the sample (n = 1) proportional stock density (PSD) of sunfish was only 1.1% (Table 3), reflecting a severely stunted sunfish population (Anderson 1980, Gabelhouse 1984). This would be the expected outcome of a system lacking significant predators, as is currently the case in Shadow Lake. Given the lack of predators in the system a Total Quality (TQ) plot could not be calculated for the lake in its current state.

The fishery, overall, would be characterized as "fair" in its current state, although the lake is still a popular fishing destination within the Park District and is well suited to families, children, and less experienced anglers who want to catch fish regardless of size or sporting quality. The fishery can be characterized as "good" for seasonally stocked rainbow trout from winter through spring, which attracts a dedicated following.

Other Recreational Uses

Other than fishing, wildlife watching is the only other significant recreational activity suited to Shadow Lake. The waterbody is too small to make paddling sports (such as kayaking and canoeing) popular, and swimming is prohibited in this area. Hiking around parts of the lake is also popular, as is picnicking and sledding in the adjacent areas (Figure 2).

Ecosystem Function Overview

Shadow Lake is a manmade impoundment, but still serves some general ecosystem functions in the watershed. The basin, which has a watershed size of 0.22 mi^2, collects stormwater from the surrounding area, functionally serving as a buffer to help mediate the affects of direct runoff into Tinker's Creek (Figures 1 and 2).

A number of associated wildlife, notably birds, utilize Shadow Lake. Great blue heron (*Ardea herodias*), belted kingfisher (*Ceryle alcyon*), mallard duck (*Anas platyrhynchos*), wood duck (*Aix sponsa*), and Canada goose (*Branta canadensis*) are observed at the lake by wildlife watchers. The waterbody is host to an assemblage of common reptiles and amphibians either year-round or during the mating season, including eastern painted turtle (*Chrysemys picta picta*), snapping turtle (*Chelydra serpentina*), American toad (*Anaxyrus americanus*), green frog (*Lithobates clamitans*), and bullfrog (*L. catesbeianus*). No threatened or endangered species of flora or fauna are known residents of the lake. Although common dragonfly (suborder Anisoptera) and damselfly (suborder Zygoptera) species can be observed utilizing the lake margin a regular basis, there has been little information collected on specific macroinvertebrate or microbial communities within the waterbody.

The vegetative community of the lake becomes progressively more dense moving toward the shallower east end of the lake. Overall, submerged aquatic vegetation and algae in the lake would normally be considered to be at non-nusiance levels, although vegetative growth was uncharacteristically heavy in 2010 due to a temporary issue outlined in the Water Quality Overview section of this report. Emergent vegetation in the

lake is sparse. A full inventory of aquatic vegetation and algae species found at Shadow Lake has not been undertaken in the past, but needs to be done in the future.

Current Fisheries Management

Shadow Lake has been a moderate intensity managed fishery in recent years, with management responsibilities at this waterbody shared between Cleveland Metroparks and the Ohio Division of Wildlife (DOW). In this arrangement DOW stocks an average of 500 trout at this location in April every year and allocates some state Wildlife Officer time to enforcement at the lake, and therefore Cleveland Metroparks defaults to state inland lake regulations on all applicable fish species. These include a daily bag limits of 2 largemouth bass (of 12" or greater) and 5 rainbow trout (no size limit) per angler at Shadow Lake. There are no bag or size limit regulations on any other fish species in the lake. All other management duties at the location (other fish stocking, fish surveys, water quality analysis) are the responsibility of Cleveland Metroparks. As is the case with all Cleveland Metroparks waters, a valid Ohio fishing license is required to fish Shadow Lake. Two wheelchair accessible fishing platforms (one each on the northern and southwestern shorelines) and one platform accessible by stairs (on the western shoreline) are available (Figure 3). The stairs and accompanying platform were constructed as an Eagle Scout project in summer 2009.

The Shadow Lake fish community is supplemented with fish stocking activities as needed. Stocking of various fish species, such as rainbow trout and largemouth bass, is a very common fisheries management activity which has been shown to have many benefits to the public, especially in urban areas (DesJardine 1983, Gordon 1983,

Halko1983, Heidinger 1993, Manfredo et al. 1983, Norville 1961, Weithman 1993). In recent years, Cleveland Metroparks has stocked an average of 800-1,000 pounds of purchased, farm-raised rainbow trout to offer a winter fishery at Shadow Lake, typically with half in mid to late December and the remainder in late January to early February. Additionally, the Ohio Division of Wildlife stocks approximately 500 trout in the lake annually in early to mid April. The winter and spring rainbow trout fisheries are the most popular fishery in the lake.

Native warmwater sportfish species are also stocked in the lake on an opportunistic basis. Most recently, in November 2005, May 2008 and 2009, and September 2010 a total of approximately 4,500 bluegill sunfish, largemouth bass, and white crappie were transferred to Shadow Lake on an opportunistic basis from non-fishing areas of Cleveland Metroparks and private waters. In the short term, it is hoped that the predatory bass will begin reducing the stunted sunfish population to a more desirable level. In the longer term, more largemouth bass will be stocked in the lake over the next few years with the hope that a significant bass population will establish by the time the next fish community survey is conducted, likely in 2016.

It has been noted by various fish managers that proper communication with the public and the media is a powerful, and often underutilized, fisheries management tool (Decker and Krueger 1993, Patterson 1983, Cohen et al. 2008). With this in mind, information regarding fishing at Shadow Lake is disseminated through multiple outlets, including Cleveland Metroparks fishing booklet and trifold, on the Cleveland Metroparks website, through the local media, and via direct communication with anglers. Although Shadow Lake does not rank among the best fisheries in Cleveland Metroparks, it is the

better of the two lake fishing venues offered on the east side of the Park District and is popular among anglers. Consequently, there is a high demand for information regarding this fishery and the aforementioned avenues of dispensing information fill this role well.

Current Wildlife Habitat Management

Overall, Shadow Lake requires a low level of management effort given its mostly natural character. With the exception of the increased vegetative growth due to an issue in summer 2010 already discussed, under normal conditions aquatic vegetation at the lake is not at levels that require herbicidal treatments.

Management Recommendations

Overall, Shadow Lake offers a fair to moderate quality, but popular, fishery with a stunted sunfish population and low numbers of predatory largemouth bass complemented by winter and spring stocking of rainbow trout. With this limitation noted, Natural Resource staff will continue the stocking of predatory largemouth bass with the goal of establishing a viable year-round predator fish population in the lake. In addition to being an important component of the ecosystem in influencing sunfish populations toward a more desirable level and community structure, bass have a high level of sporting value. Dissolved oxygen levels will be monitored under the ice in winter over the next several years to determine if this continues to be a potential habitat limitation. If it turns out that an improved largemouth bass population has not been established based on follow-up sampling, scheduled for approximately 2016, then alternative management strategies for

the lake need to be considered. These would include accepting the limited fishery of the lake as it is or changing harvest regulations.

Specifically, the fishery could potentially benefit from more restrictive largemouth bass regulations, such as a increased minimum size (currently 12"), reduced bag limit, or slot limit requiring the immediate release of all bass in a size range, thereby protecting both smaller fish being recruited into the population and larger fish that are capable of producing the most offspring. Anderson (1976) notes that a 15-18" minimum length on largemouth bass should improve or sustain the quality of fishing under conditions where catchability is high, annual recruitment is low, and/or the there is overpopulation of stunted sunfish prey species. This idea will be revisited based on findings of the follow-up fish community survey, but would need to be discussed and agreed upon by the Ohio Division of Wildlife since this is a jointly managed location.

If future surveys reveal largemouth bass are surviving, but recruitment of younger fish through spawning is low or absent, this would indicate a lack of appropriate spawning habitat in the lake. Largemouth bass are flexible in spawning preference, but prefer firmer substrates. This could be addressed through depositing gravel in water over 2 feet deep along the shoreline to provide spawning habitat. Stocking of younger bass could also serve as a form of facilitated recruitment.

The lake could also potentially benefit from stocking of other warmwater fish species. One potential candidate species would be channel catfish (*Ictalurus punctatus*). The main goal, as already outlined, would be to reestablish largemouth bass in the waterbody, but large channel catfish can also serve a role as predators on sunfish in a system. This alternative can be evaluated if a bass population cannot be established.

Increasing public education regarding introduction of aquatic invasive species should be a focus at Shadow Lake, as well as all other park waters. This issue needs to be addressed as part of a wide-reaching campaign to be effective. The presence of red-eared slider turtles (*Trachemys scripta elegans*) and round gobies (*Neogobius melanostomus*) in other nearby waters are testaments to the fact that human-introduced species have occurred in the past in Cleveland Metroparks. Continued offering of printed and online information focusing on this concern, a well as communication with the media and word of mouth with anglers and other park users, would be an effective multi-pronged approach to combat this problem.

Aside from the issue on the adjacent property already discussed, stormwater inputs to Shadow Lake are likely not increasing due to built-out nature of surrounding development in the watershed (Figures 1 and 2). In its current state Shadow Lake and the natural components of the surrounding landscape will continue to buffer stormwater effects in nearby Tinkers Creek.

The current overall assessment is that Shadow Lake could be improved in fulfilling its primary role as a fishery within the Park District, and is currently a "work in progress". Adaptive management practices currently being employed at the lake will be assessed periodically in an attempt to improve the quality of the fishery at this venue as much as can reasonably be accomplished. If the fishery continues to be limited despite these measures, then other higher quality fisheries in the area, such as the Chagrin River, will fulfill this role and Shadow Lake will be continue to be considered a fair to moderate quality fishing area in addition to offering some wildlife habitat.

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Table 1. Shadow Lake Water Quality Issue Timeline – Winter 2011 through present

Date	Action or Activity
Mid to late January 2011	*Local anglers report no fish activity while ice fishing at Shadow Lake for approximately 2 weeks despite recent stocking of rainbow trout.*
1/28/11	*Water quality investigation revealed critically low dissolved oxygen (DO) below 3.0 ppm under the ice at various locations at the lake. Also noted uncharacteristically strong phytoplankton (algae) stain to water under the ice and very strong hydrogen sulfide odor and black color coming from south creek at far east side of lake. Sanitary leak into this drainage is suspected.*
1/31/11	*Low dissolved oxygen levels again confirmed. Hundred of stressed, as well as dead and dying, small sunfish observed at seepage along north shoreline of lake (a refugia of higher oxygen levels and thin ice). Extremely high conductivity (13,000 uS/cm) noted at north stream coming into east end of lake.*
2/1/11	*City of Solon Sewer Division decides to test nearby sanitary sewer lines with closed circuit camera, as well as pressure testing, if needed, to determine if a sanitary leak is the source.*
2/2/11	*Waste Management (owner of adjacent Cuyahoga Landfill) is also involved with the investigation. Water samples collected by Cleveland Metroparks for coliform bacteria and related parameters and submitted to NEORSD lab. Former Cleveland Metroparks Fisheries Manager contacted and noted such a situation was unprecedented at Shadow Lake based on his 30 year tenure in that position.*
2/3/11	*NEORSD results indicate low levels of coliform bacteria, making sanitary origin of source unlikely.*
2/4/11	*Onsite meeting arranged with staff from Cleveland Metroparks, Waste Management (WM), Ohio EPA, City of Solon, and Cuyahoga County Board of Health. Lake posted as closed to use until further notice.*
2/7/11	*Ohio EPA makes the decision to deal with the situation as an emergency response and works with Solon and WM to intercept the flow from the south stream on the east side of the lake and pump its entirety to Solon POTW until further notice. Leachate from a City of Solon composting facility is suspected as the most likely source of nutrient input.*
2/10/11	*Lab results from the south stream reveal extreme high levels of ammonia (21 times normal for the Cuyahoga River watershed) and elevated sulfate (5x normal) and nitrate (1.5 to 2x normal) levels. Lab results from north-east stream reveal elevated sodium and calcium levels (indicating source could be NaCl and CaCl road salt).*
3/1/11	*WM contracts Eagon and Associates, Inc., to conduct a full environmental investigation of the situation.*
3/3/11	*Eagon report finds that concentrated organic material (muck) at the bottom of a retention pond adjacent to Cleveland Metroparks property is leaking into an old broken clay tile underground and is the source of the issue in the south-east stream. This scenario has unknowingly been the cause of nutrient enrichment of the lake since the summer 2010 growing season, leading to exacerbated algae and weed growth in the lake that caused the DO issue under the ice during decomposition.*
3/10/11	*Meeting between CM and WM representatives. WM further indicated the Eagon findings were that the organic material in the detention pond originated from chronic leakage from the City of Solon composting facility, and that the elevated conductivity of the north stream originated from poor housekeeping practices with road salt on the Solon maintenance facility in the drainage. WM worked with Solon on both issues and both had been resolved as of this time. Furthermore, as a good faith gesture WM offers to pay to restock Shadow Lake with fish at a time when deemed prudent.*
3/14/11	*Ice melts during a thaw and reveals hundreds of dead fish, mainly rainbow trout, as anticipated.*
3/21/11	*Lake re-opened to the public.*
4/1/11	*ODNR stocks 500 rainbow trout in the lake without incident.*
Summer 2011	*Algae and weed growth in the lake are back to normal levels. The south stream is still being fully diverted to Solon POTW.*
Winter 2011-12	*Rainbow trout stocked in Shadow Lake in mid December and late January without incident. A very mild winter has not been conducive to monitoring the situation under what little ice had formed, but the issue at this time appears to be fully resolved. Conductivity of northern stream at 3520 uS/cm (25% of level a year ago).*

Table 2. Basic characteristics of largemouth bass and bluegill/pumpkinseed sunfish populations based on 17 August 2011 assessment (sampling time = 80 minutes)

Species	Total Number	Total Weight (kg)	Average Size (mm)	Average Relative Weight (W_r)[1]
Largemouth bass	4	0.25	118.75	95.12
Bluegill and Pumpkinseed	95	1.86	99.94	101.49

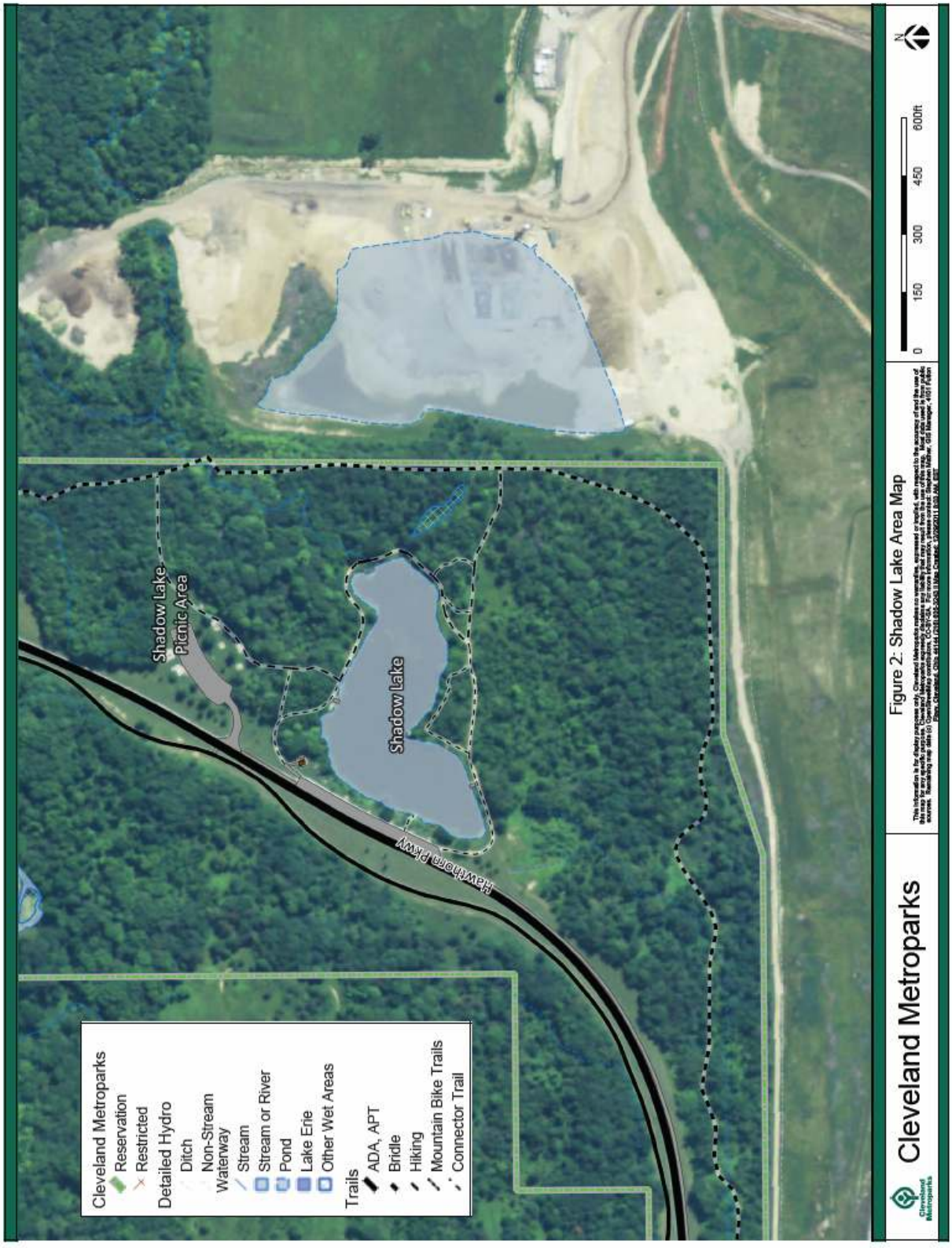
[1] As outlined in Wege and Anderson 1978 and Anderson and Gutreuter 1983.

Table 3. Predator (largemouth bass) and prey (bluegill and pumpkinseed sunfish) proportional stock density information

Species	≥ Stock Size[1]	≥ Quality Size[1]	Proportional Stock Density (%)
Largemouth bass	1	0	0.00
Bluegill and Pumpkinseed	88	1	1.12

[1] Designations per Gablehouse 1983.

Figure 1. Shadow Lake Subwatershed Map


Cleveland Metroparks
Reservation
Restricted
Detailed Hydro
Ditch
Non-Stream
Waterway
Stream
Stream or River
Pond
Lake Erie
Other Wet Areas
Trails
ADA, APT
Bridle
Hiking
Mountain Bike Trails
Connector Trail
Shadow Lake Picnic Area
Shadow Lake
Hawthorn Pkwy
Cleveland Metroparks
Figure 2: Shadow Lake Area Map
0 150 300 450 600ft
N

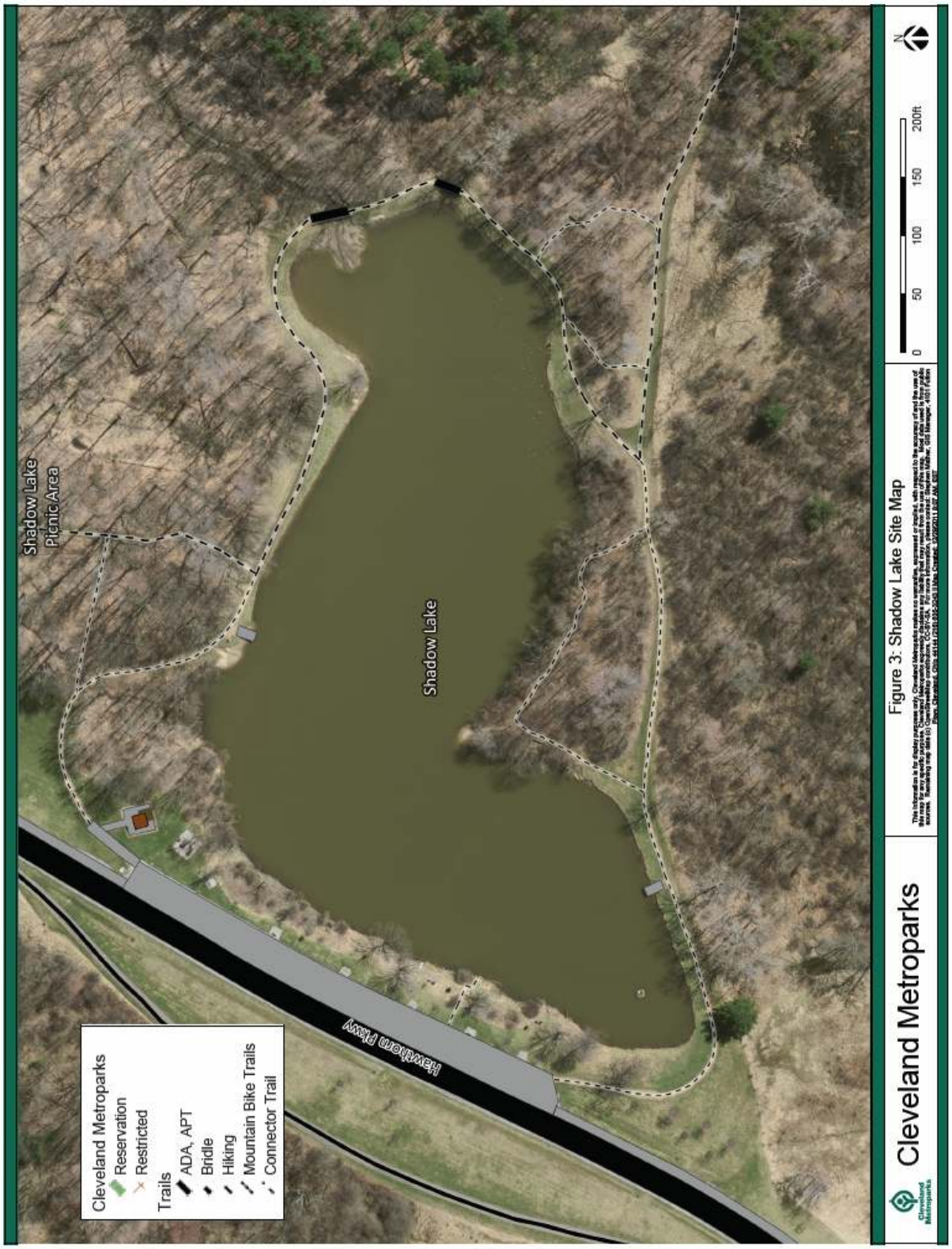

Shadow Lake
Picnic Area
Shadow Lake
HEWLETT PKWY
Cleveland Metroparks
Reservation
Restricted
Trails
ADA, APT
Bridle
Hiking
Mountain Bike Trails
Connector Trail
Cleveland Metroparks
Figure 3: Shadow Lake Site Map
0
50
100
150
200ft
N

Figure 4. Length/Frequency of Largemouth Bass

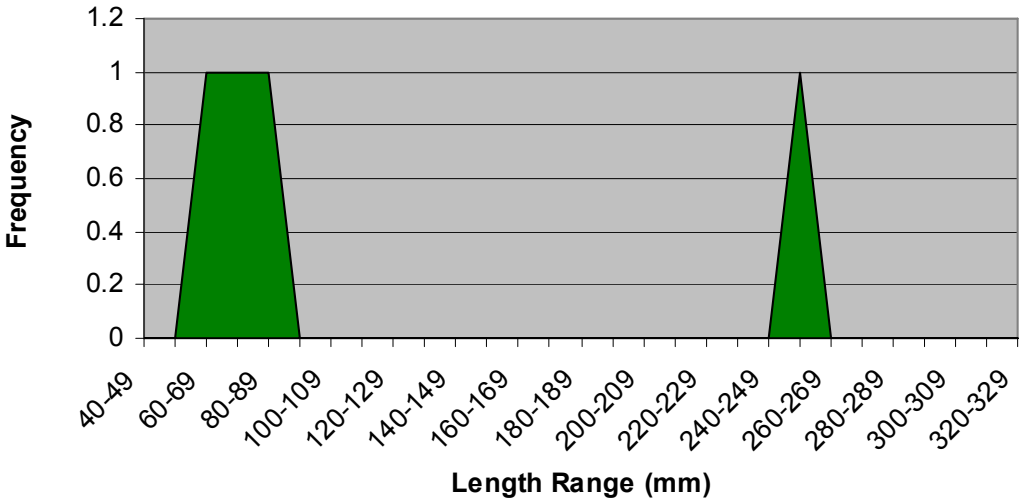
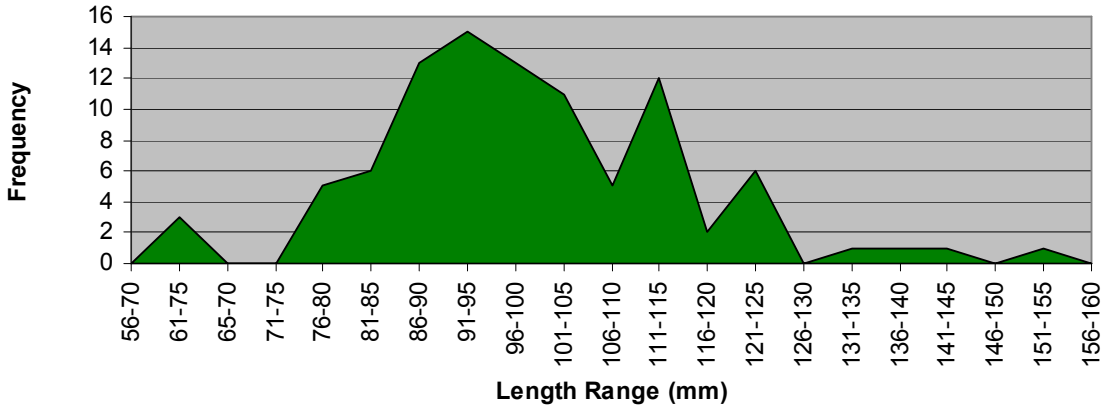


Figure 5. Length/Frequency of Pumpkinseed and Bluegill Sunfish



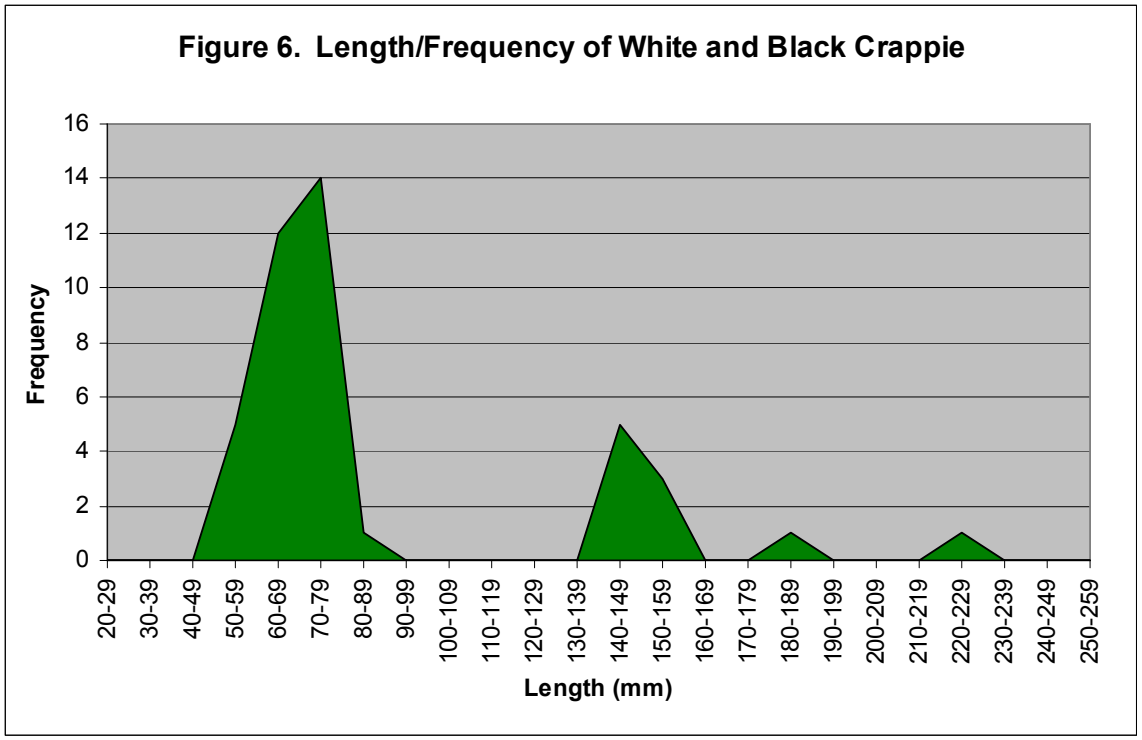


Figure 6. Length/Frequency of White and Black Crappie
Frequency
16
14
12
10
8
6
4
2
0
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100-109
110-119
120-129
130-139
140-149
150-159
160-169
170-179
180-189
190-199
200-209
210-219
220-229
230-239
240-249
250-259
Length (mm)

APPENDIX A:
Fish Population Assessment Data Sheets
17 August 2011 (three pages)

*1 carp

Run 1

Cleveland Metroparks Fish Population Assessment Data Sheet

Date: 8/17/2011 **Location:** Shadow Lake (South Chagrin Reservation)

Species: **Time Sampled:** start- 1815 end- 1859 48 min

	Sunfish Length (mm)	Weight (g)	White Crappie Length (mm)	Weight (g)	Other Length (mm)	Weight (g)	
PS 1	122	36	41 220	100	81 65	3	LMB
BG 2	115	19	42 72	4	82 70	3	LMB
BG 3	91	13	43 75	5	83 85	6	Golden Shiner
BG 4	87	10	44 70	3	84 99	9	Golden Shiner
BG 5	95	15	45 79	5	85 104	14	Golden Shiner
BG 6	105	19	46 140	41 ← Black	86 89	8	Golden Shiner
BG 7	100	17	47 155	34	87 283	235	LMB
BG 8	90	14	48 66	4	88 101	10	Golden Shiner
BG 9	85	11	49 74	5	89 79	5	Golden Shiner
BG 10	85	12	50 60	41 ← Black	90 77	76	Yellow Bullhead
BG 11	83	11	51 75	7	91		
BG 12	101	19	52 64	3	92		
BG 13	102	18	53 55	2	93		
PS 14	125	44	54 55	3	94		
BG 15	97	15	55 74	5	95		
BG 16	113	23	56 83	7	96		
BG 17	102	16	57 70	8	97		
BG 18	96	15	58 73	4	98		
BG 19	93	13	59 55	2	99		
BG 20	86	12	60 67	3	100		
BG 21	151	57	61 69	4	101		
BG 22	110	24	62 76	5	102		
BG 23	80	8	63 50	1	103		
BG 24	110	24	64 74	4	104		
PS 25	110	25	65 74	4	105		
PS 26	100	17	66 65	3	106		
PS 27	75	12	67 67	3	107		
BG 28	87	12	68 67	3	108		
BG 29	93	13	69 57	2	109		
PS 30	133	41	70 65	3	110		
PS 31	93	15	71 67	4	111		
BG 32	96	14	72 69	4	112		
BG 33	112	21	73 68	3	113		
BG 34	87	12	74 67	4	114		
PS 35	114	33	75 72	4	115		
PS 36	113	23	76		116		
BG 37	95	16	77		117		
BG 38	97	16	78		118		
BG 39	98	16	79		119		
BG 40	91	16	80		120		

Run 1

Fish Population Assessment Data Sheet

Date: 8/17/2011 **Location:** Shadow Lake (South Chagrin Reservation)

Species: Sunfish **Time Sampled:** 48 min

		Length (mm)	Weight (g)
BG	1	105	18
BG	2	76	8
BG	3	96	15
BG	4	90	12
PS	5	140	50
BG	6	105	19
PS	7	145	57
BG	8	90	12
BG	9	100	17
BG	10	99	17
BG	11	93	14
BG	12	86	12
BG	13	90	13
BG	14	113	25
BG	15	92	14
BG	16	87	12
BG	17	72	7
BG	18	99	16
PS	19	124	41
BG	20	87	12
BG	21	101	19
BG	22	81	9
PS	23	105	27
BG	24	102	19
BG	25	93	14
PS	26	104	21
BG	27	92	13
PS	28	104	23
BG	29	80	10
BG	30	82	10
BG	31	87	12
PS	32	71	7
	33		
	34		
	35		
	36		
	37		
	38		
	39		
	40		

	Length (mm)	Weight (g)
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		
72		
73		
74		
75		
76		
77		
78		
79		
80		

	Length (mm)	Weight (g)
81		
82		
83		
84		
85		
86		
87		
88		
89		
90		
91		
92		
93		
94		
95		
96		
97		
98		
99		
100		
101		
102		
103		
104		
105		
106		
107		
108		
109		
110		
111		
112		
113		
114		
115		
116		
117		
118		
119		
120		

#4 carp

Run 2

Fish Population Assessment Data Sheet

Date: 8/17/2011

Location: Shadow Lake (South Chagrin Reservation)

Species:

Time Sampled: start 1945 end 2017 32 min

Sunfish

	Length (mm)	Weight (g)
PS 1	91	16
PS 2	167	30
PS 3	112	28
BG 4	91	15
PS 5	111	30
BG 6	97	16
PS 7	114	26
PS 8	101	39
BG 9	100	17
BG 10	116	27
BG 11	104	20
BG 12	84	10
PS 13	109	24
BG 14	111	21
BG 15	112	23
BG 16	94	16
17		
18		
19		
20		
21		
BG 22	114	27
PS 23	116	31
PS 24	125	41
BG 25	76	9
BG 26	79	9
PS 27	94	17
PS 28	87	13
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

White Crappie

	Length (mm)	Weight (g)	
41	143	29	
42	142	43	← Black
43	181	59	
44	71	4	
45	146	46	← Black
46	144	41	Black
47	155	38	
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			

Other

	Length (mm)	Weight (g)	
81	80	7	LMB
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
97			
98			
99			
100			
101			
102			
103			
104			
105			
106			
107			
108			
109			
110			
111			
112			
113			
114			
115			
116			
117			
118			
119			
120			