Fisheries Management Plan

Union Lake

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Division of Fish and Wildlife
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Fisheries Management Plan

Millville
Cumberland County

Watershed Management Area: 17
Maurice, Salem and Cohansey
Maurice River Drainage
Watershed Area: (hectares)
898 Acres
Average depth: 10 ft.

Grant F-48-R Job III-1

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INTRODUCTION

Union Lake is located in Millville, Cumberland County, formed by damming the Maurice River just upstream of Sharp St. The lake has a surface area of 898 acres (363 hectares) and a maximum depth of about 27 feet (Figure 1). Historically Union Lake served as the epicenter of the Millville industrial boom of the late 1700's. A dam at the present location was created in the 1860's and reconstructed in the 1930's. However, the original dam created by the Union Estates Company in 1776 was formed further upstream presumably near the location known today as the "gate hole". Union Lake was purchased by the Division of Fish and Wildlife, through the Green Acres Program in 1982. The dam was categorized as a high hazard and reconstruction commenced in 1989. Union Lake remained closed to anglers during the dam reconstruction in 1989 and 1990. The newly constructed dam incorporated a fish ladder for the passage of anadromous migratory fish.

A fisheries inventory was last completed at Union Lake in 2005. A previous inventory was completed in 1994; four years after the dam had been replaced.

The Maurice River has a drainage area of approximately 386 square miles consisting of a wide range of soil types and pH levels depending on the degree of agriculture, urbanization and residential impacts.

Union Lake is not only the largest impoundment in southern New Jersey it is also one of the most popular Largemouth Bass destinations for recreational tournament anglers attracting thousands annually. Two public boat ramps provide ample access and parking for boat anglers. Shoreline anglers are restricted to the western shoreline in close proximity to the Division of Fish and Wildlife boat ramp. Union Lake has a 10 horsepower motor restriction which limits boating activities to smaller aluminum boats and larger fiberglass boats with electric trolling motors. Kayaks and canoes can frequently be seen paddling the headwaters of Union Lake and the Maurice River.

MATERIALS AND METHODS

Water quality parameters were measured at various locations in the lake (Figure 1). Dissolved oxygen, conductivity, pH, and temperature were measured in the field using hand held Yellow Springs Instrument (YSI) meter (Professional Plus model). Additional water quality data (nitrogen, phosphorus, and dissolved solids) was not collected because this information is available through other recent studies.

A 13.2 Smith-Root electrofishing boat was used during all electrofishing-sampling periods. Sampling locations are shown for all sampling methods in (Figure 1). A total of six electrofishing surveys were completed at Union Lake during the 2015 sampling period, of which four were conducted at night and two during the day. Four nighttime surveys were completed on May 12, June 3, October 21 and October 26. Daytime surveys were completed on August 13 and November 11.

Three seining surveys were completed during the summer on June 23, June 25 and July 23rd to assess reproduction of warmwater fish. Three experimental gillnets were set at locations representing different habitat and depths during the fall on November 5th.

Length and weight measurements were taken on all game and panfish species collected. Proportional stock densities (PSD), relative stock densities (RSD), and relative weights (W_r) were calculated for Largemouth Bass, Chain Pickerel, Bluegill, Pumpkinseed, Yellow Perch and Black Crappie. Scales were removed from a sub-sample of all gamefish species, and later mounted between two microscope slides, viewed using a microfiche projector, and aged. Back-calculation was used to obtain information on the growth history of year classes of Largemouth Bass, Smallmouth Bass, Bluegill, Pumpkinseed, Yellow Perch, Black Crappie, Chain Pickerel, Striped Bass and White Perch (using the Fraser-Lee Method and standard a values, as suggested by Carlander).

RESULTS

Water Quality

A dissolved oxygen temperature profile conducted on July 23 indicate a thermal stratification with temperatures ranging from 21.5° – 29.6° C on July 23 and dissolved oxygen ranging from 0.09 to 8.65 mg/l (Figure 3). Anoxic conditions were present below 17 feet. The average surface temperature during the sampling period was 21.3° C. Surface dissolved oxygen levels average 7.64 mg/l (n=9) and ranged from 6.0 – 8.6 mg/L. The specific conductance averaged 123.1 *u*S/cm and ranged from 97.0 – 141.3 *u*S/cm (Table 1). The pH averaged 7.17 and ranged from 6.2 – 7.5.

Aquatic Vegetation

Aquatic vegetation is extremely limited in Union Lake and appears to have declined since the last inventory in 2005. The inventory in 2005 indicated that the abundance had declined during the ten year period since the 1995 survey. A formal aquatic vegetation survey was not completed however emergent species once common, including native rushes and cattails and invasive common reed grass, *Phragmites* were far less abundant. Yellow water lily appeared to be more abundant in areas once inundated by emergent

rush. The 1995 fisheries survey indicated that coontail and lowly water milfoil were common in Union Lake, however neither species was observed during the survey. The species may have been misidentified in the past or may not longer be present.

Aquatic vegetation abundance has most likely been impacted by water level, nutrient abundance or turbidity. The dam reconstruction possibly could have resulted in a dam higher in elevation than the previous structure. Higher water levels are known to have an impact on emergent aquatic vegetation abundance. In addition, elimination of an upstream sewage treatment facility may also have reduced the nutrient input resulting in less aquatic vegetation.

Periodic water lowering, during the spring and summer growing season should be considered to help promote the growth of vegetation and improve fish habitat.

Fisheries

A total of 2,852 fish represented by twenty-eight species, twelve families and nine orders were collected during the 2015 sampling at Union Lake (Table 2).

A total of 22 species and (n=2,142) individual fish were collected during six electrofishing surveys. Yellow Perch were the most abundant species collected during electrofishing and had the highest catch per unit effort (CPUE) during electrofishing (Table 3).

Fifteen species of fish (n=124) were collected utilizing gillnets in November 2015. Chain Pickerel (n=64) were the most abundant by that sampling method (Table 4).

Fifteen species of fish (n=586) were collected by shoreline seining in July 2015. Largemouth Bass were the most abundant young-of-the-year (YOY) fish collected. Bluegill were the most abundant species collected by shoreline seining. (Table 5)

Largemouth Bass

Largemouth Bass (n=182) represented 8% of all fish collected during electrofishing (Table 3). The mean CPUE for Largemouth Bass (n=182) was 19 bass per hour during all sampling periods (Table 3). Similarly the CPUE was determined to be 19 bass per hour during the 2005 Union Lake Fisheries. At that time a total of 122 Largemouth Bass were collected during 6.85 hours of electrofishing (Smith, 2006). In 2015, the highest individual CPUE of 37 bass per hour was during fall daytime (November 5) electrofishing, with individual CPUEs ranging from 11 to 37 bass per hour. The CPUE, number/hour, for Largemouth Bass $\geq$ 200 stock size (n=61) during fall 2015 night electrofishing collectively was 17 per hour on October 21 and October 26 (Table 3). Individual CPUEs range from 11 to 37 bass per hour. Using the State of New York's equation for first order estimates of abundance renders of population density of 4.42 for Largemouth Bass $\geq$ 254 mm (Green 1989). For Largemouth Bass < 254 the first order estimate of abundance gives a value of 2.29. Both estimates indicate low density

population. Similarly, the CPUE for Largemouth Bass ≥ 200 mm stock size (n=44) during spring 2015 night electrofishing was 21 bass per hour. The CPUE for Largemouth Bass ≥ 254 mm (n=37) was 12 per hour, which correlates to a first order estimate of abundance of 6.96 indicating a moderate density. A first order estimate of abundance value less than 5.5 indicate a population of low density whereas values of 5.5 to 13.0 suggest a moderate density by the New York State Sampling Manual.

The PSD and RSD_{15} values were similar during spring and fall electrofishing. PSD and RSD_{15} values were 82 and 32 during spring 2015 electrofishing and 76 and 44 during fall 2015 electrofishing. PSD and RSD_{15} values are within the recommended 40 -70 and 10 - 40 values for a balanced population (Table 6). The length distribution graph from spring 2015 indicates the population is well distributed and moderately balanced (Figure 4). A larger sample size was collected during fall electrofishing (n=108) and indicates the population is balanced (Figure 5). Relative weights for Largemouth Bass were within the recommended 95 – 105 mean and indicate the population is in good condition. The overall mean W_r for Largemouth Bass collected during spring 2015 electrofishing was 98 ± 4.12 and ranged from 83 -120. There was no decrease in relative weights as individual size increased during spring sampling. This decrease is usually indicative of spawning stress and may suggest that the Largemouth Bass had not spawned. The overall mean W_r for Largemouth Bass collected during fall electrofishing was 101 ± 2.13 and ranged from 50 - 129 (Table 7).

Largemouth Bass reproduction appears to be relatively poor as young of the year (n=131) represented 48% of all young-of-the year collected. A total of 76 locations were sampled via shoreline seining to assess reproduction (Table 5). A total of 148 Largemouth Bass were collected from 29 locations during the 2005 survey yielding a catch rate of 5.1 Largemouth Bass YOY per seine pull. The catch rate in 2015 was 1.7 YOY per seine pull. Largemouth Bass were found at 48% of sites sampled in 2015 and 79% in 2005 (Table 5). Growth rates for Largemouth Bass collected in 2015 (n=163) are generally below average compared to statewide averages as indicated by the length at age graph (Figure 6). Age II and V individuals showed near average growth rates whereas Age III, IV and VI were below average (Table 8). The age frequency graph shows a balanced population with Age V Largemouth Bass the most abundant in 2015 (Figure 7).

The Largemouth Bass population is well distributed, relatively balanced and in good condition, however the population was found in low abundance.

Chain Pickerel

Chain Pickerel were found to be relatively abundant during spring and fall electrofishing (n=65) and during fall gill netting (n=25). Chain Pickerel represented 3% of all fish caught during electrofishing and the CPUE of 7 per hour was consistent across all sampling periods (Table 3). Chain Pickerel were the most abundant fish collected during fall gill netting at 20% of the total (Table 4). The length frequency graphs from spring electrofishing (Figure 8) and fall sampling indicate the population is well distributed (Figure 9). The length frequency from spring electrofishing suggests the population is

unbalanced. However, the length frequency graph from fall electrofishing and gillnetting combined indicate the population is balanced (Figure 9). Chain Pickerel had a wide PSD range during the sampling period, indicating the population is may not be balanced. The lowest PSD observed was 50 during spring electrofishing and the highest was 83 during fall gillnetting. RSD_{20} values were also variable ranging from 13 during spring electrofishing to 27 fall electrofishing (Table 6). The overall W_r for Chain Pickerel was higher in the spring, 99 ± 4.41, than the fall (Table 7). Chain Pickerel ≥ 510 mm collected during the fall had the lowest mean W_r at 84 ± 4.76 (Table 7). Relative weights were generally below acceptable ranges during the fall and suggest the population may be below optimal condition during that time, this could be attributed to warmer than normal fall temperatures. Relative weights were generally within the acceptable range during spring sampling and only individuals 380-510 mm were slightly under the acceptable ranges which may be attributed to spawning stress. Chain Pickerel had average too slightly above average growth rates for ages I through IV, however older larger individuals age V and VI had below average growth rates (Figure 10). The age frequency graph indicates that the population is well distributed and balanced (Figure 11). There were eight YOY Chain Pickerel collected during shoreline seining (Table 5).

Bluegill

Bluegill (n=326) had the second highest CPUE at 77 fish per hour during electrofishing and represent 15% of the total catch (Table 3). The spring electrofishing length frequency graph indicates the population is balanced and well distributed (Figure 12). The fall length frequency also indicates the population is well distributed and balanced however a larger number of small individuals were collected (Figure 13). PSD and RSDp values of 57 and 13 from spring electrofishing suggest that the population is balanced (Table 6). A PSD of 30 and RSD_8 of 8 from fall electrofishing indicate a slightly less balanced population consisting of smaller individuals. Recommended PSD and RSDp values by (Novinger and Legler, 1978) are 20-60 and 5-20 for a balanced population. The mean W_r for all Bluegill collected during spring electrofishing was 102 ± 2.93 and ranged from 70-150 (Table 7), which indicates fish are in good condition. Bluegill collected during fall electrofishing had a lower overall mean W_r of 90 ± 1.99. Growth rates for Bluegill were slightly above the statewide averages for all age classes (Figure 14). Age II Bluegill were the most abundant age class (Figure 15). A total of 60 YOY Bluegill were collected during shoreline seining and represented 22% of all YOY (Table 5). In addition there were 104 intermediate sized Bluegill collected.

Pumpkinseed

Pumpkinseed (n=46) were less abundant than Bluegill, with a CPUE of 10 per hour versus 77 per hour for Bluegill, as determined by night electrofishing. Pumpkinseed represented 2% of all fish collected during electrofishing (Table 3). The population appears to be poorly distributed based on the fall length frequency graph (Figure 16). The overall size structure of pumpkinseeds appears to be unbalanced based on a PSD of 30 and RSD_8 of 5 from those collected during spring electrofishing and 27 and 7 from individuals collected during fall electrofishing (Table 6). Relative weights were above

the recommended range of 95 – 105, for those collected during fall electrofishing with a mean W_r of 115 ± 6.86 (Table 7). Although growth rates were above average for all age classes the sample size was rather small (n=10). The age frequency graph indicates that the age structure is unbalanced, but again the sample size was small (Figure 17). Pumpkinseed YOY were not represented during shoreline seining however intermediate size Pumpkinseed represented 13% of the total (Table 5).

Yellow Perch

Yellow Perch were the most abundant species collected (n=483) electrofishing, representing 22% of the total catch. The CPUE of 79 fish per hour during electrofishing was the highest of all species (Table 3). The Yellow Perch population is poorly distributed as evident from the spring and fall length frequency graph with most individuals in the 100-124 mm range in the spring (Figure 18) and 125-149 mm range in the fall (Figure 19). The PSD and RSD_p values of 20 and 2 from the spring and 8 and 4 from the fall both indicate the population is unbalanced. The overall mean W_r was 80 ± 1.79 from fall electrofishing and ranged from 55 - 127. This suggests that the population is below average condition. Yellow Perch had a higher overall mean W_r during spring electrofishing at 95 ± 3.79. Individuals in the 100-129 mm range had the highest W_r at 99 ± 6.42 in the spring (Table 7). The age frequency graph (n=25) supports the poor distribution with Age I - III individuals the most abundant (Figure 20). Growth rates were generally below average for all age classes of Yellow Perch (Figure 21). A total of 17 YOY were collected during shoreline seining and were encountered at 11% of all sites. Yellow Perch represented 6% of the total YOY collected (Table 5).

Smallmouth Bass

Smallmouth Bass (n=11) were not well represented during the sampling period. The CPUE for the sampling period was 1 fish/hour (Table 3). The population based on the electrofishing length frequency appears to be unbalanced (Figure 22). Growth rates for Smallmouth Bass were below average for Age III - VI individuals and above average for Age I and II (Figure 23). Smallmouth Bass were well distributed based on the age frequency but the sample size was very small (Figure 24). Smallmouth Bass were well represented during shoreline seining with 17 individuals collected representing 6% of the all YOY fish (Table 5). Smallmouth Bass were found at 16% of the sampling locations. Seining was completed prior to annual stocking of YOY Smallmouth Bass.

Black Crappie

Black Crappie (n=150) were well represented during spring and fall electrofishing surveys as evident by a CPUE of 25 fish/hour during the fall and spring surveys (Table 3). Black Crappie were not well represented during fall gill netting (n=8) at 6% of the total (Table 4). The population appears to be poorly distributed based on the length frequency from spring electrofishing (Figure 25). The age frequency from the same sampling period shows a poorly distributed population with most individuals Age IV to VII (Figure 26). The length frequency (Figure 27) and age frequency (Figure 28) from

fall electrofishing indicates the population is not balance and most individuals are smaller. Based on a PSD value of 93 and RSD_{10} of 54 and RSD_{12} of 25 from spring electrofishing the population is not balanced and consists primarily of larger individuals (Table 6). Summer and fall electrofishing showed a similar trend with a PSD of 100 a RSD_{10} of 70 and a RSD_{12} of 6 from the summer and PSD of 86 a RSD_{10} of 55 and a RSD_{12} of 9 during the fall (Table 6). Recommended values are 30-60 for PSD and >10 for RSD-p. Smaller Age I individuals (n=30) were well represented during fall electrofishing and represented 58% of the total. The mean W_r of 96 ± 5.32 from fall electrofishing indicates the Black Crappies are of good condition. Black Crappies 200-249 had the highest W_r at 102 ±14.33 (Table 7). Black Crappies had average growth to above average based on the length at age graph (Figure 29). There were two Black Crappie YOY collected during shoreline seining (Table 5).

Striped Bass

Striped Bass (n=3) were not well represented during the sampling period. Two individuals > 800 mm were collected during spring electrofishing (Table 3) and one smaller individual (375 mm) was collected during fall gillnetting (Table). One adult Striped Bass 1066 mm was collected in the 2005 survey in the exact location as the two captured electrofishing during the spring 2015 survey. Juvenile Striped Bass are known to utilize the fish ladder. In addition anglers have released Striped Bass in the lake, caught downstream of the Union Lake dam in the Maurice River.

Alewife and Golden Shiners

Alewives were frequently observed while electrofishing however collection was only attempted on three nights of electrofishing. The CPUE for Alewife (n=113) was 32 fish/hour and represented 5% of the total (Table 3). Only two Alewives were collected during the 2005 survey. In 1994, Alewives represented 8% of the total catch. It appears that despite minimal utilization of the fish ladder by anadromous fish the landlocked Alewife population has improved and doing well. The Bureau of Marine Fisheries has monitored the fish ladder over the last three seasons and found that flow velocity is not optimal for the passage of river herring. The fish ladder was found to pass rather few herring during the study, though other species regularly use it. The fish ladder has been confirmed to pass river herring in the past.

Golden Shiners were found to be rather abundant (n=193) during electrofishing with a CPUE of 32 fish/hour (Table 3). They were also well represented during fall gill netting (n=23) and 19% of the total (Table 4). Only six Golden Shiners were collected in the 2005 survey during electrofishing. A total of 23 Golden Shiners were also captured in gill nets in 2005. Several large common carp were captured, but did not appear to be very abundant. Creek Chubsucker (n=38) and White Sucker (n=19) were found in similar abundance during previous electrofishing sampling.

Channel Catfish and Bullhead

Three members of the catfish family are present in Union Lake; Channel Catfish, White Catfish and Brown Bullhead, with Brown Bullhead the most abundant (n=55) as determined by electrofishing (Table 3). White Catfish (n=15) were the most abundant as determined by gill nets (Table 4). Channel catfish were not as abundant as the other two species. A total of nine Channel Catfish were collected, five by electrofishing and four by gill nets. Union Lake has only been stocked twice with Channel Catfish since 1991 (Appendix A). The lake received an additional 30,850 surplus fry in 2015 which should help to enhance the population. The largest Channel Catfish was 608 mm and weighed 2.21 kg (4.87 lbs.). The Channel Catfish population is supplemented by those utilizing the fish ladder and those entering the lake from upstream stocked waters.

White perch

White perch were encountered frequently during the sampling period. White perch are an open water member of the temperate bass family, closely related to the Striped Bass and hybrid Striped Bass. They too are a schooling fish and found in high abundance when encountered. White perch (n=380) made up 18% of the total catch electrofishing and 14% from gill nets (Table 4). Growth rates were below the statewide averages (Figure 30) and were generally in good condition based the W_r at 93±1.85 from fall electrofishing. The length frequency graph from the spring (Figure 31) and the fall indicate the population is not balanced and poorly distributed (Figure 32).

Native Fishes

Many of the species found in the Union Lake are introduced species, however one species encountered that were previously not collected during the 2005 survey, was the Pirate Perch, a native species. These fish are sensitive to habitat change and predation by non-natives and have garnered threatened and endangered status in some states.

DISCUSSION

Union Lake is the largest lake in the Southern New Jersey and has one the highest species diversities in the state with 28 species represented during the survey. A number of the species have been introduced for recreational purpose however a number of New Jersey's rare native species still inhabit these waters.

The Largemouth Bass population is well distributed, relatively balanced and in good condition, however the population was found in low abundance. Union Lake is one of the better Largemouth Bass waters in the southern part of the state despite the low electrofishing catch rate. The Division has monitored catch reports from tournaments at WMA lakes since the mid-1990s. These reports allow biologists the ability to track changes of fish size and angler catch rate. A decline in the average size and the overall number of fish being caught was observed around the time the last survey was completed

in 2005. Supplemental stockings of YOY Largemouth Bass in 2009 – 2011 and again in 2015 appear to have helped maintain the population. Stocking of adult Largemouth Bass in 2009 from the Centerton Lake fish salvage probably had a significant impact as evident from the strong 2010 year class. Reproduction appears to be impacted by the lack of shoreline cover and vegetation, with only a few spawning beds observed. Based upon observation, traditional spawning areas of Largemouth Bass are rarely utilized in recent years. In addition to habitat loss stressors from competition, angler harvest and mortality from disease have all had an impact on the Largemouth Bass population. The population currently appears to be in good condition and stable however habitat enhancement is necessary for the population to improve.

Smallmouth Bass were first introduced into Union Lake in 1995. Supplemental stockings in 2001 and 2002 provided a good foundation and established a reproducing population. In 2007 the Division began annually stocking Smallmouth Bass in Union Lake. The population really flourished after the 2007 stocking when the Largemouth Bass were in decline. Tournament results consistently show an increase in the number of Smallmouth Bass until 2010. A rebounding Largemouth Bass population has resulted in competition for habitat and spawning locations and ultimately fewer Smallmouth Bass caught in tournaments.

The habitat in Union Lake appears to be the limiting factor affecting a number of the fish species and the overall balance of the lake. A decline in emergent aquatic vegetation was identified as a limiting factor during the 2005 inventory. The water level and dam height most likely has the most impact on these species of emergent vegetation. A plan to manage the habitat in Union Lake should be established which will overall improve the fish population. There is a distinct relationship between vegetative abundance and species richness and fish abundance. Periodic water lowering should be implemented during the growing season to promote the growth of emergent species and improve habitat. Establishing native submerged aquatic vegetation should also be considered. The creation of shoreline habitat from felled trees and the placement of evergreen tree brush piles in the deeper parts of the lake will also provide additional cover for all fish species.

Pickerel population was well represented and appears to be well distributed and balanced. Growth rates were good and the current distribution should provide good fishing opportunities with many larger individuals collected.

The sunfish population is relatively abundant, well distributed and in good condition considering the limited vegetation in the lake. Bluegill are more abundant than Pumpkinseed and spawning success is rather poor for both species.

Black Crappies were encountered in good abundance and were in good condition. Growth rates were good and the current distribution should provide good fishing opportunities with a number of larger individuals collected.

Yellow Perch population was poorly distributed but growth rates were good. Spawning success appears to be good in 2013 and 2014 and these year classes should help to maintain the population.

Channel catfish were not well represented during the sampling period however those collected were in good condition. The current stocking of surplus Channel Catfish should improve recreation opportunities for this species.

Management Objectives

1. Union Lake should continue to be managed as a warmwater fishery.

2. Enhance the abundance of the quality Largemouth Bass fishery that presently exists in Union Lake.

3. Maintain the quality Chain Pickerel fishery that presently exists in Union Lake.

4. Maintain the quality Black Crappie fishery that exists in Union Lake.

5. Maintain a diverse population by continuing to stock Channel Catfish.

The management objectives for Union Lake have been established to provide the best recreational fishing opportunities for anglers. Management objectives are most often achieved through regulatory changes, stocking and habitat manipulation. Union Lake should continue to be managed under the current statewide fishing regulations.

Recommendations

1. Additional sampling should be conducted during the spring of 2016 or 2017 to evaluate the Bluegill, Yellow Perch and Black Crappie population utilizing trap nets.

2. Establish a lake lowering plan than will help to improve the habitat in Union Lake by increasing emergent vegetation in the littoral zone.

3. Continue to stock Smallmouth Bass on a biannual basis.

4. Continue to monitor the Black Bass population every three to five years. A combination of electrofishing and seining should be utilized to assess changes in the population.

5. Continue to stock surplus fry Channel Catfish, to enhance fishing opportunities and diversity.

6. Improve habitat by felling shoreline trees and placing evergreen “Christmas trees” in the deeper parts of the lake.

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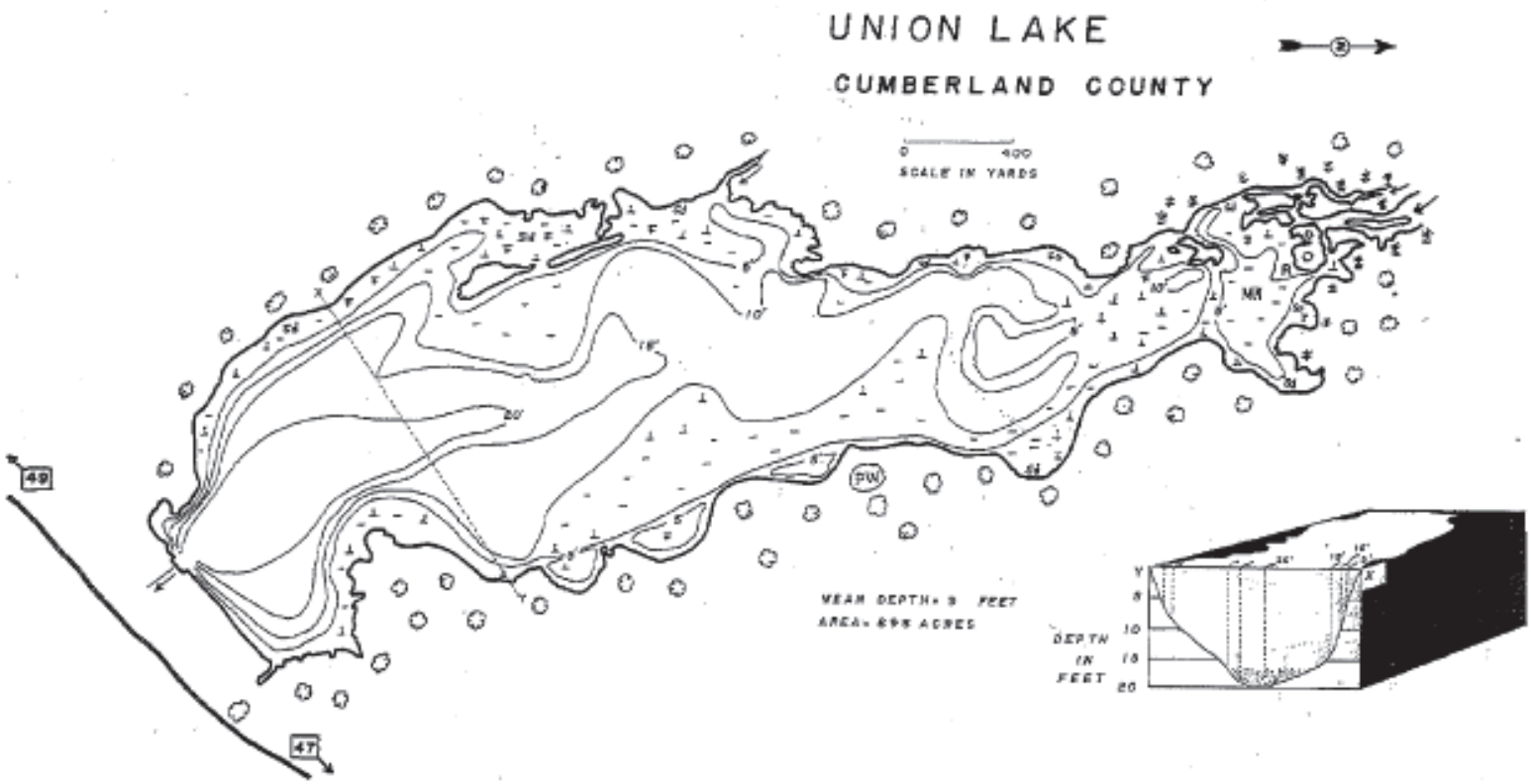

Figure 1. Bathymetric map of Union Lake.

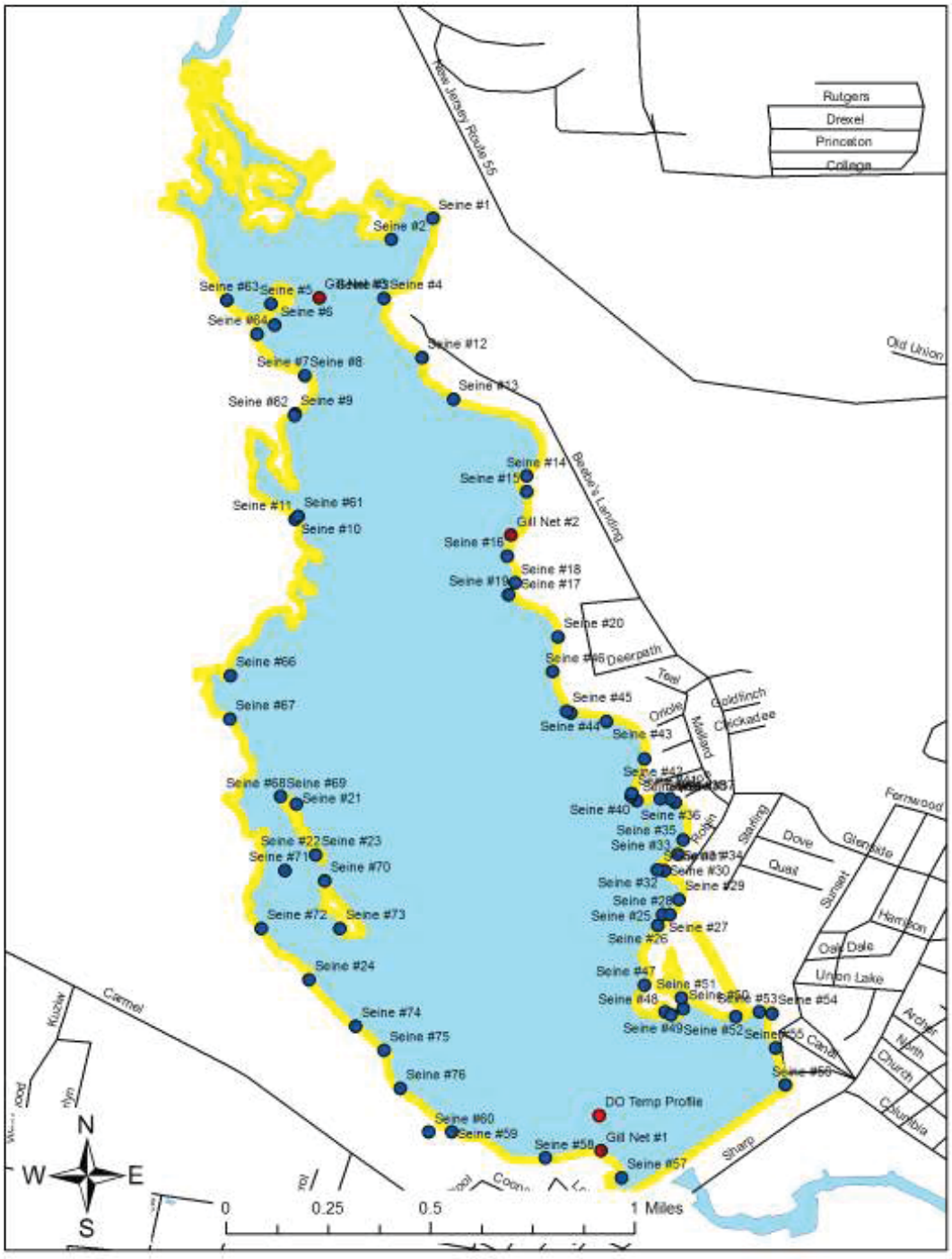

Figure 2. Map of Union Lake showing sampling locations.

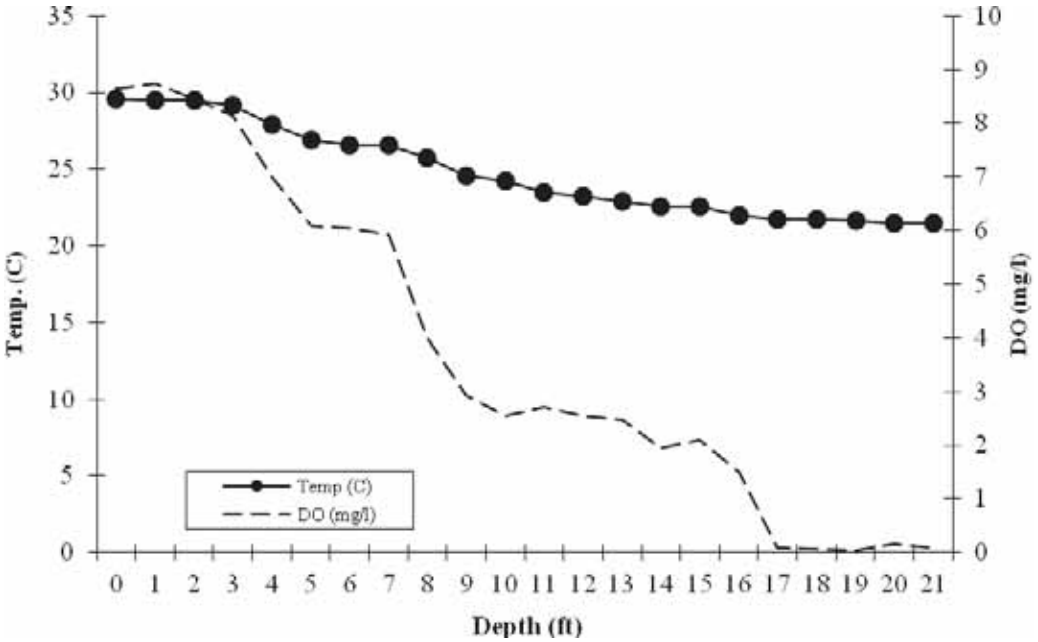

Figure 3. Dissolved oxygen temperature profile created on July 23, 2015 at Union Lake, near dam.

Table 1. Physical-chemical characteristics collected at Union Lake in 2015.

Date	Water Temp (^{o}C)	Air Temp (^{o}C)	Specific Conductance (*u*s/cm)	Conductivity (us/cm)	Dissolved Oxygen (mg/l)	Alkalinity	PH	TDS
5/12/2015	22.6	23.8	119.6	125.1	8.15	-	7.2	78
6/3/2015	20	23	140.7	134.6	7.36	-	8.18	
6/25/2015	21.8	28	111.2	104.3	6.01	-	6.45	72.2
7/23/2015	29.8	27	97	105.9	8.03	-	7.24	53.5
7/30/2015	29.8	32	116.7	127.4	7.41	-	7.49	76.1
8/13/2015	25.9	23.5	127.6	129.7	6.97	-	7.15	83.2
10/21/2015	13.8		126.4	101.1	8.62	-	6.24	
10/26/2015	14	5	127.2	101.2	8.46	-	7.34	82.5
11/5/2015	14	16	141.3	111.6	7.72	-	7.2	91.65
Average	**21.3**	**22.3**	**123.08**	**115.66**	**7.64**	**-**	**7.17**	**76.74**
Min	**13.8**	**5.0**	**97.0**	**101.1**	**6.0**	**-**	**6.2**	**53.5**
Max	**29.8**	**32.0**	**141.3**	**129.7**	**8.6**	**-**	**7.5**	**91.7**

Table 2. Fish species collected from Union Lake in 2015.

I. Order: Anguilliformes
  A. Family: Anguillidae – Eels
    1) Anguilla rostrate – American Eel
II. Order: Clupeiformes
  A. Family: Clupeidae – Herrings and Shads
    1) *Alosa pseudoharengus* – Alewife
    2) *Dorosoma cepedianum* – Gizzard Shad
III. Order: Cypriniformes
  A. Family: Catostomidae – Suckers and minnows
    1) *Catostomus commersonii* – White Sucker
    2) *Erimyzon oblongus* – Creek Chubsucker
  B. Family: Cyprinidae – Carps and minnows
    1) *Cyprinus carpio* – Common Carp
    2) *Notemigonus crysoleucas* – Golden Shiners
IV. Order: Cyprinodontiformes
  A. Family: Fundulidae – Topminnows and Killifish
    1) *Fundulus diaphanus* – Banded Killifish
V. Order: Esociformes
  A. Family: Esocidae – Pikes
    1) *Esox americanus* – Redfin Pickerel
    2) *Esox niger* – Chain Pickerel
VI. Order: Perciformes
  A. Family: Centrarchidae – Sunfishes
    1) *Enneacantus gloriosus* – Bluespotted Sunfish
    3) *Lepomis auritus* –Redbreast Sunfish
    4) *Lepomis gibbosus* – Pumpkinseed
    5) *Lepomis macrochirus* – Bluegill
    6) *Micropterus dolomieu*– Smallmouth Bass
    7) *Micropterus salmoides* –Largemouth Bass
    8) *Pomoxis annularis* – White Crappie
    8) *Pomoxis nigromaculatus* – Black Crappie
  B. Family: Percidae – Perches
    1) *Etheostoma fusiforme* – Swamp Darter
    2) *Perca flavescens* – Yellow Perch
  C. Family: Moronidae – Temperate Basses
    1) *Morone americana* – White Perch
    2) *Morone saxatilis*– Striped Bass
VII. Order: Percopsiformes
  A. Family: Aphredoderidae
    1) *Aphredoderus sayanus* – Pirate Perch
VIII. Order: Petromyzontiformes
  A. Family: Petromyzontidae – Lampreys
    1) *Petromyzon marinus* – Sea Lamprey
IX. Order: Siluriformes
  A. Family: Ictaluridae - Bullhead catfishes
    1) *Ameiurus catus* – White Catfish

2) *Ameiurus nebulosus* – Brown Bullhead
3) *Ictalurus punctatus* – Channel Catfish

Table 3. Total number collected by electrofishing and CPUE in 2015 at Union Lake.

Species	5/12/2015	6/3/2015	8/13/2015	10/21/2015	10/26/2015	11/5/2015				
Total Hours	1.50	1.58	1.85	1.67	1.75	1.00				
Panfish Hours	1.50	0.75	1.85	1.00	1.00	0.00	Total	Sampling Time (Hours)	CPUE	% of Total
Alewife	10	0	0	34	69	-	113	3.50	32	5%
American Eel	-	-	27	0	4	-	31	2.85	11	1%
Black Crappie	14	28	38	42	28	-	150	6.10	25	7%
Bluegill	45	43	-	107	131	-	326	4.25	77	15%
Brown Bullhead	26	9	7	4	9	-	55	6.10	9	3%
Chain Pickerel	19	7	12	12	15	-	65	9.35	7	3%
Channel Catfish	1	3	0	0	1	-	5	9.35	1	0%
Common Carp	1	0	2	0	0	-	3	6.10	0	0%
Creek Chubsucker	7	5	10	8	8	-	38	6.10	6	2%
Gizzard Shad	-	1	-	5	1	-	7	6.10	1	0%
Golden Shiners	30	29	69	37	28	-	193	6.10	32	9%
Largemouth Bass	31	18	27	33	36	37	182	9.35	19	8%
Pumpkinseed	6	16	-	11	9	-	42	4.25	10	2%
Redbreast Sunfish	5	15	1	1	2	-	24	6.10	4	1%
Redfin Pickerel	0	0	0	0	0	-	0	9.35	0	0%
Sea Lamprey	0	3	0	0	0	-	0	9.35	0	0%
Smallmouth Bass	3	1	2	1	4	-	11	9.35	1	1%
Striped Bass	0	2	0	0	0	-	2	9.35	0	0%
White Catfish	5	0	4	3	1	-	13	6.10	2	1%
White perch	47	96	8	144	85	-	380	6.10	62	18%
White Sucker	-	5	3	1	10	-	19	6.10	3	1%
Yellow Perch	48	77	94	79	185	-	483	6.10	79	22%
						Total	**2142**			

Table 4. Gill net totals and species composition from November 5, 2015.

Species Name	Total	Percent Composition
Alewife	3	2%
Black Crappie	8	6%
Bluegill	2	2%
Brown Bullhead	10	8%
Chain Pickerel	25	20%
Channel catfish	4	3%
Creek Chubsucker	10	8%
Gizzard Shad	1	1%
Golden Shiner	23	19%
Largemouth Bass	2	2%
Striped Bass	1	1%
White Catfish	15	12%
White Crappie	1	1%
White Perch	17	14%
Yellow Perch	2	2%
Total	**124**	

Location	Description of Location	Latitude Coordinate	Longitude Coordinate
1	Dam – Near Bluff	39.401627	-75.056684
2	East Side Near Grass Island	39.423387	-75.060092
3	East of Gate Hole	39.431882	-75.066706

Table 5. Species composition determined by seining in Union Lake 2015.

	YOY				Intermediate				Adult			
	Total No.	No. Sites Found	% Sites Found	% of Total (YOY)	Total No.	No. Sites Found	% Sites Found	% of Total (I)	Total No.	No. Sites Found	% Sites Found	% of Total (A)
Banded Killifish	2	2	3%	1%	11	6	8%	5%	66	14	18%	71%
Black Crappie	2	2	3%	1%	1	1	1%	0%	-	-	-	-
Bluegill	60	11	14%	22%	104	30	39%	47%	8	7	9%	9%
Bluespotted Sunfish	2	2	3%	1%	5	4	5%	2%	10	2	3%	11%
Brown Bullhead	4	1	1%	1%	-	-	-	-	-	-	-	-
Chain Pickerel	8	3	4%	3%	3	3	4%	1%	3	3	4%	3%
Golden Shiners	6	1	1%	2%	14	1	1%	6%	-	-	-	-
Largemouth Bass	131	44	58%	48%	1	1	1%	0%	-	-	-	-
Pirate Perch	4	1	1%	1%	3	2	3%	1%	-	-	-	-
Pumpkinseed	-	-	na	na	29	12	16%	13%	5	4	5%	5%
Redbreast Sunfish	2	2	3%	1%	19	10	13%	9%	-	-	-	-
Smallmouth Bass	17	12	16%	6%	-	-	-	-	-	-	-	-
Swamp Darter	14	8	11%	5%	-	-	-	-	-	-	-	-
White Sucker	3	1	1%	1%	-	-	-	-	-	-	-	-
Yellow Perch	17	8	11%	6%	31	12	16%	14%	1	1	1%	1%
Total	**272**				**221**				**93**			

Table 6. Proportional Stock Density (PSD), Relative Stock Density (RSD_p and RSD_m) of gamefish collected at Union Lake in 2015.

Species	Size (mm)	Number	PSD	RSD_p	RSD_m
Largemouth Bass (Spring)	≥ 200 ≥ 300 ≥ 380 >510	44 36 14 1	**PSD = 82**	**RSD_{15} = 32**	**RSD_{20} = 2**
Largemouth Bass (Summer)	≥ 200 ≥ 300 ≥ 380 >510	22 12 6 0	**PSD = 55**	**RSD_{15} = 27**	**RSD_{20} = 0**
Largemouth Bass (Fall)	≥ 200 ≥ 300 ≥ 380 > 510	98 74 43 3	**PSD = 76**	**RSD_{15} = 44**	**RSD_{20} = 3**
Chain Pickerel (Spring)	≥ 250 ≥ 380 ≥ 510 ≥ 630	24 12 3 0	**PSD = 50**	**RSD_{20} = 13**	**RSD_{25} = 0**
Chain Pickerel (Fall Electrofishing)	≥ 250 ≥ 380 ≥ 510 ≥ 630	26 19 7 1	**PSD = 73**	**RSD_{20} = 27**	**RSD_{25} = 4**
Chain Pickerel (Fall Gillnet)	≥ 250 ≥ 380 ≥ 510 ≥ 630	24 20 3 0	**PSD = 83**	**RSD_{20} = 13**	**RSD_{25} = 0**
Bluegill (Spring)	≥ 80 ≥ 150 ≥ 200	79 45 10	**PSD = 57**	**RSD_8 = 13**	**RSD_m =0**
Bluegill (Fall)	≥ 80 ≥ 150 ≥ 200	179 54 15	**PSD = 30**	**RSD_8 = 8**	**RSD_m = 0**
Pumpkinseed	≥ 80 ≥ 150 ≥ 200	20 6 1	**PSD = 30**	**RSD_8 = 5**	**RSD_m = 0**
Pumpkinseed	≥ 80 ≥ 150 ≥ 200	15 4 1	**PSD = 27**	**RSD_8 = 7**	**RSD_m = 0**
Yellow Perch (Spring)	≥ 130 ≥ 200 ≥ 250 ≥ 300	50 10 1 0	**PSD = 20**	**RSD_{10} = 2**	**RSD_{12} = 0**
Yellow Perch (Fall Electrofishing)	≥ 130 ≥ 200 ≥ 250 ≥ 300	99 8 4 0	**PSD = 8**	**RSD_{10} = 4**	**RSD_{12} = 0**

Black Crappie (Spring)	≥ 130 ≥ 200 ≥ 250 ≥ 300	28 26 15 7	**PSD = 93**	**RSD_{10} = 54**	**RSD_{12} = 25**
Black Crappie (Summer)	≥ 130 ≥ 200 ≥ 250 ≥ 300	33 33 23 2	**PSD = 100**	**RSD_{10} = 70**	**RSD_{12} = 6**
Black Crappie (Fall)	≥ 130 ≥ 200 ≥ 250 ≥ 300	22 19 12 2	**PSD = 86**	**RSD_{10} = 55**	**RSD_{12} = 9**
Smallmouth Bass (Spring)	≥ 180 ≥ 280 ≥ 350 ≥ 430	2 2 1 1	**PSD = 100**	**RSD_{14} = 50**	**RSD_{17} = 50**
Smallmouth Bass (Fall)	≥ 180 ≥ 280 ≥ 350 ≥ 430	3 3 3 2	**PSD = 100**	**RSD_{14} = 100**	**RSD_{17} = 2**
White Perch (Spring)	≥ 130 ≥ 200 ≥ 250 ≥ 300	108 7 2 0	**PSD = 6**	**RSD_{10} = 2**	**RSD_{12} =0**
White Perch (Fall Electrofishing)	≥ 130 ≥ 200 ≥ 250 ≥ 300	162 26 4 0	**PSD = 16**	**RSD_{10} = 2**	**RSD_{12} =0**

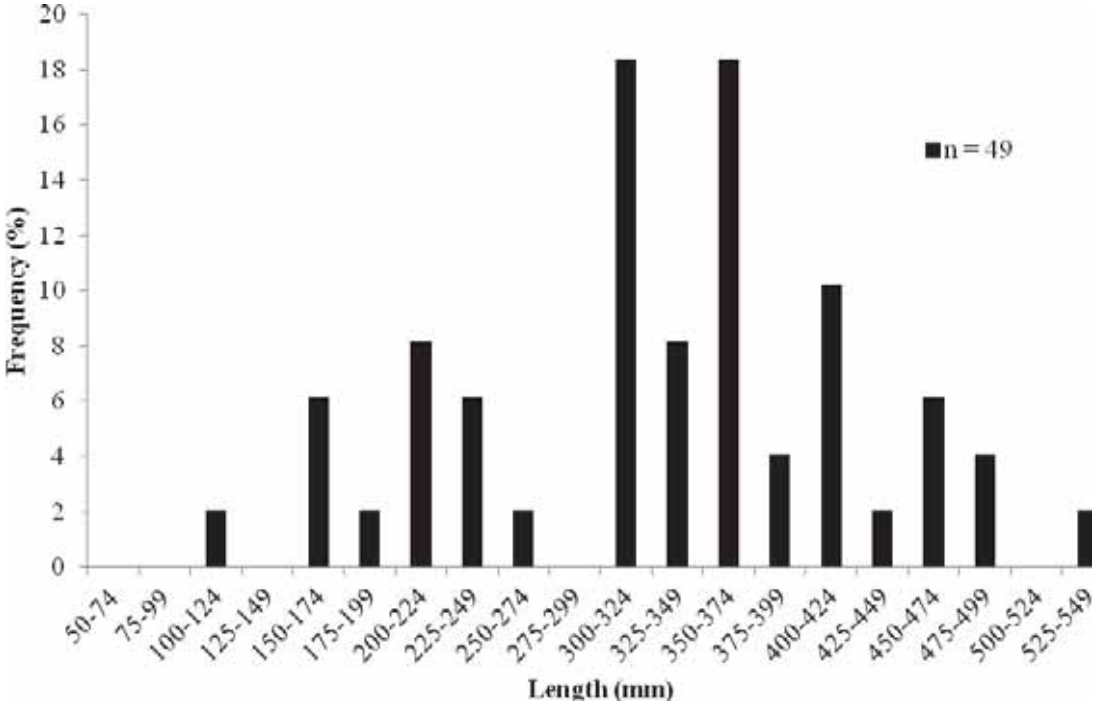

Figure 4. Length frequency of Largemouth Bass collected at Union Lake during Spring 2015 electrofishing.

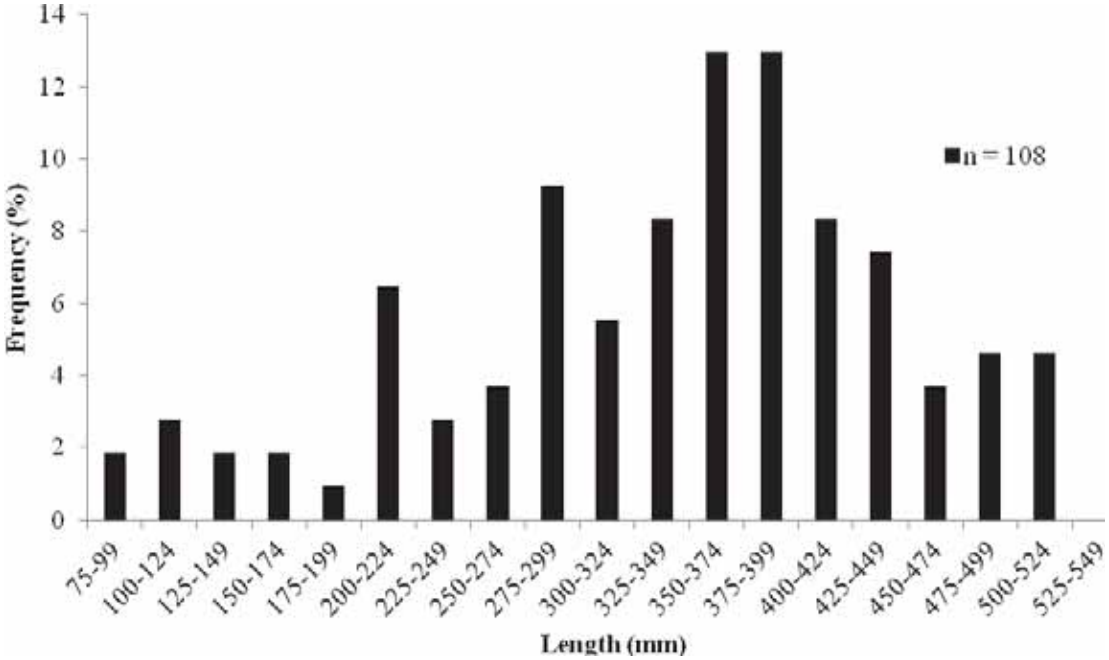

Figure 5. Length frequency of Largemouth Bass collected Union Lake during Fall 2015 electrofishing.

Table 7. Number and average W_r (mean ± 95% CI.), grouped by length, of selected species collected via electrofishing and gill net at Union Lake in 2015.

Species	Length (mm)	Number	Average W_r	SE	Range W_r
Largemouth Bass (Spring 2015)	150-199	4	91 ± 5.40	.58	88 - 99
	200-299	8	94 ± 3.32	.49	89 - 103
	300-379	22	99 ± 4.00	.96	83 - 120
	≥380	14	98 ± 4.12	.79	87 - 109
	ALL	48	98 ± 2.36	.84	83 - 120
Largemouth Bass (Fall 2015)	150-199	3	116 ± 10.56	.87	106 - 125
	200-299	24	108 ± 4.22	1.01	85 - 127
	300-379	31	105 ± 3.12	.86	92 - 125
	≥380	43	106 ± 3.70	1.20	50 -129
	ALL	101	107 ± 2.13	1.06	50 -129
Smallmouth Bass (Fall 2015)	180-279	0	-	-	-
	280-349	0	-	-	-
	≥350	3	88 ± 8.80	.83	81 - 97
	ALL	3	88 ± 8.80	.83	81 - 97
Chain Pickerel (Spring 2015)	150-249	2	100 ± 6.42	.46	97 – 104
	250-379	12	104 ± 8.00	1.39	86 – 122
	380-510	9	93 ± 4.21	.67	85 – 104
	≥510	3	97 ± 6.74	.61	91 – 103
	ALL	26	99 ± 4.41	1.15	85 – 122
Chain Pickerel (Fall 2015)	150-249	1	86	-	-
	250-379	11	94 ± 4.56	.80	80 – 105
	380-510	29	92 ± 2.52	.72	83 – 110
	≥510	10	84 ± 4.76	.84	71 – 94
	ALL	1	91 ± 2.18	.83	71 – 110
Bluegill (Spring 2015)	80 – 149	34	104 ± 5.65	1.65	70 – 150
	150 – 199	35	100 ± 2.59	.78	84 – 117
	>200	10	99 ± 9.06	1.47	78 – 130
	All	79	102 ± 2.93	1.31	70 – 150
Bluegill (Fall 2015)	80 – 149	125	91 ± 2.56	1.53	58 – 131
	150 – 199	39	88 ± 3.65	1.24	43 - 108
	>200	15	88 ± 4.06	.86	71 – 98
	All	179	90 ± 1.99	1.43	43 – 131
Pumpkinseed (Fall 2013)	80-149	14	120 ± 8.73	1.52	97 - 152
	150-199	5	104 ± 3.56		98 - 109
	>200	1	108	-	-
	All	20	115 ± 6.86	1.46	97 – 152
Pumpkinseed (Fall 2015)	80-149	11	97 ± 8.10	1.39	82 – 126
	150-199	3	91 ± 3.25	.30	62 – 158
	>200	1	80	-	-
	All	15	95 ± 6.39	1.30	80 – 126

Yellow Perch (Spring 2015)	100 - 129	55	99 ± 6.42	2.44	62 – 158
	130 - 199	40	91 ± 4.04	1.36	61 – 121
	200-249	9	89 ± 4.48	.72	82 – 102
	>250	1	80	-	-
	All	105	95 ± 3.79	2.03	61 - 158
Yellow Perch (Fall 2015)	100 - 129	89	85 ± 3.03	1.58	55 – 127
	130 - 199	91	77 ± 1.86	1.03	59 - 109
	200-249	4	71 ± 4.28	.52	68 – 78
	>250	4	76 ± 1.33	.16	74 – 78
	All	188	80 ± 1.79	1.40	55 – 127
Black Crappie (Spring 2015)	130-199	2	96 ± 4.93	.36	94 – 99
	200-249	11	90 ± 3.67	.66	78 – 99
	250-299	8	84 ± 6.70	1.06	71 – 97
	>300	7	83 ± 5.19	.77	75 – 90
	All	28	87 ± 3.03	.88	71 – 99
Black Crappie (Fall 2015)	250 - 379	3	100 ± 10.21	.90	94 – 110
	380 -509	7	102 ± 14.33	1.92	87 – 136
	510 - 629	10	93 ± 2.96	.50	86 – 102
	>630	2	84 ± 13.47	1.06	77 – 90
	ALL	22	96 ± 5.32	1.30	77 - 136
White Perch (Spring 2015)	80 - 129	34	81 ± 5.44	1.80	42 – 106
	130 - 199	101	90 ± 1.68	.91	67 – 116
	200-249	5	89 ± 7.31	.89	75 – 98
	>250	2	79 ± 17.64	1.43	70 – 88
	All	142	88 ± 1.91	1.24	42 - 116
White Perch (Fall 2015)	80 - 129	35	102 ± 6.88	2.06	53 – 143
	130 - 199	136	88 ± 1.25	.79	74 – 109
	200-249	22	103 ± 4.47	1.06	81 – 122
	>250	4	112 ± 8.48	.82	101 – 122
	All	197	93 ± 1.85	1.37	53 - 143

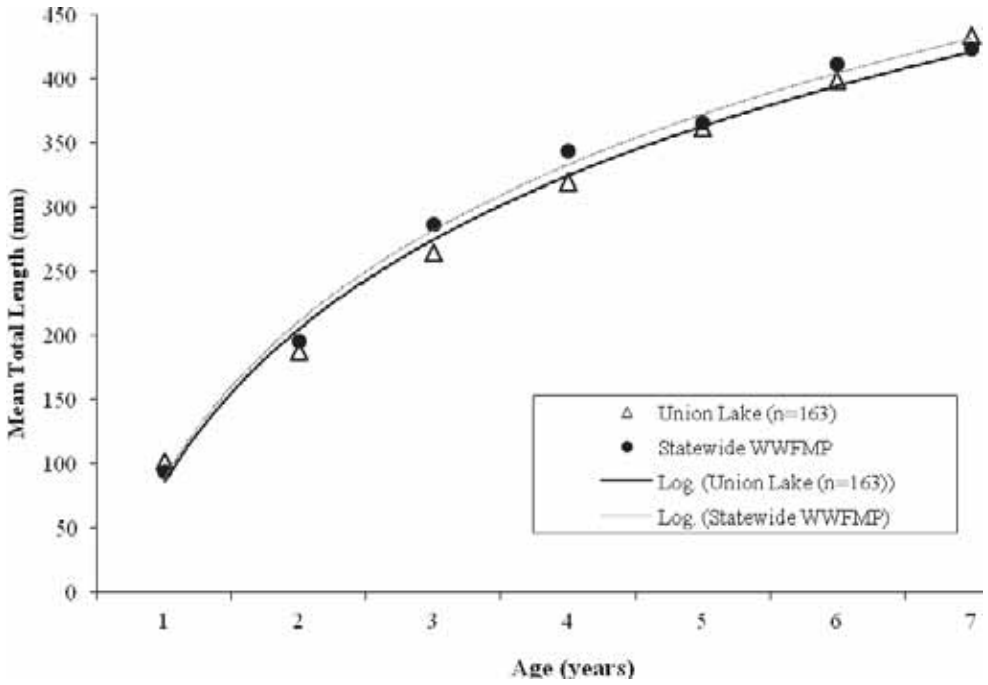

Figure 6. Length at age of Largemouth Bass collected Union Lake in 2015.

Table 8. Back calculated length at age (mean ± 95% CI) of selected species collected from Union Lake in 2015.

Species	Age	Number at age	Number of scales/age	Average total length (mm)	Length range (mm)
Largemouth Bass	1	8	163	102 ± 2.17	76 – 144
	2	26	155	188 ± 3.84	131 – 245
	3	24	129	265 ± 4.20	194 – 319
	4	28	105	320 ± 4.08	275 – 383
	5	31	77	362 ± 4.72	326 – 422
	6	14	46	398 ± 6.78	360 – 454
	7	10	32	433 ± 8.46	384 – 479
	8	12	22	462 ± 8.50	430 – 500
	9	8	10	490 ± 10.40	463 – 513
	10	2	2	520 ± 13.37	513 - 527
Chain Pickerel	1	5	74	156 ± 7.01	98 – 228
	2	21	69	274 ± 7.78	208 – 334
	3	15	48	371 ± 9.55	289 - 429
	4	16	33	444 ± 11.74	350 – 508
	5	14	17	495 ± 16.39	437 – 557
	6	2	3	537 ± 55.02	509 -593
	7	1	1	618	-
Black Crappie	1	33	98	94 ± 3.24	67 – 126
	2	3	66	151 ± 4.35	117 – 196
	3	3	63	194 ± 4.47	158 – 231
	4	20	60	229 ± 4.61	183 – 282
	5	19	40	256 ± 4.63	221 – 298
	6	12	21	285 ± 7.14	265 – 329
	7	9	9	318 ± 10.83	297 - 347
Smallmouth Bass	1	2	9	118 ± 13.03	98 – 146
	2	2	7	190 ± 24.18	147 – 232
	3	1	5	265 ± 22.36	228 – 291
	4	0	4	304 ± 18.98	284 – 330
	5	1	4	350 ± 18.05	324 – 366
	6	1	4	383 ± 28.35	340 – 401
	7	1	1	431	-
Yellow Perch	1	8	25	97 ± 4.37	76 – 125
	2	7	17	138 ± 7.34	122 – 222
	3	6	10	184 ± 15.19	159 – 239
	4	2	4	227 ± 17.17	202 – 260
	5	1	2	260 ± .86	259 – 281
	6	1	1	281	-
Bluegill	1	12	100	61 ± 1.35	43 - 79
	2	26	88	96 ± 1.85	72 – 121
	3	19	62	127 ± 2.74	106 – 150
	4	11	43	153 ± 3.30	131 – 177
	5	18	32	175 ± 3.36	158 – 195
	6	11	14	195 ± 5.41	175 – 215
	7	3	3	201 ± 19.75	186 - 220

Pumpkinseed	1	0	11	65 ± 4.20	53 - 75
	2	4	11	102 ± 5.97	89 - 116
	3	2	7	128 ± 10.75	113 – 158
	4	21	5	144 ± 13.62	136 – 172
	5	1	3	167 ± 25.67	149 -193
	6	1	2	190 ± 30.88	174 – 205
	7	1	1	218	-
White Perch	1	22	77	72 ± 3.05	46 – 103
	2	21	55	130 ± 4.82	90 – 166
	3	15	34	168 ± 4.02	146 – 193
	4	7	19	201 ± 6.17	172 – 229
	5	9	12	225 ± 7.23	208 – 247
	6	3	3	254 ± 10.67	243 - 260

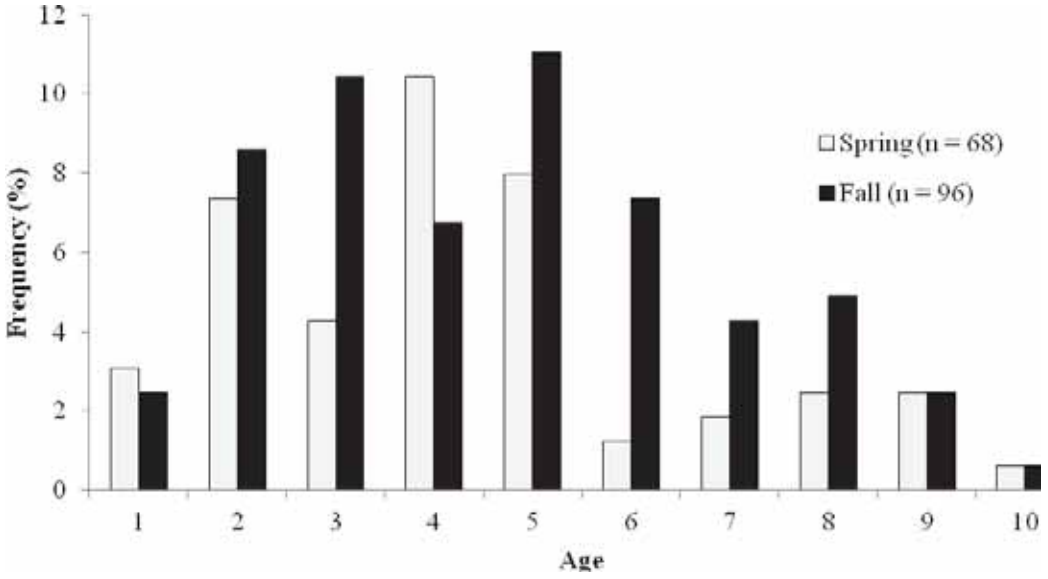

Figure 7. Age frequency of Largemouth Bass collected Union Lake in spring 2015.

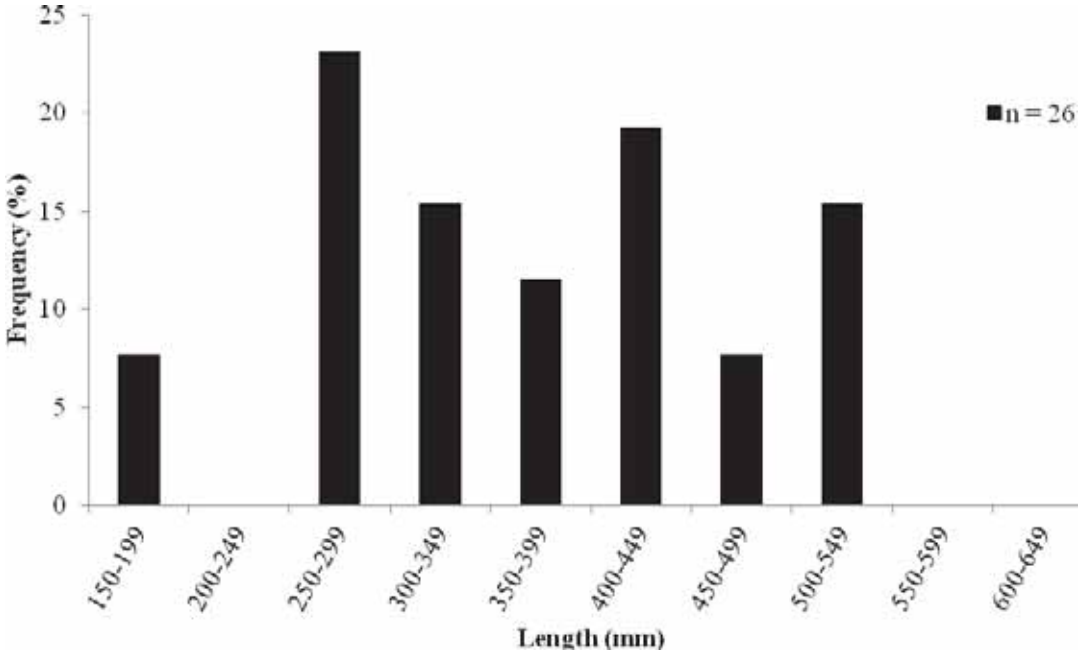

Figure 8. Length frequency of Chain Pickerel collected at Union Lake during Spring electrofishing in 2015.

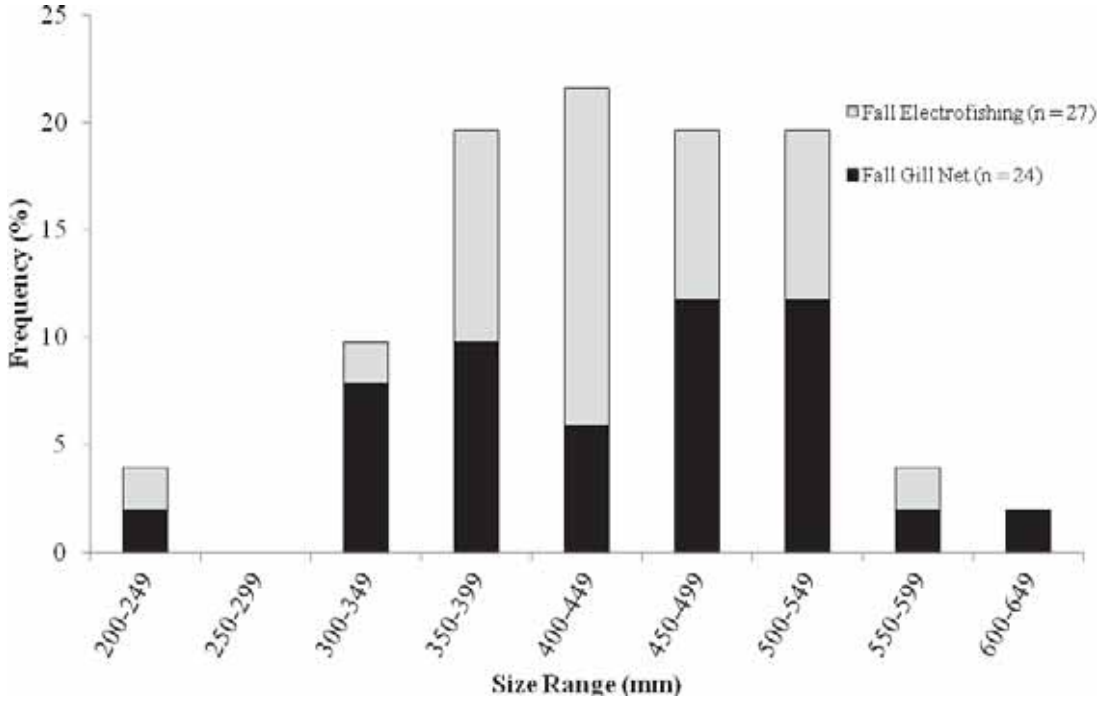

Figure 9. Length frequency of Chain Pickerel collected at Union Lake during fall electrofishing and gill netting in 2015.

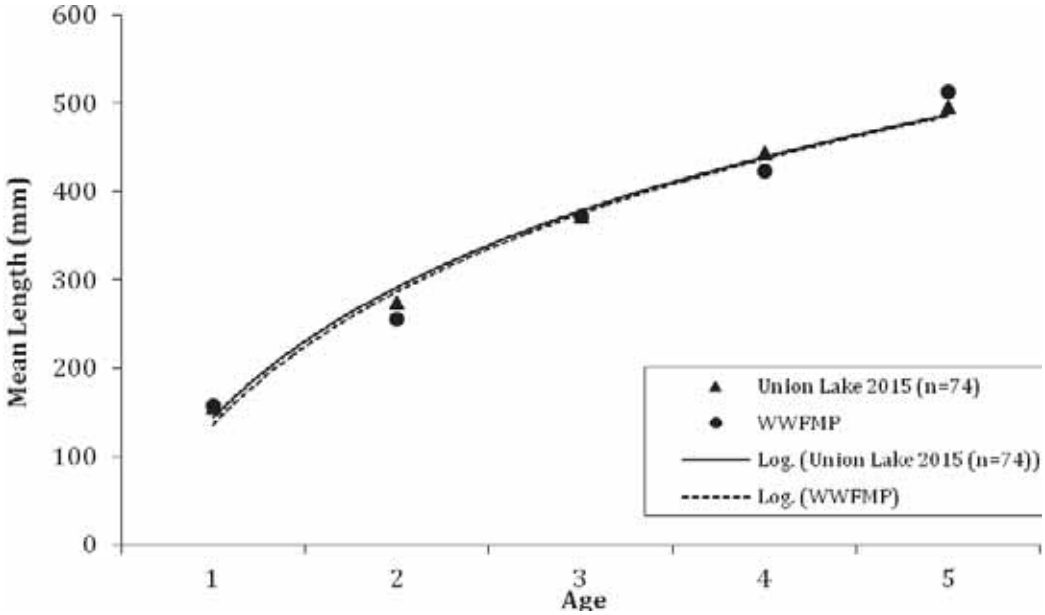

Figure 10. Length at age of Chain Pickerel collected Union Lake in 2015.

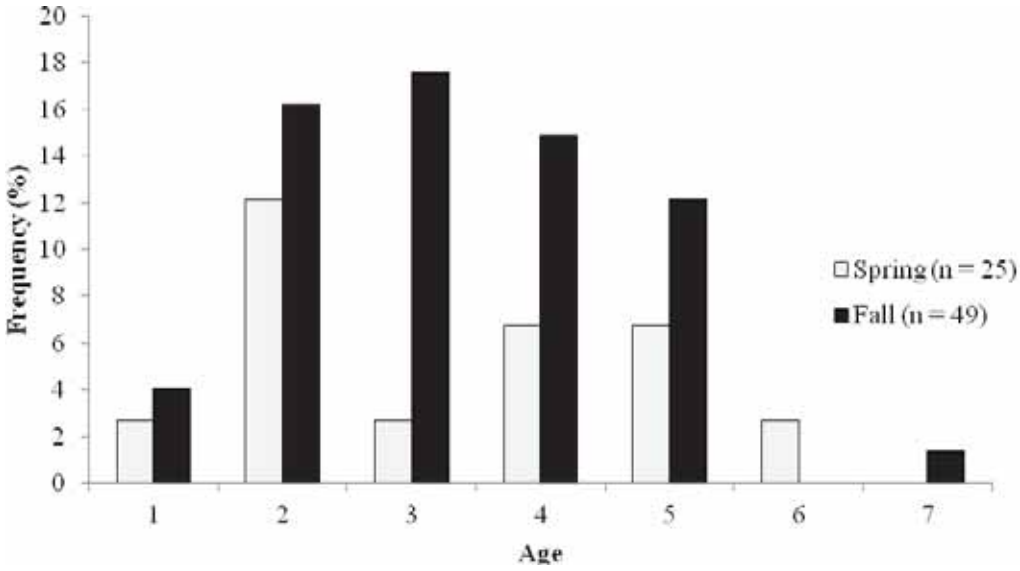

Figure 11. Age frequency of Chain Pickerel collected at Union Lake in 2015.

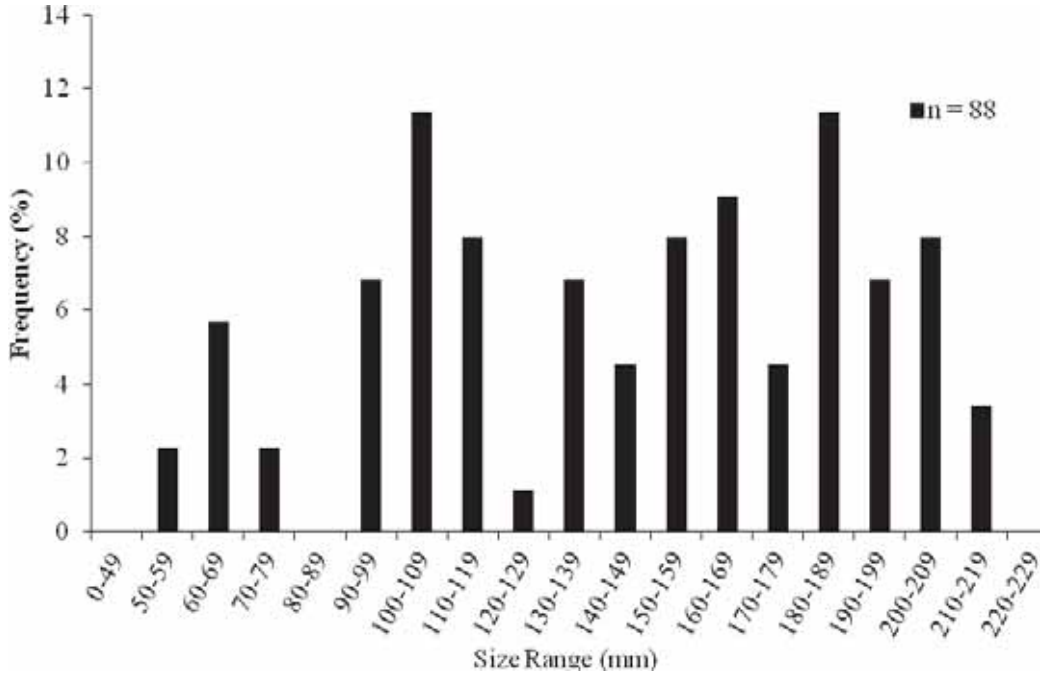

Figure 12. Length frequency of Bluegill collected at Union Lake during spring electrofishing in 2015.

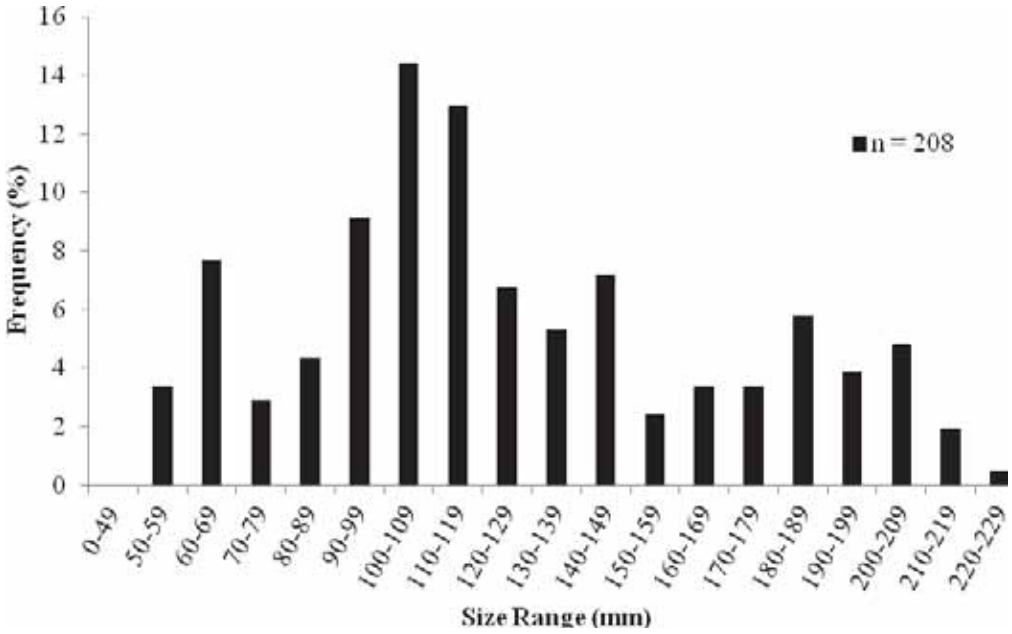

Figure 13. Length frequency of Bluegill collected at Union Lake during fall electrofishing in 2015.

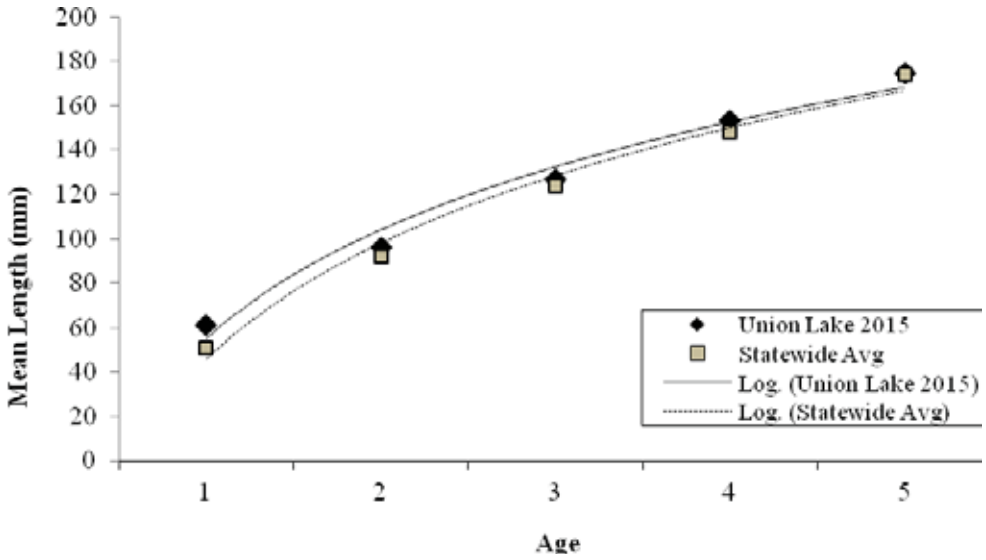

Figure 14. Length at age of Bluegill collected Union Lake in 2015.

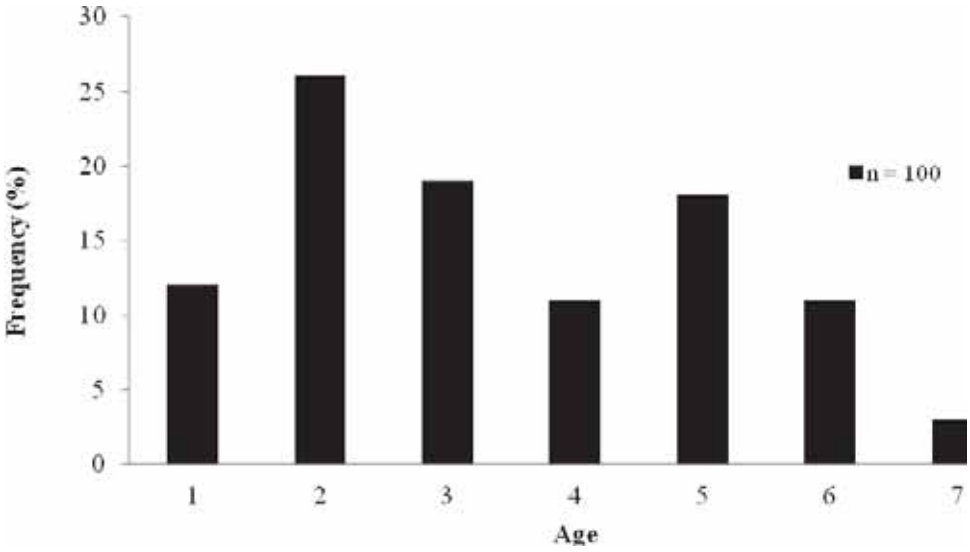

Figure 15. Age frequency of Bluegill collected at Union Lake in 2015.

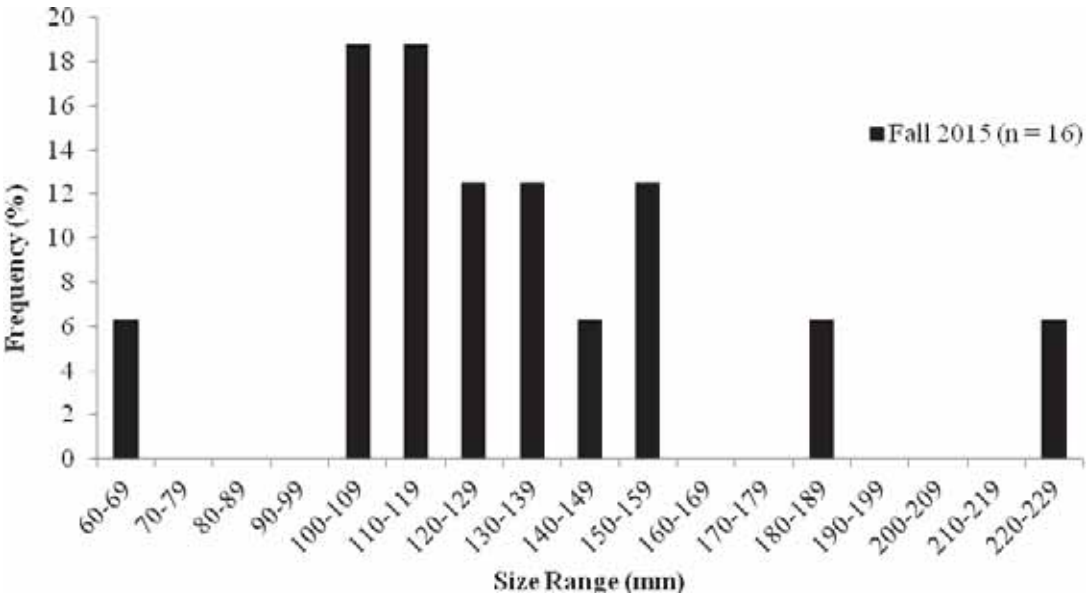

Figure 16. Length frequency of pumpkinseed collected at Union Lake during fall 2015 electrofishing.

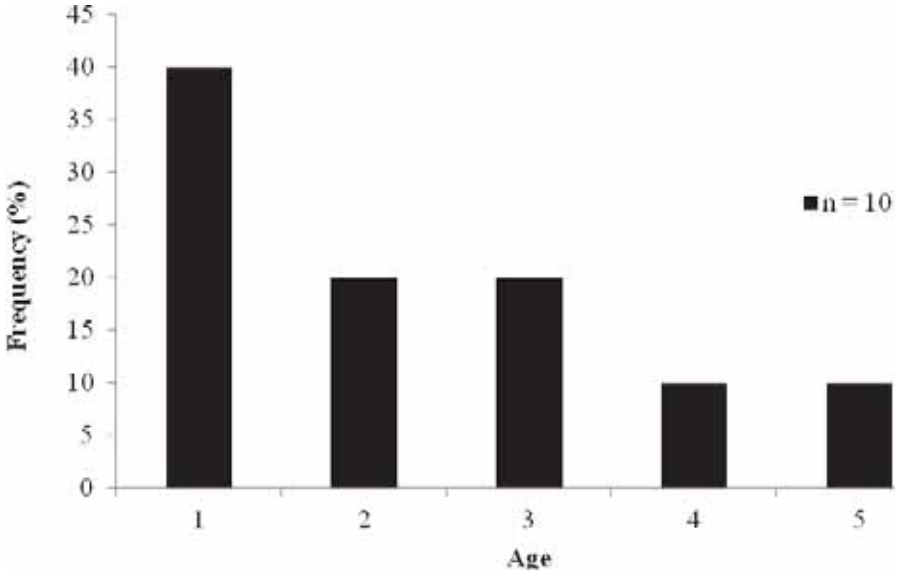

Figure 17. Age frequency of pumpkinseed collected at Union Lake in 2015.

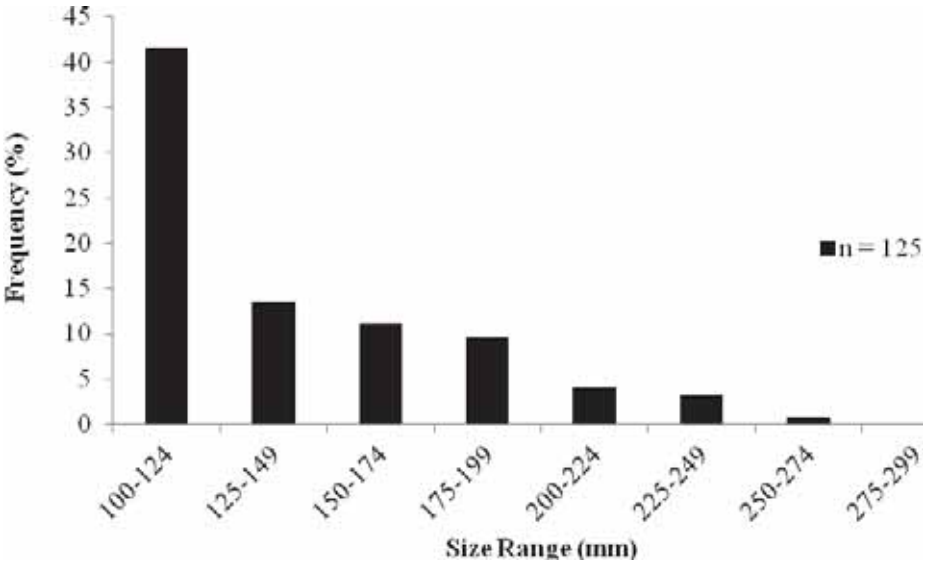

Figure 18. Length frequency of Yellow Perch collected at Union Lake during spring 2015 electrofishing.

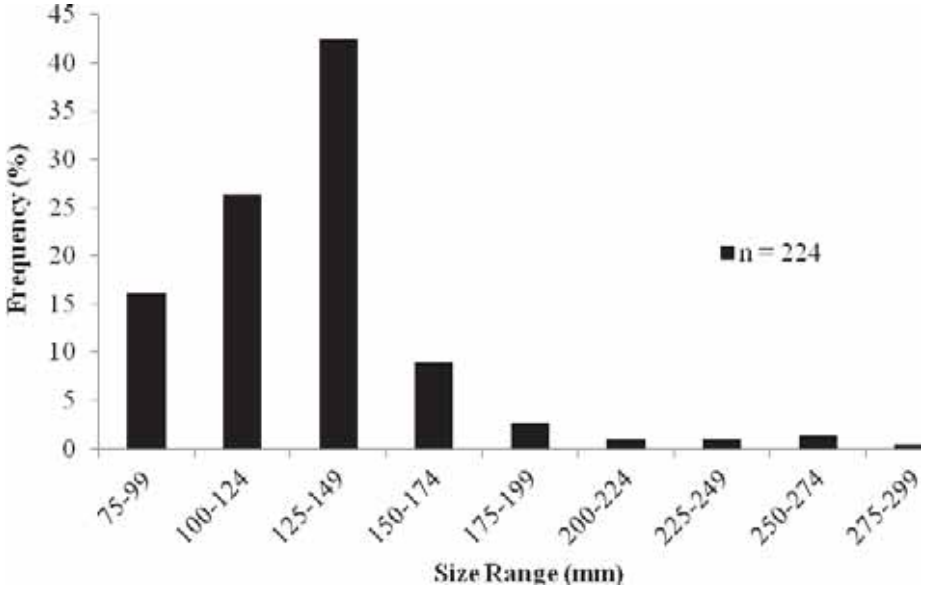

Figure 19. Length frequency of Yellow Perch collected at Union Lake during fall 2015 electrofishing.

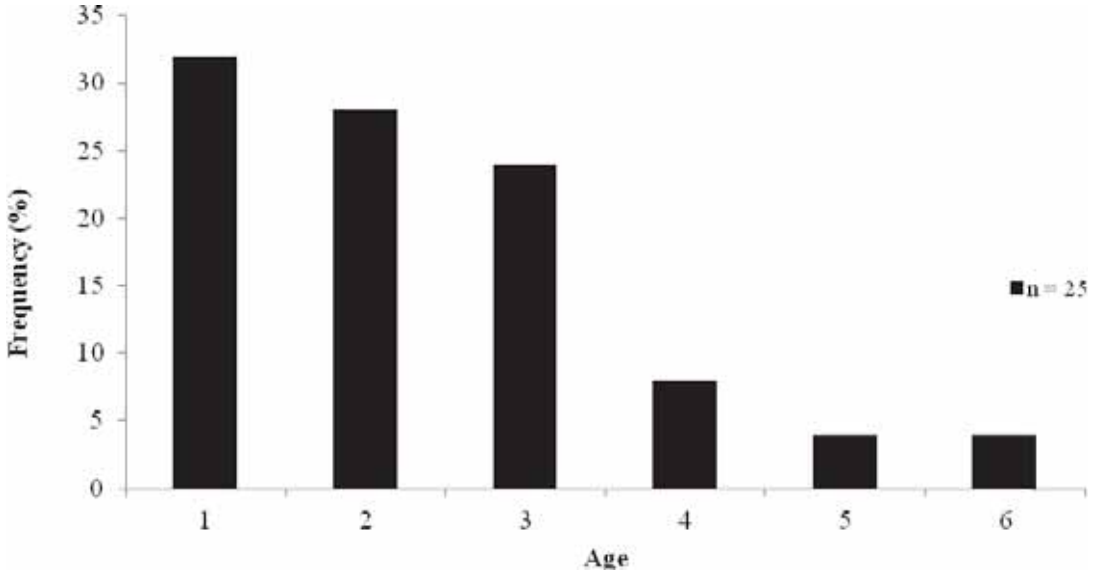

Figure 20. Age frequency of Yellow Perch collected in Union Lake in 2015.

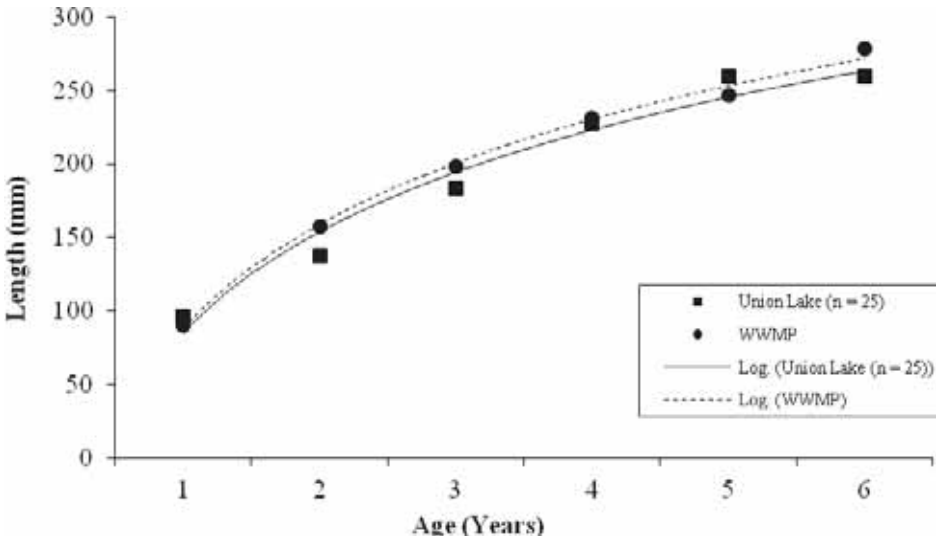

Figure 21. Length at age of Yellow Perch collected at Union Lake in 2015.

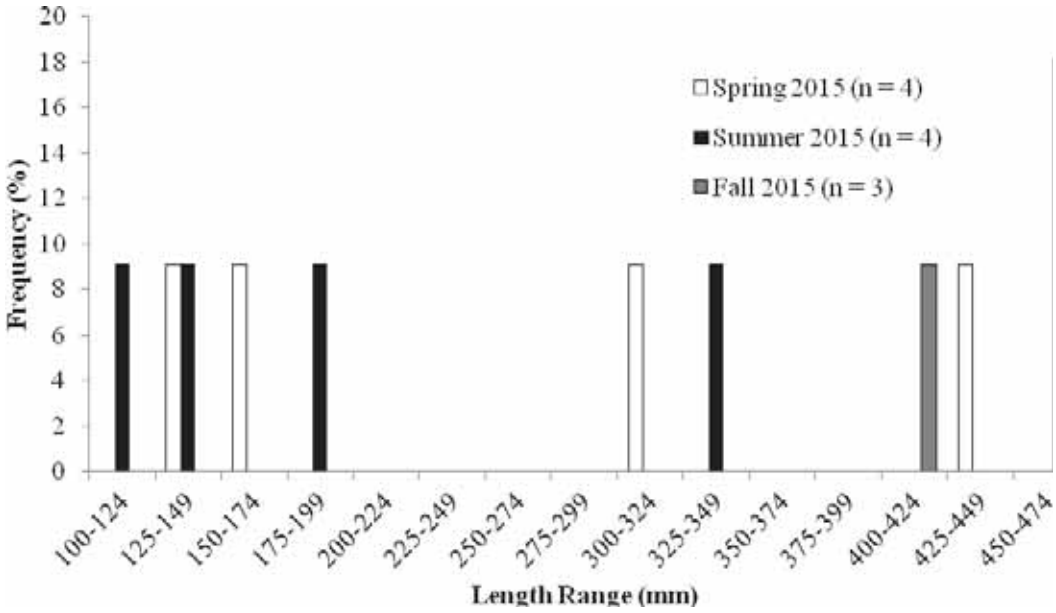

Figure 22. Length frequency of Smallmouth Bass collected at Union Lake during electrofishing in 2015.

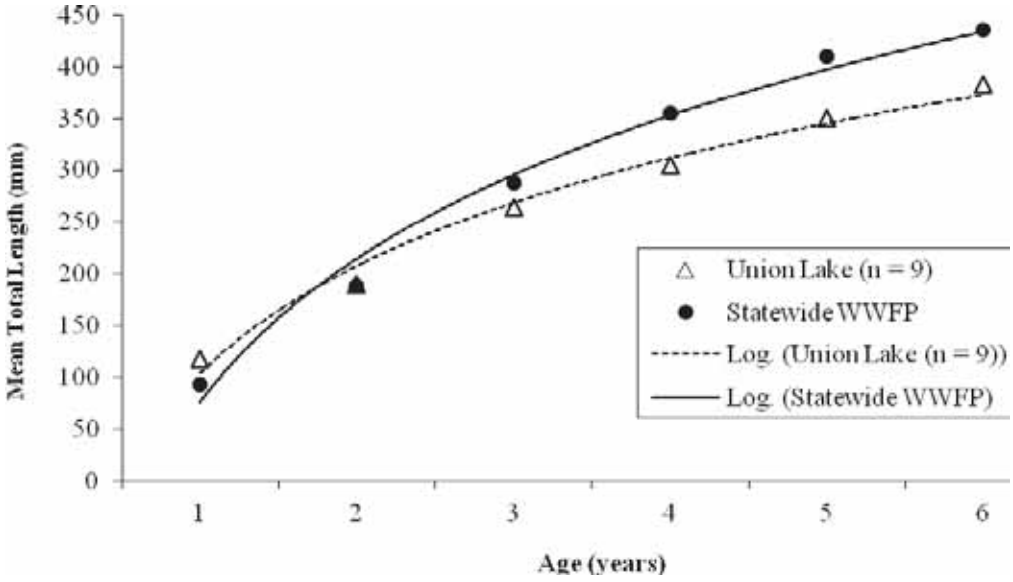

Figure 23. Length at age of Smallmouth Bass collected at Union Lake in 2015.

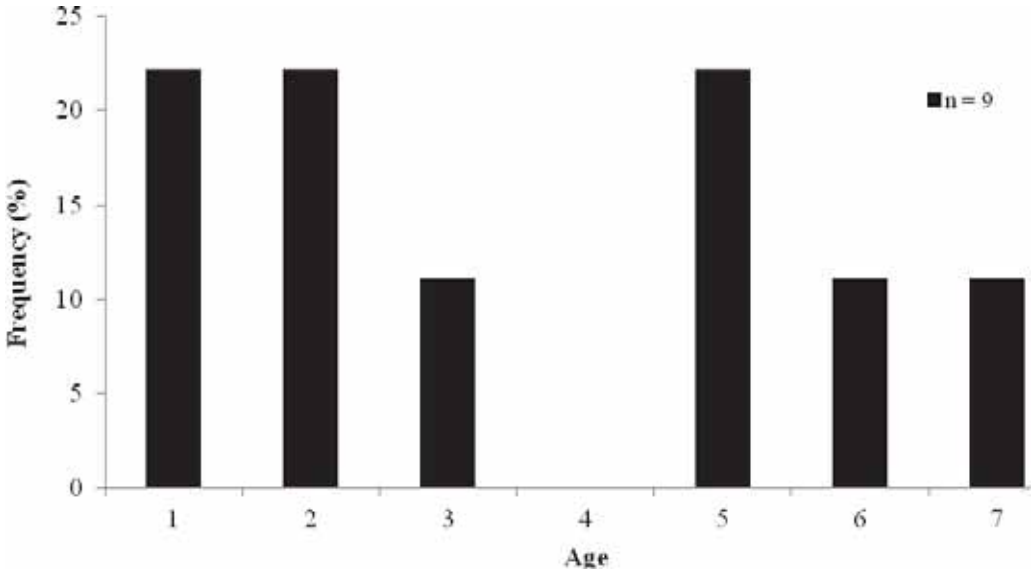

Figure 24. Age frequency of Smallmouth Bass collected Union Lake in 2015.

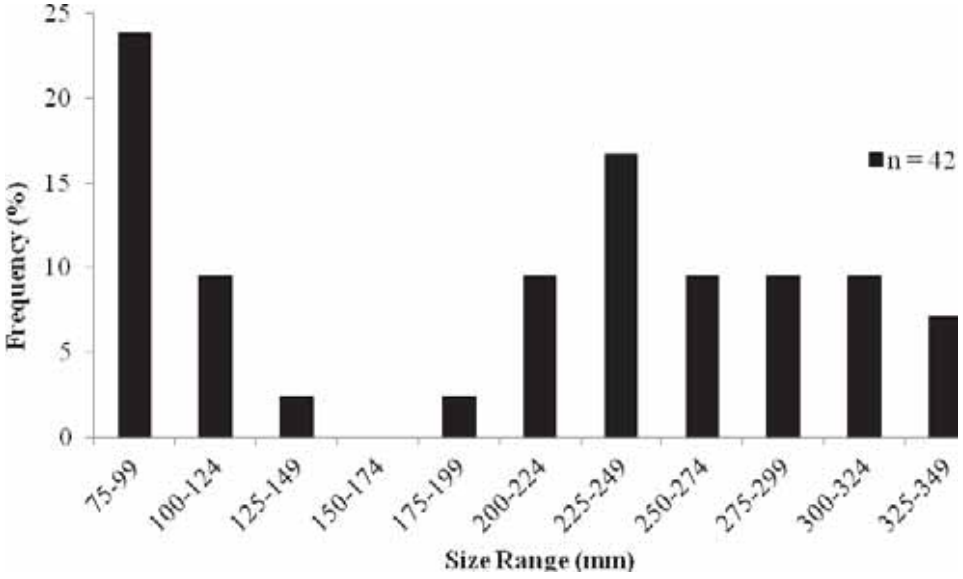

Figure 25. Length frequency of Black Crappie collected at Union Lake in Spring 2015 during electrofishing.

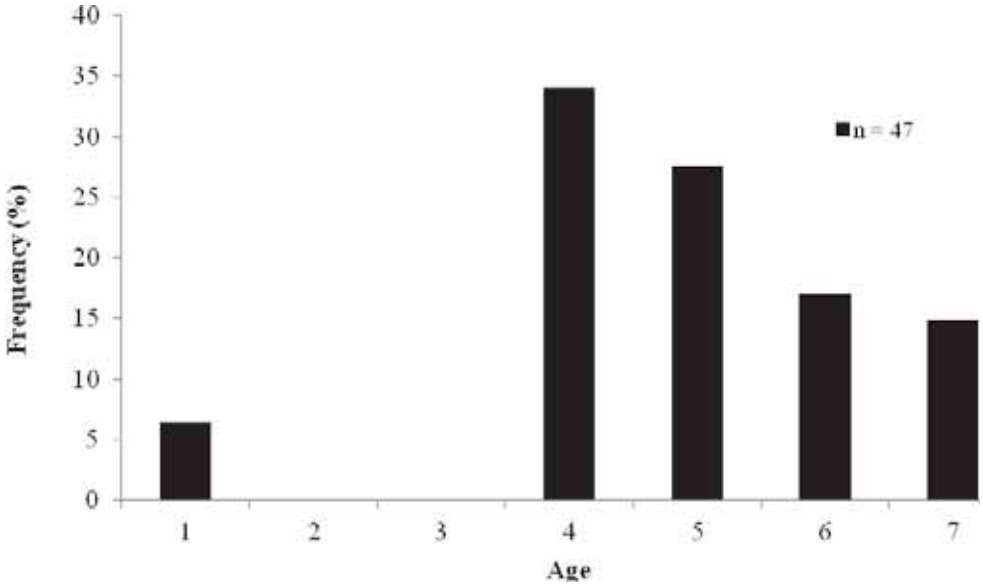

Figure 26. Age frequency of Black Crappie collected in Union Lake during spring 2015.

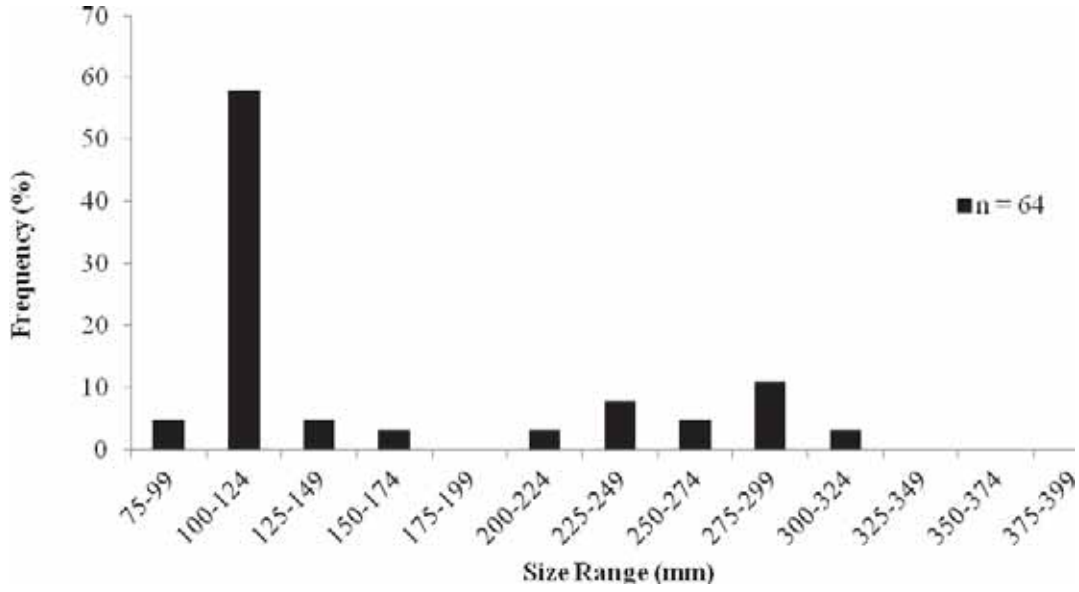

Figure 27. Length frequency of Black Crappie collected at Union Lake in fall 2015 during electrofishing.

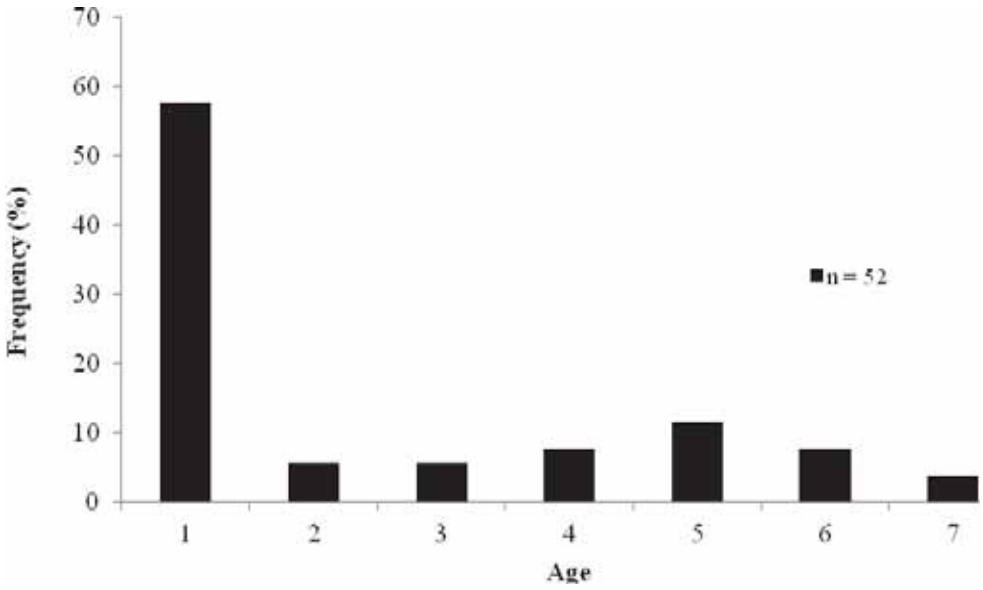

Figure 28. Age frequency of Black Crappie collected in Union Lake during fall 2015.

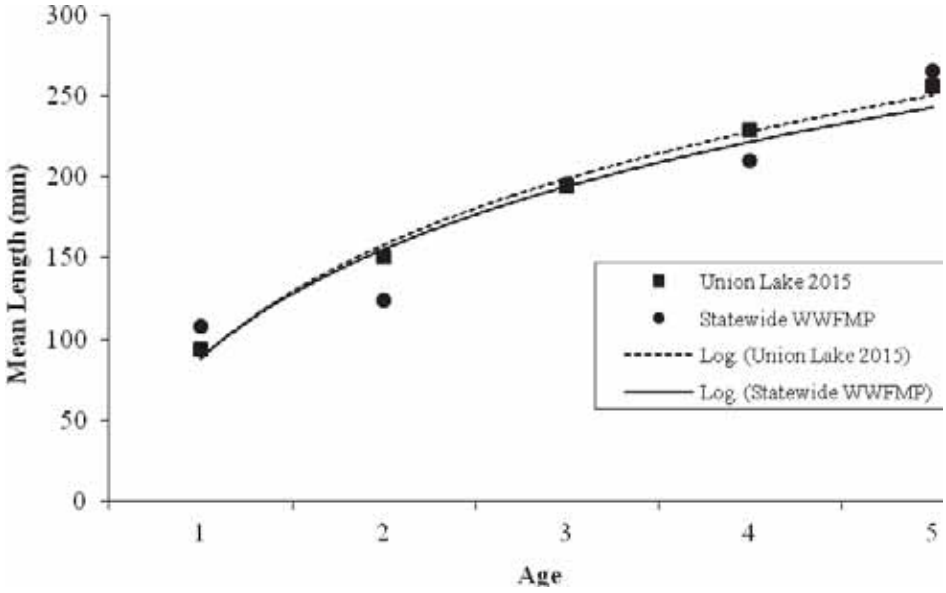

Figure 29. Length at age of Black Crappie collected in Union Lake in 2015.

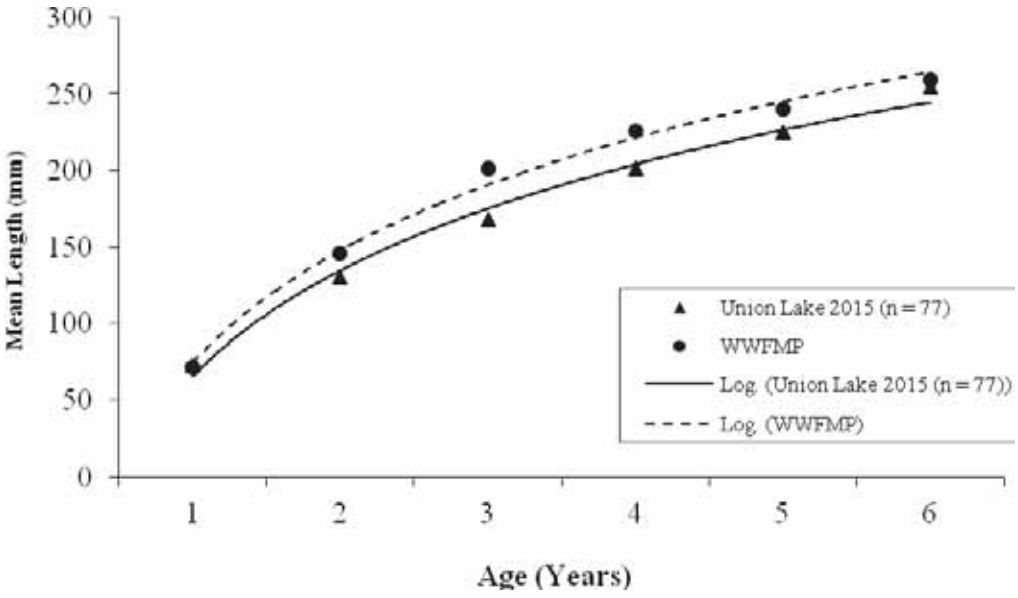

Figure 30. Length at age of White Perch collected in Union Lake in 2015.

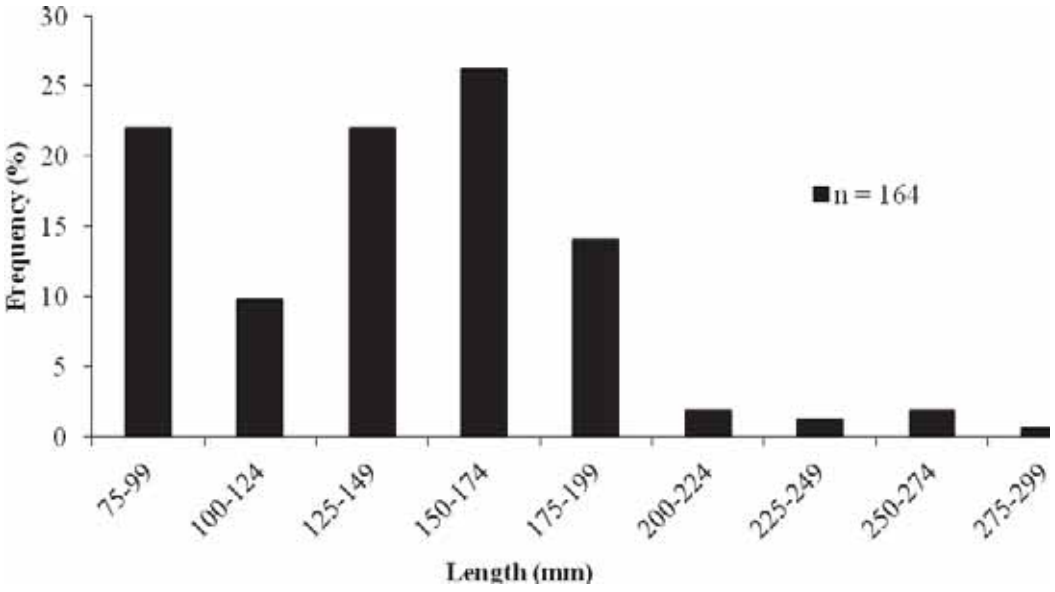

Figure 31. Length frequency of White Perch collected at Union Lake in spring 2015 during electrofishing.

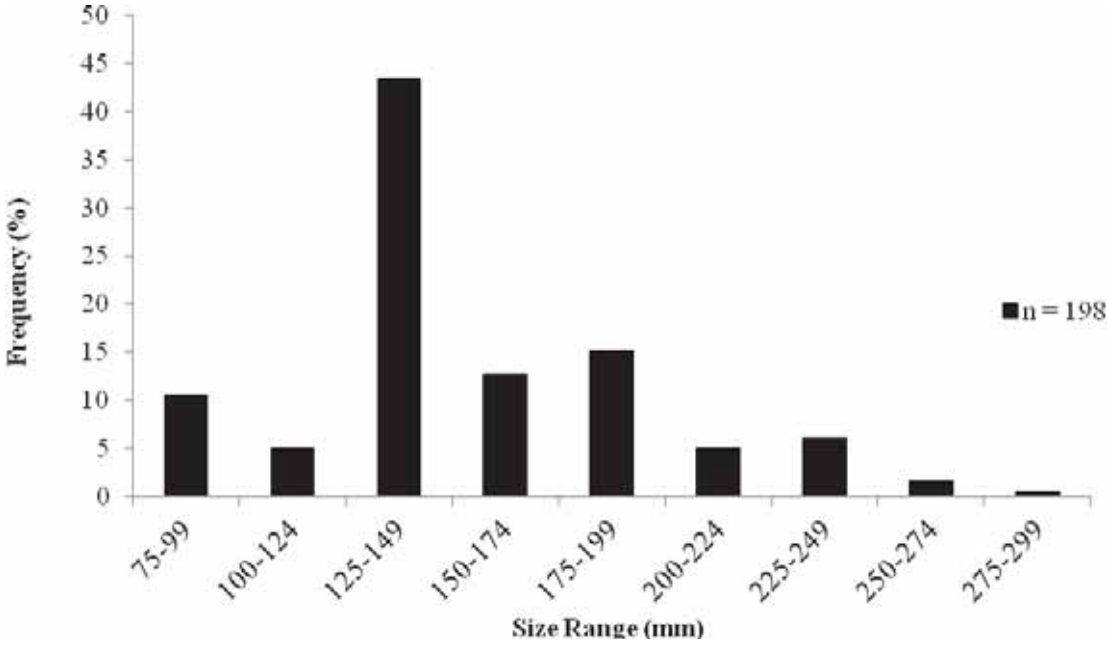

Figure 32. Length frequency of White Perch collected at Union Lake in fall 2015 during electrofishing.

APPENDIX A

New Jersey Division of Fish and Wildlife
Bureau of Freshwater Fisheries
Stocking History – Union Lake 1981-2015

Species Name	Number	Total Weight (lb.)	Mean Length (in)	Mean Weight (lb.)	Length Range	Fish/lb.	Date	Hatchery Name
Bass, Hybrid Striped	1281	179.4	6.67			7.14	10/8/85	Hackettstown State Fish Hatchery
Bass, Largemouth	12759	25.3	1.55			504	7/8/15	Hackettstown State Fish Hatchery
Bass, Largemouth	5210	12	2			430	7/19/11	Hackettstown State Fish Hatchery
Bass, Largemouth	2400	32.4	3			74	7/23/10	Hackettstown State Fish Hatchery
Bass, Largemouth	5000	55.6	3			90	8/19/09	Hackettstown State Fish Hatchery
Bass, Largemouth	600	166	8.5		5.4-16.2	4	5/31/91	Hackettstown State Fish Hatchery
Bass, Smallmouth	9000	22.3	1.6			403	7/8/15	Hackettstown State Fish Hatchery
Bass, Smallmouth	10000	10.2				976	6/27/14	Hackettstown State Fish Hatchery
Bass, Smallmouth	7814	20				380	7/2/13	Hackettstown State Fish Hatchery
Bass, Smallmouth	5500	19.5	2			282	7/6/11	Hackettstown State Fish Hatchery
Bass, Smallmouth	2881	16.8				171.5	7/15/10	Hackettstown State Fish Hatchery
Bass, Smallmouth	2565	15	2.3		1.8-2.8	171	7/9/09	Hackettstown State Fish Hatchery
Bass, Smallmouth	5000	16.6	2		1.5-2.5	301.5	7/10/08	Hackettstown State Fish Hatchery
Bass, Smallmouth	3000	10.5	2		1.5-2.5	285	7/6/07	Hackettstown State Fish Hatchery
Bass, Smallmouth	2888	21.4	2.85		2.3-5.4	135	8/29/02	Hackettstown State Fish Hatchery
Bass, Smallmouth	4019	25.7	2.4		1.5-3.2	156	7/11/02	Hackettstown State Fish Hatchery
Bass, Smallmouth	85	170	15		12-18	0.5	7/19/01	Hackettstown State Fish Hatchery
Bass, Smallmouth	8085	35	1.96		1.4-2.6	231	7/7/95	Hackettstown State Fish Hatchery
Bass, Smallmouth	11	22	15				7/7/95	Hackettstown State Fish Hatchery
Bass, Smallmouth	117	234	15		12-18		6/23/95	Hackettstown State Fish Hatchery
Bass, Striped	3475						10/7/82	Hackettstown State Fish Hatchery
Bass, Striped	5088						8/31/82	Hackettstown State Fish Hatchery
Catfish, Channel	30850	4.3	0.5				7/8/15	Hackettstown State Fish Hatchery
Catfish, Channel	23	255	28		22.8-32.1	0.09	11/14/12	Hackettstown State Fish Hatchery
Catfish, Channel	2200	81.5	5.39		4.3-6.8	27	10/25/91	Hackettstown State Fish Hatchery
Catfish, Channel	40	266	25			0	9/13/91	Hackettstown State Fish Hatchery
Muskellunge, Tiger	2700	357	8.92		7.8-11.5	8	8/30/96	Hackettstown State Fish Hatchery

APPENDIX B

New Jersey statewide average growth of selected fish species.
1990 - 1995 (NJDFW - 1997)

Species	Total length (mm) at annuli						
	I	II	III	IV	V	VI	VII
Black Crappie	108	124	196	210	265	---	---
Bluegill	51	92	124	148	174	201	---
Chain Pickerel	157	256	372	423	513	638	---
Hybrid Striped Bass	299	422	418	525	570	---	---
Largemouth Bass	94	196	287	344	366	412	424
Northern Pike (male)	410	520	570	612	669	690	---
Northern Pike (female)	431	567	658	740	841	882	914
Pumpkinseed	39	77	107	130	136	165	---
Redbreast Sunfish	60	91	106	127	142	---	---
Rock Bass	---	99	119	165	216	---	---
Smallmouth Bass	94	189	288	355	410	435	---
Tiger Muskellunge	---	---	483	767	914	1067	---
Walleye (male)	---	361	424	460	493	513	536
Walleye (female)	---	379	445	513	541	566	645
White Perch	71	146	201	226	240	259	275
Yellow Perch	90	158	198	231	247	279	---

APPENDIX C

New Jersey Division of Fish and Wildlife Standardized Criteria for Harvestable Size

Species	*Total Length* mm	inches
Trout (Brook, Brown, Rainbow)	≥228	9
Tiger Muskies – Muskellunge	≥ 1016	40
Northern Pike	≥ 610	24
Pickerel (Chain, Redfin)	≥ 380	15
Black Bass (Trophy Bass Regulations)	≥ 380	15
Largemouth Bass	≥ 305	12
Smallmouth Bass	≥ 305	12
Perch (Yellow and White)	≥ 178	7
Catfish (all species except Channel Catfish)	≥ 178	7
Channel Catfish	≥ 305	12
Rock Bass	≥ 127	5
Sunfish (all species)	≥ 127	5
Crappie (Black and White)	≥ 203	8
Striped Bass	≥ 710	28
Hybrid Striped Bass (Striped Bass x White Bass hybrid)	≥ 406	16
Walleye	≥ 457	18