Fisheries Management Plan

Lake Musconetcong

New Jersey Department of Environmental Protection
Division of Fish and Wildlife
Bureau of Freshwater Fisheries
Southern Region Office
220 Blue Anchor Rd.
Sicklerville, NJ 08081

Prepared By

Christopher Smith
Principal Fisheries Biologist

December 2009

INTRODUCTION

Lake Musconetcong covers 329 acres (1.3 km^2), has a maximum depth of about eight feet and an average of depth of less than five feet. The lake's watershed covers 14,000 acres (57 km^2). The lake is less than 1 ½ miles downstream of Lake Hopatcong and situated on the border of Sussex and Morris Counties. The Borough of Netcong, Borough of Stanhope, Roxbury Township and Byram Township surround Lake Musconetcong (Figure 1).

Referred to as Stanhope Reservoir in earlier times, Lake Musconetcong was constructed in the mid-1800s as a water source for the Morris Canal, which connected Jersey City (Passaic River) with Philipsburg (Delaware River). Lake Musconetcong was deeded to the State of New Jersey in 1924 and now is part of Hopatcong Sate Park.

The Division of Fish and Wildlife has stocked Lake Musconetcong annually with trout for many years providing enjoyment for recreational anglers. Ice fishing for yellow perch, chain pickerel and largemouth bass remain popular during the winter. There is a public boat ramp and parking area in the southwest region of the lake near the dam. Lake Musconetcong is classified as FW2-NT (non-trout) water in the NJDEP Surface Water Quality Standards. However, the Musconetcong River is classified as FW2-TM (trout maintenance).

The abundance of aquatic vegetation has been problematic in Lake Musconetcong for many years. Usually by mid-spring the aquatic vegetation is too thick for anglers to effectively fish the lake and boating becomes a hassle. The 1950 New Jersey Fisheries Survey, Report Number One states "Because of the shallowness of the lake basin, and the relative clearness of the water, which allowed the sun's rays to penetrate to all depths, the lake became entirely filled with aquatic plants as the summer progressed."

MATERIALS AND METHODS

Water quality samples were taken in Lake Musconetcong (Figure 2). General measurements of dissolved oxygen, conductivity, pH, and temperature were taken in the field with hand held YSI-models 85 and 60 devices, during sampling August, September, October and November 2009. Alkalinity samples were collected in November 2009 from a titration completed by Bureau staff. Due to the fact that the Department as well as Princeton Hyro have sampled additional water quality parameters including nitrogen, phosphorus, and dissolved solids analysis, no additional water samples were collected.

Electrofishing was conducted during the fall on the nights of September 29th and October 5th. Total running time was 3.52 hours. One additional day of eletrofishing was completed on October 20th, in order to obtain a larger sample size of largemouth bass, chain pickerel, black crappie and channel catfish. A 13.2 Smith-Root electrofishing boat was used during all electrofishing-sampling periods. The total sampling time was 2.83 hours on October 20^{th}. This data was incorporated into length frequency graphs, relative weights, and age structure analysis. A 20' x 6' seine was used at 19 locations around the perimeter of the lake to evaluate reproductive success of warmwater fish. Seining was performed during the day on August 22, 2008. Bureau staff completed a seining survey in 2008 as part of the Native Fishes Project and due to the limited number of seining locations, data collected in 2008 was used for the 2009 Lake Inventory Report.

Length and weight measurements were taken on all game and panfish species collected. Scales were removed from a sub-sample of all gamefish species. Scales were mounted between two microscope slides for age determination, using a microfiche viewer. Scale samples for largemouth bass, bluegill, pumpkinseed, yellow perch and black crappie were back calculated using the Fraser-Lee Method and Standard a- values recommended by Carlander. Chain pickerel were back calculated using the direct proportion method. All fish were back calculated to each annuli to obtain a large sample size.

Proportional stock densities (PSD), relative stock densities (RSD), and relative weights (Wr) were calculated for largemouth bass, chain pickerel, bluegill, pumpkinseed, yellow perch and black crappie.

RESULTS

Water Quality

Three dissolved oxygen temperature profiles were created from data collected on August 14^{th} (Figure 3a, b, c). There was minimal thermal stratification with temperatures ranging from 23.6 to 29^{o}C. The average temperature was 25^{o} C. Oxygen levels ranged from .3 mg/l at the bottom (5 feet) to 10.3 mg/l near the surface. The results indicate that Lake Musconetcong is eutrophic.

The specific conductance averaged 471 *u*S/cm and ranged from 452 - 501 *u*S/cm. The pH average 7.42 and ranged from 7.24 – 7.63. The alkalinity was determined to be 45.5 (Table 1).

Aquatic Vegetation

Aquatic vegetation is extremely abundant in Lake Musconetcong and it significantly impacts recreational activities such as swimming, fishing, water skiing, and boating. During the summer almost 100% of the lakes surface is covered by aquatic vegetation. In 2008 a survey of the aquatic vegetation was completed by Princeton Hydro for the Lake Musconetcong Regional Planning Board. Twenty-two species of aquatic vegetation were documented occurring in Lake Musconetcong or along the shoreline (Shannon, 2008). Many of these species are native to the region however; two species Water chestnuts *Trapa natans* and *Myriophyllum spicatum* are both invasive non-native species.

Eurasian water milfoil *Myriophyllum spicatum* is a submersed aquatic plant that is well established throughout North America and first documented in Lake Musconetcong in the early 1950's. Eurasian water milfoil can grow to depths of 12-15 feet and forms dense mats of vegetation on the surface of the water. Milfoil is difficult to completely remove from a waterbody once established.

Water chestnuts *Trapa natans* is one of the new invaders in Lake Musconetcong and has the potential to spread throughout the state. These rooted floating aquatics form extremely dense mats which reduce light penetration and hinder the growth of native beneficial aquatic macrophytes. *T. natans* drops its seeds in late summer which can lay dormant for up to 10 years. Lake Musconetcong is the first lake in New Jersey with a well-established chestnut population; however it is not the first sighting in the state. Water chestnuts were reported and confirmed at Lake Assunpink in 2002. Only a few plants were present and Division staff successfully removed the plants. Surrounding states have had well-established chestnut populations for many years. Some of New York's most popular fishing locations have flourishing populations of water chestnuts. Lake Champlain, Lake Oneida and the Hudson River all have chestnuts and are frequent destinations for New Jersey anglers.

A search of the NJDEP Natural Heritage Database identified three threatened plant species which were historically found in Lake Musconetcong; Water marigold *Bidens beckii,* Robbins pondweed *Potamogeton robbinsii* and whorled water-milfoil *Myriophyllum verticillatum. Potamogeton robbinsii* Robbins pondweed was observed to be abundant by the Bureau of Freshwater Fisheries on October 20th while electrofishing and appeared to be the preferred vegetation of the largemouth bass on that particular day. Robbins pondweed was the thickest and most abundant east of the main island.

Fisheries

Twenty species of fish representing nine families and six orders were collected during the 2008 and 2009 sampling period at Lake Musconetcong (Table 2). The most abundant species collected during sampling were bluegill (Table 3). Largemouth bass represented the largest biomass of the sample population.

The CPUE (number/hour) for largemouth bass (n = 65) was 18 per hour on September 29th and October 5th (Table 4). The CPUE for largemouth bass $\geq$ 254 mm was 11 per hour. Using the State of New York's equation for first order estimates of abundance renders a population density value of 3.85 for largemouth bass $\geq$ 254 mm (Green 1989). For largemouth bass < 254 mm the first order of estimate of abundance gives a value of 3.05. Both estimates indicate the largemouth bass population is low density. PSD and RSD_{15} values of 68 and 27 are within the recommended 40-70 PSD values and the 10-25 RSD_{15} values for a balanced population (Table 5). The length distribution graph indicates the population is well distributed and balanced (Figure 4). Relative weights W_r 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 (n = 89) collected during fall electrofishing was 100 ± 1.74 and ranged from 81 - 125 (Table 6).

Largemouth bass reproduction appears to be relatively poor, young of the year represented approximately 5% of all juvenile fish collected during shoreline seining (Table 7). Largemouth bass were collected at 32% of all seining locations. Growth rates for largemouth bass (n = 91) are below statewide averages for all age classes (Table 8). The age frequency graph shows a balanced population with Age V largemouth bass the most abundant (Figure 5). The length at age graph shows a comparison of largemouth bass growth rates at Lake Musconetcong and Statewide averages (Figure 6).

Bluegill were the most abundant fish representing 43% of the total catch during fall electrofishing (Table 3). They also had the highest CPUE at 180 per hour (Table 4). The length frequency graph indicates the population is balanced (Figure 7). The population appears to have a slight bimodal distribution. However, the size structure is unbalanced based on the PSD of 39 and a RSD_8 of 0 (Table 6). Recommended PSD and RSDp values by (Novinger and Legler, 1978) are 20-60 and 5-20 for a balanced population. The population is dominated by smaller individuals. The mean W_r for all bluegill was 98 ± 0.81 and ranged from 59-150 (Table 6), which indicates fish are in good condition. Bluegill in the 80-149 mm length range had the highest W_r at 101 ± 2.08 and ranged from 59-150. Larger bluegill 150-199 mm had a W_r of 93 ± 1.18 which is below the recommended value. Growth rates for bluegill were below the statewide average for all age classes (Figure 8). Age V bluegill were the most abundant age class (Figure 9). A total of 41 young of the year bluegill were collected during shoreline seining (Table 7). There were 118 unknown *Lepomis sp.* young of the year collected.

The pumpkinseed population (n = 75) appears to be well distributed based on the length frequency graph (Figure 7) though most individuals were small. Pumpkinseeds were not as abundant as bluegill as indicated by the CPUE of 49 per hour (Table 4). The pumpkinseed population appears to have a bimodal distribution similar to the bluegill. Collectively pumpkinseed and bluegill represented 55% of all fish collected during fall electrofishing (Table 3). The overall size structure of pumpkinseeds appears to be unbalanced based on a PSD of 22 and RSD_8 of 0 (Table 5). The overall mean W_r of 93 ± 2.80 suggests that the population is of slightly below average condition (Table 6). Pumpkinseed W_r was similar to that of the bluegill with larger individuals having lower W_r. Growth rates were average or above average for all age classes except Age VI which had slightly below average growth rates (Figure10) although the sample size was relatively small (Table 8). The age frequency graph indicates that the age structure has a normal distribution (Figure 11). Pumpkinseeds were well represented during shoreline seining making up 20% of young of the year fish (Table 7). Additionally, *Lepomis sp.* young of the year were 81% of all YOY fish.

Chain pickerel were found to be relatively abundant (n = 69) in Lake Musconetcong with a CPUE of 20 per hour. Chain pickerel consisted of 11% of all fish caught electrofishing (Table 3). The chain pickerel population has a skewed right distribution based on the length frequency graph, ranging from 238 – 660 mm (Figure 12). The Chain pickerel had a PSD of 43 an RSD_{20} of 13 and an RSD_{25} of 4 (Table 5). The overall W_r for chain pickerel (n = 82) was 90 ± 6.16 and ranged from 74-106 (Table 6). Individuals >510 mm had the lowest mean W_r at 85 ± 4.10. Wr values were below average for all size ranges and suggest a population of poor condition. The age distribution graph (Figure 13) shows the population has a large number of Age II chain pickerel. Chain pickerel had below average growth rates for all age classes (Figure 14). There were no young of the year and three intermediate chain pickerel collected during shoreline seining (Table 7).

Yellow perch were fairly abundant (n = 64) with a CPUE of 42 fish per hour (Table 4). The yellow perch population is poorly distributed as evident from the length frequency graph (Figure 15). The PSD of 79 was above the recommended 30-60 value for a balanced population (Table 5). Yellow perch made up 10% of all fish collected electrofishing (Table 3). The overall mean W_r was 79 ± 2.59 and suggests that the population is below average condition (Table 6). There were no fish collected in the 150-199 mm size range. Larger individuals >250 mm had the lowest mean W_r of 75 ± 1.85 and ranged from 60 – 83. The age frequency reflects a similar distribution as the length frequency; two year classes Age II and III were not represented (Figure 16). Growth rates were below average for all age classes of yellow perch (Table 8). Only one young of the year yellow perch was collected seining (Table 7).

Black crappie were not abundant (n = 12) with a CPUE of 3 fish/hour (Table 4). The population appears to be poorly distributed based on the length frequency (Figure 17) and the age frequency (Figure 18). Based on a PSD value of 80 and RSD_{10} of 70 the population is not balanced and consists primarily of larger individuals (Table 5). Recommended values are 30-60 for PSD and >10 for RSD-p. The mean W_r of 96 ± 5.69 indicates black crappies are of good condition. Black crappies 100-149 had a W_r 102 ±13.93 and those150-199 mm had a W_r of 103 ±6.91 (Table 6). Smaller individuals were of better condition; however the sample size was rather small. Black crappies had below average growth rates. There were no black crappies collected during shoreline seining.

Brown bullheads were collected in rather high abundance (n = 37). All individuals were greater than harvestable size $\geq$178 mm. Yellow bullhead were found in low abundance (n = 6) and all individuals were greater than the harvestable size of 178 mm. Channel catfish were not abundant but two large individuals 672mm (4.34 kg / 9.57 lbs.) and 542 mm (1.94 kg / 4.27 lbs.) were collected.

Golden shiner were found to be rather abundant (n = 22) especially on the third day of electrofishing after the lake level had been lowered. Though golden shiner were observed in rather high abundance few were netted to alleviate potential mortality. Golden shiners often experience high mortality rates in overcrowded livewells. Several large common carp were captured, but did not appear to be very abundant. Similarly, creek chubsucker and white sucker were not abundant.

DISCUSSION

Lake Musconetcong is not typical of many lakes in Northern New Jersey. It is shallow and though it has some rather large scattered boulders it lacks the abundant rocky substrate typical of the region. The soft mud substrate limits reproduction and extensive aquatic vegetation limits growth rates of warmwater fish.

Twenty species of fish were collected during 2008 and 2009 sampling in Lake Musconetcong, indicating that there is a diverse fish population. Lake Musconetcong is relatively large by New Jersey standards, species richness is known to positively correlated with the size of both the waterbody (Tonn and Magnuson 1982; Graham 1993) and the watershed (Poff and Allan 1995). Lake Musconetcong possesses both rooted and floating aquatic macrophytes in the littoral zone, and multiple studies have documented a positive correlation between aquatic macrophyte density and species richness (Tonn and Magnuson 1982).

The largemouth bass population is in good condition and balanced despite below average growth rates and moderately low reproduction. Exploitation is low despite the popularity of ice fishing at Lake Musconetcong. Lakes in which ice fishing is popular generally have increased harvest rates. The abundant vegetation during the warmer months reduces angler effort and keeps exploitation low. The current largemouth bass population should provide excellent angling opportunities.

Chain pickerel are abundant and reproduction appears to be good. The abundant aquatic vegetation is favorable for chain pickerel. Chain pickerel and largemouth bass compete for both habitat and food in Lake Musconetcong. This competition has affected the growth rates and condition of the chain pickerel. There were many quality-sized chain pickerel collected, with a few large enough to obtain a Skillful Angler Award.

Yellow perch are relatively abundant, growth rates are poor and the population is poorly distributed. Largemouth bass and chain pickerel may heavily prey upon the yellow perch. The poor condition of the yellow perch indicates significant competition with other species. Literature suggests that yellow perch growth rate is not well correlated with a lake's productivity (Green 1989). Despite the unbalanced structure and poor recruitment the Lake Musconetcong should provide good fishing opportunities for yellow perch as long as exploitation is low.

The sunfish population is abundant though bluegill are the dominant sunfish species. Pumpkinseed were the only species collected at Lake Musconetcong that had average or above average growth rates. Both sunfish species were well distributed and of good overall condition. Bluegill had slower growth rates most likely due to higher abundance and competition. It is interesting that despite occupying the same niche bluegill and pumpkinseed have significantly different growth rates. In the 1950s survey redbreast sunfish were collected, however they were not found during the recent survey.

Black crappies were encountered in very low abundance but those collected were in good condition. Growth rates have presumably been affected by excessive reproduction of other panfish species and reproduction appears to be limited.

There are a few notable differences when comparing the present fish community structure and that of the 1950s fisheries survey. The bridled shiner was reported as abundant in 1950s; however it was not encountered during sampling in 2009, nor in 2008 when Bureau staff sampled Lake Musconetcong as part of the Native Fishes Project. Blue spotted sunfish were found in good numbers. Changes in water quality, habitat and the introduction of predator species have had a significant impact on native fish populations in New Jersey.

Brown bullhead were not reported to be abundant in the 1950s, however due to the abundant mud substrate and aquatic vegetation the brown bullhead population has substantially expanded. Most individuals were of a favorable size and should provide good fishing opportunities. Though yellow bullheads have limited recreational value it is noteworthy that the species was present. White catfish were collected in the 1950s but not present in 2009. Although the Division of Fish and Wildlife does not currently stock channel catfish in Lake Musconetcong, two rather large individuals were collected. Like the brown bullheads, these fish have either been introduced by either Fishing Derby Stockings or have traveled downstream from Lake Hopatcong.

The forage base does not appear to have changed much in the almost 60 years since the first survey was completed. There are abundant populations of golden shiner, small sunfish, and juvenile yellow perch which serve as an ample food supply for large predators. Alewife may have been more abundant in past years, however due to the abundant aquatic vegetation their abundance is low. The few alewives encountered are presumably a result of individuals escaping from Lake Hopatcong.

Recommendations that were made in the 1950s Fisheries Survey are as relevant and appropriate today as they were 60 years ago. Two major problems have been identified in Lake Musconetcong, the depth of the lake and the abundant aquatic vegetation.

Mechanical, chemical and physical methods have all been utilized to control nuisance aquatic species. Mechanical harvest has been the primary method of controlling aquatic vegetation at Lake Musconetcong. Although effective in reducing existing vegetation it is only a temporary solution and can actually enhance distribution and growth rates due to Eurasian milfoil's ability to grow through fragmentation. Chemical herbicides have been widely used in the control of Eurasian milfoil throughout the country. Effective control has been reported with 2, 4-D and fluridone (brand name Sonar ®). A case study in Connecticut at Lake Quonnipaug indicated that Eurasian milfoil can be controlled utilizing fluridone with minimal impact on Robbins pondweed (Bugbee and White, 2001).

Lake Musconetcong is different from many impoundments in this region of the State. The land that was flooded to create Lake Musconetcong was a swamp, with little relief and abundant soft substrate. The lake resembles the low gradient waters of southern New Jersey. The lake should be drained and the lake bottom scraped to remove years of accumulated organic material and to expose any favorable sand and gravel substrate. Due to the natural topography of the area limited dredging could be performed.

Removing the accumulated organic material and aquatic vegetation will ultimately increase flow and release nutrients that have been trapped in the bottom sediments and plant material.

Management Objectives

1. Improve largemouth bass population density, and growth rate.
2. Improve panfish size structure condition and growth.
3. Improve chain pickerel growth rates.
4. Improve habitat.

Recommendations

1. Lake Musconetcong should be lowered and completely drained. The lake should be dredged. Dredging the lake will increase depth and remove accumulated mud and organic substrate. Dredging will also assist in the removal of aquatic vegetation.
2. Maintain Lake Musconetcong in a lowered condition for a growing season to promote growth of shoreline vegetation and woody plants, which increase the complexity of habitat and improve littoral zone habitat for juvenile centrarchids.
3. Implement an aquatic vegetation control program, avoiding mechanical weed harvesters and concentrating on chemical herbicides if needed after dredging.
4. Consider adding artificial habitat structures to increase available structure and vertical relief to improve warmwater fish habitat.
5. Develop a restocking plan for the lake which will maximize the recreational potential of the lake, after dredging.

LITERATURE CITED

Barbour, C.D and J.H Brown. 1974. Fish species diversity in lakes. The American Naturalist 108: 473-489.

Bugbee, Gregory and White, Jason. 2001. Control of Cabomba and Eurasian Milfoil in Lake Quonnipaug with Fluridone and 2, 4-D. The Connecticut Agricultural Experiment Station, New Haven.

Graham, J.H 1993. Species diversity of fishes in naturally acidic lakes in New Jersey. Transactions of the American Fisheries Society 122: 1043-1057.

Green, D.M. 1989. N.Y.S. Bureau of Fisheries Centrarchid Sampling Manual. Warmwater Fisheries Unit, Cornell Biological Field Station, Bridgeport. N.Y.

Murphy, B. R. & D.W. Willis, editors. 1996. Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, Maryland.

New Jersey Department of Environmental Protection, 2008. Surface Water Quality Standards. N. J. A. C. 7:9B.

New Jersey Department of Conservation and Economic Development, Division of Fish and Game. 1950. New Jersey Fisheries Survey, Report Number One.

Novinger, Gary D. & Legler, Robert E. 1978. "Bluegill Population Structure and Dynamics", North Central Division, American Fisheries Society, Special Publication No. 5.

Poff, N.L and J. D Allan. 1995. Functional organization of stream fish assemblages in relation to hydrological variability. Ecology 76:606-627.

Shannon, Robynn K. 2008. Final Report on the Vegetation of Lake Musconetcong. Prepared for the Lake Musconetcong Regional Planning Board.

Staff, Bureau of Freshwater Fisheries. 1998. "Warmwater Fisheries Management Plan." New Jersey Division of Fish and Wildlife. Bureau of Freshwater Fisheries.

Wege, Gary J. and Anderson, Richard O. 1978. "Relative Weight: A Index of Condition for Largemouth Bass", North Central Division, American Fisheries Society, Special Publication No. 5.

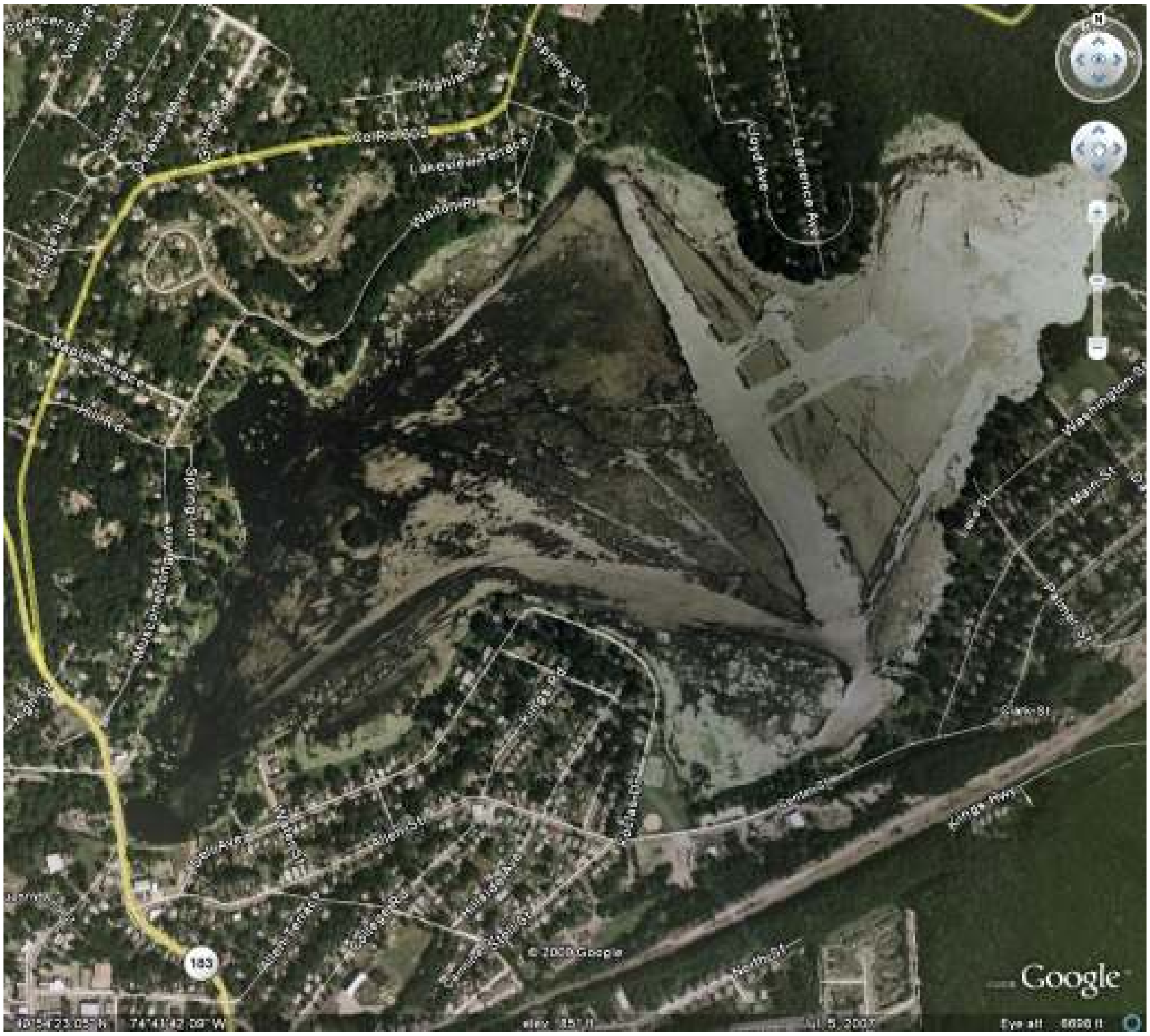

Figure 1. Aerial photo of Lake Musconetcong showing aquatic vegetation abundance and distribution.

Figure 2. Map of Lake Musconetcong showing sampling locations.

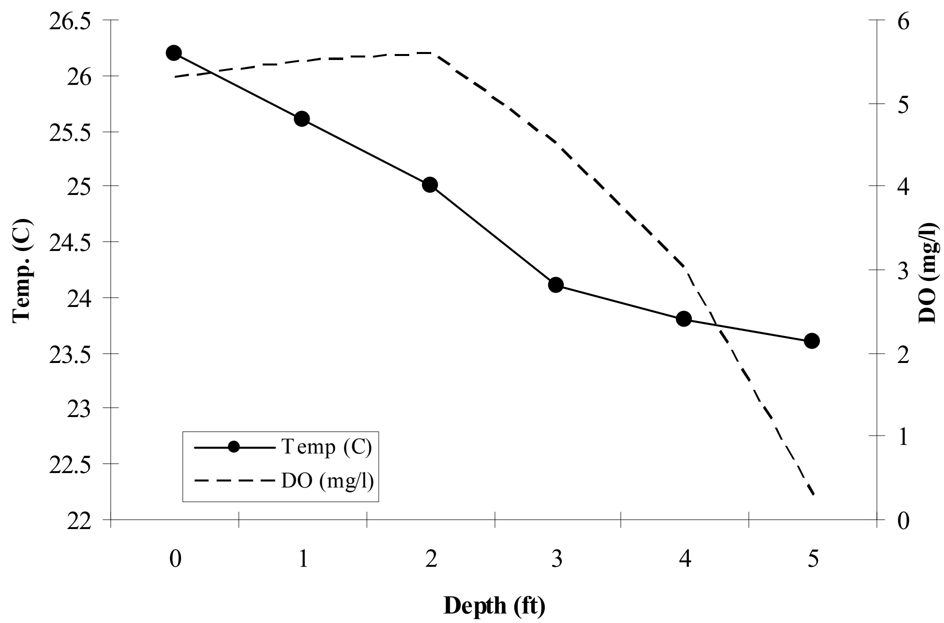

Figure 3a. Dissolved oxygen temperature profile created on August 14, 2009 at Lake Musconetcong.

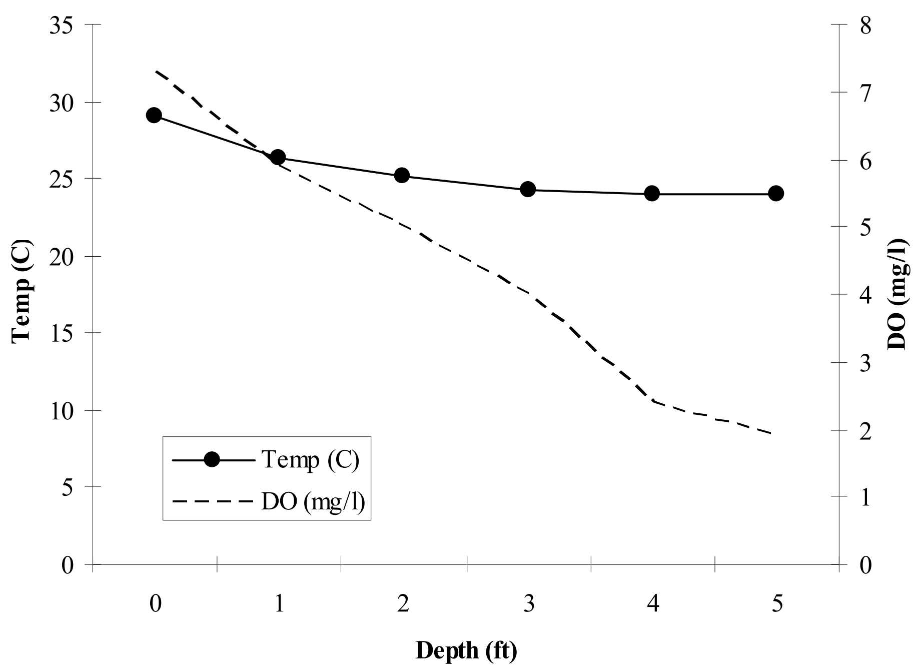

Figure 3b. Dissolved oxygen temperature profile created on August 14, 2009 at Lake Musconetcong.

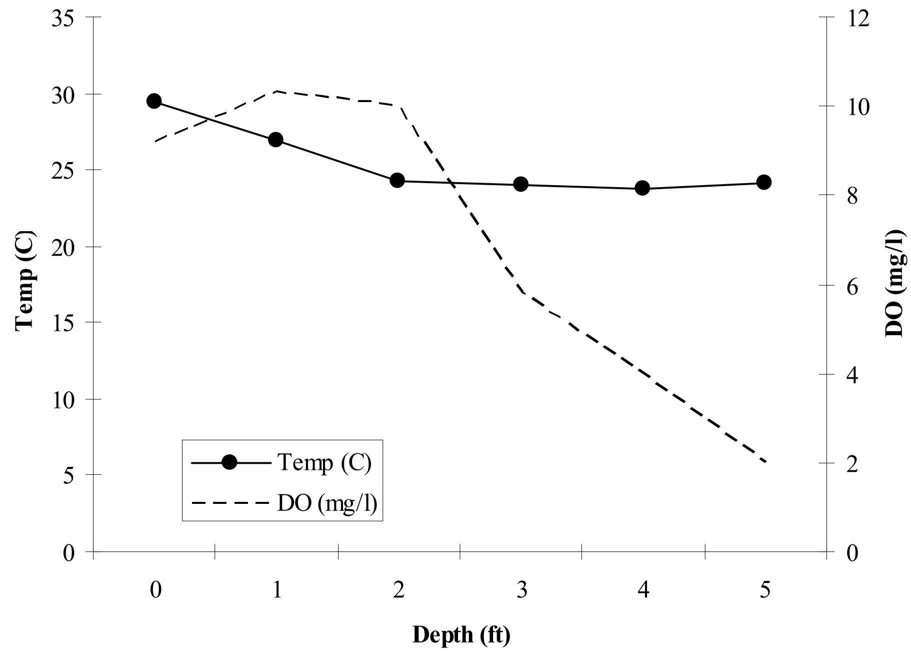

Figure 3c. Dissolved oxygen temperature profile created on August 14, 2009 at Lake Musconetcong.

Table 1. Physical-chemical characteristics collected at Lake Musconetcong in 2009.

Parameters	Mean Values (n)	Range	Dates
Water Temperature (C)	14.5 (3)	10.50 – 17.7	9/29/09 – 10/20/09
Air Temperature (C)	12.7 (3)	10.0 – 15.5	9/29/09 – 10/20/09
Specific Conductance (*u*S/cm)	471.27 (3)	452.8 - 501	9/29/09 – 10/20/09
Conductivity (*u*S/cm)	375.5 (3)	363.6 - 389.1	9/29/09 – 10/20/09
Dissolved Oxygen (mg/l)	8.07 (3)	6.87 – 9.45	9/29/09 – 10/20/09
Secchi Disk (m)	NA	NA	NA
Total Phosphorous (mg/l)-Water Surface	-	-	-
TKN (mg/l)-Water Surface	-	-	-
T.D.S (mg/l)	-	-	-
Alkalinity (mg/l)	45.5	45.5	11/23/09
pH	7.42 (3)	7.24 – 7.63	9/29/09 – 10/20/09

Table 2. Species collected at Lake Musconetcong, during the 2008 - 2009 sampling period.

I. Order: Clupeiformes
- A. Family: Clupeidae – Herrings and Shads
  - 1) *Alosa pseudoharengus* – **Alewife**

II. Order: Cypriniformes
- A. Family: Catostomidae – Suckers and minnows
  - 1) *Catostomas commersoni* – **White Sucker**
  - 2) *Erimyzon oblongus* – **Creek Chubsucker**
- B. Family: Cyprinidae – Carps and minnows
  - 1) *Cyprinus carpio* – **Common carp**
  - 2) *Notemigonus crysoleucas* – **Golden shiner**

III. Order: Cyprinodontiformes
- A. Family: Fundulidae – Topminnows and Killifish
  - 1) *Fundulus diaphanus* – **Banded Killifish**

IV. Order: Esociformes
- A. Family: Esocidae – Pikes
  - 1) *Esox niger* – **Chain pickerel**

V. Order: Perciformes
- A. Family: Centrarchidae – Sunfishes
  - 1) *Ambloplites rupestris* – **Rock bass**
  - 2) *Enneacantus gloriosus* – **Bluespotted sunfish**
  - 3) *Lepomis auritus* – **Redbreast sunfish**
  - 4) *Lepomis gibbosus* – **Pumpkinseed**
  - 5) *Lepomis macrochirus* – **Bluegill**
  - 6) *Micropterus salmoides* – **Largemouth bass**
  - 7) *Pomoxis nigromaculatus* – **Black crappie**
- B. Family: Percidae – Perches
  - 1) *Etheostoma olmstedi* – **Tessellated darter**
  - 2) *Perca flavescens* – **Yellow perch**
- C. Family: Moronidae – Temperate Basses
  - *1) Morone americana* – **White perch**

VI. Order: Siluriformes
- A. Family: Ictaluridae - Bullhead catfishes
  - 1) *Ameiurus natalis* – **Yellow bullhead**
  - 2) *Ameiurus nebulosus* – **Brown bullhead**
  - 3) *Ictalurus punctatus* – **Channel catfish**

Table 3. Species composition determined by electrofishing at Lake Musconetcong in 2009.

	Total		Harvestable	
Species	**No.**	**% of Pop. By No.**	**No.**	**% of Total No.**
Alewife	2	0%	-	-
Black Crappie	8	1%	5	1%
Bluegill	274	43%	142	22%
Brown Bullhead	37	6%	37	6%
Chain Pickerel	69	11%	32	5%
Golden Shiner	22	3%	-	-
Largemouth Bass	65	10%	31	5%
Pumpkinseed	75	12%	29	5%
White Sucker	1	0%	-	-
Yellow Perch	64	10%	48	8%
White Perch	3	0%	3	0%
Rock Bass	2	0%	2	0%
Yellow Bullhead	6	1%	6	1%
Creek Chubsucker	4	1%	-	-
Common Carp	2	0%	-	-
Total	**634**	**100%**	**335**	**53%**

Table 4. CPUE (fish/hour) of all species collected electrofishing on September 29th and October 5th, 2009 at Lake Musconetcong.

Species	Number	Time (hours)	CPH (Catch Per Hour)
Bluegill	275	1.52	180
Pumpkinseed	75	1.52	49
Yellow perch	64	1.52	42
Largemouth bass	65	3.52	18
Alewife	2	1.52	< 1
Black crappie	12	3.52	3
Chain pickerel	69	3.52	20
Golden shiner	22	1.52	14
White sucker	1	1.52	< 1
Brown bullhead	37	1.52	24
Rock Bass	2	1.52	< 1
Yellow bullhead	6	1.52	4
White perch	3	1.52	2
Creek chubsucker	4	1.52	3
Channel catfish	2	3.52	< 1
Common carp	2	1.52	< 1

Table 5. Proportional Stock Density (PSD), Relative Stock Density (RSD_p and RSD_m) of gamefish collected at Lake Musconetcong during fall 2009 electrofishing.

Species	Size (mm)	Number	PSD	RSD_p	RSD_m
Largemouth bass	≥ 200 ≥ 300 ≥ 380	81 55 22	**PSD = 68**	**RSD_{15} = 27**	**RSD_{20} = 0**
Chain pickerel	≥ 250 ≥ 380 ≥ 510 ≥ 630	79 34 10 3	**PSD = 43**	**RSD_{20} = 13**	**RSD_{25} = 4**
Bluegill	≥ 80 ≥ 150 ≥ 200	246 96 1	**PSD = 39**	**RSD_8 = 0**	**RSD_m =0**
Pumpkinseed	≥ 80 ≥ 150 ≥ 200	74 16 0	**PSD = 22**	**RSD_8 = 0**	**RSD_m =0**
Yellow perch	≥ 130 ≥ 200 ≥ 250 ≥ 300	61 48 35 3	**PSD = 79**	**RSD_{10} = 57**	**RSD_{12} = 5**
Black crappie	≥ 130 ≥ 200 ≥ 250 ≥ 300	10 8 7 1	**PSD = 80**	**RSD_{10} = 70**	**RSD_{12} = 10**

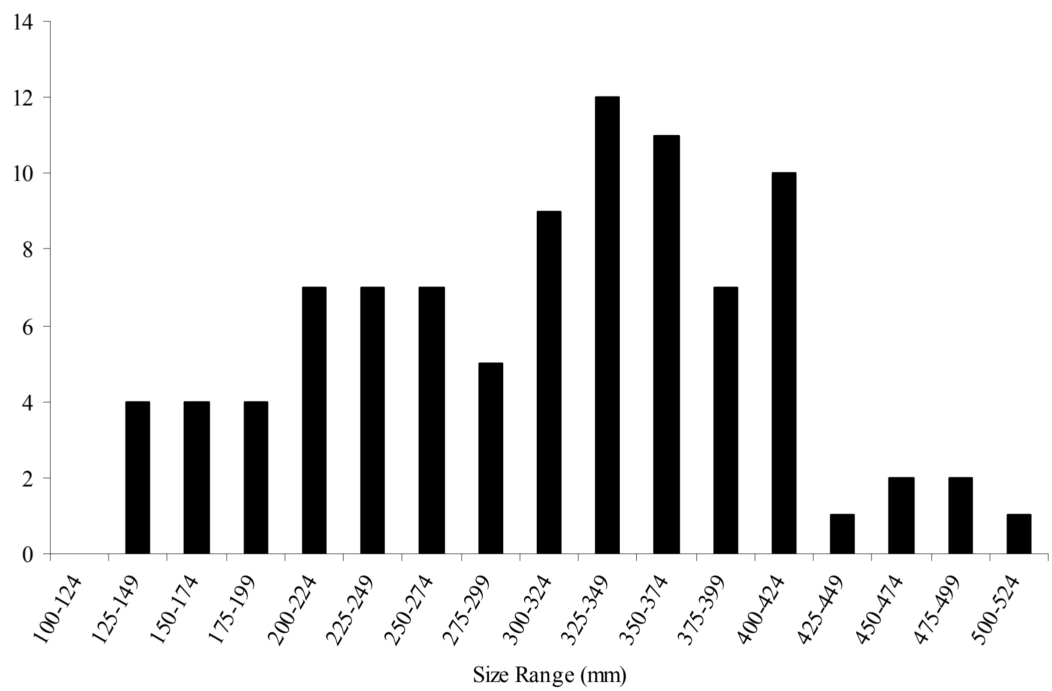

Figure 4. Length frequency of largemouth bass collected at Lake Musconetcong in 2009.

Table 6. Number and average W_r (mean ± S.E.), grouped by length, of selected species collected via electrofishing at Lake Musconetcong in 2009.

Species	Length (mm)	Number	Average W_r	SE	Range W_r
Largemouth bass	150 – 199	8	98 ± 3.96	2.02	91 - 108
	200 – 299	26	96 ± 2.35	1.20	87 - 109
	300 – 379	33	102 ± 2.91	1.49	81 -125
	≥ 380	22	102 ± 3.31	1.69	81 - 115
	ALL	89	100 ± 1.63	.83	81 - 125
Chain pickerel	150-249	3	88 ± 3.04	1.55	85 - 90
	250-379	45	93 ± 1.45	.74	78 - 106
	380-510	24	87 ± 2.25	1.15	78 - 96
	≥510	10	85 ± 4.10	2.09	74 - 96
	ALL	82	90 ± 1.33	.68	74 - 106
Bluegill	80 – 149	150	101 ± 2.08	1.06	59 - 150
	150 – 199	95	93 ± 1.18	.60	79 - 108
	>200	1	89	-	-
	All	246	98 ± .81	-	59 - 150
Pumpkinseed	80-149	58	97 ± 3.48	1.78	71- 145
	150-199	16	92 ± 2.24	1.14	85 - 98
	>200	0	-	-	-
	All	74	93 ± 2.80	1.43	71 - 145
Yellow perch	100-149	16	90 ± 7.13	3.64	66 - 128
	150-199	-	-	-	-
	200-249	13	80 ± 3.24	1.65	68 - 90
	>250	35	75 ± 1.85	.94	60 - 83
	All	64	79 ± 2.59	1.32	60 - 128
Black crappie	100-149	2	102 ± 13.93	7.11	95 -109
	150-199	2	103 ± 6.91	3.52	100 - 107
	200-249	1	87	-	-
	>250	7	94 ± 2.31	1.18	89 - 99
	All	12	96 ± 5.69	2.90	87 - 109

Table 7. Species composition determined by seining in Lake Musconetcong in 2008.

	YOY		Intermediate		Adult	
Species	**Locations**	**No.**	**Locations**	**No.**	**Locations**	**No.**
Largemouth bass	9,10,11,12, 13,14	13	17	1	-	-
Bluegill	1,2,3,4,5,6, 12	41	3,5,7,9,10, 11,12,13,1 7	31	10	2
Pumpkinseed	1,2,6	54	4,5,7,9,10, 11,12,13,1 7,18	27	12	1
Yellow perch	9	1	-	-	-	-
Bluespotted sunfish	1,3,9,10,11 ,12,13,14,1 5,16,17	33	1,13,14,	5	-	-
Unknown Lepomis spp.	2,4,8,9,10, 11,12,13,1 4,15,16,17	118	-	-	-	-
Yellow bullhead	3, 17	3	10	1	-	-
Chain pickerel	-	-	5,9,10	3	-	-
Rock bass	14	1		0	-	-
Tessellated darter	-	-	7	1	-	-
Redbreast sunfish	-	-	8	1	-	-
Banded killifish	-	-	18,19	33	-	-
Totals		**264**		**103**		**3**

Table 8. Back calculated length at age (mean ± 95% CI) of selected species collected from Lake Musconetcong in 2009.

Species	Age	Number at age	Number of scales/age	Average total length (mm)	Length range (mm)
Largemouth bass	1	11	91	74 ± 3.61	51 – 126
	2	15	80	164 ± 5.80	116 – 231
	3	10	65	238 ± 6.94	181 - 294
	4	15	55	296 ± 6.04	255 - 357
	5	21	40	337 ± 3.81	298 – 410
	6	8	19	379 ± 5.95	341 – 442
	7	6	11	406 ± 8.39	375 – 469
	8	4	5	435 ± 16.02	405 - 492
	9	1	1	466	–
Chain pickerel	1	7	82	156 ± 5.83	100 - 228
	2	24	75	249 ± 6.44	188 - 310
	3	17	51	329 ± 9.87	264 - 409
	4	12	34	410 ± 16.44	334 - 511
	5	14	22	479 ± 22.02	397 - 586
	6	4	8	559 ± 34.89	476 - 623
	7	4	4	604 ± 35.37	567 - 646

Bluegill	1	6	93	46 ± 1.32	36 - 76
	2	10	87	76 ± 1.96	54 - 106
	3	4	77	104 ± 2.16	80 - 123
	4	18	73	130 ± 2.44	106 – 156
	5	47	55	152 ± 3.03	126 – 180
	6	5	8	171 ± 5.05	159 – 179
	7	2	3	190 ± 4.90	187 - 195
	8	1	1	209	
Pumpkinseed	1	5	47	51 ± 1.66	41 - 66
	2	10	42	81 ± 2.56	62 -101
	3	8	32	108 ± 3.22	93 – 126
	4	10	24	128 ± 4.30	114 – 158
	5	6	14	143 ± 4.15	134 – 165
	6	7	8	156 ± 6.21	148 - 175
	7	1	1	170	-
Yellow perch	1	8	54	83 ± 2.25	66 – 104
	2	0	46	130 ± 4.42	102 - 169
	3	0	46	173 ± 4.99	134 - 209
	4	2	46	207 ± 4.74	173 - 261
	5	26	44	236 ± 4.32	204 - 281
	6	14	18	261 ± 7.90	226 - 297
	7	4	4	272 ± 14.64	262 - 294
Black Crappie	1	2	12	74 ± 2.27	68 - 81
	2	2	10	116 ± 6.40	99 - 130
	3	0	8	158 ± 8.76	140 - 178
	4	1	8	203 ± 10.24	181 - 217
	5	2	7	238 ± 9.11	217 - 250
	6	1	5	263 ± 10.58	248 - 281
	7	4	4	286 ± 10.50	279 - 302

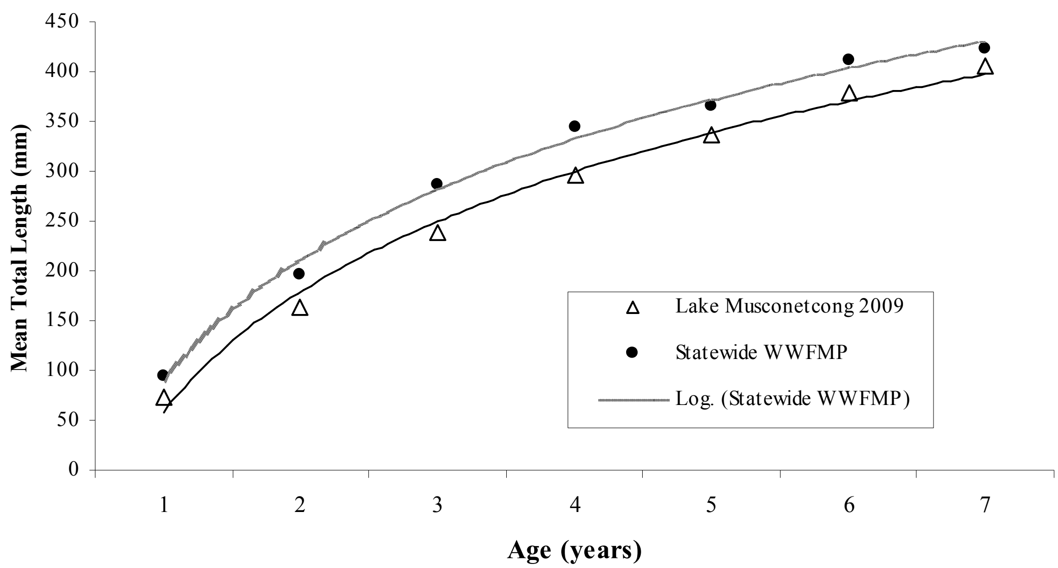

Figure 5. Length at age of largemouth bass collected at Lake Musconetcong in 2007.

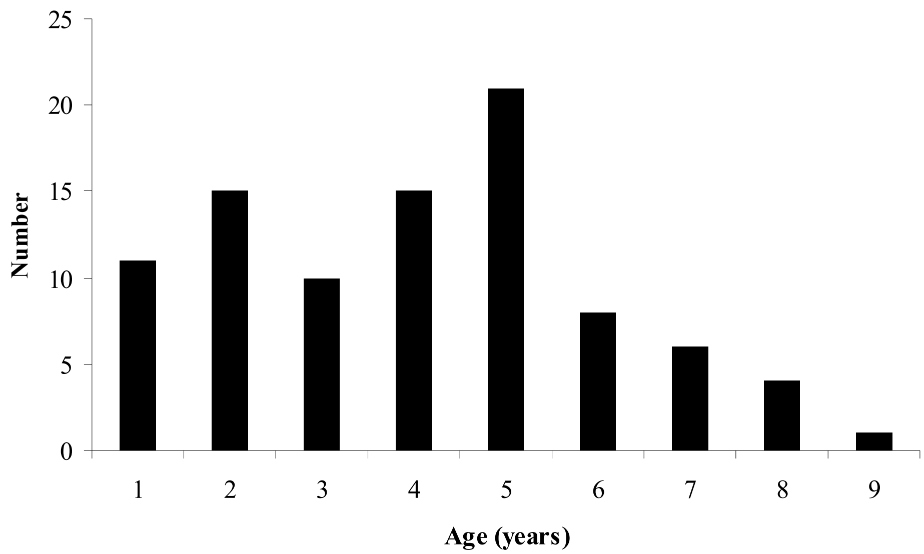

Figure 6. Age frequency of largemouth bass collected at Lake Musconetcong in 2009.

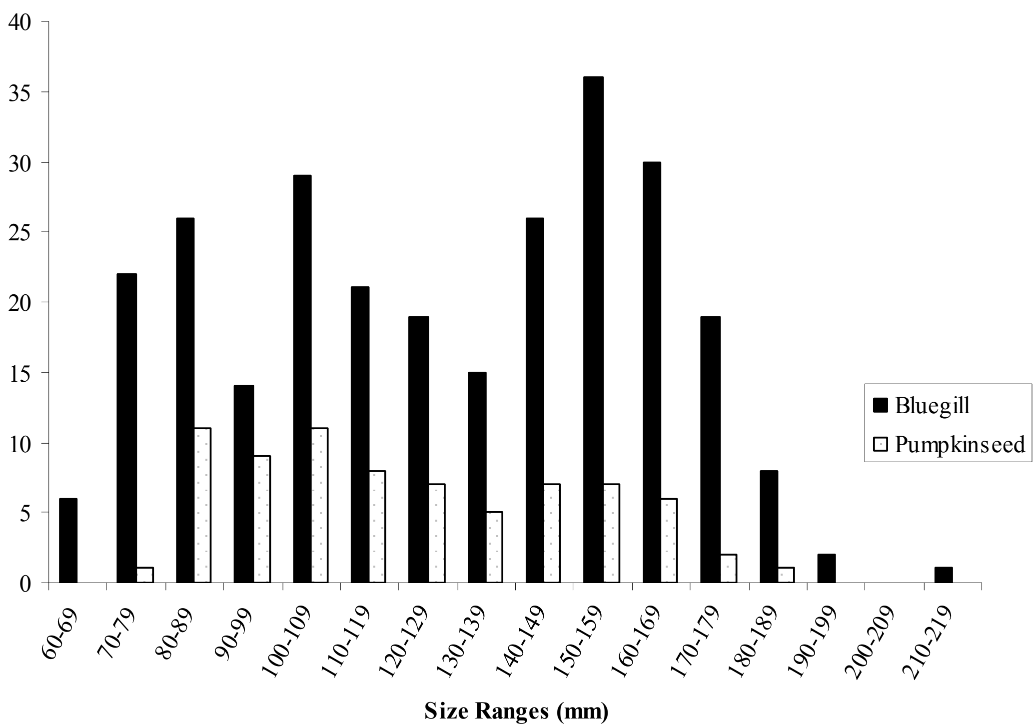

Figure 7. Length frequency of bluegill and pumpkinseed collected at Lake Musconetcong in 2009, during fall sampling.

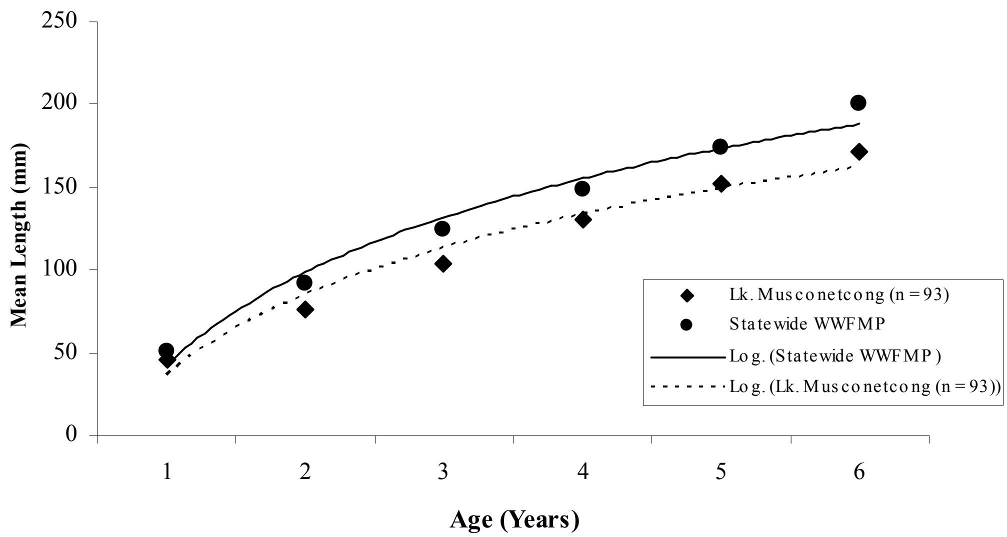

Figure 8. Length at age of bluegill collected at Lake Musconetcong in 2009

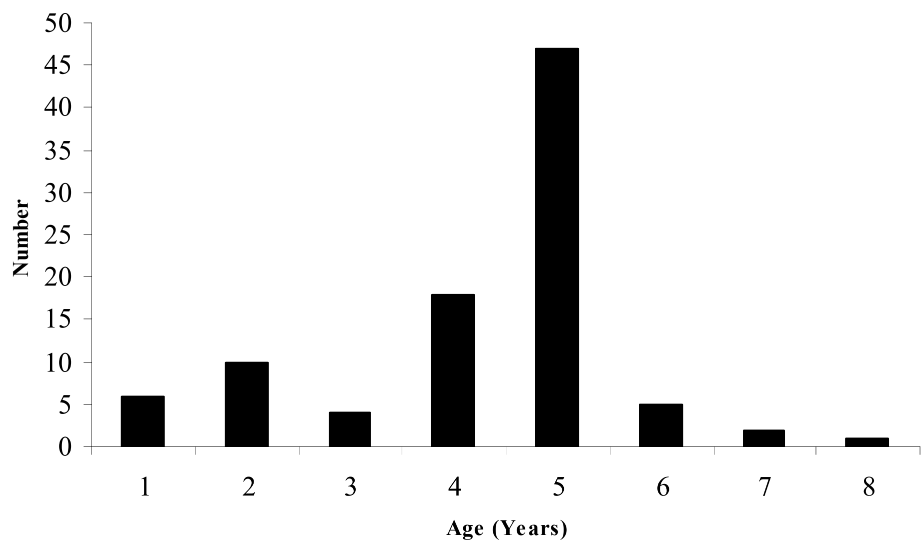

Figure 9. Age frequency of bluegill collected at Lake Musconetcong in 2009.

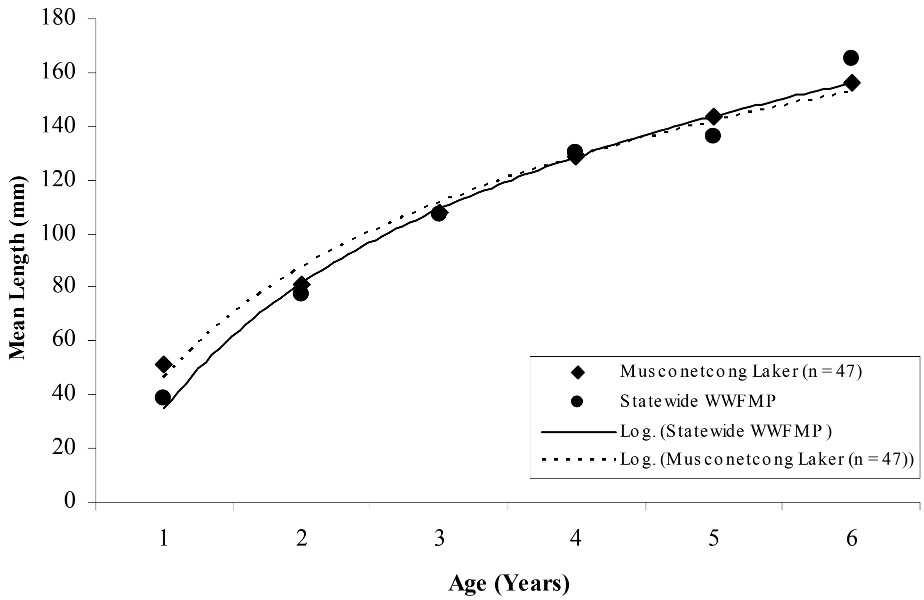

Figure 10. Length at age of pumpkinseed collected at Lake Musconetcong in 2009

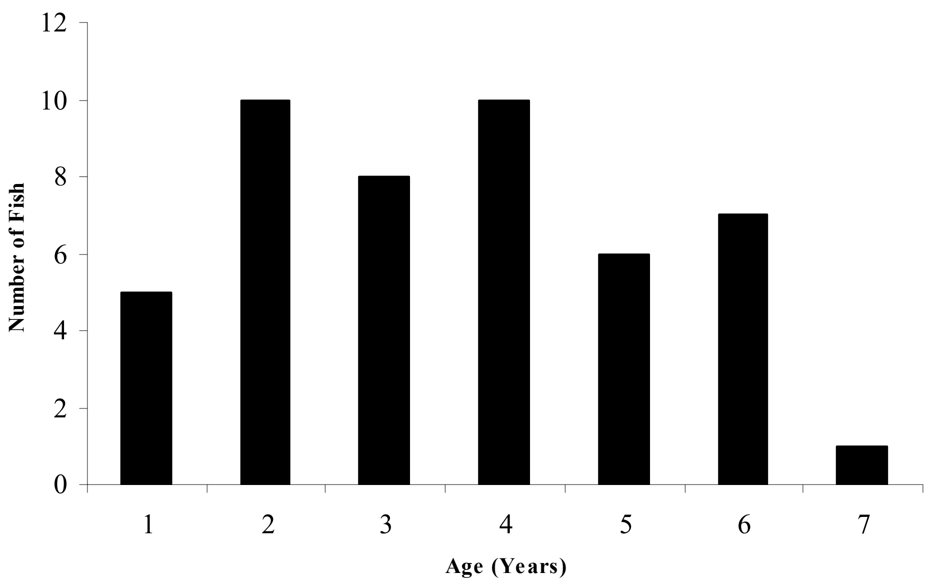

Figure 11. Age frequency of pumpkinseed collected at Lake Musconetcong in 2009.

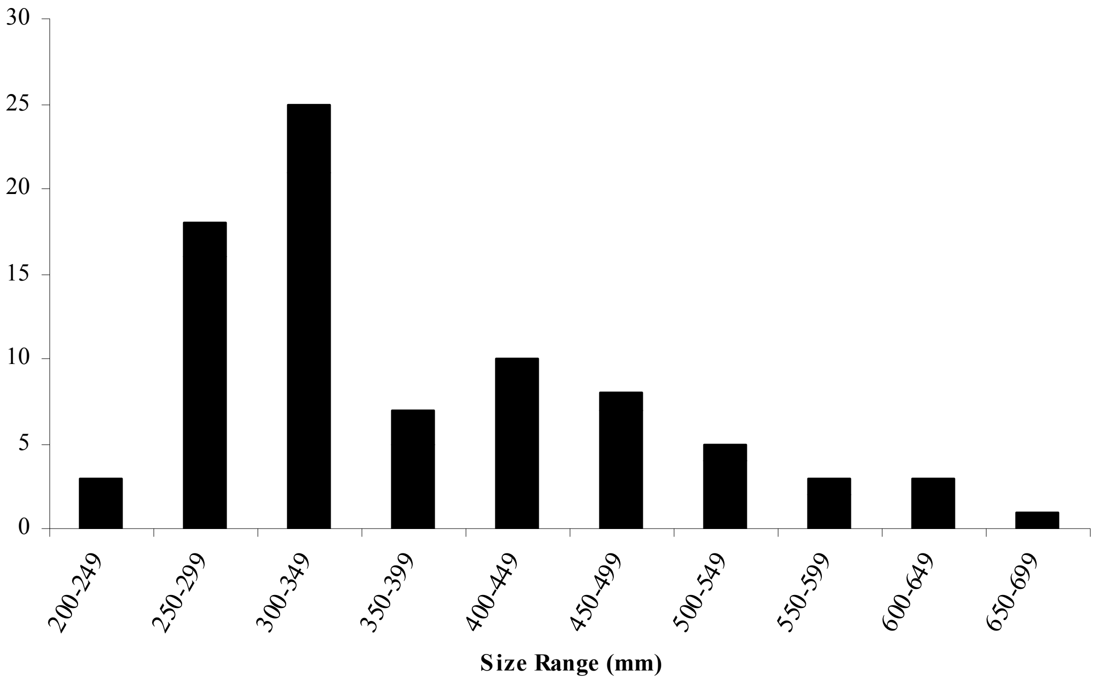

Figure 12. Length frequency of chain pickerel collected at Lake Musconetcong during fall electrofishing in 2009.

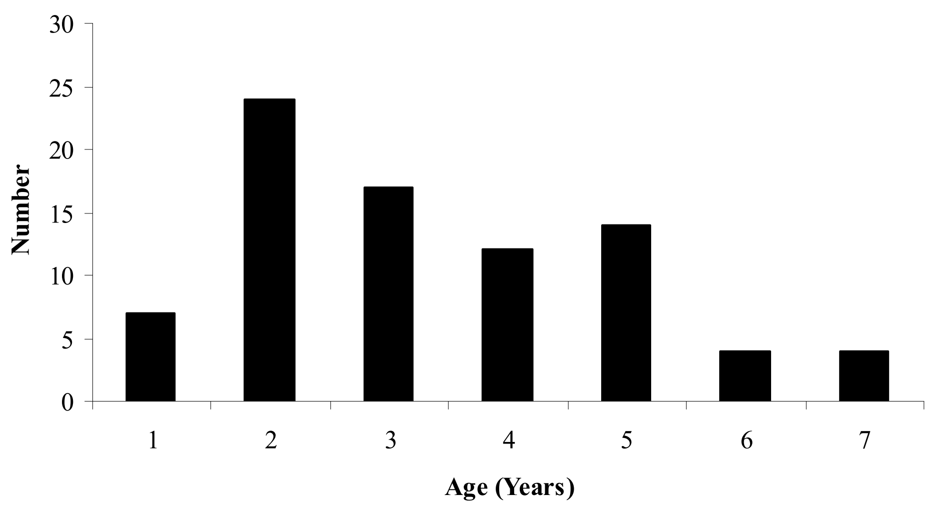

Figure 13. Age frequency of chain pickerel collected at Lake Musconetcong in 2009.

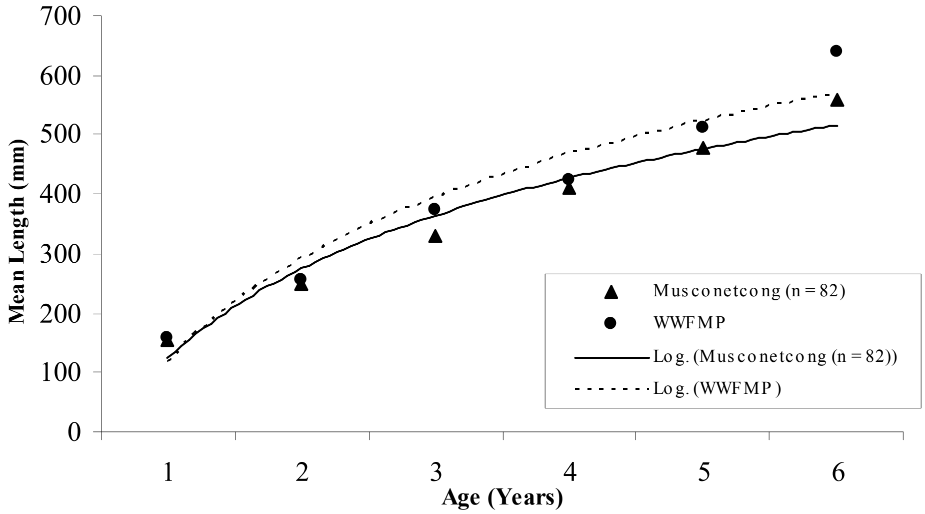

Figure 14. Length at age of chain pickerel collected at Lake Musconetcong in 2009

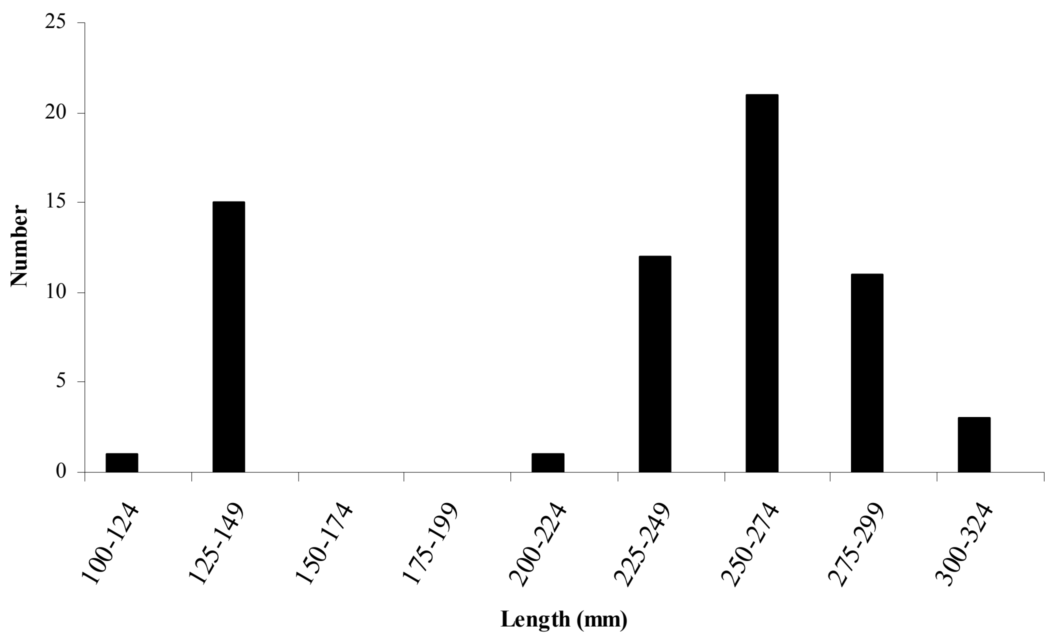

Figure 15. Length frequency of yellow perch collected at Lake Musconetcong in 2009.

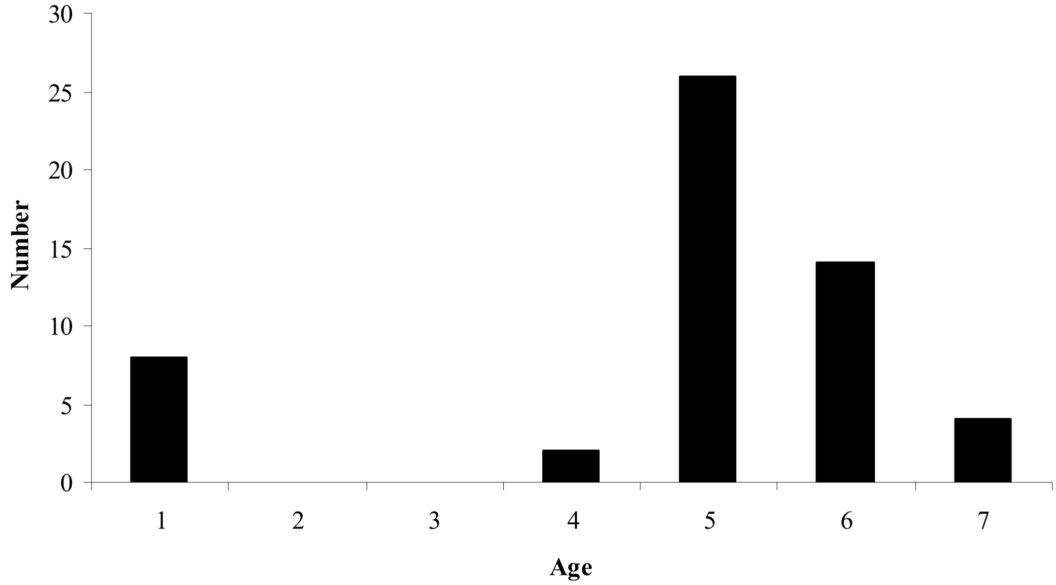

Figure 16. Age frequency of yellow perch collected in Musconetcong Lake in 2009.

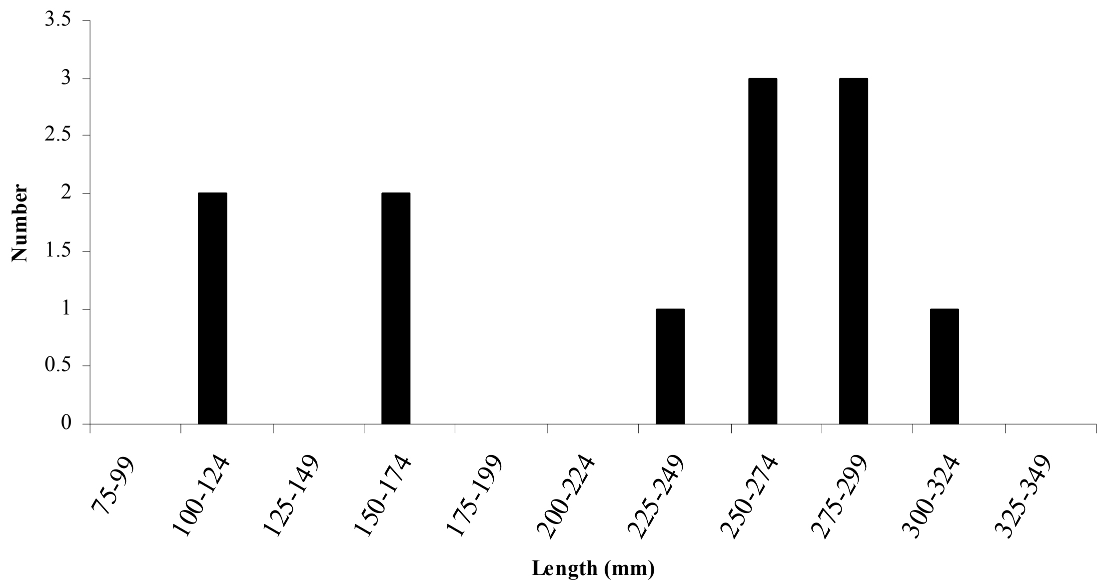

Figure 17. Length frequency of black crappie collected at Lake Musconetcong in 2009.

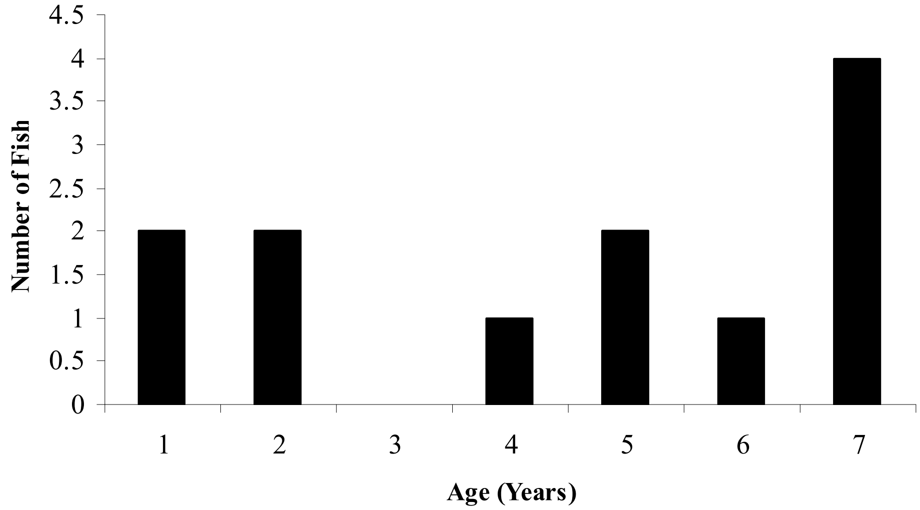

Figure 18. Age frequency of black crappie collected in Musconetcong Lake in 2009.

APPENDIX A

List of fish species stocked in Lake Musconetcong (1986 – 2009)

Date	Species	Number
1986 - 2009	Brook Trout	16740
1989, 01, 04, 05, 08	Brown Trout	60
1986 - 2009	Rainbow Trout	31155

APPENDIX B

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

	Total length (mm) at annuli						
Species	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

	Total Length	
Species	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 hybrid)	≥ 406	16
Walleye	≥ 457	18