Peppermill Lake Survey

FINAL REPORT

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Executive Summary

Peppermill Lake is a shallow impounded wetland area located in southeast Adams Co., WI. Because the lake was once a wetland, there is a large quantity of phosphorous in the sediment leading to large phosphorous loadings into the lake, which in turn increases the availability of nutrients to aquatic vegetation such as muskgrass. Over the last two decades higher levels of aquatic vegetation and higher abundance of small bluegill have become of increasing concern for landowners around Peppermill Lake. The Wisconsin Cooperative Fishery Research Unit was asked to evaluate the current status of the fish community and provide information on potential management options for the lake. Similar to previous surveys by the Wisconsin Department of Natural Resources, we found bluegill in high abundance and top predators such as largemouth bass and northern pike in much lower abundance. Other species collected in the survey include: yellow perch, pumpkinseed, rock bass, black crappie, green sunfish, and minnows. The size structure of the bluegill in Peppermill Lake is poor which may result from high densities and slow growth. In addition, predator densities are too low to effectively decrease the bluegill population, although the condition (i.e., size and weight) of the existing top predators in Peppermill Lake is marginal to good. High macrophyte abundance, resulting from high phosphorous loadings may further hinder predation and bluegill growth. The results of our study indicate that in several years, with a sound management plan in place, there is the potential to improve black crappie, yellow perch, northern pike, and largemouth bass fisheries. Potential management options include: a growth study of the bluegill population to determine if stunting or angler harvest is responsible for the current size structure of the population, mechanical harvest of aquatic vegetation, continued

stocking of northern pike and largemouth bass, or possible regulation changes. If a long-term management plan is not implemented for Peppermill Lake, nutrients from the lake bed and surrounding homes will continue to strongly influence the aquatic vegetation and thus the structure of the fish community.

Introduction

The Wisconsin Cooperative Fishery Research Unit was asked to conduct a fish survey and summarize the findings relative to the status of the fish community in Peppermill Lake, located in Adams Co., WI. This report is part of a series of studies conducted in conjunction with the Environmental Task Force Lab at UWSP, which, in addition to assessing fish community structure, is assessing water quality and the structure of the aquatic plant community. Peppermill Lake is a shallow, spring-fed impoundment. The lake was enlarged and impounded in 1967 through dredging and the placement of a dam on Peppermill Creek thus flooding the adjacent wetlands. The Adams County Land Conservation Department now owns and maintains the dam (Ironside 1999).

Landowners have expressed concern about the habitat and fishery in the lake. The lake historically has had problems with low dissolved oxygen levels in winter and high abundance of aquatic vegetation (Ironside 1999). Previous lake surveys by the Wisconsin Department of Natural Resources (WDNR) from 1970-1999 have indicated that abundance of bluegill has been increasing as aquatic vegetation has increased. Previous attempts at lake improvement have met varying degrees of success. Some of the lake improvement projects have included: placement of pea gravel spawning beds, aquatic plant control, fish crib projects, fish feeding, aeration of the lake, stocking of largemouth bass and northern pike, among others (Ironside 1999).

The objective of this portion of the study was to conduct a fisheries survey in Peppermill Lake, to assess the size structure, relative abundance, and status of the fish community. This information will be used to evaluate the quality of the fish community,

as well as provide baseline information for making fishery recommendations for proper management of Peppermill Lake.

Methods

Personnel from the Wisconsin Cooperative Fishery Research Unit conducted fish surveys of Peppermill Lake on the evenings of October 9 and 10, 2001 using an A.C. electrofishing boat. Electrofishing was the only sampling gear used because Peppermill Lake is a shallow impoundment, and this gear is effective at obtaining a sufficient sample of the fish community. Approximately 90% of the entire shoreline was surveyed by electrofishing, which totaled 3.1 hours of shocking time. Sampling depths averaged from 1.5-4.0 ft following the contour of the shoreline. During the first hour of the survey, all species including minnows (Cyprinids) were collected. Weight and total length were taken on each fish throughout the entire survey, with the exception of minnows. Total lengths and aggregate weights of minnows were taken only during the first hour. For the remaining portion of the survey all species except minnows were collected.

Data analyses consisted of generating length-frequency histograms and weight-length relations for each species, assessing relative abundance, and catch rates, and then calculating relative weights (RW), proportional stock density (PSD) values, and relative stock density values for preferred sized gamefish (RSD-P). Relative weight is the weight of an individual fish in relation to a predetermined standard weight of a healthy growing fish of the same length. The ratio of the weight of a fish to its length will vary by species, size, and ecological conditions and is a measure of a fish's well being. Recommended weight and length at age values can be found in Scott and Crossman (1973). Relative weights of 90-110 are generally found to be acceptable among fisheries professionals.

RSD's and PSD's are a measure the balance of the fish community. A fish population is balanced when it sustains a satisfactory harvest of good-size fish relative to the productivity of the habitat. PSD's and RSD-P's are calculated by the following equation:

$$\text{PSD} = \frac{\text{number of fish} \geq \text{minimum quality length}}{\text{number of fish} \geq \text{minimum stock length}}$$

$$\text{RSD-P} = \frac{\text{number of fish} \geq \text{minimum preferred length}}{\text{number of fish} \geq \text{minimum stock length}}$$

Recommended values for quality, stock, and preferred lengths (Anderson and Neumann 1996) are listed in Table 4, along with the PSD and RSD-P values for each species. Generally, quality-sized fish approximate the size most anglers begin to harvest a species at if regulations allow it. Normally RSD's are calculated for quality (RSD-Q = PSD), preferred (RSD-P), memorable (RSD-M), and trophy (RSD-T) sized fish. However, we did not calculate RSD-M and RSD-T because there were no fish in these size ranges captured in this survey. For instance, a memorable largemouth bass would be 20 inches long.

Results

The majority of the fish collected in the electrofishing surveys were bluegill (50%) and yellow perch (21%) (Figure 1). The catch rates for each of these species were 306/hr and 131/hr respectively (Table 1). Bluegill catch rates were similar to those found during the WDNR survey of the lake in 1999 (342/hr) (Table 2). Yellow perch were not documented in the 1999 WDNR survey, but were captured at a rate of 131/hr in this survey. Northern pike catch rates increased from 12/hr in 1999 to 20/hr in 2001 (Table 2). Catch rates have been increasing for northern pike and bluegill since 1970 (Ironside 1999). Black crappie showed similar trends to that of the northern pike in that the catch

rate increased from 6/hr in 1999 to 32/hr in 2001 (Table 1). Largemouth bass catch rates experienced a small decrease from 37/hr in 1999 to 33/hr in 2001. It must be emphasized that bluegill and yellow perch clearly dominate the fish community of Peppermill Lake.

Overall, the length structure of the fish community for most species was poor (Figure 2). Because of the high abundance of bluegill and the likelihood of stunted growth, it is difficult to detect distinct age classes being present in the lake from the length-frequency histogram. The mean length of bluegill increased less than 1", and pumpkinseed mean lengths remained similar to the survey taken in 1999 (Table 2). The length-frequency histograms suggest that the 2001 year class of yellow perch is strong, with possibly one other year class represented in the samples; specific aging could confirm these findings. Northern pike mean length decreased more than 6" from 1999 to 2001. The length-frequency histogram indicates that at least three year classes of northern pike likely exist in Peppermill Lake, but possibly four year classes. Surprisingly, only one northern pike in our survey was over the minimum length limit of 26" established by the WDNR, indicating possible growth limitations or over harvest. Catch rates for black crappie increased from 1999 to 2001, but mean length of black crappie decreased approximately 4.5" in those years. The length-frequency histogram for black crappie indicates that multiple age classes are present in the lake, with the strongest year class being 2001 young-of-year (Figure 2). Largemouth bass mean length decreased from 10.6" in 1999 to 7.1" (WDNR 2001) and experienced an even greater decrease in size from the 1995 survey (Table 2). Length-frequency histograms indicate that at least 4-year classes of largemouth bass likely exist in the lake, with the 2001 young-of-year being the strongest year class (Figure 2).

Weight-length relations were non-linear for each of the four popular gamefish evaluated (Figure 3). Presenting the data in this form allows one to estimate weight based on length such as, how much a 15" largemouth bass in Peppermill Lake weighs. The weight-length relation for bluegill in Peppermill Lake indicates that overall growth is potentially slow as there are very few bluegill bigger than 4.5" in the lake.

Relative weights (RW) were highly variable within and among species in Peppermill Lake. Northern pike had the lowest mean RW, while yellow perch, black crappie, and bluegill also fell below healthy and desirable ranges (Table 3). To illustrate how variable the relative weight data is, northern pike RW ranged from 43-124, and bluegill RW ranged from 32-117. On the other hand, pumpkinseed, rock bass, and largemouth bass had the highest mean relative weights of the seven species evaluated. Largemouth bass at or above the minimum length limit of 14" had a mean relative weight of 101, again indicating that this population is healthy based on RW results. It must be emphasized again, though, that relative weights, a measure of well being, were extremely variable for all species, except the largemouth bass (RW range 86-117) in Peppermill Lake. The proportional stock density (PSD) (% of fish at or above the minimum quality length in the fishery) value for bluegill (Table 4) was below those recommended for a healthy fishery. The black crappie PSD of 83 was higher than the recommended value of 30-60, and the RSD-P value was >10 as is recommended for a healthy fishery. However, these values for black crappie may be an artifact of small sample size. Largemouth bass PSD and RSD-P values fell within the recommended ranges, as did the northern pike PSD value.

Discussion

Being a relatively shallow, clear impoundment with high nutrient inputs and internal nutrient cycling, Peppermill Lake will continue to be a water resource at risk. Small impoundments on rivers can be difficult systems to manage as lakes, because rivers are sources of nutrients and sediment. Because Peppermill Lake is an impounded wetland with potentially large nutrient sources, it is an even greater challenge to manage. The extreme coverage of aquatic vegetation will continue to pose many challenges if a long-term management plan for the fish and aquatic plant communities of Peppermill Lake is not implemented. While previous attempts at controlling the aquatic vegetation have been made, the fish community has not benefited from these measures.

Data from water quality and aquatic vegetation surveys indicate that there is an extreme abundance of muskgrass (*Chara sp.*) in the lake (nearly 100% of the lake is covered predominately by muskgrass), which can be attributed to internal loading of phosphorous from the lake bed (Turyk personal communication) and is due perhaps to the lake being a wetland area prior to impoundment. Water quality evaluations found very little free phosphorous in the water column (Stelzer personal communication) and thus explains why the water column is so clear. Phosphorus is being utilized predominately by the aquatic vegetation in the lake, making it unavailable to phytoplankton (algae), a critical food source for zooplankton, which are the main food source for developing larval fish. Low phytoplankton and zooplankton concentrations may in turn affect the growth and survival of larval fish. The temperature and dissolved oxygen data indicate that from April to October water quality is sufficient to sustain a healthy fishery. However, due to the shallow nature of the lake and the sporadic history

of winterkills throughout the last 30 years, the lake should continue aerated during the winter and closely monitored for fish kills.

Relative to total catch, bluegill are by far the predominant fish in Peppermill Lake. However, while our counts may not have been entirely accurate because the extremely dense aquatic vegetation in the lake, (which makes it harder to capture all fish by electrofishing) we feel that our counts accurately reflect the composition of the fish community of Peppermill Lake. Based on the findings of this study, the quality of bluegill fishing is poor in Peppermill Lake. Most of the bluegill we captured were 3-6" long, an undesirable size to most anglers. When a population of bluegill becomes overcrowded such as it appears is occurring in Peppermill Lake, there will be increased competition for food, which in turn leads to decreased growth. We saw evidence of this phenomenon in the low mean length, RW, and PSD values for this species. Another reasonable explanation of the current size structure of the bluegill population is that these fish are being harvested once they reach a length of 6" or greater. There are very few bluegill above this size, verifying that growth rate analysis would provide unequivocal evidence of stunting in this lake.

If stunting of bluegill is the problem, dense vegetation can make it extremely difficult for large predators to locate and consume prey such as bluegill. This results in larger populations of small bluegill. After evaluating the abundances of top predators (largemouth bass and northern pike) captured in the survey, it is doubtful that there could possibly be enough predation pressure to decrease the number of bluegills present. While both largemouth bass and northern pike have previously been stocked in Peppermill Lake,

the length frequency distribution suggests that once these fish reach the minimum length limits of 14" and 26" respectively, angler harvest occurs immediately.

Another issue to consider in dealing with the large numbers of macrophytes is that the thickness of aquatic vegetation in the lake may lead to poor survival and increasingly poorer spawning habitat for both largemouth bass and northern pike. Use of muskgrass, the main macrophyte in the lake, for spawning by these species is unclear. Northern pike more typically will spawn on muskgrass if available, while largemouth bass may make nests in sand-gravel pockets, but are also known to spawn on aquatic vegetation. However, poor spawning can lead to poor recruitment of young-of-year fishes into the lake. The smaller largemouth bass in the lake may have been, and may continue to experience poor survival due to predation by northern pike once they move from the vegetation into the more open waters, as they get older.

The results of this study indicate that the largemouth bass that are persisting in the lake are healthy, but larger bass are not present in high enough abundances neither to have an affect of the bluegill population nor to sustain a reasonable fishery. Large numbers of small largemouth bass were captured during the survey, indicating that with time and proper management, the largemouth bass fishery may improve and recruitment potential is reasonable. Northern pike are unlikely helping balance the size structure of the bluegill population, as larger pike are rare. It seems probable that the larger northern pike are being harvested from the lake once the fish reach the minimum length limit. Relative weight values are low for this species; this is likely again due to the dense vegetation making it more difficult to prey on the bluegill, yellow perch, or young-of-year largemouth bass. PSD values again fall within the acceptable range for this species,

however; caution must be taken in regard to these results because only 30 northern of the 62 we caught were of stock size (greater than or equal to 14”). There are not many large fish of either species but with a sound management plan potential exists for a reasonable fishery.

Black crappie PSD and RSD-P values were within recommended ranges as there is a fair number of quality or preferred size crappie in the lake. However, again these results should be viewed with caution, as there were only 18 out of 100 crappies over quality size in the survey (greater than or equal to 8”). Length-frequency histograms indicate that there is a strong year class (fish 3-3.5”) starting to grow in the lake, suggesting better angler opportunities for black crappie in years to come. However, crappies can be very cyclic, creating inconsistent year classes, and thus should not be relied on to consistently contribute to the fishery each year.

Relative weight results for rock bass and pumpkinseed indicate that even though they are low in abundance, they are in good condition, (i.e., plump). Lower abundances can also lead to better growth through less competition for food. It is likely that with stronger year classes, the condition of these fish may decline if access to food does not increase with increased population size. The lower abundance of rock bass and pumpkinseed relative to bluegill may also be attributable to a suite of factors, two of which are 1) the fish are being harvested upon capture due to their plumpness 2) the dense vegetation in Peppermill Lake is not suitable habitat for these fishes, i.e. poor spawning habitat and poor recruitment. In general, the fishery in Peppermill Lake is poor and will require substantial cooperative effort to improve the conditions in the lake.

Summary

- The fish community of Peppermill Lake is unbalanced; large numbers of small bluegill and low abundance of top predators may be resulting from dense aquatic vegetation and harvest of large predators.
- This report along with previous reports by the WDNR have stated that nutrient loading from the lake bed, along with shoreline development are responsible for aquatic vegetation increases.
- Large amounts of phosphorous are being tied up in aquatic vegetation, which may be influencing food availability, and thus survival of young fishes. This may also be affecting predator-prey dynamics of bluegill: largemouth bass-northern pike.
- An evaluation of growth rates is needed to determine if the bluegill population is stunted or the bluegill are being harvested once size desirable to anglers is reached. This should be done before any management plans involving the fishery are enacted.
- Mechanical removal of both aquatic vegetation and bluegill (if stunting is the problem) may improve the condition of the Peppermill Lake fish community. Removal of bluegill can be done by outside contractors, or by fishing tournaments sponsored by the lake associations. It is possible that through proper training, the landowners can remove the vegetation without the use of outside contractors. Continued stocking of largemouth bass and northern pike along with mechanical aquatic vegetation removal may help reduce the bluegill population and increase the growth of the remaining bluegill.

- Prohibiting harvest of largemouth bass and northern pike for at least 5 years may also help decrease bluegill abundance by increasing predators and thus predation rates.
- It is also possible that more restrictive size limits may need to be employed in order to increase the abundance of large predators in the system.
- An effective management plan should contain detailed information of how management actions will correct the problems of this lake including: setting goals, objectives, timelines, and specific protocols. All landowners need to recognize and accept a comprehensive management plant. This type of plan will be in the best interest of the fishery.
- Development and implementation of a comprehensive management plan should be done with the assistance of county and/or state personnel with expertise in the fields of limnology, fish management, and aquatic vegetation dynamics.

Acknowledgments

We would like to thank Aaron Frey, Kerilynn Carden, Brian Achuff, and Peter Brown for their help in the field and Scot Ironside of the WDNR for his input on the present and past status of the Peppermill Lake fish community.

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Table 1.-- Mean lengths (inches) and catch per hour October 9-10, 2001, Peppermill Lake, Adams Co. Total catch represents 3.1 hours of effort

Species	Mean Lengths	Catch Per Hour	Total Catch
Black Crappie	4.1	31	95
Bluegill	4.4	306	950
Brown Bullhead	9.5	2	5
Green Sunfish	3.2	14	45
Largemouth Bass	7.1	33	101
Northern Pike	14.1	20	63
Pumpkinseed	4.7	13	39
Rock Bass	5.1	14	44
Yellow Perch	3.1	131	405
Total		564	1747

Table 2.-- Historical catch rates, size ranges, and mean lengths for bluegill, largemouth bass, and northern pike captured in Peppermill Lake. Data from 1970-1999 were collected by the WDNR, while Wisconsin Cooperative Fishery Research Unit personnel collected 2001 data.

	1970	1983	1989	1995	1999	2001
Bluegill						
Catch Per Hour	20	47	51	64	342	306
Size Range (in)	6.0-6.4	3.5-6.3	3.2-7.8	3.0-8.9	3.0-7.6	1.2-7.0
Mean Length	5.3	4.9	5.3	5.2	3.9	4.4
Largemouth Bass						
Catch Per Hour	22	12	38	28	37	33
Size Range (in)	1.0-16.4	9.5-17.4	3.0-17.9	7.5-20.0	7.5-20.0	2.0-19.2
Mean Length	3.5	12.6	9.7	13.6	10.6	7.1
Northern Pike						
Catch Per Hour	6	3	none captured	15	12	20
Size Range (in)	8.5-19.4	17.5-32.4		9.5-25.0	7.5-25.0	3.2-26.3
Mean Length	11.2	21.7		17.9	20.6	14.1

Table 3.—Mean relative weights and ranges for gamefish collected on Peppermill Lake, Adams Co. Values of 100 indicate the average weight this species attains at a given length. Values below 100 indicate fish with lower than desirable weight; values over 100 indicate fish with higher than average weight for a given length.

SPECIES	N	Mean RW	Range
Black Crappie	19	88	64-100
Bluegill	352	88	32-117
Largemouth Bass	37	99	86-117
Northern Pike	61	80	43-124
Pumpkinseed	39	102	77-128
Rock Bass	30	109	62-132
Yellow Perch	53	84	65-103

Table 4.-- Minimum lengths for stock, quality, and preferred size classes used to calculate PSD and RSD-P along with actual PSD and RSD-P values for gamefish from Peppermill Lake, Adams Co. RSD-Q values are the same as PSD values. (--) indicate there are no published values for that species. Recommended values are from Anderson and Neumann (1996).

	Minimum Lengths			Actual		Recommended
Species	Stock	Quality	Preferred	PSD	RSD-P	PSD Values
Black Crappie	5	8	10	83	28	30-60
Bluegill	3	6	--	5	--	20-60
Green Sunfish	3	6	--	5	--	--
Largemouth Bass	8	12	15	82	59	40-70
Northern Pike	14	21	--	40	--	30-60
Pumpkinseed	3	6	--	8	--	--
Rock Bass	4	7	--	33	--	--

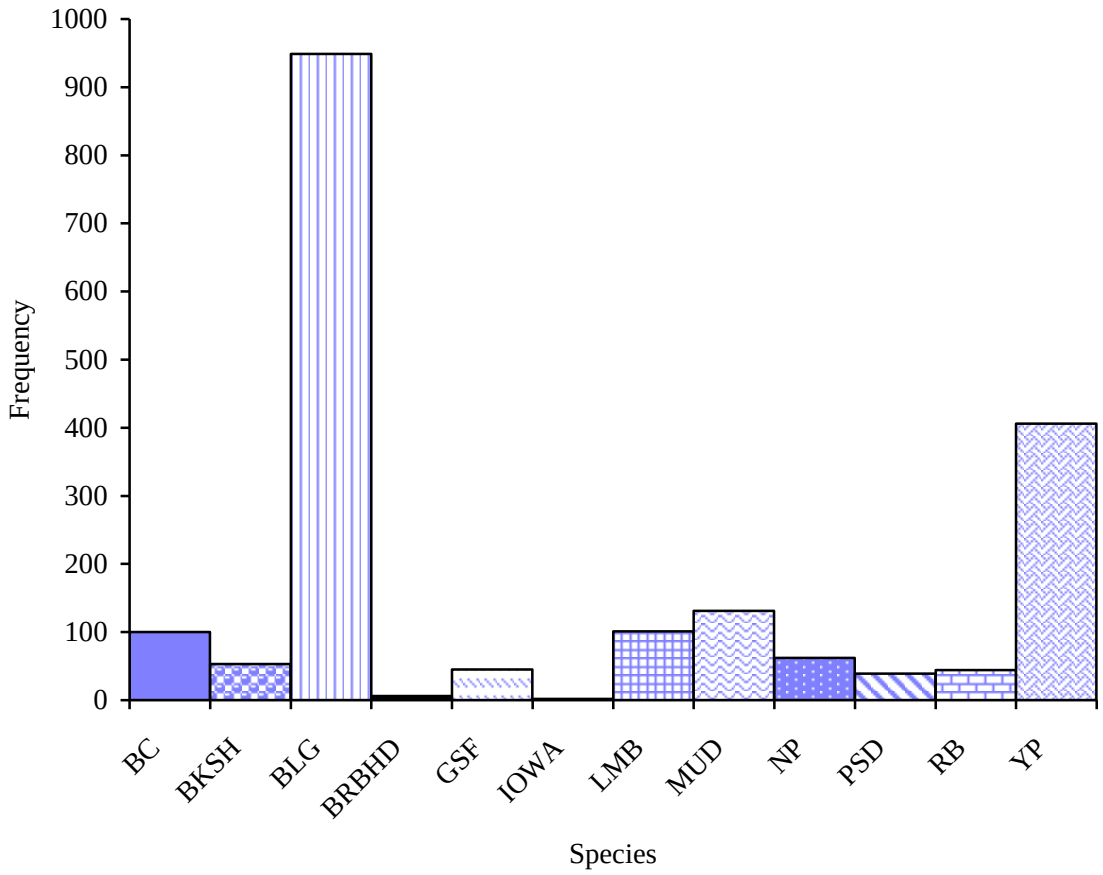


Figure 1.--Frequency distribuation for fish species collected in Peppermill Lake, Adams Co., October 9-10, 2001. BC = black crappie, BKSH = blackchin shiner, BLG = bluegill, BRBHD = brown bullhead, GSF = green sunfish, IOWA = Iowa darter, LMB = central mudminnow, NP = northern pike, PSD = pumpkinseed, RB = rock bass, YP = yellow perch. Mimic shiners (n = 1) and hybrid sunfish (n = 3) are not listed as only 1 to 3 specimens were collected of each species.

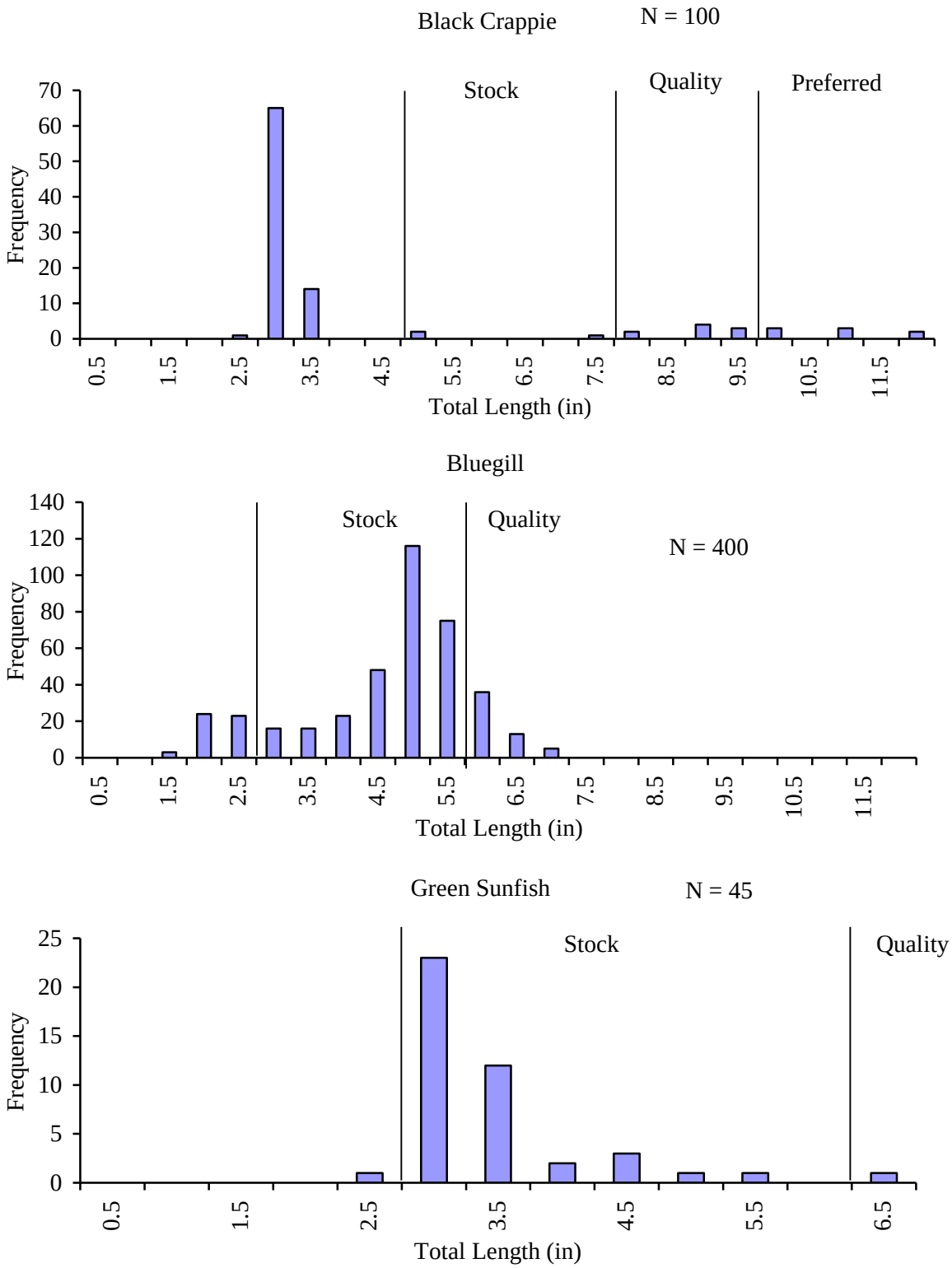


Figure 2. -- Length frequency data for fish from Peppermill Lake, Adams Co., October 9-10, 2001. Lines indicate fish used to calculate PSD and RSD values.

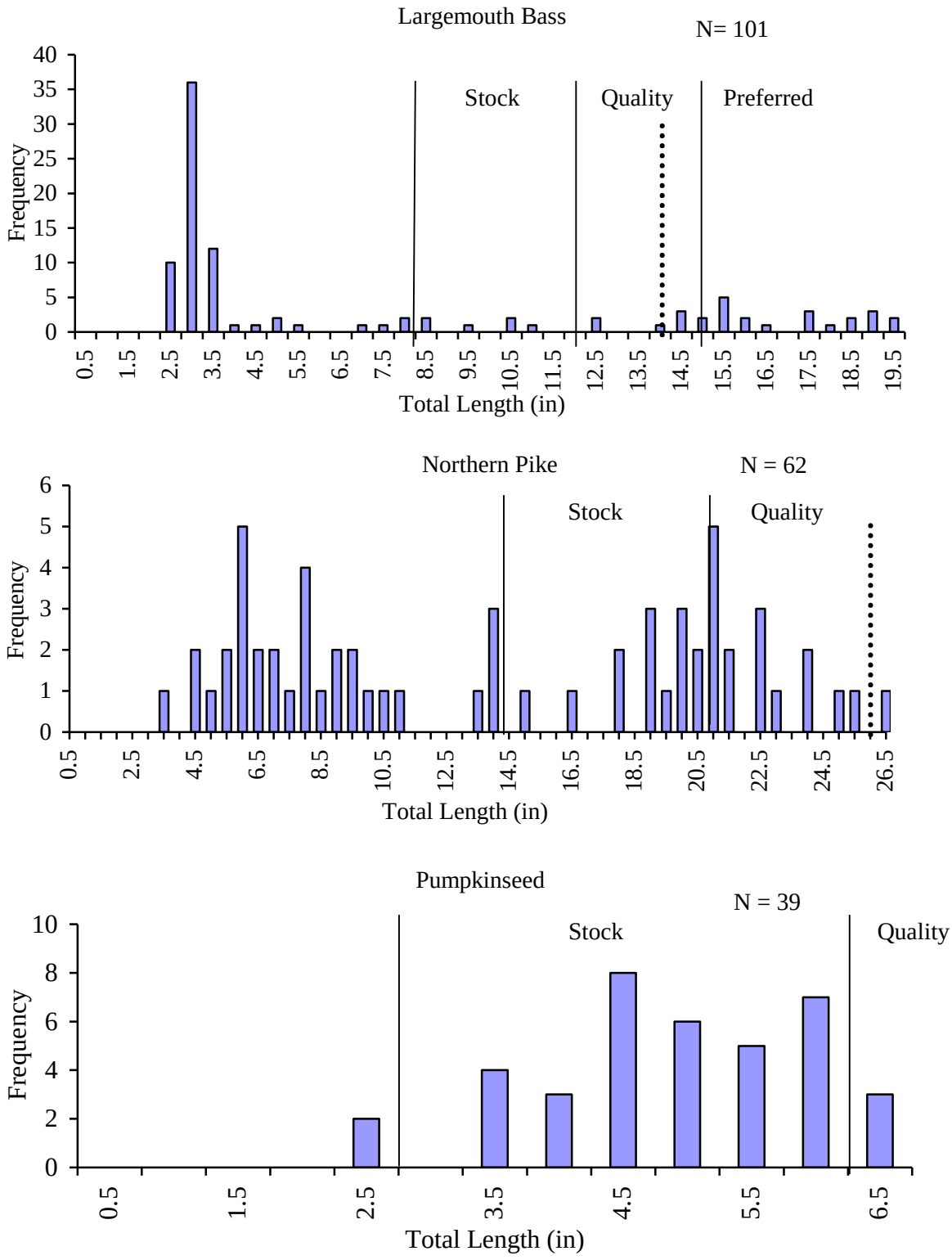
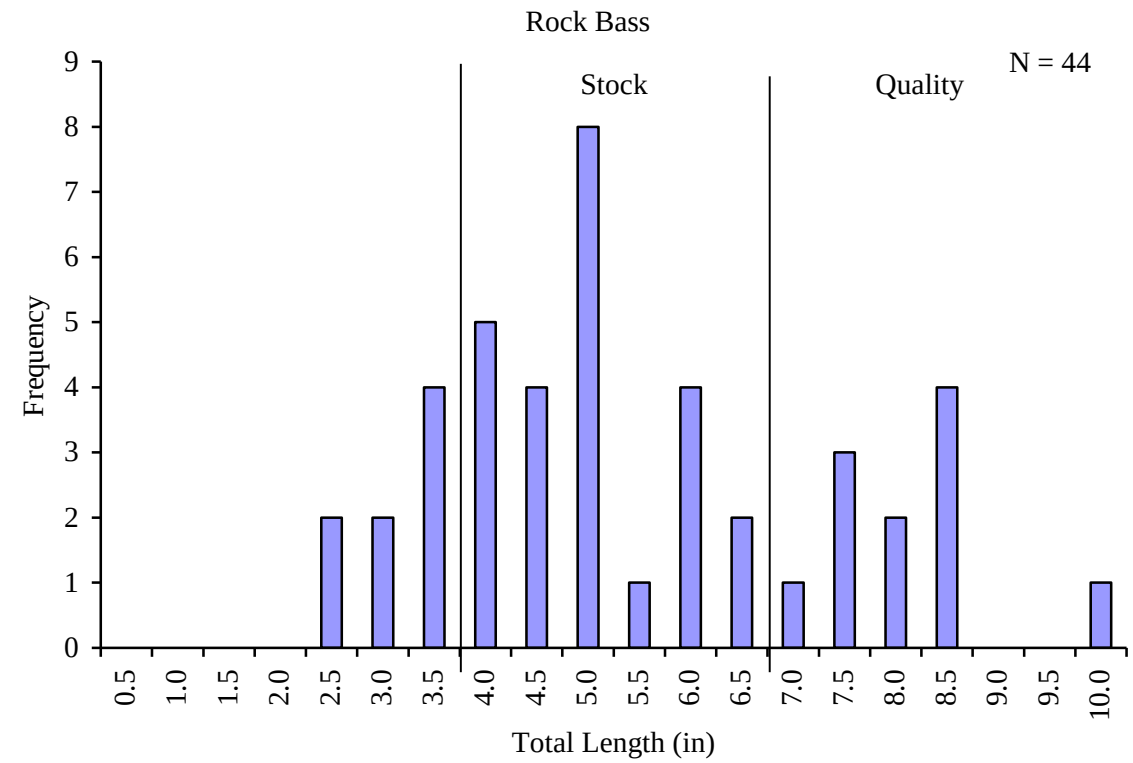
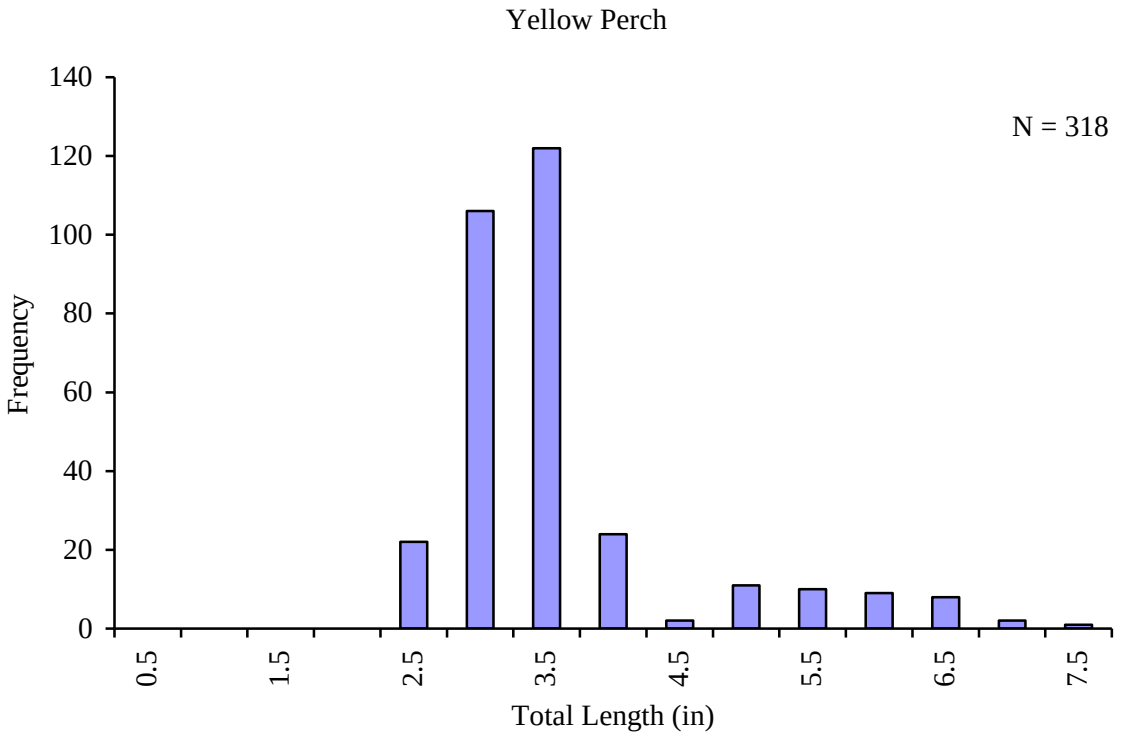


Figure 2.--Continued. Dashed lines indicate minimum length limits set by the WDNR.





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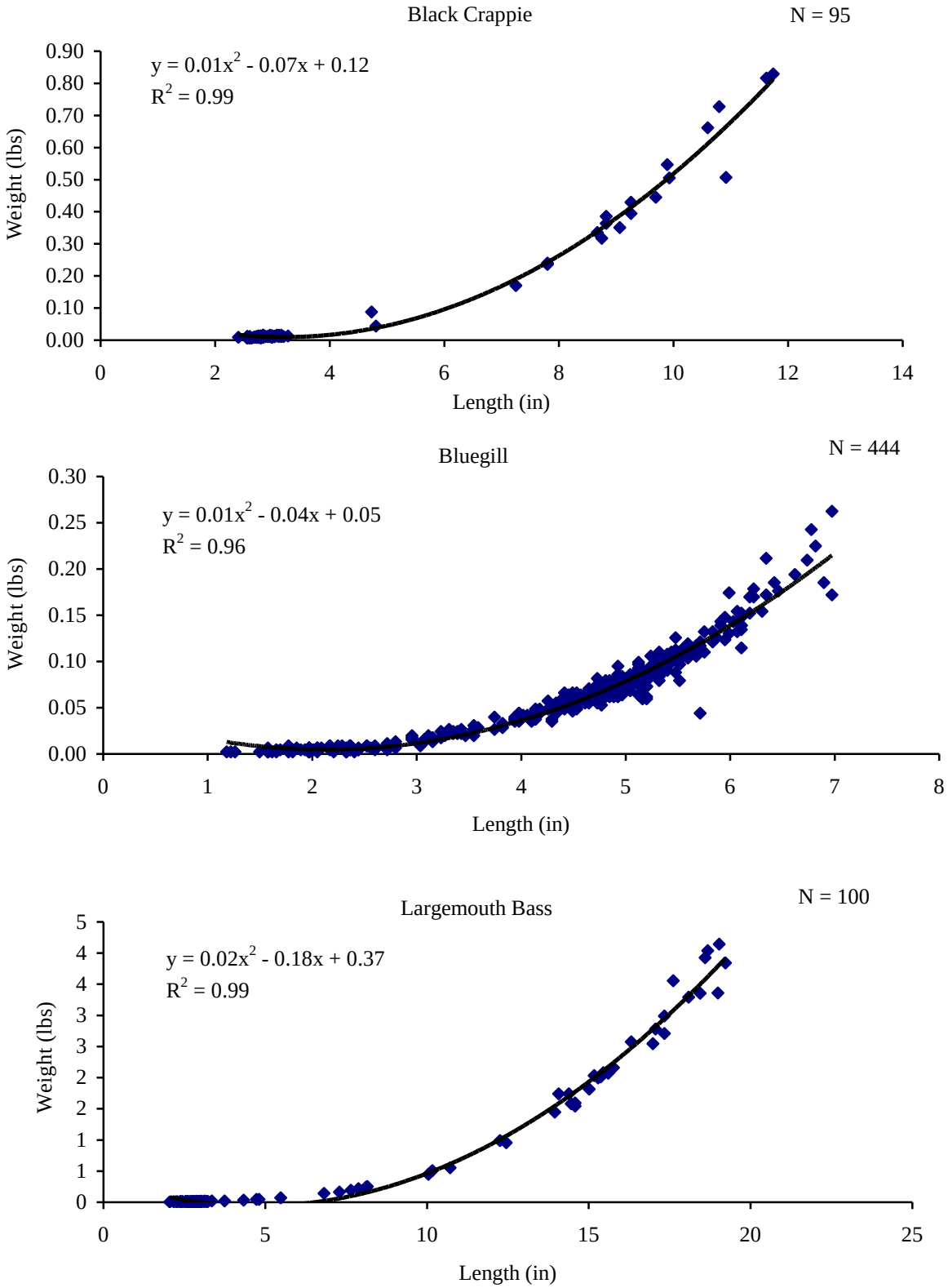

Figure 3. Weight-length relations for gamefish collected from Peppermill Lake, Adams Co., October 9-10, 2001.

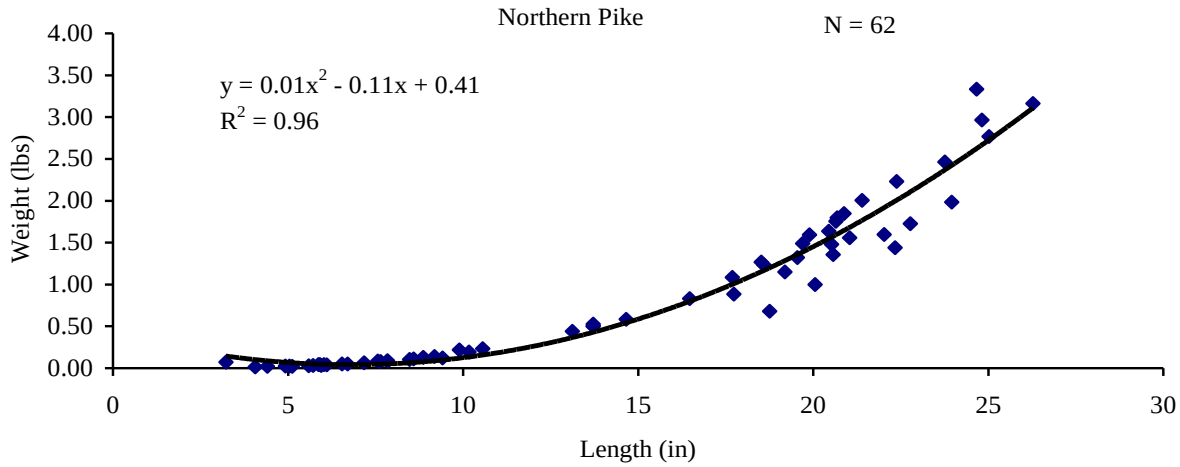

Figure 3.-- Continued