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Pond
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Management

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Aquatic
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•
Fish
Population
Surveys

•
Electrofishing
Surveys

•
Fish for
Lake
Stocking

•
Pond
and Lake
Aeration
Systems

•
Waterfowl
Habitat
Management

•
Stream
Surveys

•
Fish
Elimination

•
Water
Quality
Management

2018

Fish Population Survey

Arrowhead Lake

INTRODUCTION

On September 11, 2018 a fish population survey was conducted on Arrowhead Lake by Aquatic Environment Consultants, Inc. The purpose of this survey was to collect data on the fish population, identify problems with the lake and update a management plan for the lake. Data that related to water quality, fish habitat and the fish population was collected.

MANAGEMENT GOAL

Arrowhead Lake has an established fish population that has reached its' carrying capacity. It is a shallow lake relative to its size and contains some areas that are difficult to access. The goal is to manage the fish population in such a way as to maintain a healthy, balanced fishery that provides an enjoyable angling experience. Special emphasis will be made on managing the predator population that consists of largemouth bass, chain pickerel and black crappie. Each species will be evaluated regarding its growth rate, size and reproductive potential.

FISH POPULATION MANAGEMENT

Freshwater lakes have fish populations that are composed of fish that fall into one of two categories. They are classified as either a predator or forage fish. The predator fish feed on the forage fish. In a "balanced" population, predator fish will prevent the forage fish from overpopulating. Also, there are about three to four pounds of forage fish for every pound of predator fish in a "balanced" population. In some fish populations, the predator fish are removed much faster than the forage fish and the population quickly shifts to one that is "out of balance". Certain predator species work better with certain forage species. In general, a forage fish works well with a predator that shares the same habitat. The spawning period for the forage fish should be shortly after the spawning period for the predator. The reason this delay is important is that the young of the year predators will have a supply of newly hatched forage fish that are small enough for the newly hatched predators to eat. If the forage fish hatch before the predator, the forage is too large for the predator fish to eat when they hatch. A good example of this relationship is that of the largemouth bass and bluegill. Bluegills spawn after the largemouth bass, share the same habitat and provide good forage for the young of the year largemouth bass.

The first goal in the management of the fish population in any water body is to match the proper predator fish with the proper forage fish. Once this is accomplished, the object is to manage the forage fish population to produce large numbers of young fish on which the predators can feed. The predator fish must also be maintained in large enough numbers to prevent the forage fish from overpopulating. As the forage fish overpopulate, they stunt out, their reproduction decreases and the fish population of the entire water body deteriorates. The opposite can also be the case where the predator fish numbers are too high for the available forage base causing overcrowding of the predator fish resulting in stunted growth and poor weights.

FISH POPULATION SURVEY METHODS

Fish populations were sampled using an electrofishing boat equipped with a 4000 watt VVP electrofishing unit. The electrofishing boat was used to sample the lake for the various species of fish. Electrofishing took place along the shoreline and was used to sample around the structure found in the lake.

FISHES PRESENT

| Common Name | Scientific Name |
|-----------------|--------------------------------|
| Largemouth Bass | <i>Micropterus salmoides</i> |
| Chain Pickerel | <i>Esox niger</i> |
| Smallmouth Bass | <i>Micropterus dolomieu</i> |
| Walleye | <i>Stizostedion vitreum</i> |
| Bluegill | <i>Lepomis macrochirus</i> |
| Pumpkinseed | <i>Lepomis gibbosus</i> |
| Yellow Perch | <i>Perca flavescens</i> |
| Black Crappie | <i>Pomoxis nigromaculatus</i> |
| Brown Bullhead | <i>Ictalurus nebulosus</i> |
| Golden Shiner | <i>Notemigonus crysoleucas</i> |
| White Sucker | <i>Catostomus commersoni</i> |
| Carp | <i>Cyprinus carpio</i> |

Largemouth Bass

The largemouth bass is one of the main predator in the fish population. The majority of this fish's diet is composed of smaller forage fish in the lake. It feeds well on small sunfish and golden shiners. The largemouth thrives best in shallow, weedy lakes or in river backwaters. Largemouth bass prefer weedy habitats not only because their food supply is available in those areas, but also because aquatic plants and sunken debris furnish protection. The largemouth bass population in Arrowhead Lake is composed of various sized fish. Largemouth bass were sampled in a variety of inch classes up to 18 inches. Fish over 11 inches were found in less than desirable numbers. Reproduction from 2018 was good. These young bass were 4 to 6 inches in length and appeared to be growing at a good rate.

Chain Pickerel

Chain Pickerel are usually found where larger species of pike are either rare or absent. Chain Pickerel grow rather quickly and can reach 14 inches in 3 years. It takes about 6 years to attain a length of 20 inches and if it survives to the probable maximum of 10 years, it should be 36 inches long and weigh approximately 9 pounds. Chain pickerel sampled during the survey were a variety of sizes. Older fish (over 1 year old) ranged in size from 9 to 19 inches. The 2018 reproduction sampled during the survey was fair. These small fish ranged in size from 4 to 6 inches and

were observed throughout the lake. Their growth rate for the summer of 2018 was normal for northeastern Pennsylvania. Lower than desirable numbers of chain pickerel were sampled during the survey. The chain pickerel are good predators and should remain in the lake.

Smallmouth Bass

The smallmouth bass is usually found in rocky locations in lakes and streams. They prefer clear, rocky lakes with a minimum depth of 25 to 30 feet and temperatures in the summer no less than 60°F and no more than 80°F. In streams, this bass prefers a good percentage of riffles flowing over gravel, boulders or bedrock. Smallmouth bass prefer a slightly different food supply than largemouth bass. The first food for smallmouth consists of minute crustaceans and later it graduates into insect larvae, crayfish and fish. More smallmouth bass were found during the survey than what was observed in 2015. Numerous smaller smallmouth bass were collected during the survey. They appear to be healthy and growing at a good rate.

Walleye

The walleye is the largest member of the perch family and can reach weights of over 20 pounds. It prefers lakes with clear or unmuddied water and an adequate supply of food in the form of forage fish. Walleye were stocked in Arrowhead Lake in past years. Walleye are a very good predator for the yellow perch. The fish were approximately 5 to 8 inches when they were stocked. The stocked fish are growing well and are healthy. Several walleyes over 20 inches were sampled during the survey. Walleye have shown good success at surviving in Arrowhead Lake and need to be stocked on a regular basis.

Bluegill

The bluegill is a species of sunfish that prefers quiet, weedy waters where they can hide and feed. In the daytime the smaller fish are close to shore in coves and under docks. The larger bluegills prefer the adjacent deeper waters in the daytime but move into shallow areas in the morning and evening to feed. Bluegills also work well in a predator-prey relationship with largemouth bass. Bluegills also spawn after the bass, which gives the young of the year bass a good supply of food for growth their first year. Bluegills tend to spawn more often during the summer than pumpkinseeds, resulting in a larger food supply for the young bass. The bluegill population is in good balance with the predator fish population. Bluegills are spawning very well and the adult bluegills are large and healthy. Many one to four-inch bluegills were sampled during the survey.

Pumpkinseed

The pumpkinseed is a species of sunfish that inhabits standing water with soft bottoms covered with sunken plant material. It prefers weed patches, docks and logs

for cover, and is most often found in these locations. These sunfish are a species that work well in a predator-prey relationship with the largemouth bass. Pumpkinseeds spawn after the bass, which gives the young of the year bass a good supply of food for growth that first year. The pumpkinseed population appears to be very healthy with a good growth rate. The pumpkinseed population is comparable in size to that of the bluegill. Pumpkinseeds are reproducing at a desirable rate.

Yellow Perch

This is the most widely distributed member of the perch family. The perch is at home in small and large lakes alike and though found in rivers, it is considered primarily a lake fish. Lakes with cool, clean, water and ample amounts of sandy or rocky bottom make better perch lakes. The yellow perch works well as a forage fish with chain pickerel and walleye. They do not work as well with largemouth bass since they prefer a slightly different habitat. Yellow perch in a variety of sizes were sampled during the survey. Large numbers of yellow perch were sampled in the 4 to 6-inch ranges and are overcrowded.

Black Crappie

The black crappie is another predator species found in Arrowhead Lake. The black crappie is a popular freshwater panfish found throughout the United States. The black crappie likes quiet waters and prefers more vegetated areas than the white crappie. The black crappie is strictly carnivorous, feeding on small fishes, aquatic insects and crustaceans. Large numbers of black crappie are present in the lake. In fact, the crappie population is present in such high numbers that it is competing with the largemouth bass population. Most adult crappies in the sample were 10 to 14 inches in size. Black crappie are reproducing well based on the numbers of 2 to 4 inch fish observed during the survey.

Brown Bullhead

Brown bullheads are a medium size slender-bodied catfish. Bullheads are an omnivorous feeder and will feed on anything from plant material to fish. Being a bottom feeder, however, a major portion of its diet is composed of insect larvae and mollusks. All bullheads sampled during the survey were 10 to 13 inches in size. The population appears healthy and not a real concern in the management of the lake.

Golden Shiner

The golden shiner is a fish found in relatively clear, weedy lakes and quiet streams. Although schools may be found in openwaters, they are not often far from weed beds. Golden shiners are a desirable forage fish for largemouth bass. Bass can eat a large shiner, which aids in a faster growth rate. Large adult golden shiners ranged in size from 5 to 8 inches. They are reproducing well as large amounts of young 2 to 3-

inch golden shiners were sampled during the survey. Golden shiners in these size ranges are ideal forage for the predator fish in the lake.

White Sucker

The white sucker is quite tolerant of a great variety of conditions. It prefers large streams and the deeper water of impoundments. White suckers feed on a variety of foods, including aquatic insect larvae, crustaceans, mollusks and algae. Numerous white suckers were sampled during the survey.

Common Carp

Common carp were sampled during the survey. They are commonly found in lakes in the Pocono region. No recommendations are being made for the management of this species as they are not having a significant impact on the fishery.

FISH MANAGEMENT ARROWHEAD LAKE

Results of the fish population survey indicate that the fish population in Arrowhead Lake is what would be classified as balanced but leaning towards having too few predators. The predator fish (largemouth bass, smallmouth bass, walleye and black crappie) population is in relatively good balance with the sunfish (bluegill and pumpkinseed) population. While there is a desirable number of predator fish in the lake, it is composed of a higher number of black crappie than largemouth bass. This is not necessarily a bad thing it just means that there are less bass to be caught. Usually largemouth bass will outnumber the black crappie. As figure 1 indicates, largemouth bass are spawning well, but there are less than a desirable number of larger bass present. While there has been some stocking of medium sized largemouth bass, they do not seem to be surviving very well. Most of the largemouth bass stocking has taken place during the summer when fish are more difficult to transport. Largemouth stocked during the summer have a lower survival rate than fish stocked in the spring or fall. The best time to stock bass is in the fall of the year when water temperatures are cooler and fish are less susceptible to stress. They should also be obtained from a supplier that has fingerlings from similar water quality.

The yellow perch is a forage species that works better in a relationship with predators such as chain pickerel and walleye. While largemouth bass will feed on yellow perch, bluegills and pumpkinseeds are a better forage fish for them. Largemouth bass prefer softer non-spiny forage such as small sunfish and golden shiners. While they will eat yellow perch, they are not a preferred forage species due to their rough spiny texture. Results of the survey show that there are very high numbers of 4 to 6-inch yellow perch in Arrowhead Lake. Over population of yellow perch will continue if the proper predator population is not maintained in the lake. While chain pickerel feed on yellow perch, walleye are a better suited predator. Walleye were stocked in the fall of 2013 and 2104 to help manage the yellow perch population. Walleye are members of the perch family and share the same habitat. Several walleye were sampled during the

2018 survey that exceeded 20 inches in length. These fish are most likely from those stockings in 2013 and 2014. The growth rate of the walleye is exceptional and indicates that they can survive well in Arrowhead Lake. Our recommendation is that you continue stocking 1000, 6 to 8-inch walleye in the fall of the year for the next three years.

The smallmouth bass population continues to improve as was indicated by the increase in both their numbers and size. Young of the year smallmouth bass were observed during the survey indicating that there is suitable habitat for them to reproduce. Their population should continue expanding in future years.

In order for Arrowhead Lake to sustain a high-quality fish population, a proper management plan must be followed. The main goal of the management plan is to maintain a desirable number of predator fish in the lake. A desirable number of predators will result in a desirable number of forage fish in the lake. By controlling the number of forage fish, they will not over populate and stunt out; but rather continue to grow and reproduce well. The higher reproduction will result in an increase in the food supply for young of the year predator fish. This process will maintain a healthy predator population.

Largemouth bass should be stocked in the fall of each year. Our recommendation is that you stock 750, 6 to 8-inch largemouth bass on an annual basis. In addition to this, walleye should be stocked each year for the next 3 years. The stocking of 1000, 6 to 8-inch walleye in the fall of the year for the next few years will greatly improve their chances of survival and will lead to a better-balanced yellow perch population. Aquatic Environment Consultants, Inc. can provide these fish from a reliable hatchery. The fish population should also be sampled again in August or September of 2021. By studying the fish population on a regular basis, adjustments can be made to the management recommendations.

WATER QUALITY DATA

Total Alkalinity 9.1 mg/liter

Total alkalinity refers to the total concentration of bases in water expressed as milligrams per liter of equivalent calcium carbonate. Waters with total alkalinity of less than 20 mg/liter usually have little available carbon dioxide to permit growth of plankton which is the main source of food for bluegills and other forage fish in your lake. Since the alkalinity in your lake is less than 20 mg/liter, the growth of plankton may be limited. This limited growth of plankton will cause the pounds per acre of fish to be less than that of lakes with higher total alkalinity.

Total Hardness 25.0 mg/liter

The calcium concentration in water is normally expressed as calcium hardness in terms of equivalent calcium carbonate. Desirable levels for total hardness for fish

production usually fall in the range of 20 to 300 milligrams per liter. Hardness is not as important as alkalinity but should be about the same numeric value. The hardness of your water is within the desirable range of the total alkalinity.

pH 6.0

The desirable range for fish production is pH 6.5 to 9.0. Any pH value found in the range pH 4.0 to 6.5 is in the slow growth range. Very little if any reproduction will occur if the pH is in the range of pH 4.0 to 5.0. The acid death point for fish is around pH 4.0 or less. The pH in a lake will vary during the day based on weather conditions. Usually a lake's pH will be higher on a sunny day in the afternoon than it is in the morning. This variation is a result of the photosynthetic process of phytoplankton and other plants that are present in the lake. The pH of your water falls within the slow growth range and should continue to be checked on an annual basis. The pH result collected during the 2018 survey were lower than what was observed in 2015. This may be due to the heavy rainfall that occurred during the summer of 2018.

WATER QUALITY MANAGEMENT

The water quality parameters that were tested during the survey indicate that your lake has similar levels as other lakes in the region. While the water quality is less than desirable for fish production, but the fishery in Arrowhead Lake has done very well and is above average for the region. Nothing needs to be done to change the water quality as it is dictated by the geology in the region.

CONCLUSION

Arrowhead Lake is a valuable resource that with proper management can produce exceptional recreational opportunities for years to come. The overall condition of the fish population is good; however, there is room for improvement. Management guidelines for the fish population should be followed in order to keep the population in balance. Water quality in the lake is very similar to other lakes located in the same region of the state. Aquatic Environment Consultants, Inc. will continue to work with Arrowhead Lake Community Association on the proper management of Arrowhead Lake.

RECOMMENDATIONS TO FOLLOW

- Stock 750, 6-8 inch Largemouth Bass each fall on an annual basis
- Stock 1000, 6-8 inch walleye in the fall of the year for 3 years.
- No harvest of any Largemouth Bass under 20 inches.
- Survey the fish population in August or September 2021.
- Strictly enforce harvest recommendations.
- Control nutrients that enter the lake.

TABLE 1

Survey Data on Arrowhead Lake taken 9-11-18

| SPECIES | NUMBER SAMPLED | LARGEST FISH | MOST COMMON SIZE |
|-----------------|----------------|--------------|------------------|
| Largemouth Bass | 17 | 18" | 4"-5" |
| Chain Pickerel | 10 | 19" | 17"-18" |
| Smallmouth Bass | 12 | 16" | 6"-7" |
| Walleye | 4 | 22" | 20"-22" |
| Bluegill | 36 | 8" | 1"-2" |
| Pumpkinseed | 39 | 7" | 1"-2" |
| Yellow Perch | 88 | 10" | 4"-5" |
| Black Crappie | 22 | 11" | 10"-11" |
| Brown Bullhead | 2 | 12" | 10"-12" |
| Golden Shiner | 12 | 10" | 4"-6" |
| White Sucker | 100's | 17" | 15"-16" |
| Carp | 2 | 30" | |

Figure 1
2018 Arrowhead Lake
Largemouth Bass Sample

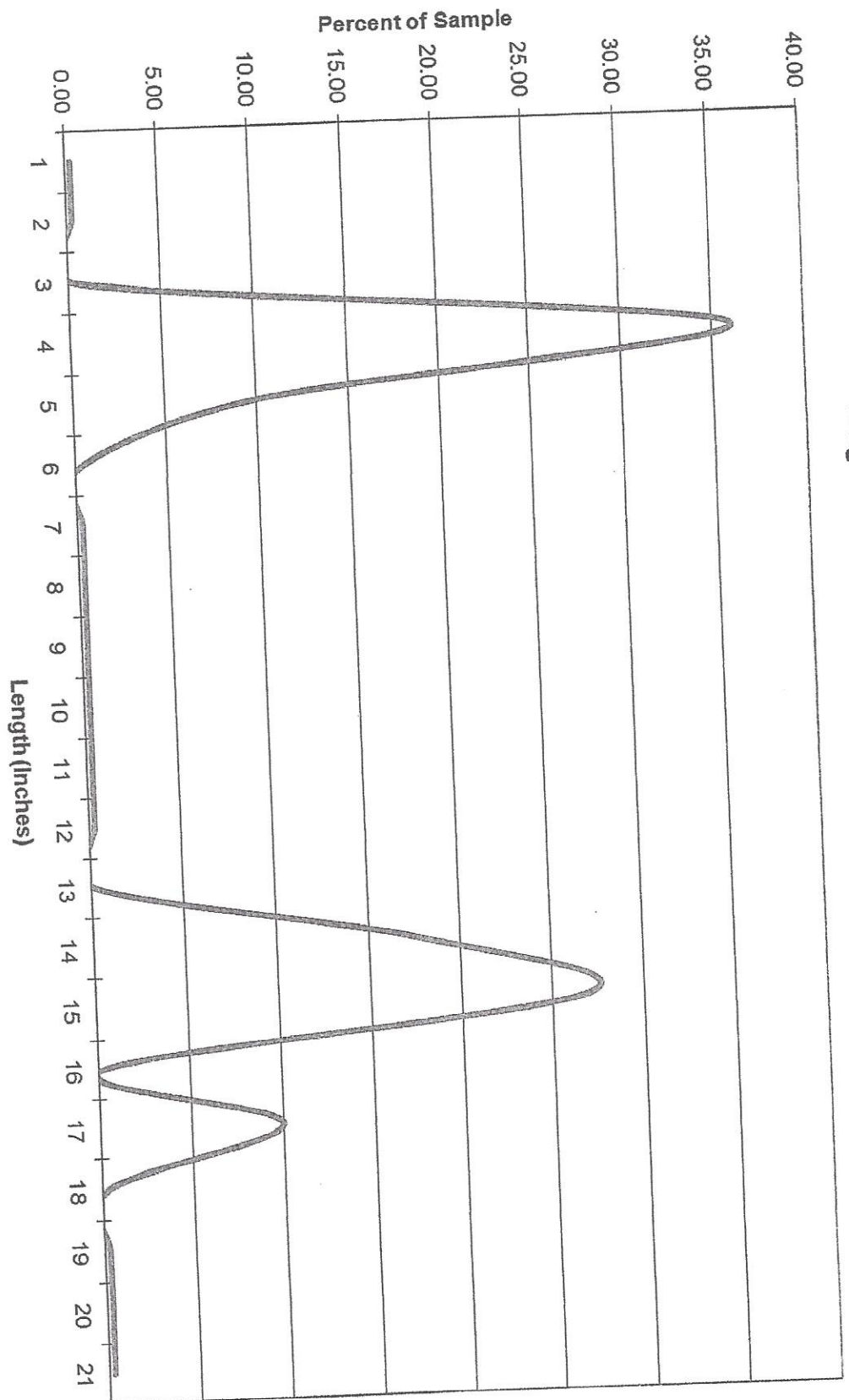


Figure 2

2018 Arrowhead Lake Largemouth Bass Length / Weight Ratio

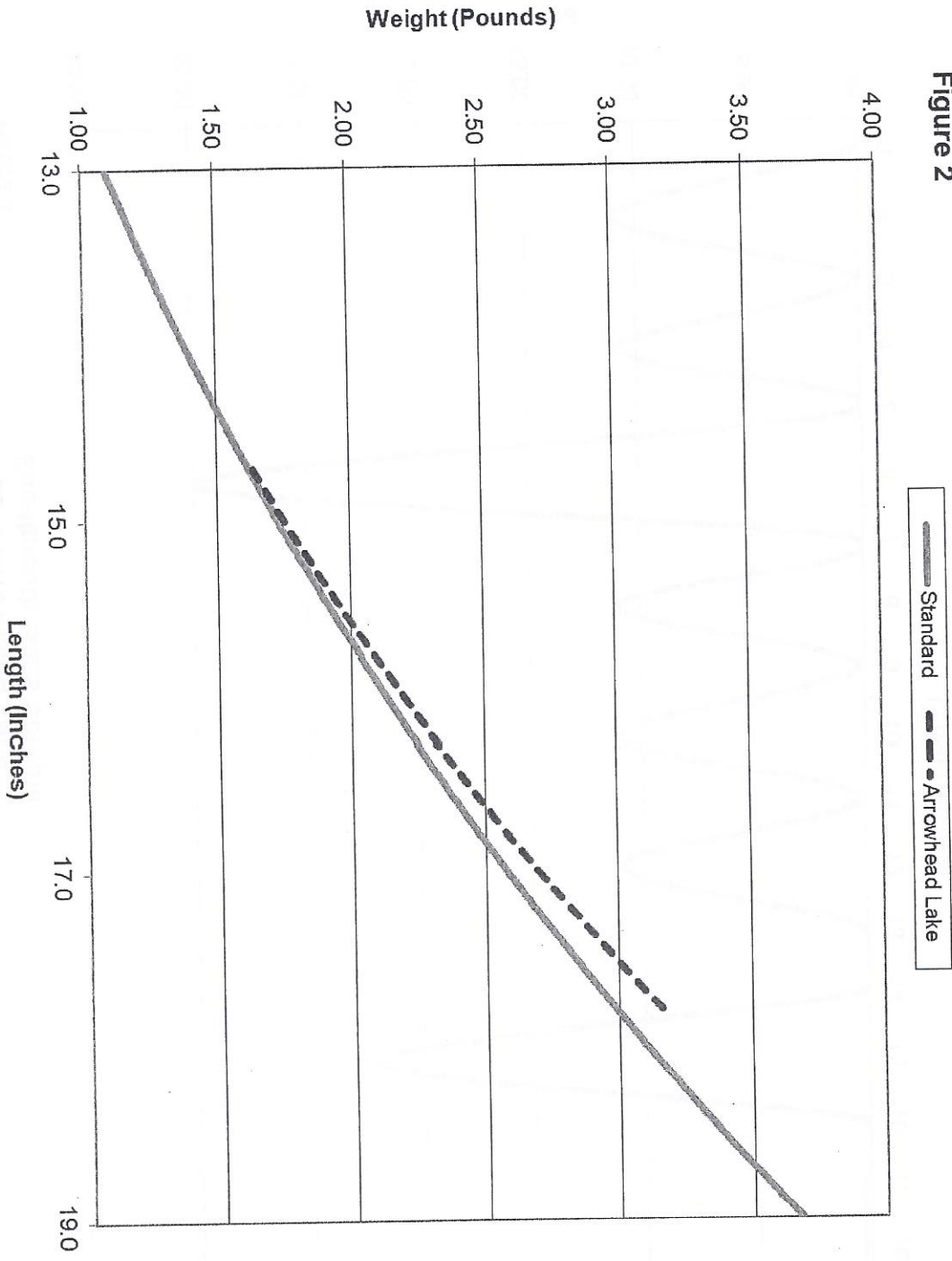


Figure 3
2018 Arrowhead Lake
Smallmouth Bass Sample

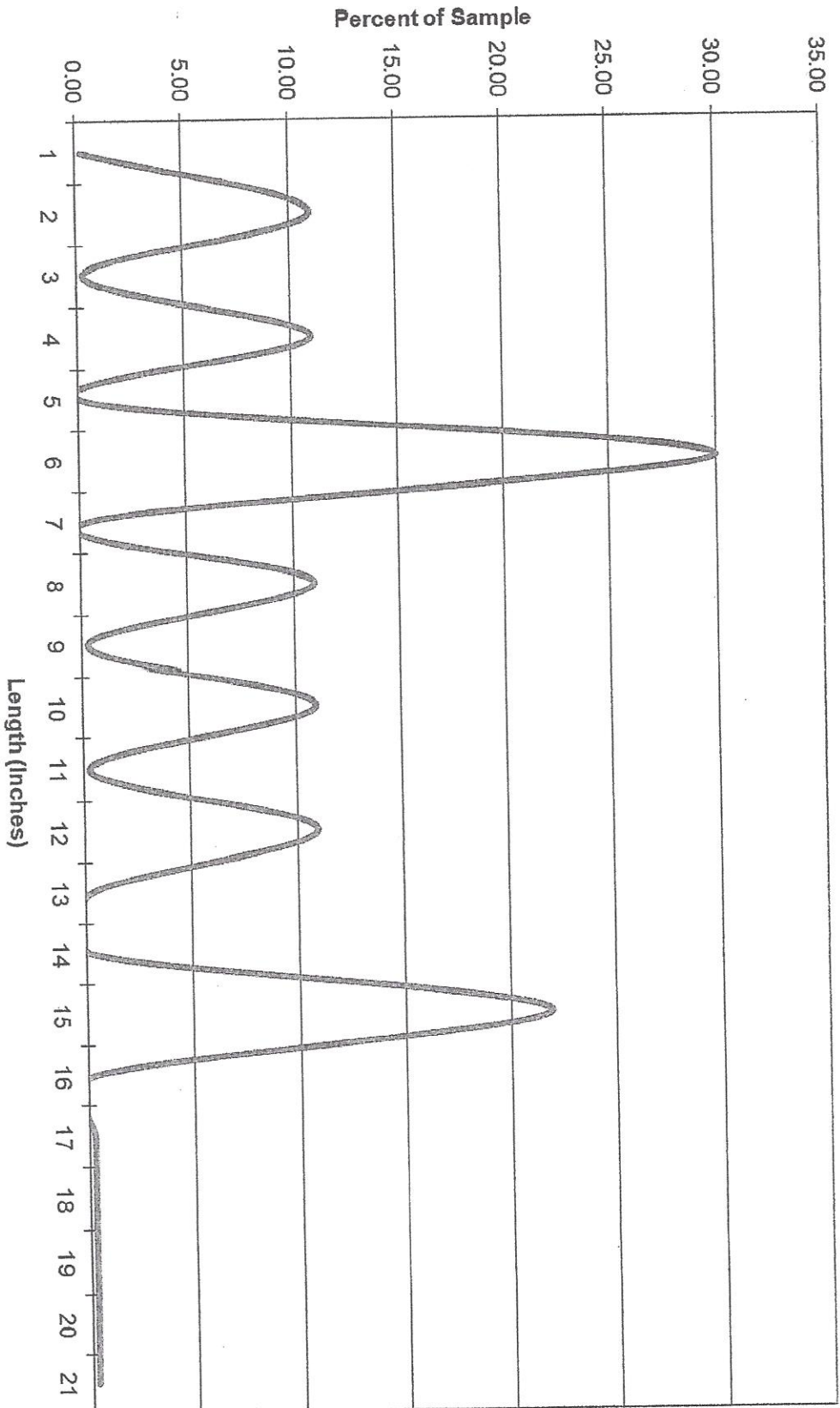


Figure 4

2018 Arrowhead Lake Smallmouth Bass Length / Weight Ratio

