

May 4, 2020

Mr. Billy Hahn  
Cardinal Lake Estates  
PO Box 217  
Duluth, GA 30096

RE: Fisheries Study for Cardinal Lake Estates

Dear Mr. Hahn:

Aquascape Environmental (AE) performed an electrofishing survey on Cardinal Lake and Canary Lake at Cardinal Lake Estates on April 15, 2020. The purpose of this study was to analyze the relative abundance of the existing fisheries populations within the impoundment and compare it to data collected in 2012 - 2019. We have completed our report and are pleased to present it for your review.

#### **Site Overview**

The property is located in western central Gwinnett County, Georgia and contains two impoundments, Cardinal Lake of  $\pm 35$  surface acres and Canary Lake of  $\pm 8$  surface acres (Figure 1). The lakes are bordered by residences and multiple tributaries and runoff drain into both lakes. The original construction of the lakes is unknown. They are present on the earliest historical satellite imagery available from 1993. The lakes have been overseen by AE since 2012.

Each lake was sampled at random stations using boat mounted electrofishing gear in order to determine the current fish population structure and predator-prey balance. A station was composed of a run of five minutes and the time recorded. At each station an attempt was made to collect all fish in the energized area. Cardinal Lake had five stations and Canary Lake had three stations. At the end of each station all the fish collected were sorted into species and then lengths and weights were taken on each individual fish and then the fish were returned to the lake unharmed though on Cardinal Lake Black Crappie were removed.

**Figure 1. Impoundments at Cardinal Lake Estates**



**Table 1. Water Quality Parameters with Comparison Values**

Test Parameter	Cardinal	Canary	Ideal Range	Values for Local Lakes			
				Min	Max	Avg	Median
H2O Temperature (°F)	62	62	< 90	37.4	90.2	69.8	69.9
pH (units)	7.22	7.63	6.5 - 9.0	4.88	9.76	7.27	7.26
Dissolved Oxygen (mg/L)	9.08	9.09	4 - 12	2.23	12.10	8.09	8.40
Alkalinity (ppm)	36	32	> 20	8	45	22	16
Conductivity (µs)	90	81	< 200	5	150	59	51
Hardness (ppm)	28	24	10 - 200	4	100	22	20
Clarity (in.)	36	72	18 - 36	6	72	34	36

Water quality parameters were recorded and are presented in Table 1 along with comparison values for lakes in the Atlanta metro area. The measured values were within the normal range for this time of year. The water appearance was green on both lakes due to a phytoplankton bloom. Both lakes were fertilized as part of the management program on April 2, 2020. The alkalinity and hardness are in an ideal range for fertilizer applications to be successful in stimulating the growth of phytoplankton (base of the food chain). The fertilizer program has been successful on Cardinal Lake for a number of years. Water lilies prevented fertilizer applications for many years on Canary but they were treated with herbicide as part of the lake management program. The last of the lilies were cleared within the last couple of seasons and fertilizer applications were restarted, successfully establishing a bloom.

## Analysis Methods and Terminology

Several methods of measurement are utilized to analyze fish populations. Definitions of these methods are as follows with the results of each one listed in the table under the results section.

**Length** measurements were taken in millimeters (mm) and converted to inches and **weight** measurements were taken in grams and converted to pounds (lbs).

**Stock-size** and **quality-size** are **species specific lengths**. Stock-size indicates the approximate length of a fish at maturity while quality-size indicates the minimum size of a species of fish that most anglers prefer to catch. The stock-size for Largemouth Bass is 8" or greater and the quality-size is 12" or greater. The stock-size for Bluegill is 3" or greater and the quality-size is 6" or greater while the stock-size for Redear Sunfish is 4" or greater and the quality-size is 7" or greater. Other species-specific lengths include prestock, preferred, memorable, and trophy; these fish are listed in the tables but their values do not count into the analysis. *The Bluegill and Redear Sunfish are listed separately in the species-specific lengths table but are combined and collectively referred to as bream for all other analyses as these fish are routinely managed as a single group and coexist well together.*

A **length-frequency histogram** is a visual display that shows groups of data in ranges. The taller the bar in the histogram, the greater the data in the range. This is useful in displaying specific lengths fish that were analyzed and will show any missing year classes.

**Proportional stock density (PSD)** is the percentage of the stock-size fish that are greater than or equal to the quality-size for a specific species collected in a lake. In a balanced population the desirable PSD range for Largemouth Bass is 40-60% while the desirable PSD range for bream is 20-40%. Very low PSD values indicate few large fish in the population while very high PSD values indicate few small fish in the population.

**Relative weight ( $W_r$ )** is an index of body condition. A  $W_r$  of 100% represents a fish that is of the ideal weight for its measured length. Values less than 100% represent fish that are thin and have a lack of food sources while values greater than 100% represent fish that are heavy with more than adequate food sources.

## Cardinal Lake

Various species of fish were collected from the lake including Largemouth Bass (*Micropterus salmoides*), Bluegill (*Lepomis macrochirus*), Redear Sunfish (*Lepomis microlophus*), Black Crappie (*Pomoxis nigromaculatus*) Green Sunfish (*Lepomis cyanellus*), Threadfin Shad (*Dorosoma petenense*), and Common Carp (*Cyprinus carpio*).

Largemouth Bass and Bluegill are the primary predator and prey fish stocked in Southeastern waterbodies. Largemouth Bass generally spawn from late April to June when the water temperature is in a 65-75° F range. The young fish feed on zooplankton, insects, and small fish. Adult bass feed primarily on fish though they will consume anything that fits into their mouth. Largemouth Bass can grow to attain lengths of 25+ inches and weights of 20+ pounds if managed properly. The current world record is 22.25 pounds and also serves as the Georgia state record. The largest bass caught in the sampling was 6.43 pounds. Bluegill start their spawn in the spring when water temperatures reach 70° F and will continue to have multiple spawns throughout the spring and summer. Their repetitive spawning activity makes them an ideal prey pairing for the predator Largemouth Bass. Young fish feed on zooplankton and progress on to larval insects as well as adult insects and worms as they age. The world record is 4.75 pounds while the Georgia state record is 3.3 pounds and the largest Bluegill caught in the sampling was 0.61 pounds. Redear Sunfish are similar in body shape to Bluegill though are slightly more elongated and have a different color pattern; they have a distinct red edge on the ear. Redears are routinely stocked with Bluegill though as a much smaller percentage of the population as Redears have a much shorter spawning season they are limited in their ability to produce forage for the predator species. They are also commonly referred to as shellcrackers for their ability to eat snails and other mollusks, in having this ability they are able to utilize a different forage source than Bluegill which reduces competition among prey species. The world record is 5.78 pounds while the Georgia state record is 4.125 pounds and the largest Redear caught in the sampling was 0.48 pounds.

Multiple competing species were caught in the assessment and these include Green Sunfish (4 fish, 5-8" size range) and Black Crappie (19 fish, 4-13" size range). Competing species are undesirable in a Largemouth Bass/Bluegill population structure as they are direct competitors for food sources. Catfish are another competing species and catfish are typically not collected in a fish assessment as they inhabit areas below the energized field of the equipment. None were in the sample this year though they have been present in past samples.

Green Sunfish are similar in shape to Bluegill but have a more elongated body and typically do not grow as large. Green Sunfish spawn from May through August. Green Sunfish are more aggressive on the food chain than Bluegill and while they compete with Bluegill for food they will also target small Bluegill as food sources.

Black Crappie spawn from April to June though not always consistently throughout that time frame. They compete with Largemouth Bass as their primary forage as adults is other fish. They are a good fish to eat though they are difficult to manage and lakes managed for trophy Largemouth Bass are better off without them.

Fish species noted in the sample though not collected for lengths and weights were the Threadfin Shad (2 of 5 stations), and Common Carp (3 of 5 stations). Threadfin Shad make an excellent forage fish for Largemouth Bass. In situations where Black Crappie are also present the shad help reduce competition between the bass and crappie. The presence of the shad also increases Bluegill survival rates and the population overall by giving the predator species a second source of forage. The diet of shad consists of phytoplankton and zooplankton. Once stocked shad will reproduce and do well in a lake unless winter water temperatures are sustained at temperatures below 40° F then a partial or complete kill may occur. Shad can recover from a partial kill, however a complete kill would require the fish to be restocked. AE stocked shad in the lake in 2016 and a partial kill occurred in the early part of 2018. An attempt was made to stock shad in 2018 but none were available. Shad were successfully stocked in the early spring of 2019 to boost the population of those that survived the 2018 winter kill. Common Carp were noted at several stations. Their origination into the lake is unknown. Somewhat related to Grass Carp, Common Carp were introduced to North America in the 1800's. While they will eat aquatic vegetation, they are not as productive controllers of it as Grass Carp are. They are also not to be confused with Asian Carp which are the fish that leap out of the water at the sound of a boat motor. In the state of Georgia only triploid (sterile) Grass Carp can be stocked. AE last stocked Triploid Grass Carp in Cardinal in 2015.

**Results**

The results of the sampling are presented below in tables and graphs. Only the Largemouth Bass, Bluegill, and Redear Sunfish are included in the data analysis as the rest of the fish fall under competing or forage species.

**Table 2**

<b>Lengths and Weights</b>				
<b>Largemouth Bass</b>				
Total Caught	Measurement	(mm)	(inches)	(lbs)
38	Minimum	150	5.91	0.06
	Maximum	595	23.43	6.43
	Average	403	15.86	2.17
<b>Bream</b>				
Total Caught	Measurement	(mm)	(inches)	(lbs)
115	Minimum Stock	80	3.15	0.01
	Maximum	230	9.06	0.61
	Average	122	4.78	0.08

**Table 3**

<i>Species Specific Lengths</i>					
<b>Largemouth Bass</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 8"	≥ 8"	≥ 12"	≥ 15"	≥ 20"	≥ 25"
1	35	31	21	4	0
<b>Bluegill</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 3"	≥ 3"	≥ 6"	≥ 8"	≥ 10"	≥ 12"
41	60	4	1	0	0
<b>Redear Sunfish</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 4"	≥ 4"	≥ 7"	≥ 9"	≥ 11"	≥ 13"
2	12	10	1	0	0

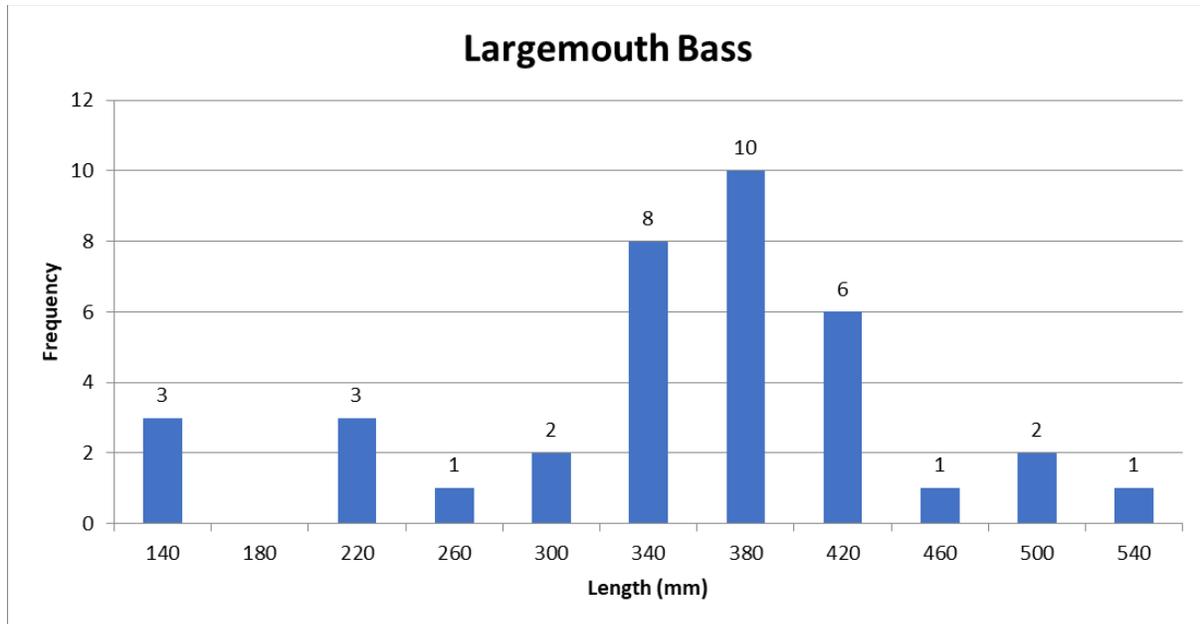
**Table 4**

<i>Proportional Stock Density (PSD)</i>				
<b>Largemouth Bass</b>			<b>Bream</b>	
Percent (%)			Percent (%)	
Value	Desirable		Value	Desirable
89	40-60		19	20-40

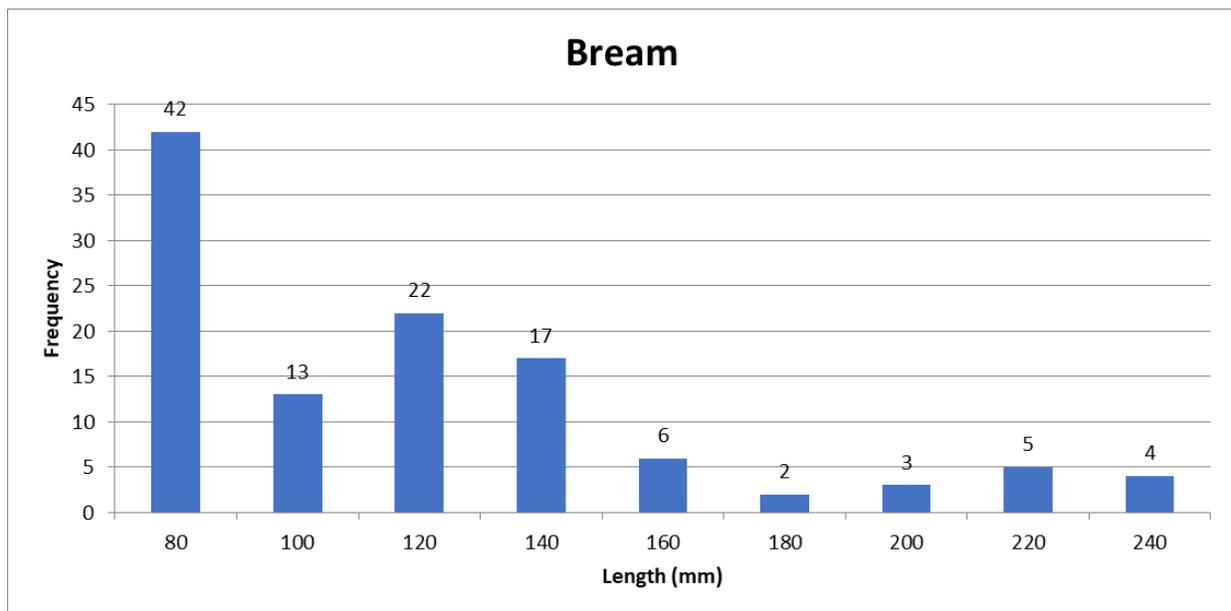
**Table 5**

<i>Relative Weight (W<sub>r</sub>)</i>					
<b>Largemouth Bass</b>					
Percent (%)					
Minimum	Maximum	Average	Underweight	Appropriate	Overweight
61	98	82	< 100	100	> 100
<b>Bream</b>					
Percent (%)					
Minimum	Maximum	Average	Underweight	Appropriate	Overweight
39	106	80	< 100	100	> 100

**Graph 1. A length-frequency histogram of 38 Largemouth Bass**



**Graph 2. A length-frequency histogram of 115 Bream**



## Analysis

The Proportional Stock Density (PSD) value for Largemouth Bass rated high at a value of 89 (normal 40-60) and this indicates that there are few small fish in the population; only one prestock size ( $> 8''$ ) fish was caught. Of all the stock-size ( $\geq 8''$ ) fish caught, 89% were also of a quality size ( $\geq 12''$ ) while 60% were of a preferred-size ( $\geq 15''$ ) and 11% were of a memorable size ( $\geq 20''$ ). No trophy size ( $\geq 25''$ ) fish were caught.

The PSD for bream rated close to the normal range with value of 19 (normal 20-40) and this indicates that there is a balance of fish sizes but not as many large individuals as is preferred. Of all the bream caught 37% were of a prestock size ( $< 4''$ ). Of all the stock size ( $\geq 4''$ ) fish caught, 19% were also of a quality size ( $\geq 7''$ ) while 3% were of a preferred size ( $\geq 9''$ ). No memorable size ( $\geq 11''$ ) or trophy size ( $\geq 13''$ ) bream were caught in the sample.

These PSD values are supported by the length-frequency histograms. The length-frequency histogram for bass (Graph 1) shows a low frequency of smaller year classes of bass. These missing year classes are likely getting outcompeted by the quality-size and larger fish as well as competing species. The length-frequency histogram for bream (Graph 2) shows an abundance of small fish with proportionate sizes of mature fish but not many that are of a size that anglers prefer to catch. The stock-size fish are likely having a difficult time reaching larger sizes due to the presence of multiple competing species.

The average relative weights for both bass (82%) and bream (80%) indicate fish that are underweight. Compared to the 2019 sample the bass average relative weight did not see much change from 2019 (83%) and this is likely attributable to competition with crappie as well as their own species due to a lack of managed harvest. The bream average relative weight saw a decrease from 2019 (110%) and this is likely attributable to an increase in recruitment (survival to maturity) as a result of the introduction of additional shad as they helped reduce pressure from the bass and crappie.

## Canary Lake

Various species of fish were collected from the lake including Largemouth Bass (*Micropterus salmoides*), Bluegill (*Lepomis macrochirus*), Redear Sunfish (*Lepomis microlophus*), and Black Crappie (*Pomoxis nigromaculatus*).

Descriptions of each species can be found under the Cardinal Lake Results section. In Canary Lake the largest bass caught in the sampling was 4.18 pounds. The largest Bluegill caught in the sampling was 0.51 pounds while the largest Redear caught in the sampling was 0.6 pounds. Only one competing species was caught in the assessment and that was the Black Crappie (3 fish, 11.2-11.6" size range). Competing species are undesirable in a Largemouth Bass/Bluegill population structure as they are direct competitors for food sources.

Half a load of Threadfin shad were stocked in the early spring of 2019 as well as 40 Triploid Grass Carp. Neither of these fish were found at any of the sampling stations. They may still be present but no visual confirmations were made.

**Results**

The results of the sampling are presented below in tables and graphs. Only the Largemouth Bass, Bluegill, and Redear Sunfish are included in the data analysis as the rest of the fish fall under competing or forage species.

**Table 6**

<i>Lengths and Weights</i>				
<b>Largemouth Bass</b>				
Total Caught	Measurement	(mm)	(inches)	(lbs)
35	Minimum	240	9.45	0.31
	Maximum	535	21.06	4.18
	Average	372	14.63	1.51

<b>Bream</b>				
Total Caught	Measurement	(mm)	(inches)	(lbs)
46	Minimum Stock	80	3.15	0.01
	Maximum	250	9.84	0.60
	Average	165	6.49	0.24

**Table 7**

<i>Proportional Stock Density (PSD)</i>			
<b>Largemouth Bass</b>		<b>Bream</b>	
Percent (%)		Percent (%)	
Value	Desirable	Value	Desirable
88	40-60	45	20-40

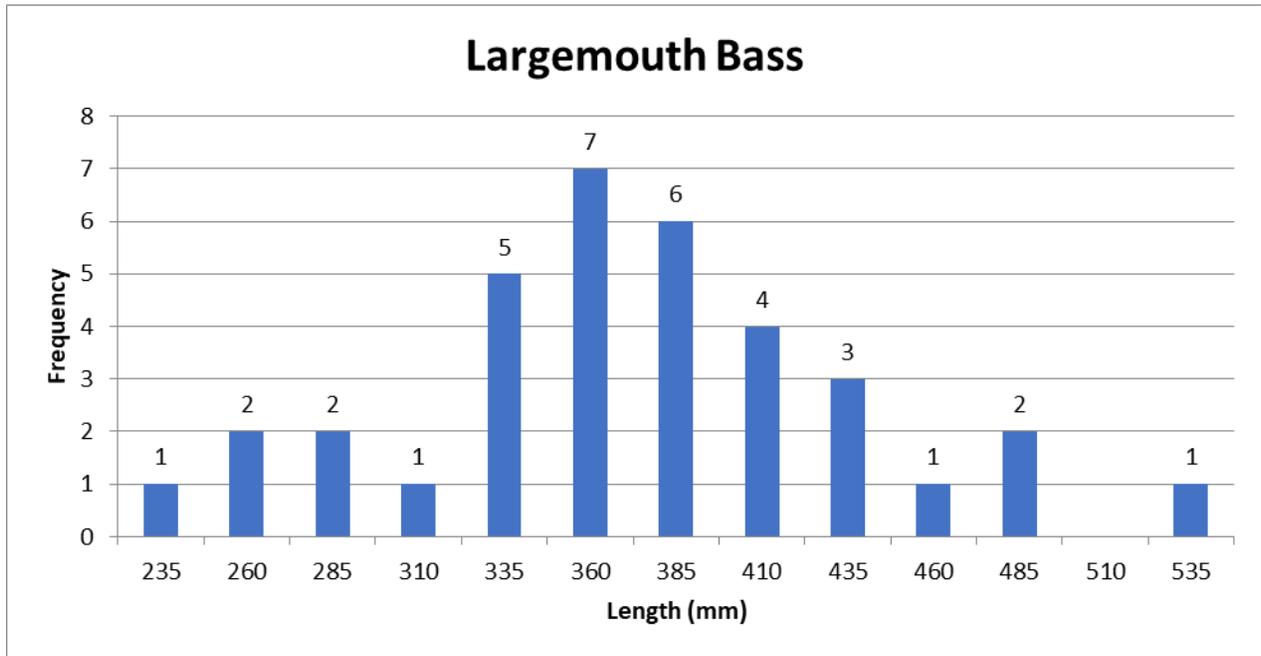
**Table 8**

<i>Species Specific Lengths</i>					
<b>Largemouth Bass</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 8"	≥ 8"	≥ 12"	≥ 15"	≥ 20"	≥ 25"
1	34	30	13	1	0
<b>Bluegill</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 3"	≥ 3"	≥ 6"	≥ 8"	≥ 10"	≥ 12"
10	22	4	1	0	0
<b>Redear Sunfish</b>					
Prestock	Stock	Quality	Preferred	Memorable	Trophy
< 4"	≥ 4"	≥ 7"	≥ 9"	≥ 11"	≥ 13"
0	14	13	7	0	0

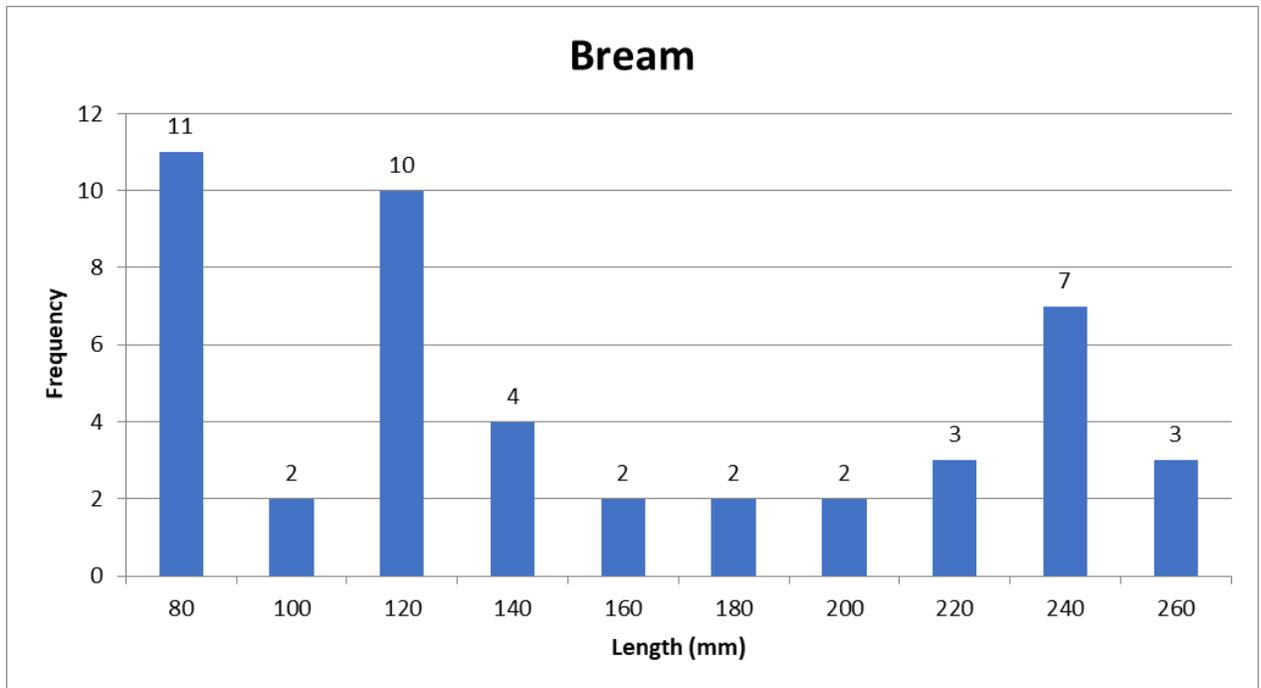
**Table 9**

<i>Relative Weight (W<sub>r</sub>)</i>					
<b>Largemouth Bass</b>					
Percent (%)					
Minimum	Maximum	Average	Underweight	Appropriate	Overweight
73	94	81	< 100	100	> 100
<b>Bream</b>					
Percent (%)					
Minimum	Maximum	Average	Underweight	Appropriate	Overweight
73	99	85	< 100	100	> 100

Graph 3. A length-frequency histogram of 35 Largemouth Bass



Graph 4. A length-frequency histogram of 46 Bream



## **Analysis**

The PSD value for Largemouth Bass rated high at a value of 88 (normal 40-60) and this indicates that there are few small fish in the population; only one prestock size ( $> 8''$ ) fish was caught. Of all the stock-size ( $\geq 8''$ ) fish caught, 88% were also of a quality size ( $\geq 12''$ ) while 38% were of a preferred-size ( $\geq 15''$ ) and 3% were of a memorable size ( $\geq 20''$ ). No trophy size ( $\geq 25''$ ) fish were caught.

The PSD for bream rated close to the normal range with value of 45 (normal 20-40) and this indicates that there is a balance of fish sizes but not as many large individuals as is preferred. Of all the bream caught 22% were of a prestock size ( $< 4''$ ). Of all the stock size ( $\geq 4''$ ) fish caught, 47% were also of a quality size ( $\geq 7''$ ) while 22% were of a preferred size ( $\geq 9''$ ). No bream of a memorable size ( $\geq 11''$ ) or trophy size ( $\geq 13''$ ) were caught in the sample.

These PSD values are supported by the length-frequency histograms. The length-frequency histogram for bass (Graph 3) shows a low frequency of smaller year classes. These smaller fish classes likely getting outcompeted by the quality-size and larger fish as well as competing species. The length-frequency histogram for bream (Graph 4) shows an proportionate size classes of fish but not many that are of a size that anglers prefer to catch. The stock-size fish are likely having a difficult time reaching larger sizes due to the presence of competing species.

The average relative weights for both bass (81%) and bream (85%) indicate fish that are near an appropriate weight but are somewhat affected by competing species. The average relative weight of the bass decreased slightly from the April 2019 sample (83%) and reason is unknown as Threadfin Shad were introduced in the early spring of 2019 it would be expected for the relative weight to increase, though a lack of bass harvest may play a role. The decrease in the bream average relative weight from 2019 (110%) to the present 85% could be attributed to the shad as the introduction of the shad gave the bass and crappie another food source, this reduced the pressure on the bream allowing better recruitment (survival to maturity).

## **Management Recommendations**

Since it would be difficult and costly to completely eliminate all the competing species from the lakes, we recommend slightly different plans for Cardinal Lake and Canary Lake as there are likely stakeholders that enjoy trophy bass fishing as well as those that enjoy crappie fishing. The result of our data collection shows that the quantity of bass has increased annually in both lakes since 2012 and the crappie population has been maintained in both lakes as well.

### **Cardinal Lake Management Approach**

For Cardinal Lake a plan to maintain the base of the food chain while also removing competing species and keeping bass numbers in check through harvesting efforts is recommended. These three items will benefit the Largemouth Bass and bream populations and get them to the next level.

Cardinal Lake has maintained its quantity of quality size fish from 2019 due to the continued fertilization program and survival of the shad. A conservative harvest approach was recommended in 2019. At the time of the current assessment no records were available to indicate if any harvest had been performed. With the fertilization program being successful and the shad surviving the winter, limiting factors in advancing the bass population to a trophy fishery are the crappie presence and the lack of bass harvest.

If catch and release has become the norm then those released fish are continually competing and producing new fish and adding to the competition. In order to reduce competition among the bass and assist the larger bass in reaching memorable and trophy size lengths as well as encourage recruitment (survival to maturity) of prestock and growth of stock size fish a conservative harvest approach should be taken for the course of the year. The results of this approach will be evaluated in next spring's sampling effort.

- Continue the 16-inch minimum length limit on largemouth bass that was instituted last year to manage the harvest on both lakes.
- The annual amount of harvested largemouth bass should not exceed 5 pounds per acre for a maximum of 175 pounds removed from Cardinal Lake.
- Crappie should be harvested to remove them as competition with the bass. This will increase the amount of forage available to the bass. While crappie numbers will be reduced with harvest, they will never be eliminated without a complete renovation which is not recommended due to the costs involved.
- Individuals harvesting bass or crappie from the lake should submit numbers of fish and total weights to the lake committee so the harvested fish can be tracked. A bass tournament is a great time to perform a harvest; AE has sponsored tournaments in the past. An electrofishing removal is a third option to remove bass from the lakes.
- Grass Carp were last added to Cardinal Lake in 2015. Budget for replacing older grass carp this year or in the near future. Adding grass carp can help control unwanted weed infestations. Grass carp can help minimize the use of herbicides in lakes. Herbicides can sometimes work against the "good algae" that the fertilizer program creates.
- Continue the fertilization program. This program is currently done in conjunction with the lake management program and will continue year after year as part of the contract. Fertilization stimulates growth at the bottom of the food chain and generates growth of the "good algae" called phytoplankton.

### **Canary Lake Management Approach**

For Canary Lake a plan to maintain the base of the food chain while also promoting a stable population of competing species and keeping bass numbers in check through harvesting efforts is recommended. These three items will benefit the Largemouth Bass and bream populations while also providing an opportunity for crappie fishing.

Canary Lake has increased its quality of fish from 2019 due to the fertilization program and the introduction of the shad. A conservative harvest approach was recommended in 2019. At the time of the current assessment no records were available to indicate if any harvest had been performed.

If catch and release has become the norm then those released fish are continually competing and producing new fish and adding to the competition. In order to reduce competition among the bass and assist the larger bass in reaching memorable and trophy size lengths as well as encourage recruitment (survival to maturity) of prestock and growth of stock size fish a conservative harvest approach should be taken for the course of the year. The results of this approach will be evaluated in next spring's sampling effort.

- Continue the 16-inch minimum length limit on largemouth bass that was instituted last year to manage the harvest on both lakes.
- The annual amount of harvested largemouth bass should not exceed 5 pounds per acre for a maximum of 40 pounds removed from Canary Lake.
- Individuals harvesting bass or crappie from the lake should submit weights to the lake committee so the harvested fish can be tracked. A bass tournament is a great time to perform a bass harvest; AE has sponsored tournaments in the past. An electrofishing removal is a third option to remove bass from the lakes.
- Grass Carp were added to Canary Lake last year; budget for replacing older grass carp in 5-7 years in Canary Lake. Adding grass carp can help control unwanted weed infestations. Grass carp can help minimize the use of herbicides in the impoundments. Herbicides can sometimes work against the "good algae" that the fertilizer program creates.
- Threadfin Shad were not collected in the sample this year. Keep an eye out for schools of shad. If no signs of shad are noticed over a long period of time, introduce new shad to the lake in early 2021. A half load of shad was introduced in 2019.
- Continue the fertilization program. This program is currently done in conjunction with the lake management program and will continue year after year as part of the contract. Fertilization stimulates growth at the bottom of the food chain and generates growth of the "good algae" called phytoplankton.

If you have any questions or comments, please do not hesitate to contact me. We would be pleased to help you achieve your fisheries management goals and appreciate the opportunity to be of service. I will follow up with you after you have had a chance to review the report.

Sincerely,



Matt Troxler  
Lake Operations Supervisor  
Fisheries Biologist

**Attachments:** Photo Documentation

### References

- Etnier, D. A., and W. C. Starnes. 1993. *The Fishes of Tennessee*, 2<sup>nd</sup> edition. The University of Tennessee Press, Knoxville, Tennessee.
- Kohler, C. C., and W. A. Hubert, editors. 1999. *Inland Fisheries Management in North America*, 2<sup>nd</sup> edition. American Fisheries Society, Bethesda, Maryland.
- Murphy, B. R., and D. W. Willis, editors. 1996. *Fisheries Techniques*, 2<sup>nd</sup> edition. American Fisheries Society, Bethesda, Maryland.



Cardinal Lake: Station Total Catch



Cardinal Lake: Largemouth Bass 6.43 lbs



Cardinal Lake: Largemouth Bass



Cardinal Lake: Largemouth Bass 4.73 lbs.



Cardinal Lake: Bluegill



Cardinal Lake: Redear Sunfish (Shellcracker)



Cardinal Lake: Threadfin Shad



Canary Lake: Station Total Catch



Canary Lake: Largemouth Bass



Canary Lake: Largemouth Bass



Canary Lake: Largemouth Bass