# LEE CREEK

## ANNUAL RESERVOIR/WATERSHED REPORT 2019

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**Department of Environmental Quality**
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# INTRODUCTION

The Fort Smith Utilities, Environmental Quality section conducts annual fisheries and water quality assessments on both surface water reservoirs and their watersheds. The reservoirs are used to supply raw water to the city's two (2) drinking water treatment facilities. Changes in fish, algae and macro-invertebrate population and community structure can reflect shifts in water quality. Monitoring the overall fisheries and water quality of the two (2) raw water reservoirs is one (1) tool utilized by the Fort Smith Utilities to ensure quality drinking water, in the quantity demanded by the City of Fort Smith and the surrounding communities. Combinations of active and passive sampling techniques are used to evaluate reservoir/stream fish populations, through the generation of specific indices. Aquatic macro-invertebrate populations are evaluated by the generation of specific indices. Indices are evaluated using trend analysis to follow changes in structure, abundance and condition of target fish and macro-invertebrate populations. Algae assessments are done weekly to monitor algal blooms that may affect taste and odor of water produced. The degree of monitoring effort varies annually and is typically a function of weather and water conditions.

# SITE SELECTION

## *Passive Sampling*

Due to reservoir's physical characteristics, site selection for passive collection techniques was difficult at best. Lee Creek Reservoir covers approximately 634 acres and has an average depth of eight (8) feet. The 439 square mile watershed delivers extremely high flows to the reservoir during storm events, resulting in large quantities of woody material being washed in and deposited along the reservoir littoral zone. Mats of woody material are often formed after storm events and drift with prevailing winds. The extreme fluctuations in water level, flow and the introduction of woody material hinder the deployment and operation of passive sampling techniques, including trap netting, experimental gill netting and trammel netting. For this reason, a random sampling approach could not be used for site selection. Trap netting sites were selected for their ease of deployment and reduced surface and sub-surface debris that tend to entangle nets and therefore reduce netting efficiency. Two (2) sites are located on the East side and two (2) on the West side of the reservoir. This increases the ability to monitor fish movement during various diel cycles.

One (1) gill and one (1) trammel net site were selected for Lee Creek Reservoir. These two (2) sites are on the West side of the reservoir and were also selected for their ease of deployment and reduced surface and sub-surface debris that tend to entangle nets and therefore reduce netting efficiency. Both nets are set across the primary channel of Lee Creek, thus reducing some bias from their relatively close proximity to one another and their placement only on the West side of the reservoir. Historic data suggests abundant fish movement within the channel, thus ensuring collections that reflect current fishery conditions.

### *Active Sampling*

Boat electro-shocking is conducted over the entire length of the reservoir. Fort Smith Utilities has adopted a random electro-shocking sampling approach, currently being used by the Arkansas Game and Fish Commission (AGFC). This approach will be detailed in the Methods section of this document.

## METHODS

### *Trap Nets*

Standard trap nets require a relatively flat, hard substrate for pot placement and a clean bottom for leader/wing deployment. Nets are set perpendicular to the shoreline. The nets are set and contents emptied every 24-hour after deployment. Nets are typically deployed on the Monday of the sampling week, with collections being made on the following days and final net retrieval on Friday. Attempts are made to sample crappie populations early in the season to minimize the effects of post spawn individuals on fish condition indices. Fish are identified to species level, measured, weighed (game fish only) and returned to the water. Some incidental mortality is typically experienced and can be expected while conducting any fisheries study. Catch-per-unit-effort (CPUE), relative weight (Wr) analysis and percent composition indices are calculated from the recorded data. For evaluation purposes, target fish species are grouped into 25-millimeter increments.

Standard trap nets are constructed of two (2) 3X6 foot, 5/16 inch diameter steel frames, with center bracing, set 2.5 feet apart. The second 3x6 foot frame has a slit throat. Netting material consists of ½ inch square, No. 150 knotless netset treated nylon. Four (4) 2.5-foot diameter hoops set 24 inches apart lead to a cod end with a five (5) inch, No. 5 braided drawstring closure. The first hoop has a six (6) inch throat and is set 32 inches from the 3x6 foot frame. The leader is constructed of the same net material, hung 14 meshes per foot on a No. 60 nylon twine and will be 50x3.5 feet. A leader float line is fitted with 2x1.5 inch corks and a sinker line fitted with 1.5-ounce weights. The leader will also be netset treated and connected to the second 3x6 foot frame center base.

### *Experimental Gill Nets*

Experimental gill nets require a relatively flat or gently sloping substrate, and a clean bottom to prevent excessive damage to the monofilament netting. Experimental gill nets are 91.4 meters in length, 2.4 meters in height and have panels of increasing mesh size (¾ to 2 inches). The nets are set perpendicular to the shoreline, stretched taut by boat and anchored to the substrate. Nets are set and the contents are emptied every 24-hours after deployment. Nets are typically deployed on Monday of the sampling week, with collections being made on the following days and final net retrieval on Friday. Fish are identified to species level, measured; weighed (game

fish only) and returned to the water. CPUE, Wr analysis and percent composition of dominant taxa are calculated. For evaluation purposes, target fish species are grouped into 25-millimeter increments.

### *Trammel Nets*

Trammel nets require a relatively flat or gently sloping substrate, and a clean bottom to prevent excessive damage to the monofilament netting. Trammel nets are 91.4 meters in length and have a single mesh size (3 inches). Nets are set perpendicular to the shoreline, stretched taut by boat and anchored to the substrate. Nets are set and the contents are emptied every 24-hours after deployment. Nets are typically deployed on the Monday of the sampling week, with collections being made on the following days and final net retrieval on Friday. Fish are identified to species level, measured; weighed (game fish only) and returned to the water. CPUE, Wr analysis and percent composition of dominant taxa are calculated. For evaluation purposes, target fish species are grouped into 25-millimeter increments.

### *Boat Electro-shocking*

Electro-shocking is conducted through the use of a boat mounted Smith-Root Incorporated®, 5.0 Electro-fishing System, powered by a Honda® GX340, 11.0 horsepower gasoline generator. A single standard anode boom, with a 40-inch diameter array is mounted to the front of the boat. Lighting mounted on the front of the boat, is powered by a Honda® EM650 gasoline generator and converter box combination. Sampling is typically conducted during nighttime conditions. When the unit is operational, fish are stunned and drawn to the electric field at the front of the boat where they are retrieved using long handled dip nets. Upon collection, the fish are placed in two (2) 30-gallon tubs, partially filled with reservoir water. At the end of each collection period, fish are identified to species level, measured (mm) and weighed (g) (game fish only). The fish are then released in an area that will not influence future sampling numbers. Catch-per-unit-effort (CPUE), relative weight analysis, Proportional Stock Density (PSD), and percent composition of dominant taxa are calculated. Relative Stock Density (RSD) is also calculated but has now been changed to PSD-P. For evaluation purposes, target fish species are grouped into 25-millimeter length increments. A random sampling approach has been adopted to better ensure representative fishery collections.

As previously mentioned, a random sampling approach has been adopted to better ensure representative fishery collections. Lee Creek Reservoir is divided into 40, 600-meter sampling sites. A minimum of 14 sites must be electro-shocked, for a period of 10-minutes each, to ensure a random sample. Prior to sampling, sites are selected from a random number generator. Sites not conducive to sampling efforts, due to shallow or extremely deep water, are excluded from the selection and a substitute site is chosen at random. Due to the large number of sites and in case of equipment problems, the 14-sites can be sampled over the course of two

(2) nights. However, sampling must be completed during the same week if possible to reduce the bias of fish movement related to changing water or weather conditions.

### *Backpack Electro-shocking*

Backpack Electroshocking is conducted in streams in the Lee Creek Watershed. The species of stream fish present are a good indication of water quality depending on the tolerance value assigned to certain species. A Smith-Root Backpack Electro-shocker is used to stun the fish for collection. Two (2) 20-minute runs are done on each stream and the fish are identified to species level after each run. Fish collected are identified and released on site after identification. Data is then analyzed and an Index of Biotic Integrity (IBI) trend analysis is done based on a predetermined set of values for each species. The IBI analysis will give a stream condition number that will help determine stream health.

### *Surber Net*

Aquatic macro-invertebrates are key indicators of stream health. The City of Fort Smith samples twice a year for macro-invertebrates in all the streams in each watershed. Three (3) samples are taken at each site at riffles with enough flow to carry the macro-invertebrates into the surber net. The surber net is 12 inches by 12 inches (1 sq. ft.) and is placed in a spot determined by the sampler to have sufficient cobble and flow. The sampler then rubs each rock to detach the macro-invertebrates clinging to each rock in the one (1) square foot area. After all the rocks are rubbed sufficiently a garden shovel is used to disturb the streambed for any macro-invertebrates that are buried. The net is then emptied into a container and the macroinvertebrates are fixed in 10% formalin for picking at a later date. The macroinvertebrates are then picked, preserved, and sent off to an outside contract laboratory for identification and enumeration. The data received is then compiled and four (4) different metrics are used to obtain a “Stream Condition” factor. Each of the four (4) metrics is on a scale of one (1) to five (5). Five (5) is the best score for each metric and a 20 is the best stream condition factor.

### *Algal Enumeration*

Algae Enumeration is done weekly on both reservoirs. A secchi disk is lowered into the water and used to determine the visible photic zone. This number is then divided by two (2) to obtain the ¼ zone depth, at which the algae sample is taken. Samples are collected in a 2.2L PVC Beta Plus water bottle (Wildco Inc.) that is lowered to a depth determined by the secchi disk. One (1) sample is collected on Lee Creek at the L2 site. The samples are then taken to the lab and 100 mL of the sample is measured out and concentrated down to 20 mL, using a 63-µm nominal pore size Wisconsin Plankton Bucket. A one (1) mL sample is then taken and placed into a Sedgwick-Rafter counting chamber slide. After the algae are counted, the data is entered into a database to obtain phytoplankton units per liter and MIB & Geosmin (Taste and Odor) levels. This helps to better track trends and predict blooms that could affect water quality or taste.

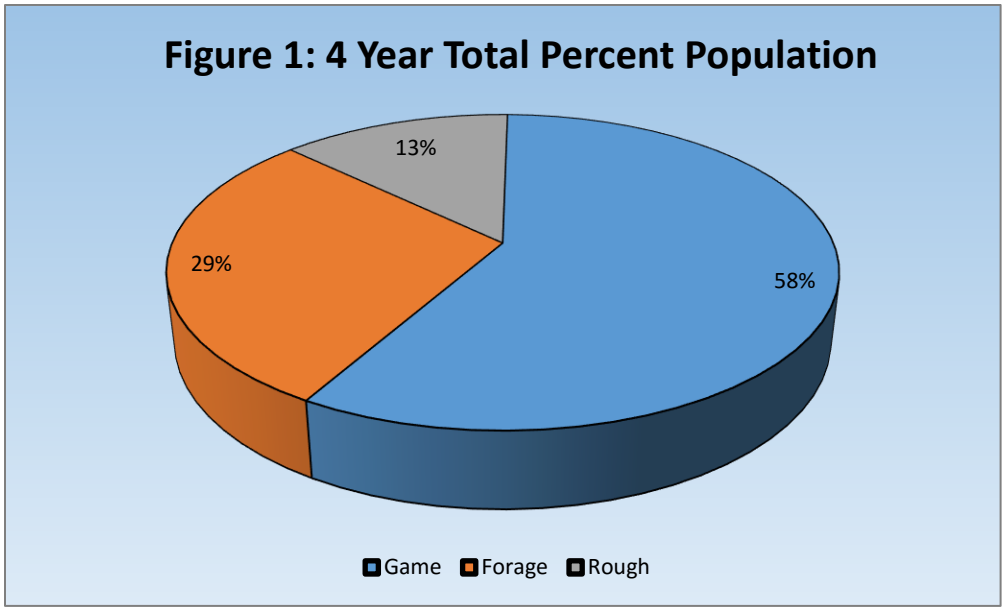
### *Water Quality*

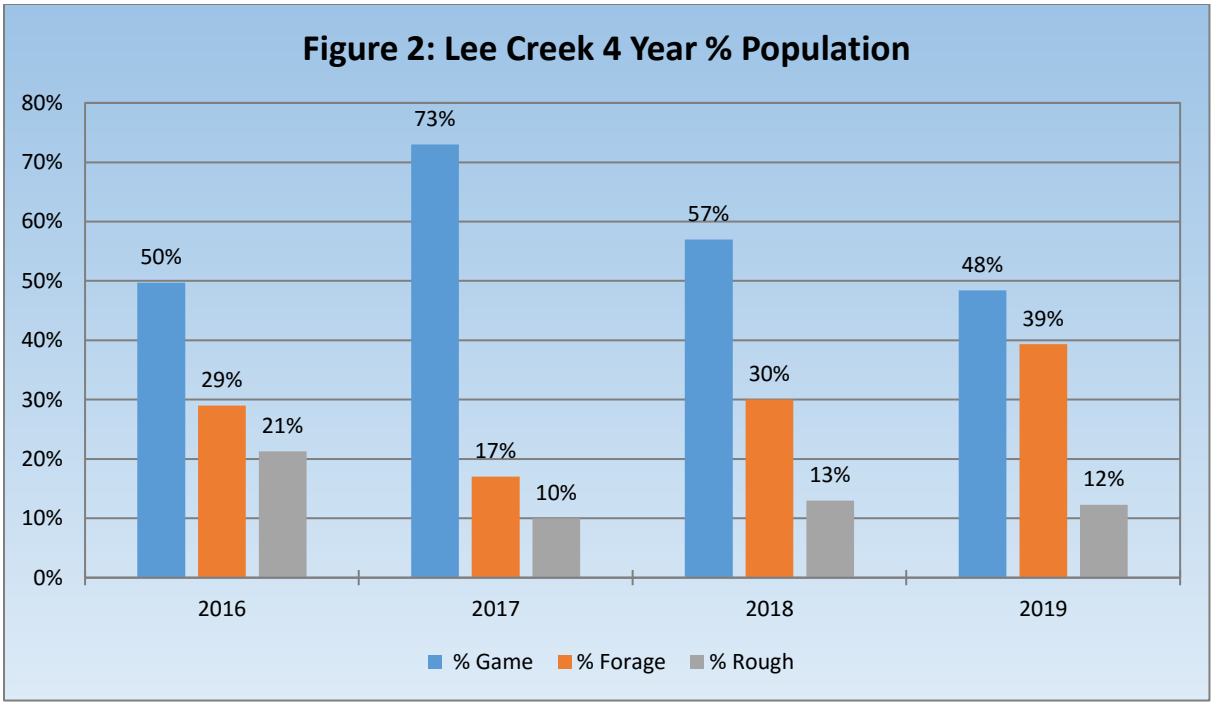
Phosphorous, nitrogen, and chlorophyll-α are three (3) water quality indicators tested by the City of Fort Smith. Phosphorous samples are obtained by a surface grab at five (5) pre-determined sites that extend the length of the reservoir. Nitrogen sampling is done on a monthly basis at two (2) sites on both reservoirs. One sample is taken at the site nearest the intake structure (L2) while the other sample is taken at the site that is at the uppermost part of the reservoir (O). Chlorophyll-α is taken at the site nearest the intake structure and two (2) samples are taken. One (1) sample is determined by the secchi disk depth obtained for the algae sample. The other sample is taken at two (2) meters. Phosphorous and nitrogen samples are an indicator of nutrient loading from the reservoir's watersheds and elevated levels can lead to uncontrollable algae blooms. Chlorophyll-α is used to determine primary productivity and can give you an insight into the reservoirs trophic status.

## RESULTS

### *Total Percent Population*

A total of 21 species of fish were collected on Lee Creek Reservoir during the four (4) year sample period. Game fish included two (2) species of bass, two (2) species of crappie, and three (3) species of catfish. Game fish made up 58% of the population sampled in the past four (4) years and varied from 48% to 73% in that period. Forage fish made up 39% of the sample rising from 30% last year (2018). 2017 saw low forage populations due to the large sampling of white crappie skewing game fish to a larger percentage. 2018 and 2019 data is more reflective of the forage fish population. The rough fish were around 13% of the population and that seems to be in the normal range from previous years seen in Figure 2.



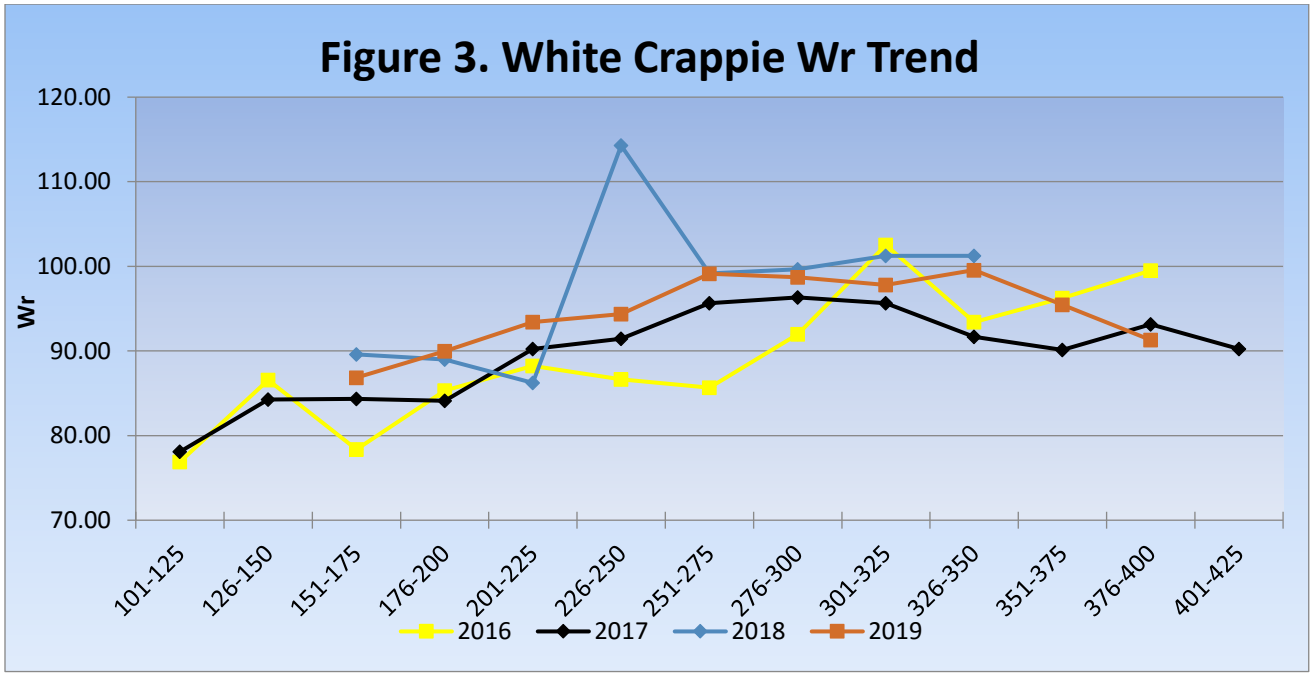



## *Trap Nets*

Trap netting was conducted from March 19, 2019 to April 12, 2019 for 22 net nights. A total of 138 white crappie (*Pomoxis annularis*) were sampled. Black crappie (Pomoxis nigromaculatus) were also sampled, but only 14 individuals were caught making up 9.2% of the total crappie. The average Wr of those 14 individuals was around 100.7. Lee Creek black crappie typically average around 10% of the crappie population caught in a given year and for this reason the black crappie data was omitted from this report. The average relative weight (Wr) of the white crappie sampled was 97.11 meaning the crappie are in the 97$^{th}$ percentile for the standard length specific weight. This would indicate the population does not have to compete too much for limited forage fish numbers, which would lead to lower crappie weights and a smaller Wr. Figure 3 shows average Wr for each length class for the past four (4) years. PSD and PSD-P values were calculated since the N (sample number of fish) was over 125, the recommended minimum sample size for calculating PSD according to Quist et al. (2009). The PSD was at 94 and the PSD-P was at 80.4. Both of these numbers are above acceptable ranges for white crappie populations meaning there was an overabundance of large crappie sampled compared to smaller crappie. PSD should range from 30-60 where as PSD-P should be >10. PSD-P is the new accepted terminology for $RSD_{10}$. One explanation as to why the PSD and PSD-P numbers are so large is due to a dominant age class being present between the 276-350 mm length classes. These three (3) length classes made up 70% of the sample size (276-300 mm, 301-325 mm, and 326-350 mm) in 2019. All of these length classes are above the specified lengths for both PSD (203 mm) and PSD-P (254 mm) leading to values above the acceptable ranges. PSD and PSD-P

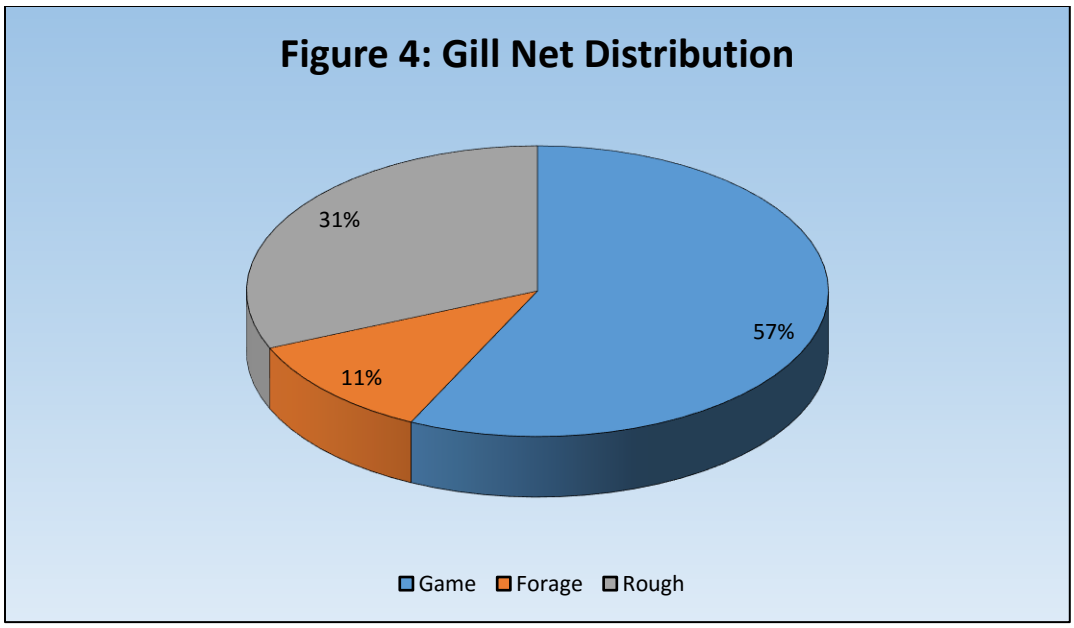
values should drop closer to acceptable ranges in the next few years when the larger older fish die off allowing smaller crappie to flourish.

| Table 1. White Crappie Net Summary of Statistics | | | | |
|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 |
| Net Nights | 37 | 20 | 20 | 22 |
| N | 90 | 553 | 81 | 138 |
| Mean L (mm) | 235.18 | 244.8 | 275.95 | 294.18 |
| Mean W (g) | 226.78 | 217.53 | 339.26 | 408.3 |
| Mean Wr | 88.32 | 91.81 | 97.71 | 97.11 |
| CPUE | 0.101 | 1.15 | 0.344 | 0.261 |
| PSD | 85.0 | 93 | 88.9 | 94 |
| PSD-P | 27.0 | 28 | 72.8 | 80.4 |




### *Gill Nets*

Gill nets were set out for three (3) nights, 2/5/2019, 2/26-27/2019, for four (4) net nights this year. Most of the game fish caught were channel catfish (*Ictalurus punctulatus)* with a few white crappie and largemouth bass. Gizzard shad (*Dorosoma cepedianum*) made up almost all of the forage fish netted and spotted sucker (*Minytrema melanops*) made up all but two (2) of the rough fish. Spotted gar (*Lepisosteus oculatus*) being the other two (2).



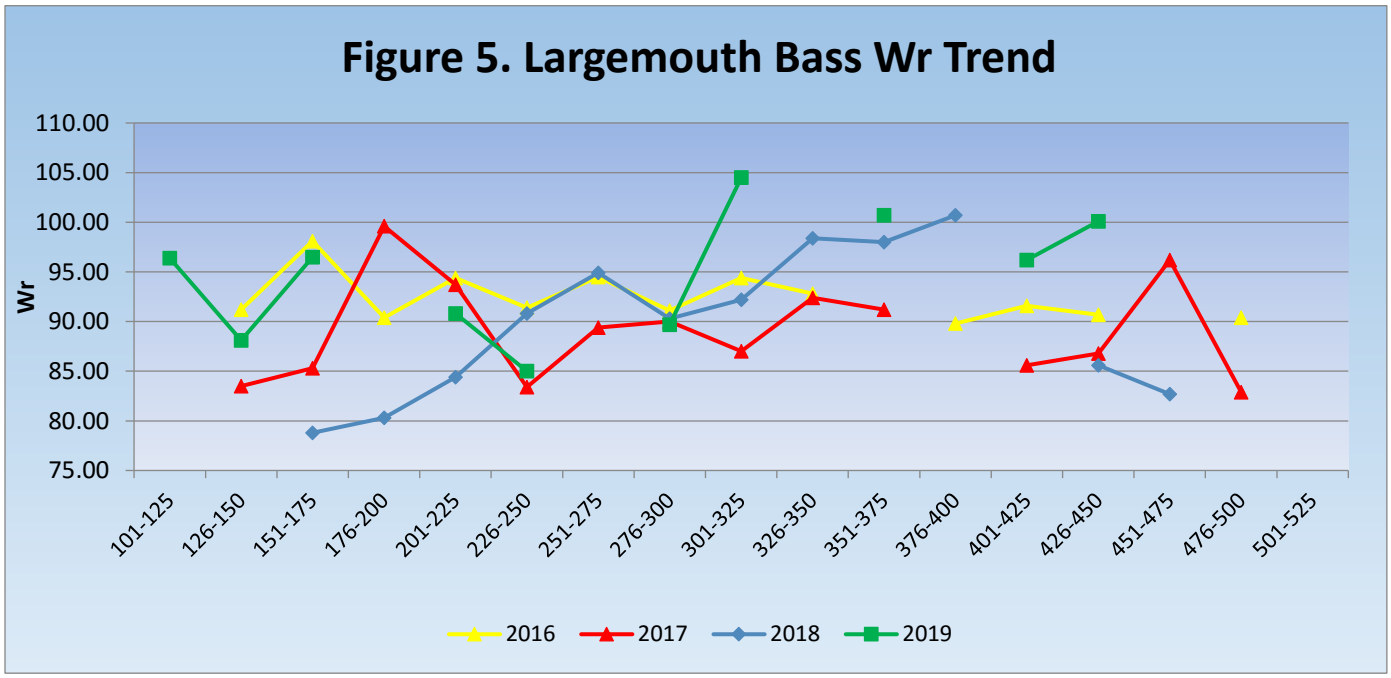

### *Trammel Nets*

No trammel nets were set out this year due to weather constraints.

### *Boat Electro-shocking*

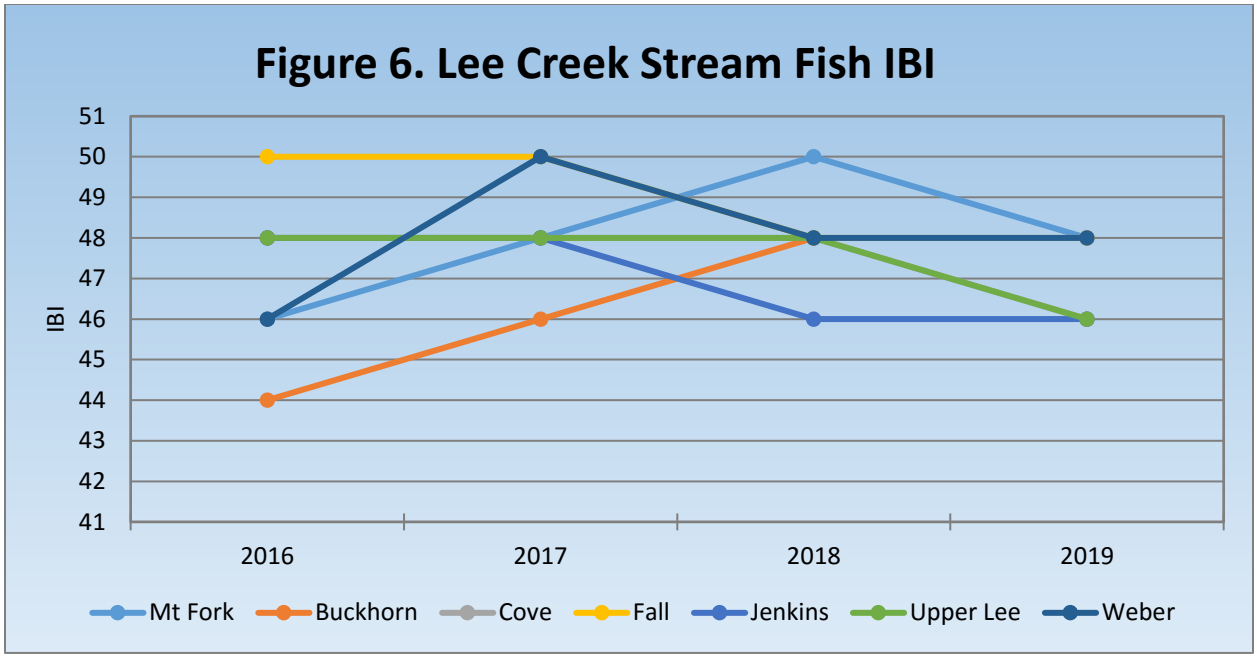
Boat electro-shocking was conducted on one night, November 19, 2019, due to high turbidities within the reservoir. A total of 19 largemouth bass were sampled. Mean length was 244.1 mm while the mean weight was 348.2 grams. The Wr average came to 93.5 although the small sample size (N) should be noted. PSD and PSD-P were calculated even though the recommended minimum (N≥125) was not reached. The acceptable PSD range for largemouth bass is from 40-70 and the acceptable range for PSD-P is 10-40. PSD is 41.7 at the lower end of the acceptable range, but once again, such a small N does not lead to much confidence in the value calculated. The PSD-P is 25, which is within an acceptable range typically indicating there is not an overabundance of larger bass. Small N size will also affect PSD-P values. Table 2 and Figure 6 show the data for the previous four (4) years.

| Table 2. LMB Electroshocking Summary of Statistics | | | | |
|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 |
| N | 110 | 43 | 50 | 19 |
| Mean L | 242.6 | 316.5 | 277.1 | 244.1 |
| Mean W | 251.40 | 507.4 | 364.9 | 348.2 |
| Mean Wr | 92.9 | 89.1 | 89.7 | 93.5 |
| CPUE | 47.21 | 18.45 | 21.46 | 10.38 |
| PSD | 20.3 | 60.0 | 33.3 | 41.7 |
| PSD-P | 12.7 | 25.0 | 13.3 | 25 |




### *Backpack Electro-shocking*

Backpack Electro-shocking was conducted from July 17, 2019 to August 15, 2019. Six (6) sites were sampled this year to obtain IBI scores to gauge the "health" of each stream. Buckhorn was inaccessible for sampling this year. The number of taxa ranged from 13 at Mountain Fork to 19 at Weber, Cove and Upper Lee. All creeks sampled this year stayed the same in IBI scores except for a few lowering by a point or two. This year saw record rainfalls so some creeks were above usual shocking levels, which could account for smaller numbers in taxa and IBI scores. The increased water will allow the stream fish more room to escape the electrical current.




### *Surber Nets*

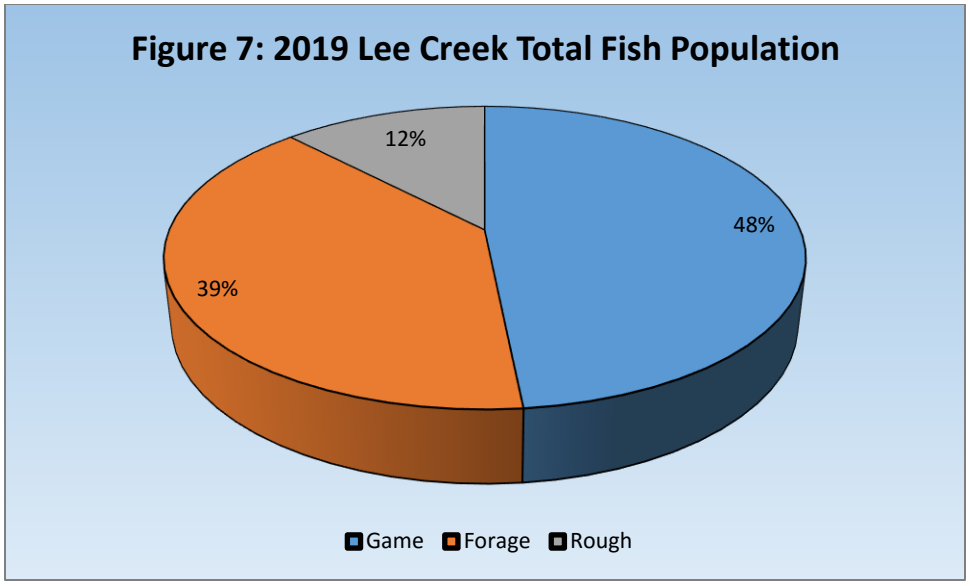
First quarter macroinvertebrate samples were taken from March 22, 2019 to March 28, 2019. Historical data shows all scores were within acceptable ranges for stream condition, which tops out at 20. Six (6) of the creeks sampled this year scored out at a 20, and one (1) at 18. Buckhorn was the only creek that scored 18 because of lower EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa. The EPT numbers were normal for Buckhorn, which typically averages less macroinvertebrates with it being dry for months out of the year. The second quarter samples were taken from 6/21/2019 to 7/17/2019. The second quarter saw four (4) creeks with 20's, one (1) 16, and two (2) 14's. Buckhorn once again is expected to be lower since it is a first order stream that is dry for months out of the year. Cove dropped from a 20 to a 14 in the second quarter probably due to heavy rains affecting the taxa richness by more than half from previous years. This would also explain a smaller EPT richness since less taxa overall were sampled. This could also be due to samplers varying what riffle they sampled. Upper Lee was another that dropped in score more than likely due to heavy rains. Upper Lee's water level was also up when samples were taken and this could explain less taxa picked up.

| Table 3: First Quarter Stream Condition | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| **Buckhorn** | 14 | 14 | 18 | 18 | ** | 18 | 18 |
| **Cove** | 16 | 16 | 20 | 20 | ** | 16 | 20 |
| **Jenkins** | 20 | 20 | 20 | 20 | ** | 20 | 20 |
| **Upper Lee** | 20 | 12 | 20 | 20 | ** | 20 | 20 |
| **Mt. Fork** | 20 | 18 | 18 | 20 | ** | 20 | 20 |
| **Weber** | *** | ** | 18 | 20 | ** | 18 | 20 |
| **Little Lee** | ** | ** | ** | 20 | ** | 20 | 20 |
| **no samples available for analysis | | | | | | | |

| Table 4: Second Quarter Stream Condition | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| **Buckhorn** | 10 | 14 | | 16 | 10 | 14 | 14 |
| **Cove** | 16 | 18 | ** | 10 | 18 | 20 | 14 |
| **Jenkins** | 16 | 20 | ** | 20 | 18 | 20 | 20 |
| **Upper Lee** | 18 | ** | ** | 20 | 20 | 20 | 16 |
| **Mt. Fork** | 16 | 20 | ** | 16 | 20 | 16 | 20 |
| **Weber** | ** | ** | ** | 18 | 20 | 18 | 20 |
| **Little Lee** | 16 | ** | ** | 20 | 16 | 18 | 20 |
| **No sample available for analysis | | | | | | | |

### *Reservoir Population Distribution*

The reservoir population distribution is split up into three (3) groups: Game, Forage, and Rough fish. The game fish are most of the predators that are sought after by anglers e.g. crappie, bass, and catfish. This group made up 48% of the population sampled this year. Forage fish are at the bottom of the food chain and are typically predated on or eaten by the game fish and other predators. Forage fish made up 39% of the fish sampled this year and are important because low numbers can lead to more competition among predators leading to lower game fish Wr's. The last group is the rough fish or suckers, gar, and carp. These fish are not typically sought after by anglers and made up around 12% of the population in 2019.




## *Algal Enumeration*

Algae counts are conducted on samples collected weekly. The counts are done to determine the percent composition of MIB & Geosmin producing algae, which affect drinking waters taste and odor. The counts are also done to monitor phytoplankton growth especially blue-green algae, which are becoming more of a concern in drinking water reservoirs worldwide. 2019 was a normal year for Lee Creek with algae counts staying fairly low until the summer growing months, (July, August, September), when a peak is expected in algae growth and activity. The spring and summer were fairly wet keeping the reservoir flushed of excess nutrients keeping algae competing and limiting any blooms that may occur. The major spike in late July early August was a mix of diatoms *Fragilaria spp., Rhizosolena spp.* and the Chrysophyte *Dinobryon sp.* These are all common algae that often make up the abundance of Lee Creek's algae counts and pose no real harm to people. Blue-green algae numbers are typically very low unless Lee Creek does not receive a lot of rain inflow. This is in part because blue-greens can fix their own nitrogen so when nutrients get low there is less competition with other algae species allowing blue-greens more chance to thrive. During wetter years, Lee Creek tends to stay lower in algae numbers due to water running over the dam flushing the reservoir of excess nutrients. This will also flush algae out keeping populations low and helping prevent blooms.

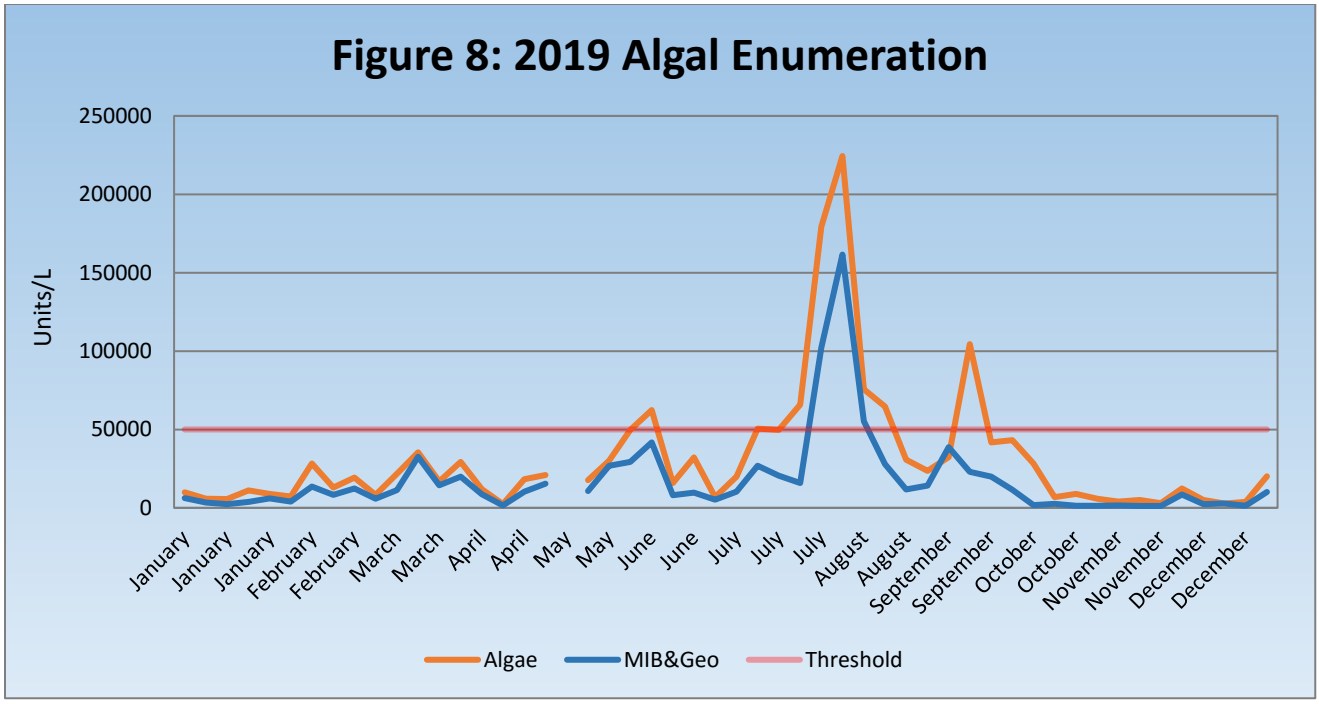


Figure 8: 2019 Algal Enumeration
250000
200000
150000
100000
50000
0
Units/L
January
January
January
February
February
March
March
April
April
May
May
June
June
July
July
July
August
August
September
September
October
October
November
November
December
December
Algae
MIB&Geo
Threshold

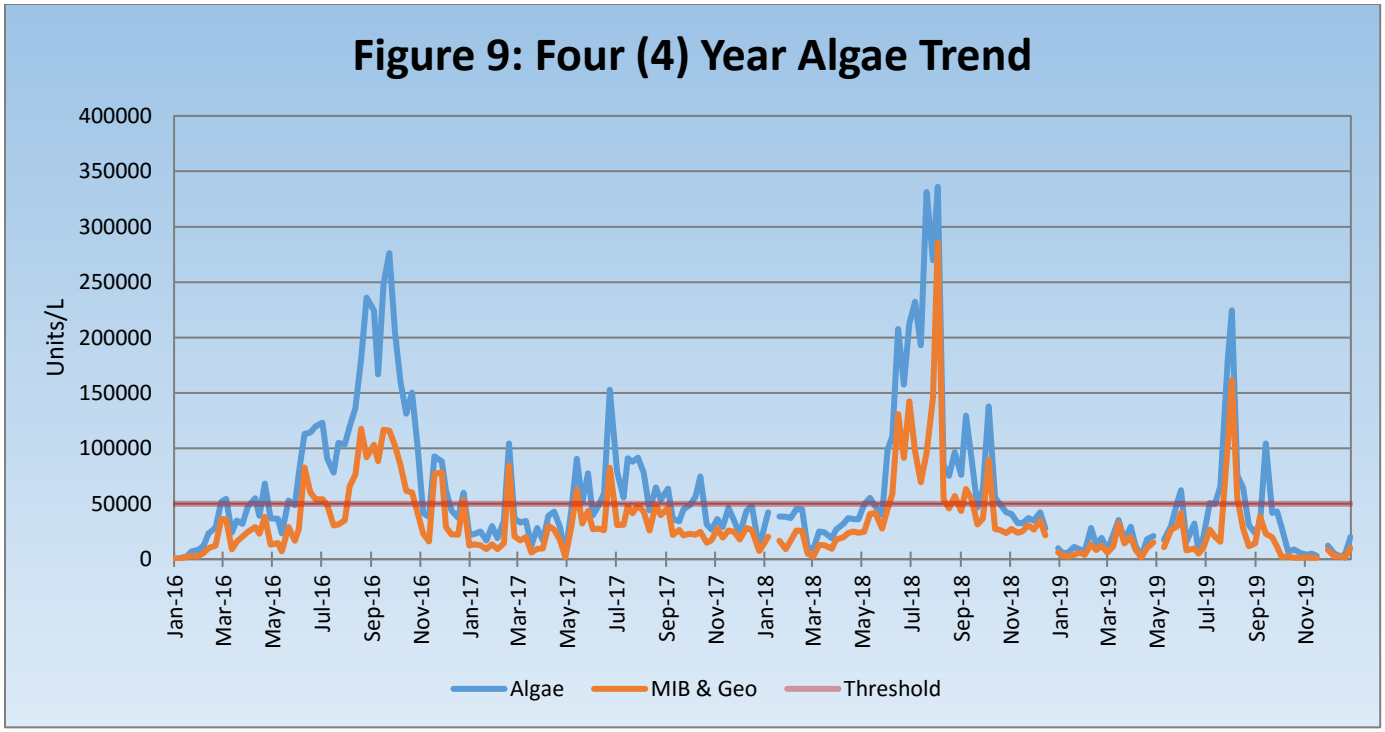
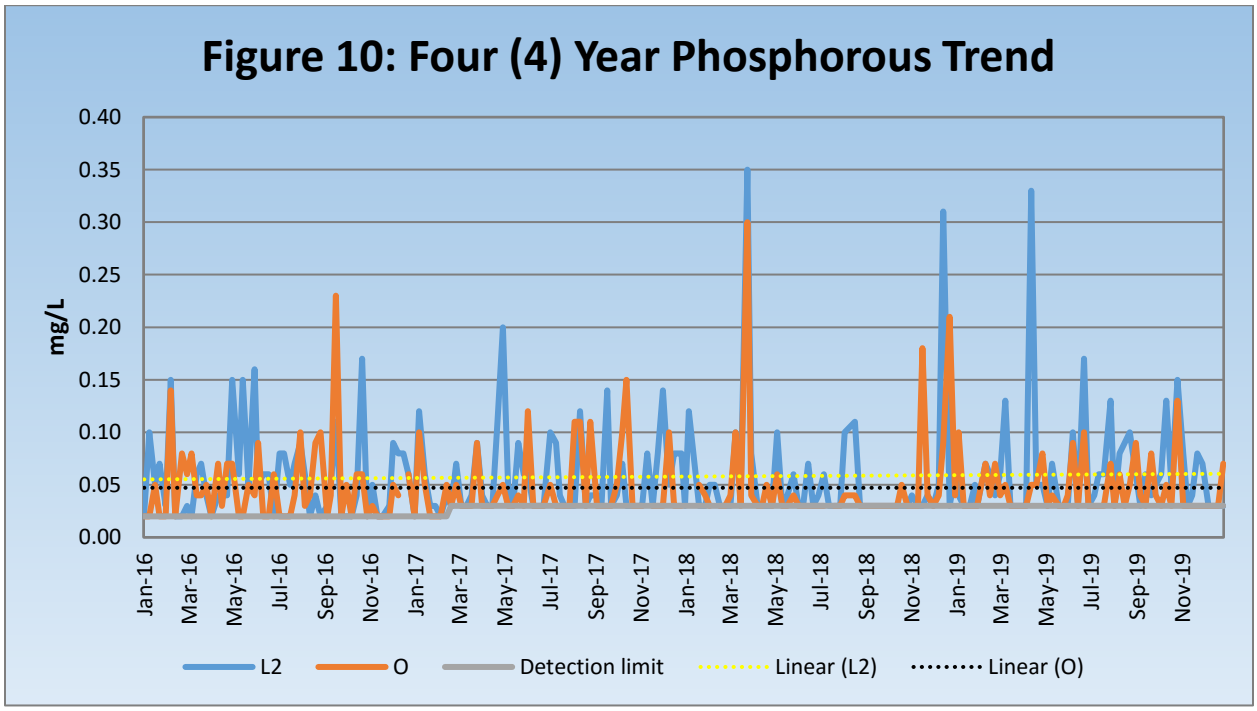


Figure 9: Four (4) Year Algae Trend
400000
350000
300000
250000
200000
150000
100000
50000
0
Units/L
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Mar-17
May-17
Jul-17
Sep-17
Nov-17
Jan-18
Mar-18
May-18
Jul-18
Sep-18
Nov-18
Jan-19
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Algae
MIB & Geo
Threshold

### *Water Quality*

Phosphorous (P) data is stable over the (4) year sample period at both sample sites as seen in Figure 10. L2 saw a slight rise in P levels this year while the O sample sight stayed fairly stable just under 0.05 mg/L. 2019 saw a major spike in phosphorous in late April to May then levels stayed slightly elevated because of a wetter year with a lot of run-off. Agricultural and cattle operations can be a major source of phosphorous from manure and fertilizer. Another source of P is soil erosion. Phosphorous is bound in the soil and when excessive erosion events happen P levels typically spike. Lee Creek basin does not have many large agricultural or cattle operations so most phosphorous seen is from soil runoff or erosion from rain events. The nitrogen trend shows a rise for the Oklahoma (O) site over the four (4) year period while the L2 site is trending downward. Nitrogen runoff comes from cattle and agricultural operations, but can also be scrubbed from the atmosphere during rain events. Once again, most nitrogen loading is from runoff and the atmosphere since no large agricultural operations are in the basin.



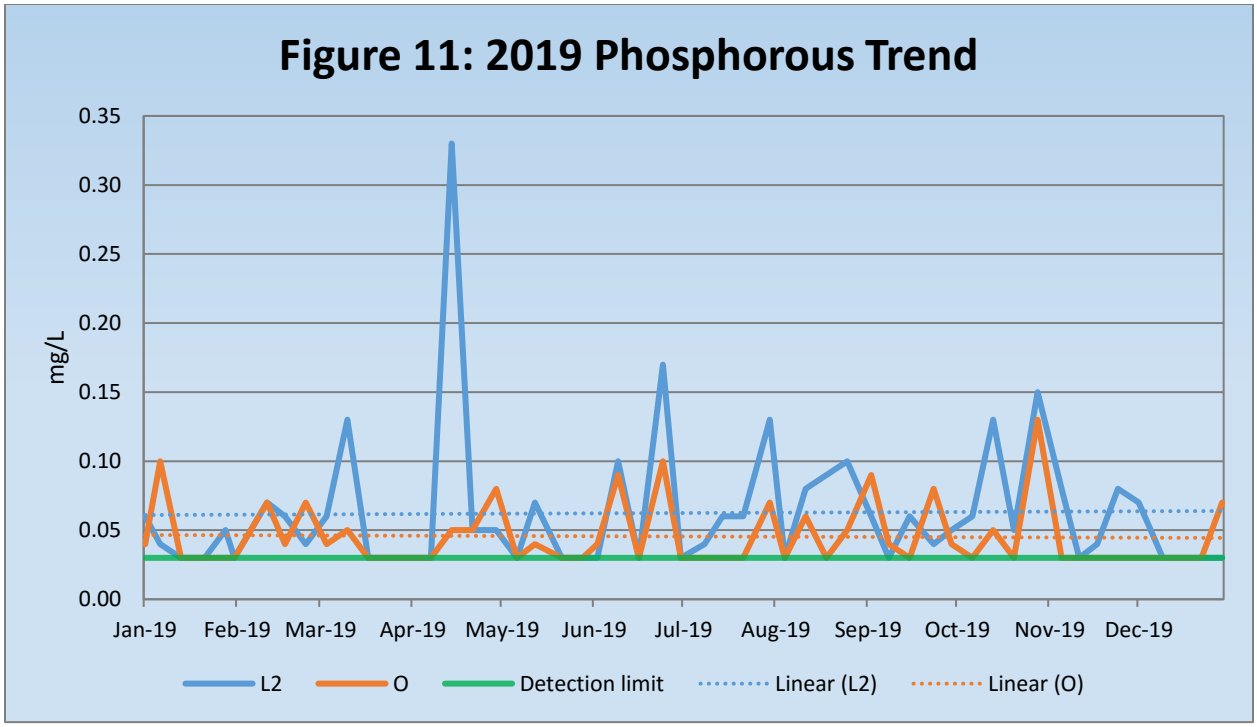


Figure 11: 2019 Phosphorous Trend
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
mg/L
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
L2
O
Detection limit
Linear (L2)
Linear (O)

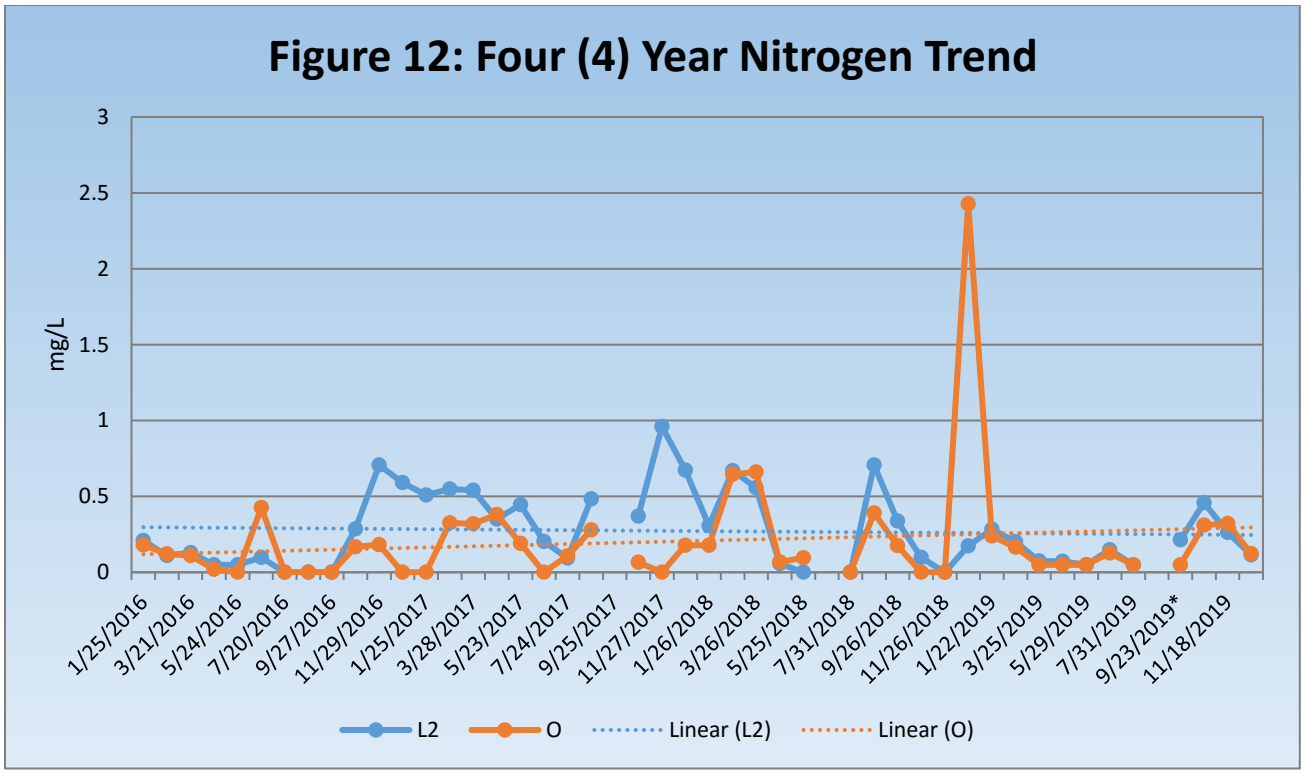
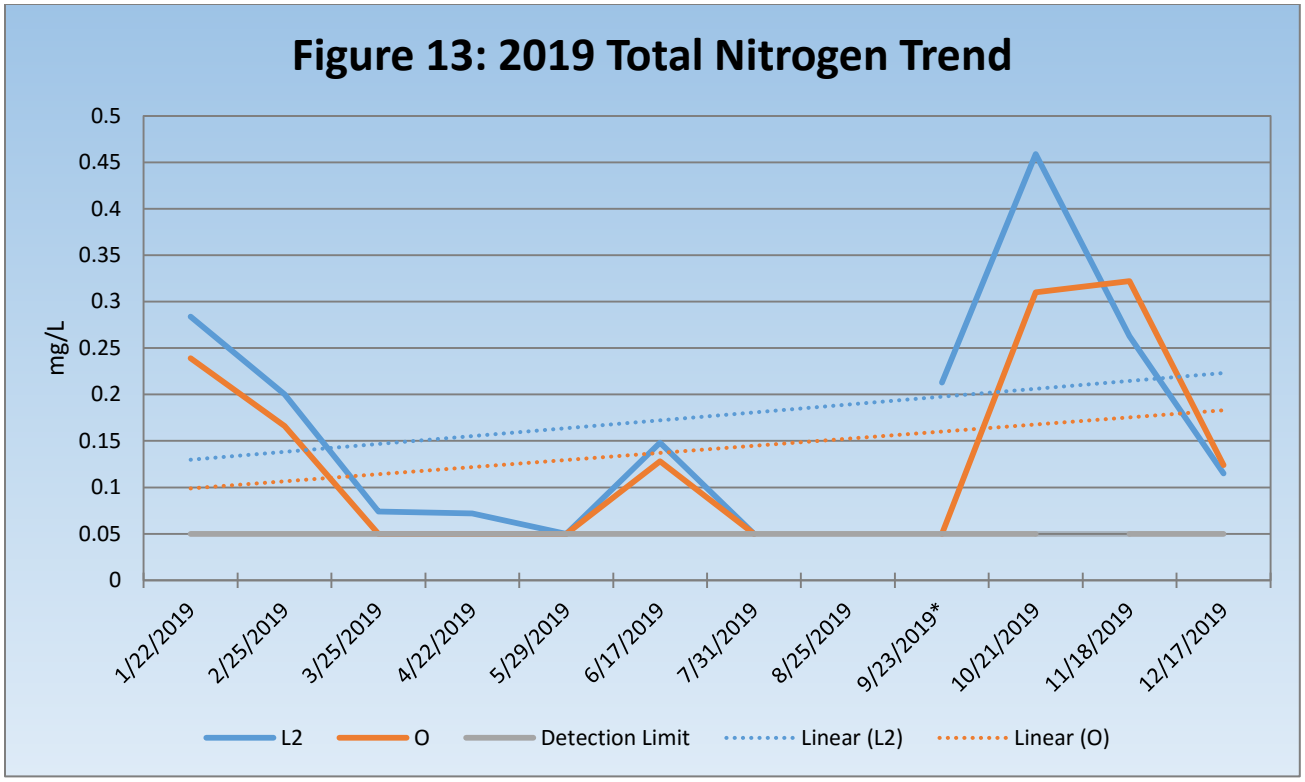


Figure 12: Four (4) Year Nitrogen Trend
3
2.5
2
1.5
1
0.5
0
mg/L
1/25/2016
3/21/2016
5/24/2016
7/20/2016
9/27/2016
11/29/2016
1/25/2017
3/28/2017
5/23/2017
7/24/2017
9/25/2017
11/27/2017
1/26/2018
3/26/2018
5/25/2018
7/31/2018
9/26/2018
11/26/2018
1/22/2019
3/25/2019
5/29/2019
7/31/2019
9/23/2019*
11/18/2019
L2
O
Linear (L2)
Linear (O)




*9/23/2019* samples were received out of holding time and above preservative temp.*

## CONCLUSION

2019 was a fairly normal year for Lee Creek fisheries and water quality. A wetter than normal year was experienced and kept nutrient levels a little elevated but nowhere near levels that are cause for concern. Total fish population percent's look to be in a good range with game and forage fish making up a good portion of the sample size with rough fish population staying fairly stable around 10-13%.

Trap nets are showing that the sampled crappie population is trending towards larger fish with very high PSD and PSD-P values. Three length classes made up 70% of the sample size all in ranges that skew PSD and PSD-P to a higher number.

Boat electro-shocking only yielded a small number of largemouth bass (N=19). The water was more opaque from heavy rains so not all bass could be netted and landed. The average Wr on the largemouth bass was at 93.5 meaning the fish caught were healthy and not starved. Confidence in PSD and PSD-P numbers is low because of such a small sample size not being indicative of the population as a whole.

IBI scores for stream fish stayed around the same or dropped slightly in 2019 mainly due to creek levels being elevated from excessive rains. Water levels being up will affect how well the fish can escape the electrical current leading to less taxa as whole being caught.

Surber netting this year saw a few creeks drop in stream condition score, likely due to heavy rains. The creeks that seemed most affected by the rains were Cove and Upper Lee. Cove

saw a drop in taxa richness by over half from previous years and also saw a drop in EPT taxa. All other creeks scored in their normal ranges and were less affected by the rain.

Algae numbers and nutrient levels were normal for Lee Creek in 2019. The summer months were the only time MIB and Geosmin levels exceeded threshold limits which is normal considering the summer is peak growing season. Phosphorous levels saw a very slight rise for the year and the four (4) year trend is showing a slight increase in P at L2. The O sample site is trending slightly downward for 2019 but is trending fairly flat for the four (4) year sample period. Nitrogen at L2 site is trending slightly downward over the four (4) year sample period but is trending upwards for 2019. This is more than likely due to heavy rains leading to more soil runoff or erosion somewhere in the watershed. The O site is trending upwards for both 2019 and the four (4) year sample period. Once again a wetter than normal year could be the cause for the 2019 trend to be upward.

Overall, the water quality for 2019 seems to be within the normal range from historical data. The reservoir is being dominated by a white crappie population that is trending towards larger fish and not enough bass were collected to accurately gauge the population. Excess rain led to some creeks IBI and stream condition scores to drop but that was expected with how much high flows affect the dynamics of the creeks and macroinvertebrate/stream fish populations. Nutrient levels were slightly elevated by the rain while algae populations were kept low because of constant flushing.

**Appendix A.**

| Lee Creek Watershed Stream Fish Species List | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Family** | **Genus** | **Species** | **Common Name** | **2016** | **2017** | **2018** | **2019** |
| Atherinidae | Labidesthes | sicculus | Brook Silverside | | | | |
| Catostomidae | Moxostoma | duquesnei | Black Redhorse | | | | |
| Catostomidae | Moxostoma | erythrurum | Golden Redhorse | | ✓ | ✓ | ✓ |
| Catostomidae | Hypentelium | nigricans | Northern Hog Sucker | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | cyanellus | Green Sunfish | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | macrochirus | Bluegill | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | megalotis | Longear Sunfish | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Micropterus | dolomieu | Smallmouth Bass | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Micropterus | punctulatus | Spotted bass | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | gulosus | Warmouth | | | | |
| Cyprinidae | Notropis | greenei | Wedgespot | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Campostoma | anomalum | Central Stoneroller | | | | |
| Cyprinidae | Campostoma | spadiceum | Highland Stoneroller | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Luxilus | cardinalis | Cardinal Shiner | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Pimephales | notatus | Bluntnose Minnow | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Notropis | atherinoides | Emerald Shiner | | | | |
| Cyprinidae | Notropis | boops | Bigeye Shiner | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Semotilus | atromaculatus | Creek Chub | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Nocomis | asper | Redspot Chub | | | | ✓ |
| Cyprinidae | Notropis | whipplei | Steelcolor Shiner | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Notropis | nubilus | Ozark Minnow | ✓ | ✓ | ✓ | ✓ |
| Fundulidae | Fundulus | catenatus | Northern Studfish | ✓ | ✓ | ✓ | ✓ |
| Fundulidae | Fundulus | notatus | Blackstriped Topminnow | ✓ | ✓ | ✓ | ✓ |
| Ictaluridae | Noturus | exilis | Slender Madtom | ✓ | ✓ | ✓ | ✓ |
| Ictaluridae | Ameiurus | natalis | Yellow Bullhead | ✓ | ✓ | ✓ | ✓ |
| Ictaluridae | Ameiurus | melas | Black Bullhead | | | | ✓ |
| Percidae | Etheostoma | blennioides | Greenside Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Etheostoma | flabellare | Fantail Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Etheostoma | spectabile | Orangethroat Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Etheostoma | punctulatum | Stippled/Sunburst Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Etheostoma | whipplei | Redfin Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Etheostoma | zonale | Banded Darter | ✓ | ✓ | ✓ | ✓ |
| Percidae | Percina | caprodes | Logperch | ✓ | ✓ | ✓ | ✓ |
| Ictaluridae | Pylodictis | olivaris | Flathead Catfish | | | ✓ | |
| Ictaluridae | Ictalurus | punctatus | Channel Catfish | | | | ✓ |

**Appendix B.**

| Lee Creek Reservoir Fish Species List | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Family** | **Genus** | **Species** | **Common Name** | **2016** | **2017** | **2018** | **2019** |
| Catostomidae | Minytrema | melanops | Spotted Sucker | ✓ | ✓ | ✓ | ✓ |
| Catostomidae | Moxostoma | erythrurum | Golden Redhorse | ✓ | ✓ | ✓ | ✓ |
| Catostomidae | Moxostoma | carinatum | River Redhorse | ✓ | | | ✓ |
| Centrarchidae | Micropterus | salmoides | Largemouth Bass | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Micropterus | punctulatus | Spotted Bass | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | macrochirus | Bluegill | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | microlophus | Redear Sunfish | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | cyanellus | Green Sunfish | ✓ | | ✓ | ✓ |
| Centrarchidae | Lepomis | gulosus | Warmouth | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Lepomis | megalotis | Longear Sunfish | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Pomoxis | annularis | White Crappie | ✓ | ✓ | ✓ | ✓ |
| Centrarchidae | Pomoxis | nigromaculatus | Black Crappie | ✓ | ✓ | | ✓ |
| Clupeidae | Dorosoma | cepedianum | Gizzard Shad | ✓ | ✓ | ✓ | ✓ |
| Cyprinidae | Cyprinus | carpio | Common Carp | ✓ | ✓ | | |
| Cyprinidae | Notemigonus | crysoleucas | Golden Shiner | | | | |
| Ictaluridae | Ameiurus | natalis | Yellow Bullhead | ✓ | ✓ | | ✓ |
| Ictaluridae | Ictalurus | punctatus | Channel Catfish | ✓ | ✓ | ✓ | ✓ |
| Ictaluridae | Ictalurus | furcatus | Blue Catfish | ✓ | | | |
| Ictaluridae | Pylodictis | olivaris | Flathead Catfish | | ✓ | | |
| Lepisosteidae | Lepisosteus | oculatus | Spotted Gar | ✓ | ✓ | ✓ | ✓ |
| Lepisosteidae | Lepisosteus | osseus | Longnose Gar | ✓ | | | |
| Petromyzontidae | Ichthyomyzon | castaneus | Chestnut Lamprey | ✓ | ✓ | | ✓ |