LEE CREEK

ANNUAL RESERVOIR/WATERSHED REPORT 2018

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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 shore line. 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 mono-filament 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 shore line, 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 mono-filament netting. Trammel nets are 91.4 meters in length and have a single mesh size (3 inches). Nets are set perpendicular to the shore line, 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 night time 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, the fish are identified to species, 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 stream bed 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 and 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) being the best score for each metric and a twenty (20) being 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 is 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.

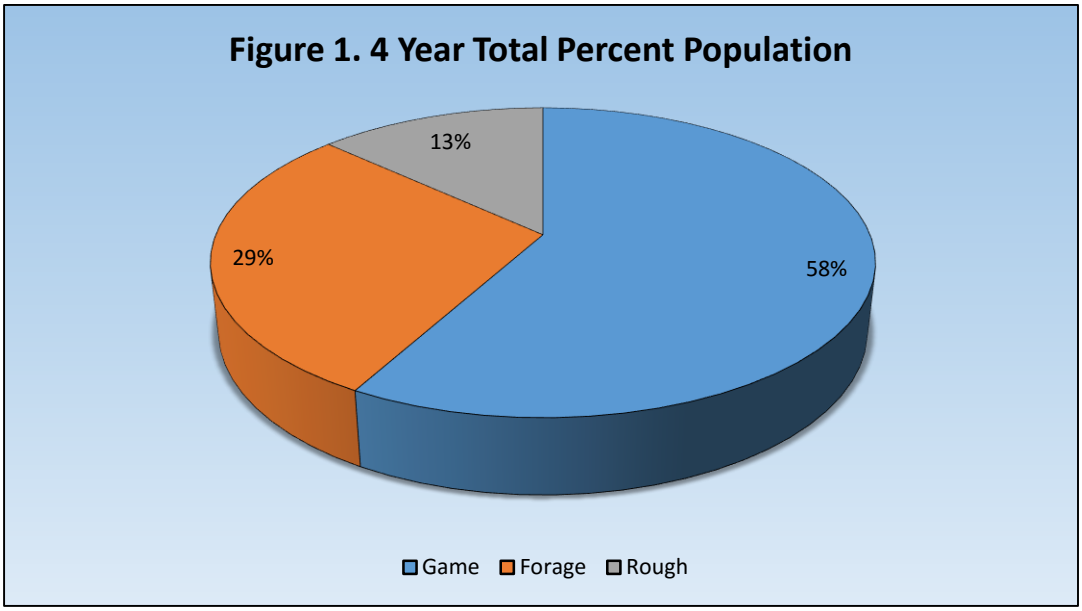
Water Quality

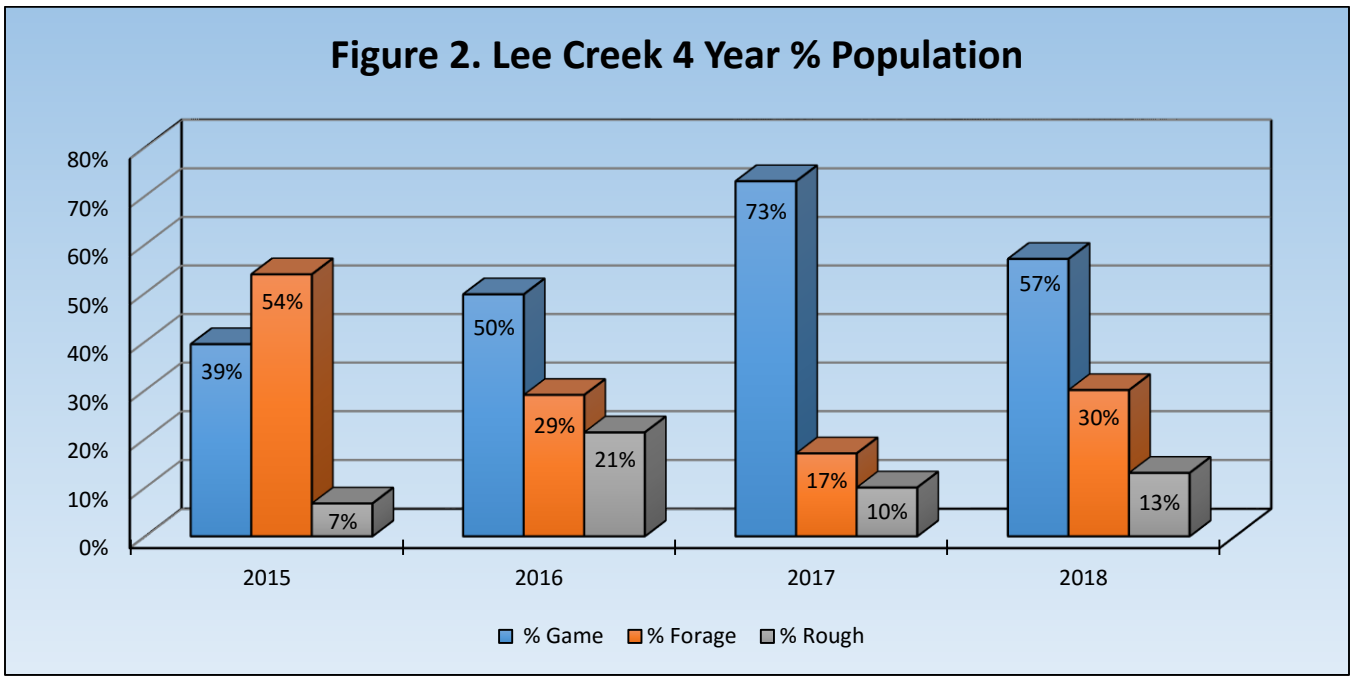
Phosphorous, nitrogen, and chlorophyll-α are three (3) water quality indicators tested by the City of Fort Smith. Phosphorous samples are obtained by a surface grab at five (5) pre-determined sites that extend the length of the reservoir. Nitrogen sampling is done on a monthly basis at two (2) sites 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 varies from 39% to 73% yearly in that time frame. Forage fish made up 29% of the sample and almost doubled their percentage from last year going from 17% of the sample population to 30%. This drastic increase could be due to the large crappie sampling of 2017 skewing game fish numbers larger than normal for that year. The rough fish was around 13% of the population and that seems to be in the normal range from previous years.

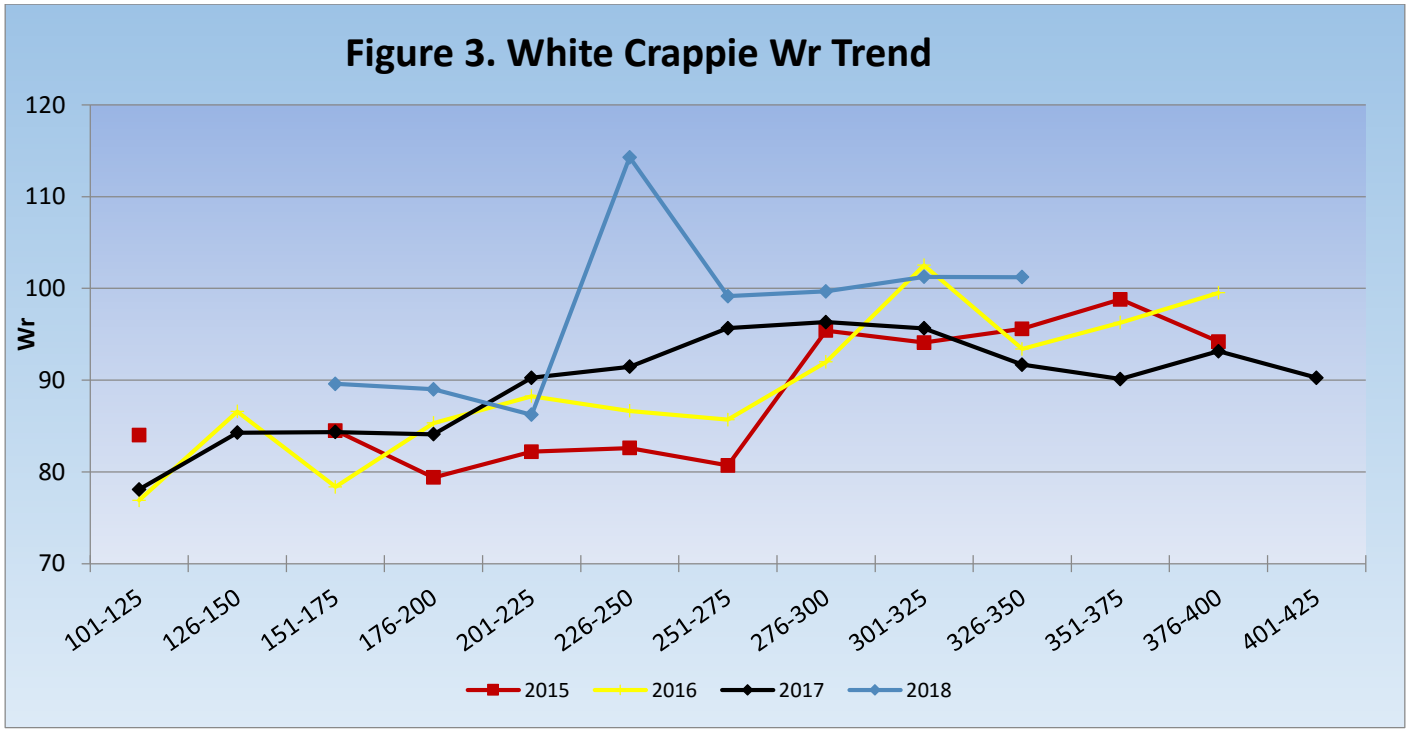




Trap Nets

Trap netting was conducted from March 19, 2019 to April 12, 2019 for a total of 20 net nights. A total of 81 white crappie (*Pomoxis annularis*) were sampled. The average Wr of the white crappie sampled was 97.71 meaning the crappie are in the 97th percentile for the standard length specific weight. This would indicate the population isn't having to compete too much for limited forage fish numbers. Figure 3 shows average Wr for each length class for the past four (4) years. PSD and PSD-P values were calculated even though the N (sample number of fish) was lower than 125, the recommended minimum sample size for calculating PSD according to Quist et al. (2009) The PSD was at 88.9 and the PSD-P was at 72.8. Both of these numbers are above acceptable ranges for white crappie populations. 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 a dominant age class being present between the 276-300 mm and 301-325 mm length classes. This seems to agree with the 2017 data in that two length classes made up around 64% of the sample size. This year the dominant age class made up 64% of the sample size as well. Unlike 2017, this year the dominant age class was above the specified lengths for both PSD and PSD-P leading to the values to be above the acceptable ranges. The dominant age class should fall off within the next few years and we should see a normalization in the data as a younger age class of white crappie takes over.

Table 1. White Crappie Trap Net Summary of Statistics				
	2015	2016	2017	2018
Net Nights	30	37	20	20
N	91	90	553	81
Mean Length (mm)	271.9	235.18	244.8	275.95
Mean Weight (g)	385.19	226.78	217.53	339.26
Mean Wr	91.18	88.32	91.81	97.71
CPUE	0.126	0.101	1.15	0.344
PSD	68.2	85.0	93	88.9
PSD-P (RSD_{10} previously)	63.6	27.0	28	72.8



Gill Nets

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

Trammel Nets

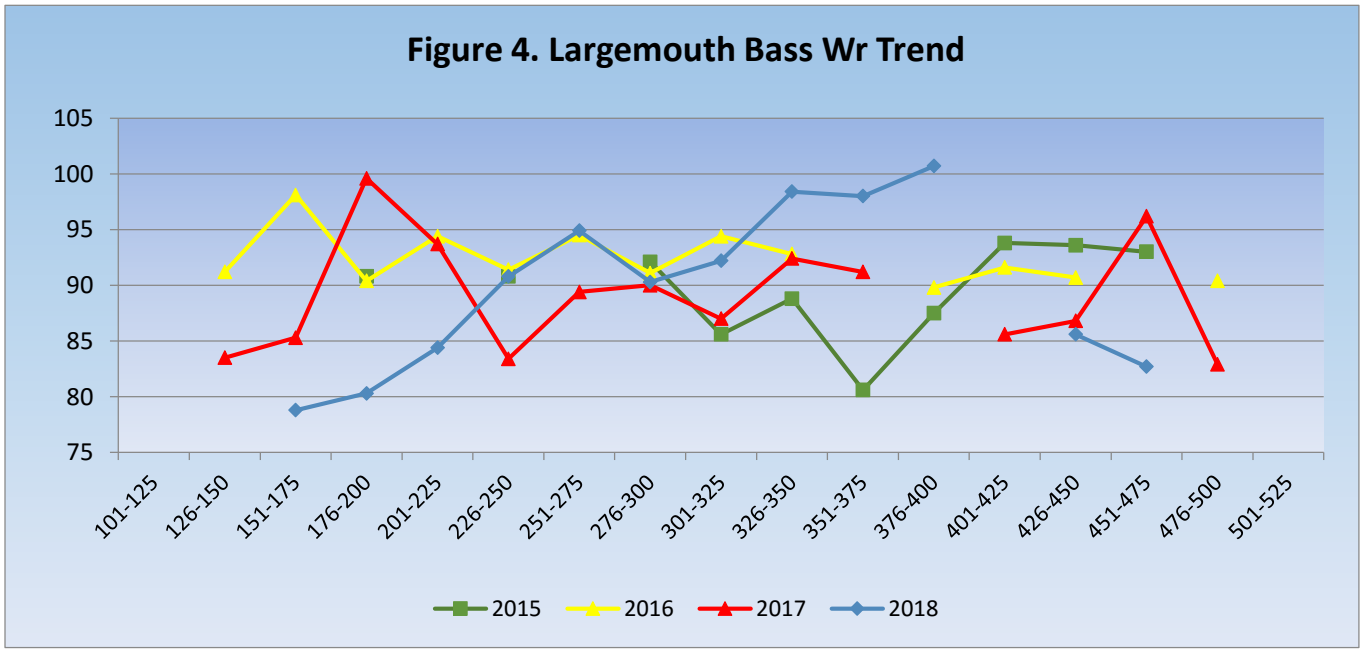
No trammel nets were set out this year due to weather constraints.

Boat Electro-shocking

Boat electro-shocking was conducted on two nights, November 6th, 2018 and November 13th, 2018. A total of 50 largemouth bass (*Micropterus salmoides*) were sampled. Mean length was 277.1 mm while the mean weight was 364.9 grams. The Wr average came out about the same as last year at 89.7 meaning the fish are fairly stable and aren't having to compete much for forage. As with the crappie 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 slightly lower than accepted values but when taking the mean length (277.1 mm) value sampled and comparing it to the minimum quality length (305 mm) value used to calculate PSD the lower number is expected. This just means an abundance of smaller fish was sampled and without a strong sample size a slight skew in data is expected. The PSD-P is within the lower portion of the acceptable range indicating there is not an overabundance of larger bass. Table 2 and Figure 6 show the data for the previous four (4) years.

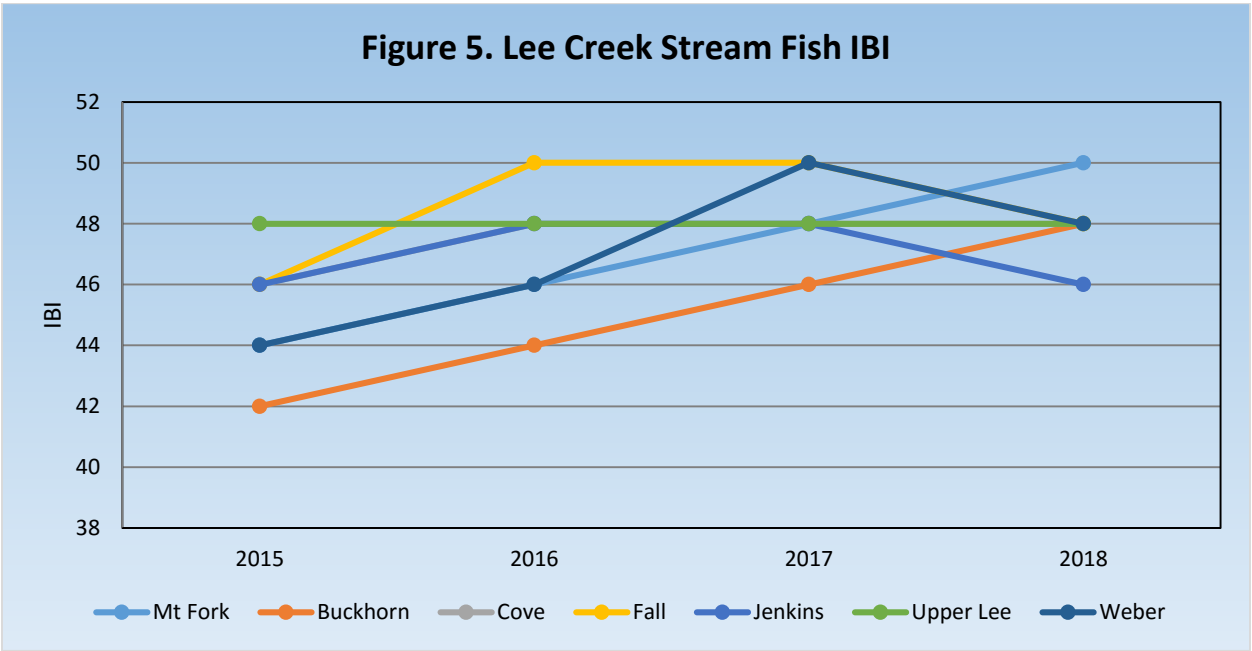
Table 2. LMB Electroshocking Summary of Statistics

	2015	2016	2017	2018
N	34	110	43	50
Mean L	371.0	242.6	316.5	277.1
Mean W	755.71	251.40	507.4	364.9
Mean Wr	89.4	92.9	89.1	89.7
CPUE	14.59	47.21	18.45	21.46
PSD	84.8	20.3	60.0	33.3
PSD-P	57.6	12.7	25.0	13.3



Backpack Electro-shocking

Backpack Electro-shocking was conducted from July 20, 2017 to August 4, 2017. Seven (7) sites were sampled this year to obtain IBI scores to gauge the "health" of each stream. The number of taxa ranged from 13 at Jenkins Creek to 21 at Weber Creek. Weber, Mt. Fork and Buckhorn all saw increases in taxa for 2018. Buckhorn went from 10 taxa in 2017 to 15 taxa in 2018, while Weber went from 19 to 21 taxa, and Mt. Fork went from 14 to 18. Jenkins was the only creek that saw a decrease in species from 15 to 13. Jenkins is very dynamic right now with a lot of heavy rainfall causing gravel bars to be fairly transient. This could be a reason for decreased taxa as habitat is constantly changing. The IBI scores ranged from 46 (Jenkins) to 50 (Mountain Fork). Six (6) of the creeks sampled were considered in the good range of the IBI index, from the EPA, scoring between 48 and 52. Only Jenkins creek scored lower at a 46 which is in between the fair (40-44) and good (48-52) ranges. A list of species collected is in Appendix A.



Surber Nets

First quarter macroinvertebrate samples were taken from March 13, 2018 to March 22, 2018. All scores were within acceptable ranges for their stream condition scores which tops out at 20. Four (4) of the creeks sampled this year scored out at a 20, two (2) at 18, and one (1) at 16. Cove scored 16 due to low numbers of taxa and EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa. The taxa richness dropped from 32 to 18 and the EPT taxa dropped from 18 to 8. Other than Cove all the other creeks sampled were within normal ranges. While Cove was lower in stream condition, 16 is not uncommon and this low number could be due to scouring in late 2017 early 2018 from previous rains. This wouldn't allow enough time for the bugs to repopulate from being flushed out. The second quarter samples saw Mt. Fork and Buckhorn with lower stream condition numbers. Buckhorn is expected to be lower since it is a first order stream that is dry for months out of the year, so the drop from 18 to 14 is not too concerning.

Mt Fork saw a drop from 20 to 16 which is also not a huge concern. This could be due to samplers varying what riffle they sampled or just small scouring rains. Mt. Fork is fairly unstable at the site where bugs are collected so moving gravel bars could also explain the drop.

Table 3. Lee Creek First Quarter Stream Condition

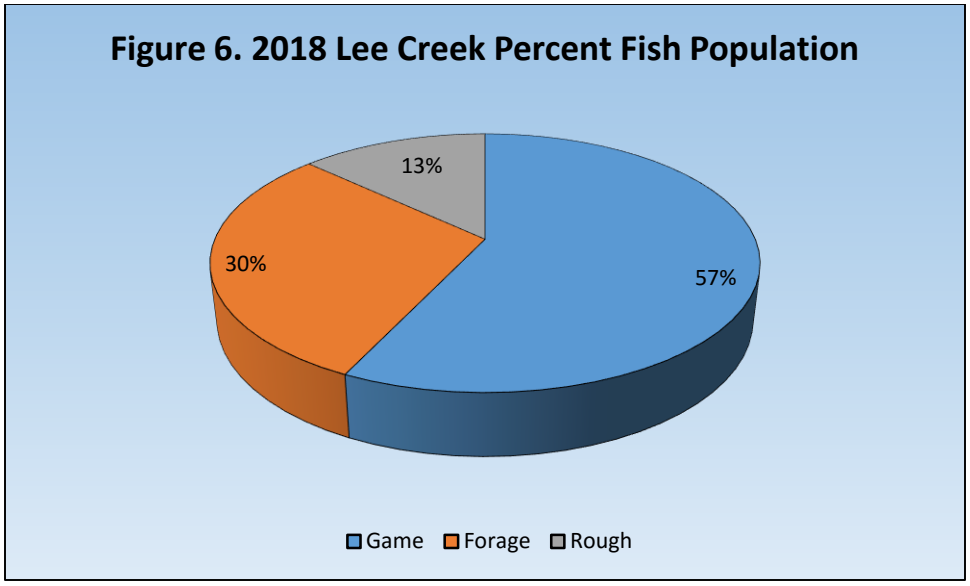
	2013	2014	2015	2016	2017	2018
Buckhorn	14	14	18	18	**	18
Cove	16	16	20	20	**	16
Jenkins	20	20	20	20	**	20
Upper Lee	20	12	20	20	**	20
Mt. Fork	20	18	18	20	**	20
Weber	***	**	18	20	**	18
Little Lee	**	**	**	20	**	20
**no samples available for analysis						

Table 4. Lee Creek Second Quarter Stream Condition

	2013	2014	2015	2016	2017	2018
Buckhorn	10	14	**	16	10	14
Cove	16	18	**	10	18	20
Jenkins	16	20	**	20	18	20
Upper Lee	18	**	**	20	20	20
Mt. Fork	16	20	**	16	20	16
Weber	**	**	**	18	20	18
Little Lee	16	**	**	20	16	18
**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 57% of the population sampled this year. Forage fish are the herbivores and insectivores that typically get predated on by the game fish and other predators. Forage fish made up 30% of this year's sample which is good to see since they are towards the bottom of the food chain. The last group is the rough fish or suckers, gar, carp and shad. These fish are typically not sought after by anglers and they made up around 13% of the population in 2018.



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 and more of a concern in drinking water reservoirs worldwide. 2018 was a typical year for Lee Creek with algae counts staying fairly low until the summer months which is the growing season and numbers are expected to rise. July, August and September are expected to be the months with highest algae numbers and this year's data reflects that. The summer wasn't unusually wet but there were enough days of rain to keep nutrients cycling into Lee Creek to allow algae to flourish and not have to compete as much for resources. The major spike in late July early August was mainly the green alga *Ankistrodesmus spp.* and a mix of diatoms *Fragilaria spp., Rhizosolena spp.,* and *Cyclotella spp.* These are all common algae's 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 doesn't 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. The other part that helps Lee Creek stay low in algae numbers is that with enough rain water will spill over the damn in effect flushing the reservoir not allowing much algae to take hold.

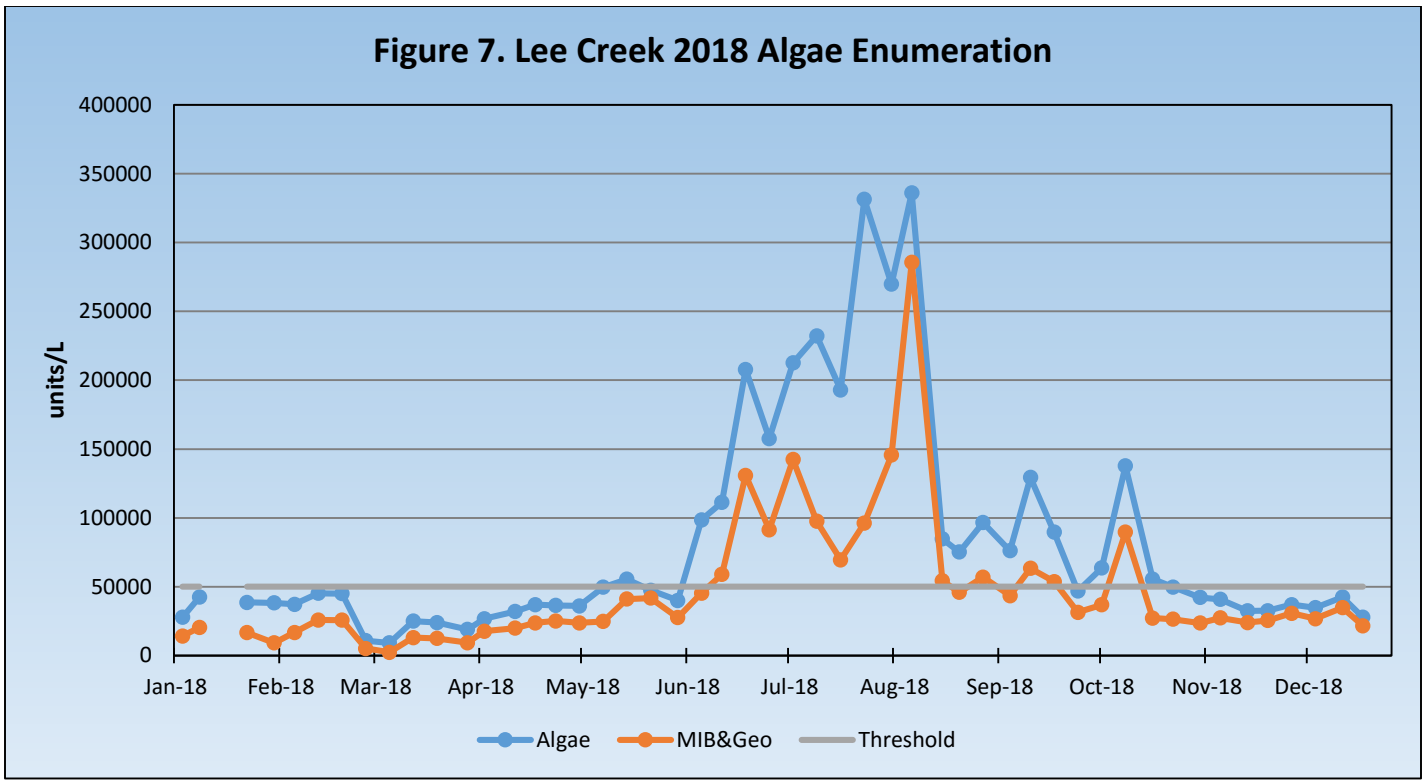


Figure 7. Lee Creek 2018 Algae Enumeration
400000
350000
300000
250000
200000
150000
100000
50000
0
units/L
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Algae
MIB&Geo
Threshold

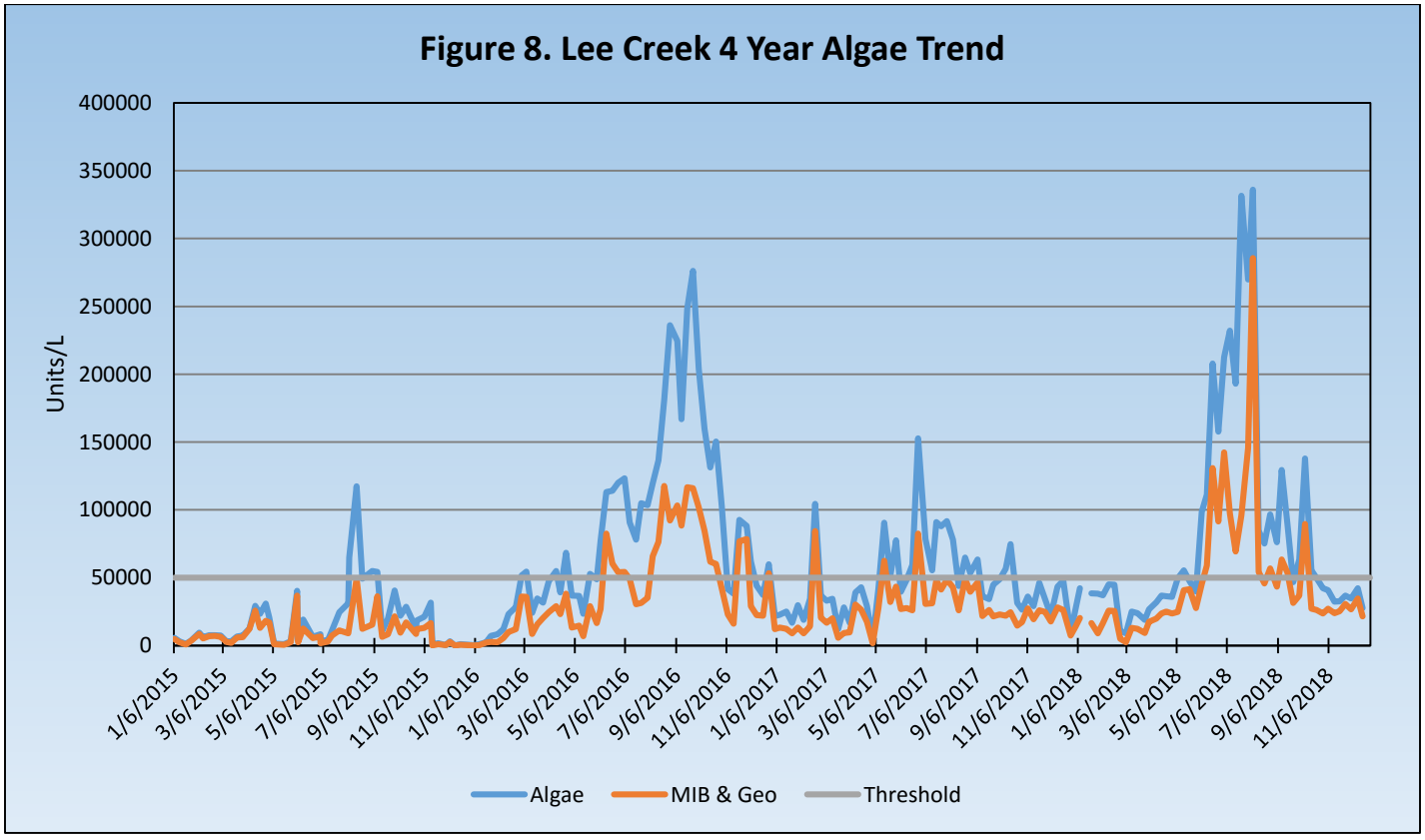
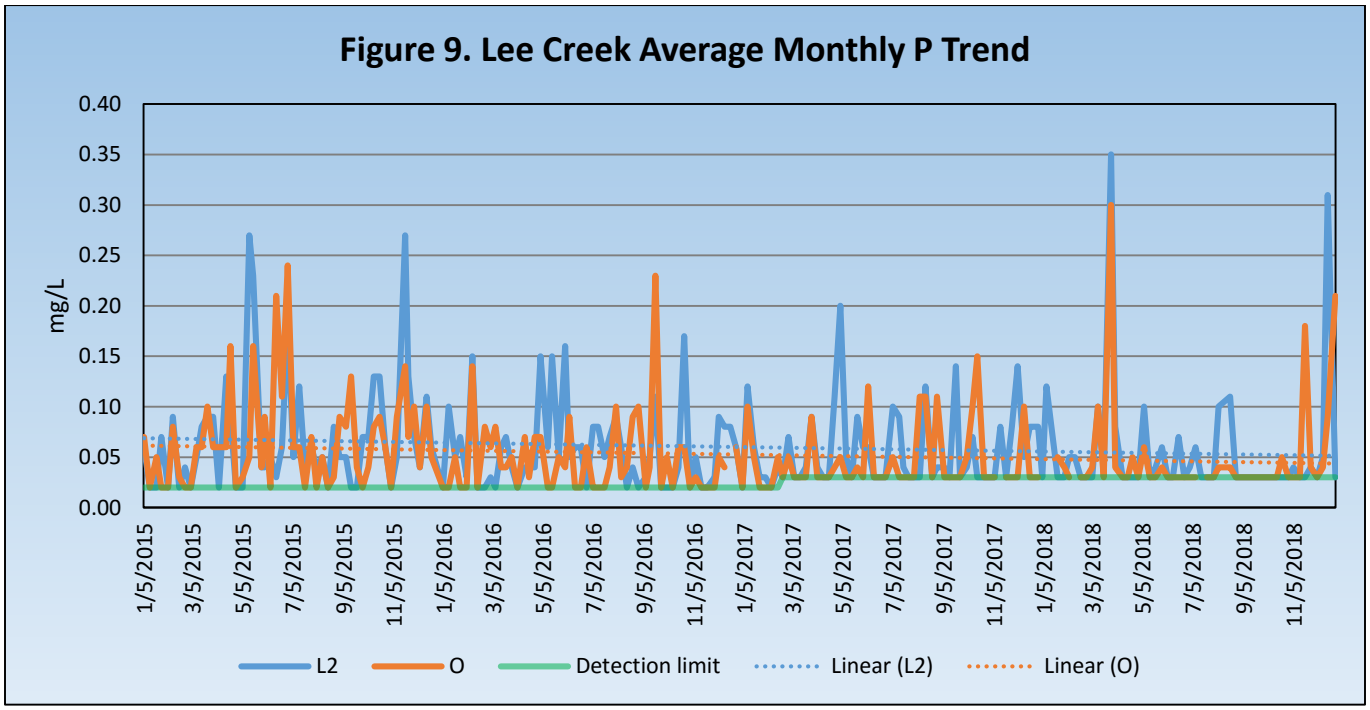


Figure 8. Lee Creek 4 Year Algae Trend
400000
350000
300000
250000
200000
150000
100000
50000
0
Units/L
1/6/2015
3/6/2015
5/6/2015
7/6/2015
9/6/2015
11/6/2015
1/6/2016
3/6/2016
5/6/2016
7/6/2016
9/6/2016
11/6/2016
1/6/2017
3/6/2017
5/6/2017
7/6/2017
9/6/2017
11/6/2017
1/6/2018
3/6/2018
5/6/2018
7/6/2018
9/6/2018
11/6/2018
Algae
MIB & Geo
Threshold

Water Quality

Phosphorous data is showing a slight drop over the (4) year sample period at both sample sites as seen in Figure X. 2018 saw two (2) major spikes in phosphorous one in late March, early April and another towards the end of the year. These more than likely coincide with larger rain events that caused a good amount of surface runoff into the creeks and then into Lee Creek. Agricultural and cattle operations are a big source of phosphorous from manure and fertilizer. Lee Creek basin does not have many big operations of either so most phosphorous seen is from soil runoff from rain events. The nitrogen trend shows a slight rise for both sites over the 4 year period while the L2 site actually dropped when looking at just 2018. The spike seen towards the end of the year can be explained by a very wet winter that the area experienced. Nitrogen comes from runoff from cattle and agricultural operations, but also can be scrubbed from the atmosphere during rain events. Once again most nitrogen loading is from runoff and the atmosphere since no big agricultural operations are in the basin.



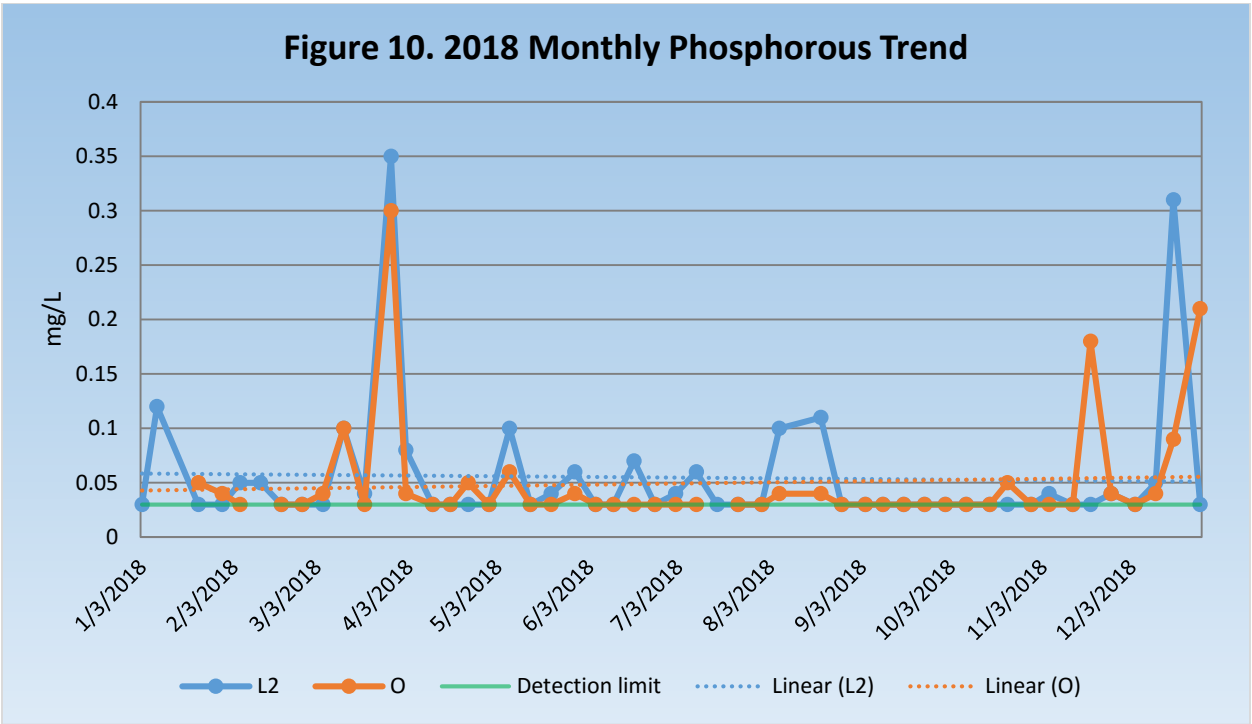


Figure 10. 2018 Monthly Phosphorous Trend
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
mg/L
1/3/2018
2/3/2018
3/3/2018
4/3/2018
5/3/2018
6/3/2018
7/3/2018
8/3/2018
9/3/2018
10/3/2018
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12/3/2018
L2
O
Detection limit
Linear (L2)
Linear (O)

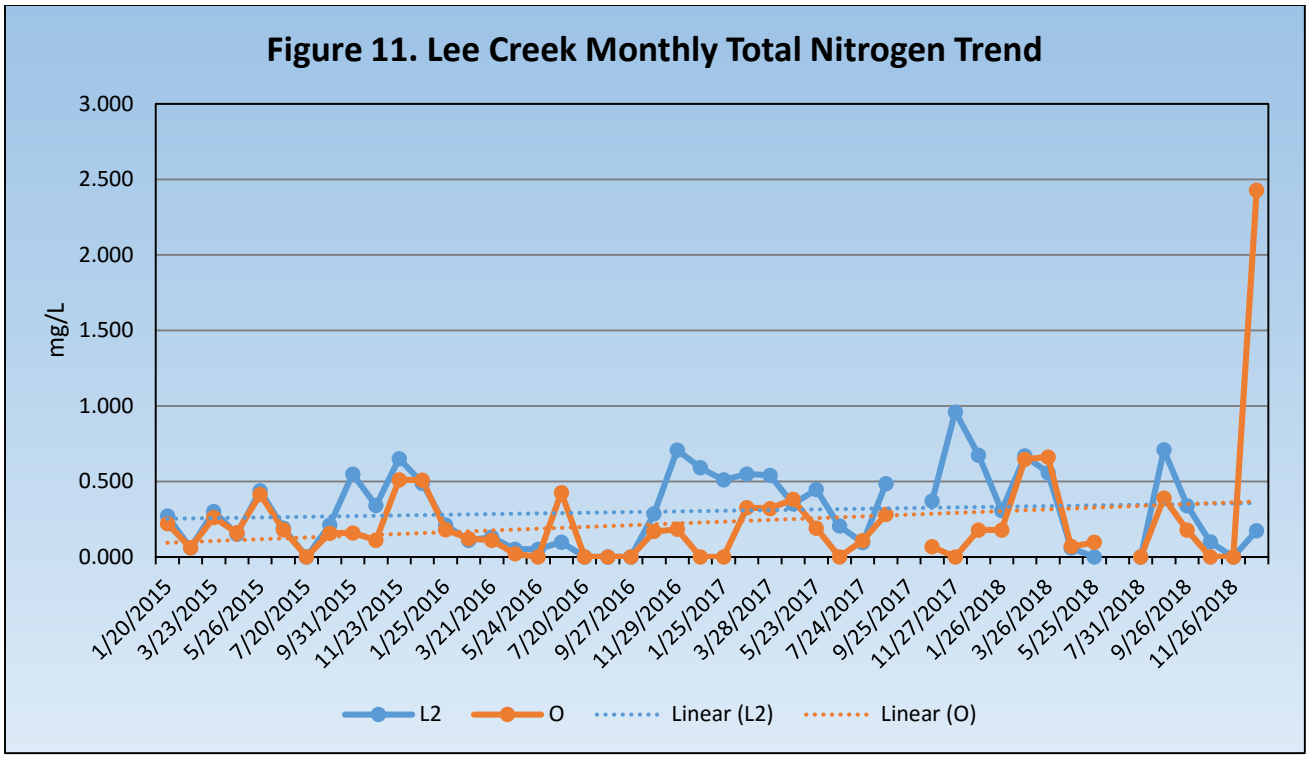
Figure 11. Lee Creek Monthly Total Nitrogen Trend
3.000
2.500
2.000
1.500
1.000
0.500
0.000
mg/L
1/20/2015
3/23/2015
5/26/2015
7/20/2015
9/31/2015
11/23/2015
1/25/2016
3/21/2016
5/24/2016
7/20/2016
9/27/2016
11/29/2016
1/25/2017
3/28/2017
5/23/2017
7/24/2017
9/25/2017
11/27/2017
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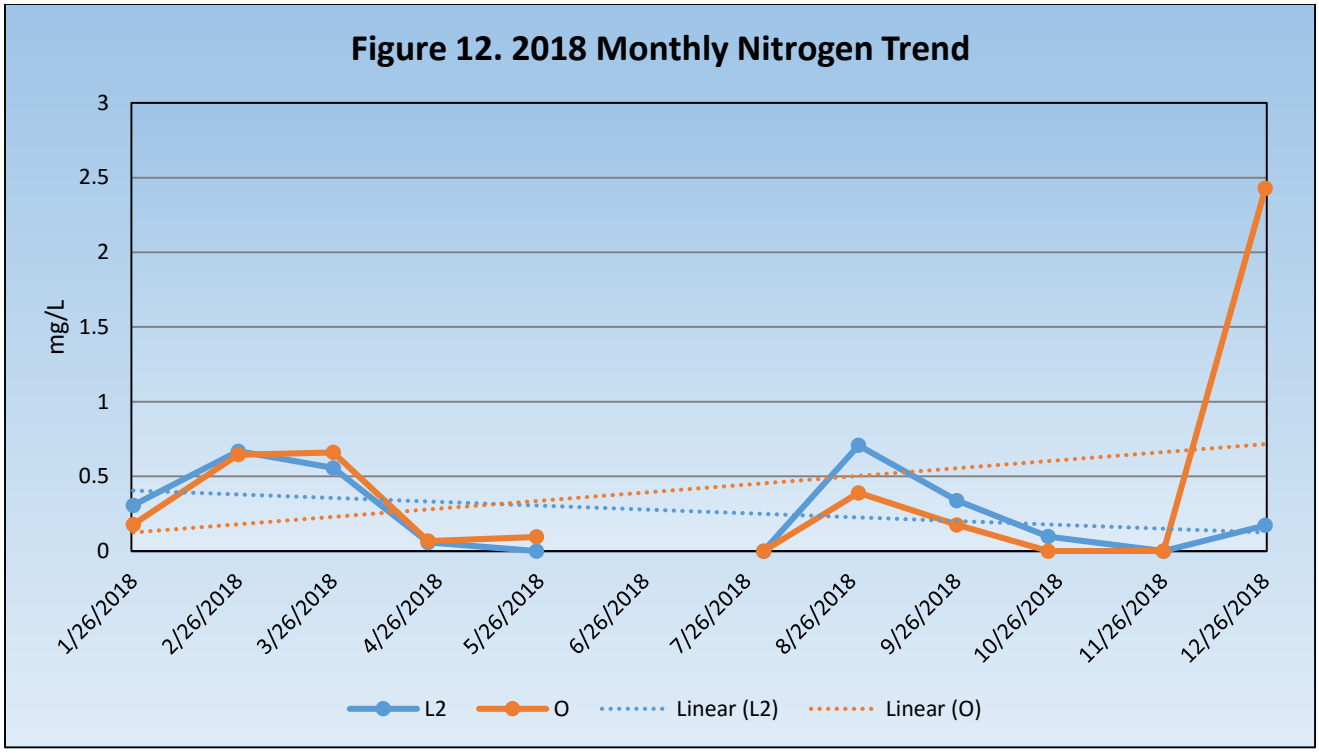
9/26/2018
11/26/2018
L2
O
Linear (L2)
Linear (O)



CONCLUSION

Over the four (4) year sample period 2018 numbers returned back to a more normal population distribution. Figure 2 shows game fish made up 57% of the sample with forage fish being around 30%. This better reflects the population distribution of Lee Creek as opposed to 2017 and the record crappie sampling. Rough fish numbers stayed within the normal range at 13%.

The trap net data this year showed a trend toward a higher number of large crappie as opposed to an even distribution. One hypothesis is that the white crappie population in Lee Creek has a dominant age class as explained by Jerald Horst in “Sack of Milk”. Following the population through the years shows that a majority of crappie caught are within two length classes and you can follow the two class’s growth through the years. 2017 saw 64% of the fish sampled being between 201-225 mm and 226-250 mm. 2018 saw 64% of the fish sampled being between 276-300 mm and 301-325 mm. The 64% is just coincidence but if a dominant age class was present you would expect that majority to make up the most of a sample at the given length class(s) for their age. This is exactly what the data is showing in Lee Creek. This age class will continue to skew the data toward larger fish until the dominant class begins to die out allowing smaller crappie classes to grow and mature.

No gill or trammel nets were run this year. Weather limited time available for sampling and floating debris was not conducive to sampling accurately.

Boat electroshocking only saw a sample size of 50 largemouth bass leading to an inaccurate PSD and PSD-P, the new RSD. The Wr of fish sampled was at 89.7 well within the normal range when compared to the four (4) year trend. This means the fish are within the 90th percentile of growth meaning they are not starved of forage.

Backpack electroshocking and the surber nets both showed the streams feeding Lee Creek were in fairly good condition. Jenkins saw a decrease in fish species but Jenkins is very dynamic right now with transient gravel bars. This may be a cause for the drop in species since some habitat has more than likely been lost. First quarter macroinvertebrates taxa saw an increase but the second quarter saw almost 10 species less. Jenkins is still within normal ranges so there is no concern of impairment. The rest of the creeks sampled had numbers within their normal ranges.

Algae productivity in Lee Creek for 2018 was normal. It is expected with such a shallow and nutrient rich reservoir that algae blooms will happen without sufficient flow through in the summer, growing, months. Elevated algae numbers were seen from late June through most of August mostly from the phylum *Bacilliariophyceae* (diatoms) and the phylum *Chlorophyta* (green algae). Neither of these are harmful to human health like blue-greens but some species of both diatoms and greens will produce taste and odor compounds when lysing that can affect waters palatability. This is the main reason the City of Fort Smith monitors algae in its reservoirs.

Nutrient levels in Lee Creek were pretty stagnant this year. Figure 10 shows that phosphorous levels entering Lee Creek stayed about the same year round when a trend line is added. The peaks more than likely represent rain events. Figure 12 shows nitrogen levels decreasing at site L2 while increasing at site O. The Oklahoma (O) site is the uppermost part of the reservoir sampled and is where most of the inflowing water enters Lee Creek. Higher nutrients are expected here rather than L2 since they don't have as much time to settle out of suspension at O.

Appendix A.

Lee Creek Watershed Stream Fish Species List							
Family	**Genus**	**Species**	**Common Name**	**2015**	**2016**	**2017**	**2018**
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	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		✓	✓	✓
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				✓

Appendix B.

Lee Creek Reservoir Fish Species List							
Family	**Genus**	**Species**	**Common Name**	**2015**	**2016**	**2017**	**2018**
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		✓	✓	