

Section 3: Sampling and Laboratory Analysis

3.1: Stations and Parameters

Lake sampling for water quality is performed at monthly intervals. Monthly sampling yields multiple samplings for each season: summer; fall; winter and spring. This helps track seasonal variations and storm events. A map of the lakes monitored is in figure 3.1.1. Station locations can be found in table 3.1.1. Maps of the individual lakes with stations can be found in the lake section of this report.

3.2: Field Physical/Chemical Parameters Monitored

The following water quality parameters are monitored on site by the Leon County Lakes Ecology program: Time of Day; Cloud Cover; Wind Speed and Direction; and Air Temperature. Physical-Chemical Parameters: Station Depth; Stage; Secchi Depth; Water Temperature; Turbidity (NTU); Dissolved Oxygen (mg/L); Percent Saturation; pH; Conductivity. Nutrients.

3.3: Laboratory Water Quality Parameters Monitored

The following water quality parameters are measured by the Leon County Lakes Ecology Program in the laboratory from samples taken in the field under FDEP approved sampling techniques, EPA approved preservation techniques and EPA approved holding times: Turbidity (NTU); True Color (PtCo Units); Alkalinity (mg/L); Chloride (mg/L); TSS, Residue, @ 103-105 degrees C (mg/L); TDS, Residue, @ 103-105 degrees C (mg/L); Ortho-Phosphorus (mg/L, filtered in the field); Total Phosphorus (TP, mg/L); Total Inorganic Phosphorus (TIP, mg/L); Nitrite (mg/L); Nitrate + Nitrite (mg/L); Nitrate (mg/L); Total Inorganic Nitrogen (TIN, mg/L); TIN/TIP Ratio; Ammonia (mg/L); Total Kjeldahl Nitrogen (TKN, mg/L); Total Nitrogen (TN, mg/L); TN/TP Ratio; Chlorophyll (mg/L); Pheophytin (mg/L); Enterococcus (colonies/100ml); E. Coli (colonies/100ml); Fecal Coliforms (colonies/100ml) and Total Coliforms (colonies/100ml).

3.4: Sediment Quality Parameters

Sediments (sampled annually): Sediment Depth; Sediment Type/Grain Size; Depth from sediment/water interface to underlying hard pan; Moisture Content of Sediment (mg/kg); Organic Content of Sediment (mg/kg); Inorganic Content of Sediment (mg/kg); Total Kjeldahl Nitrogen (mg/kg, dry weight); Total Phosphorus (mg/kg, dry weight).

3.5: Aquatic Plant Monitoring

Estimated percent coverage of the lake bottom by submerged and emergent macrophytes within three non-overlapping randomized quadrants; Estimated percent coverage of the lake surface by submerged and emergent macrophytes within three non-overlapping randomized quadrants; Estimated percent total volume of the water column occupied by submerged and emergent macrophytes within three non-overlapping randomized

quadrants; Identify the dominant species and two subdominant species of macrophytes occurring at each station.

3.6: Algal Bloom Toxicity Monitoring

Five algal toxicity assays can be run on algal blooms in any of the lakes specified, at the request of the Counties Environmental Compliance Director.

3.7: Certification

McGlynn Laboratories is certified as a National Environmental Laboratory Accreditation Program (NELAC) laboratory by the Florida Department of Health (figures 3.7.1 and 3.7.2). Field sampling is performed in accordance with Florida Department of Environmental Protection (FDEP) and Environmental Protection Agency (EPA) protocols (figure 3.7.3). McGlynn Laboratories maintains a laboratory Quality Manual, Standard Operating Procedures, Chain of Custodies, Sample Receipt Logs and Analysis Logs for all sampling and analytical procedures. Method detection limits are listed in table 3.7.1. Table 3.7.2 lists the laboratory and field QA/QC checks. Proficiency testing, the blind analysis of EPA Certified Samples containing contaminants at unknown concentrations, is required every six months for all NELAC laboratories. NELAC inspects and audits all certified laboratory facilities every two years. The records of NELAC audits and proficiency testing by McGlynn Laboratories are available on request. McGlynn Labs Florida Department of Health NELAP Certification, continuous certification since September 11, 2001.



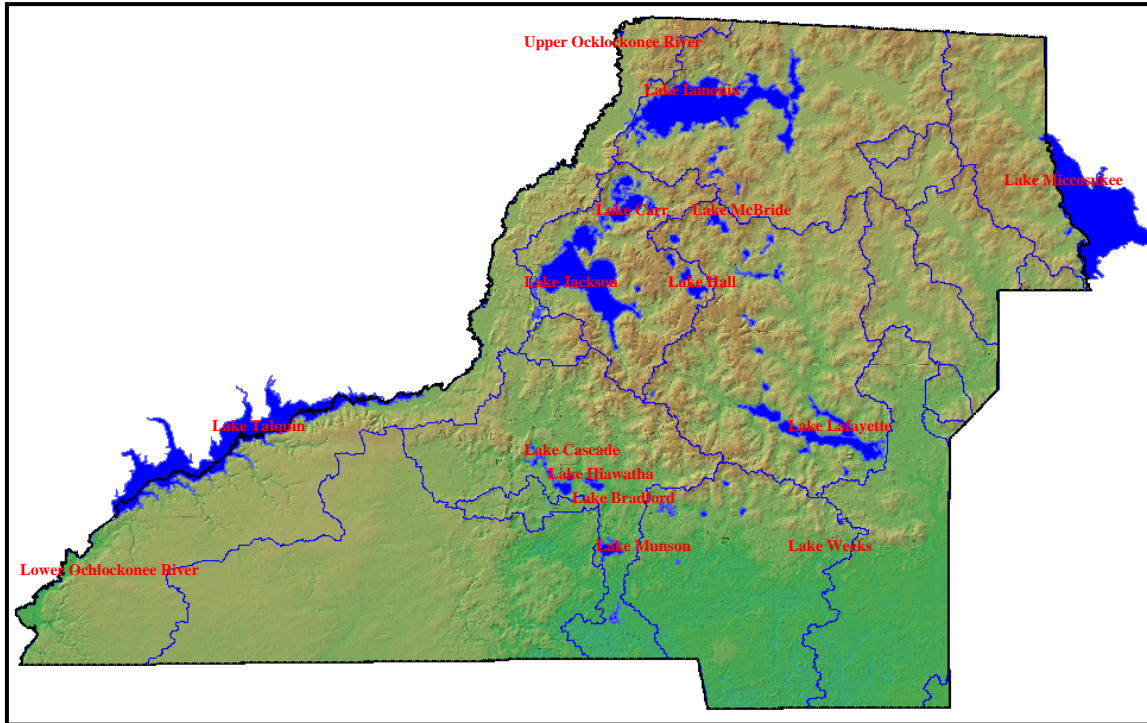


Figure 3.1.1: The lakes monitored by Leon County are lettered in red. Watersheds are depicted as blue lines. Map created by Greg Mauldin, Tallahassee-Leon County GIS using LIDAR imagery.

Table 3.1.1: Leon County Lakes sampling stations

Station ID	Station Description	Latitude	Longitude
B0B	Lake Bradford	30 24 17.92	84 20 19.2
B0C	Lake Cascade	30 25 11.5	84 21 9.24
B0H	Lake Haiwatha	30 24 45.36	84 20 56.9
CA1	Middle of Lake	30 34 41.0556	84 17 19.432
H01	western end near McClay house	30 31 24.9319	84 15 12.019
H06	eastern end near Thomasville Road	30 31 27.4969	84 14 29.4749
IA1	Meridian Road Slough (north)	30 37 40.2762	84 17 26.1236
IA2	western Lake Iamonia near islands	30 37 53.8007	84 15 21.4448
IA3	near Bull Headley	30 37 56.095	84 15 2.74
IA4	Anders Flats	30 37 58.521	84 14 37.6998
IA5	near Lester Cove	30 37 51.1518	84 13 38.0219
IA6	near the Beadle House	30 38 25.7327	84 12 33.7878
IA7	eastern end near Thomasville Road	30 37 59.5697	84 11 21.3547
J01	Meginnis Sink	30 30 7.91	84 18 24.96
J03	Meginnis Arm	30 30 26.342	84 18 32.789
J05	Rhoden Cove	30 30 46.857	84 17 50.04
J08	between Meginnis Arm and Rhoden Cove	30 30 55.943	84 18 32.83
J10	near Porterhole Sink	30 32 3.84	84 19 12.72
J16	middle of northwestern end	30 32 2.4	84 20 34.8
L02	Upper Lafayette Sink	30 27 15.88	84 12 9.83
L15	Near Windwood	30 26 3.637	84 10 25.792
L20	Near Landfill	30 25 50.437	84 9 1.667
L21	Near Chaires	30 26 3.72	84 8 15.263
L22	Near Talquin STP	30 25 21.35	84 8 4.09
L28	Alford Arm	30 27 48.513	84 10 15.367
LPZ1	Lake Piney Z	30 26 25.2	84 11 14.64
LW1	Off Don Axelrod's property	30 22 23.3288	84 8 20.8727
MB1	southeastern end	30 33 31.3279	84 13 39.4039
MB3	middle	30 33 45.6959	84 13 53.6189
MB6	northwestern end	30 33 46.1138	84 14 24.7999
MI1	near northern sink	30 36 26.9485	84 0 10.5267
MU1	northern finger	30 22 30.2948	84 18 33.52
MU3	north side	30 22 11.505	84 18 29.3069
MU5	south side	30 22 .034	84 18 24.4948
T01	northern Leon County at FL/GA border	30 40 7.8787	84 18 21.4168
T02	southern of Lake Talquin	30 23 3.5628	84 39 17.3657
T0B	southern end of Lake before the dam	30 23 54.1039	84 37 58.5347
T0C	northern end near Coes Landing	30 27 23.8108	84 29 1.6458
T0L	near Lewis Hall Landing	30 25 16.3268	84 34 23.7227
T0W	near Williams Landing	30 26 58.366	84 31 24.006



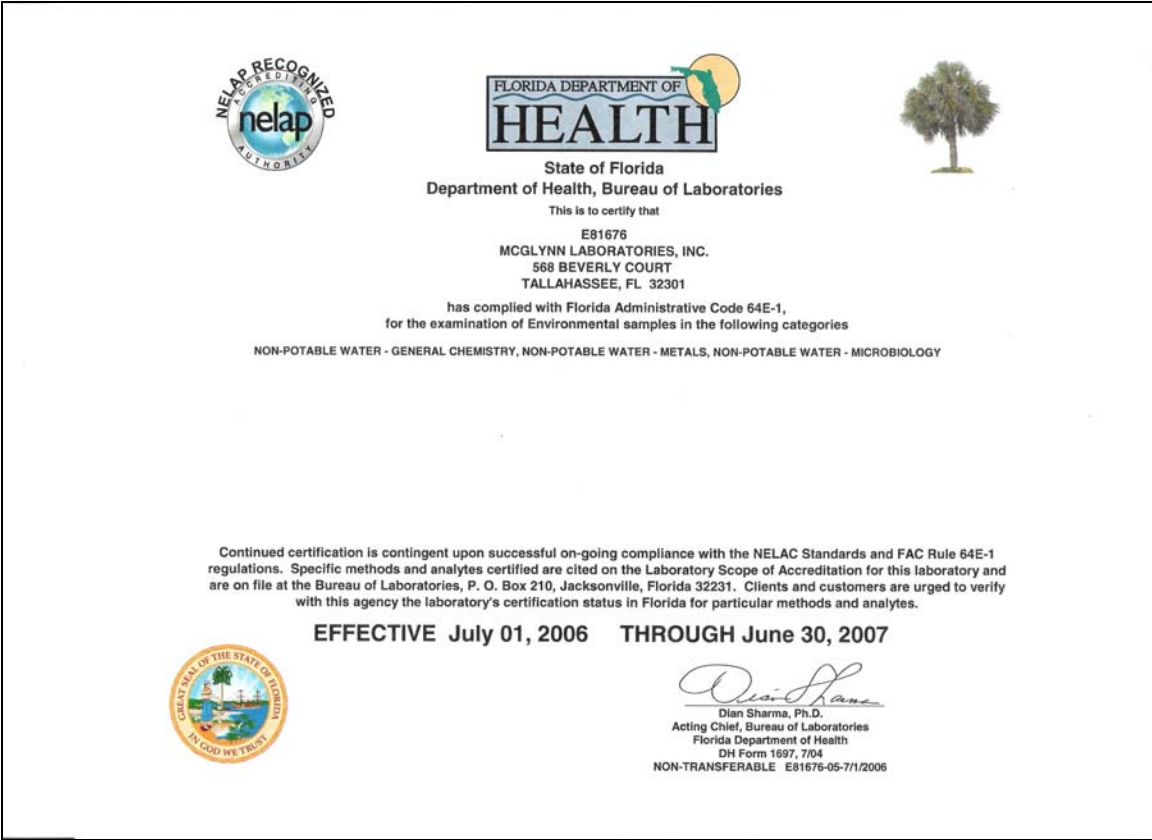


Figure 3.7.1: McGlynn Labs NELAP Certification, continuous certification since September 11, 2001.





Figure 3.7.2: McGlynn Laboratories Inc is a locally owned MBE (Woman-Owned Business Enterprise). McGlynn Laboratories Inc has offices in Tallahassee, Destin and Baton Rouge, Louisiana.

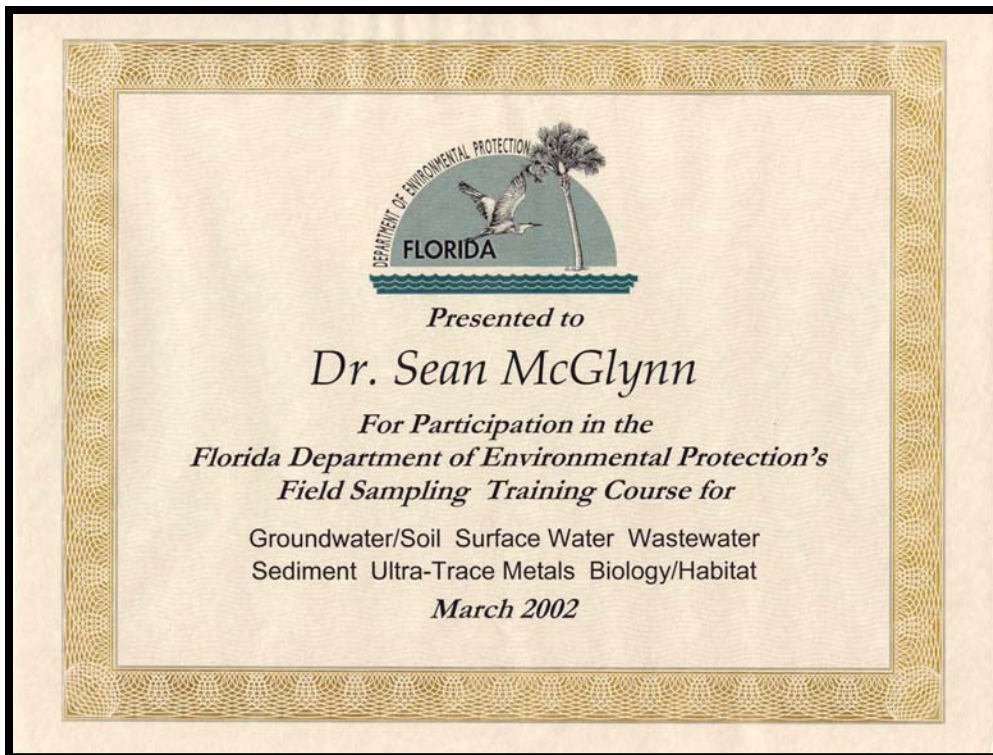


Figure 3.7.3: Dr. McGlynn's field sampling with FDEP for: Groundwater/Soil; Surface Water; Wastewater; Sediment; Ultra-Trace Metals and Biology/Habitat. McGlynn Labs is FDEP approved for TMDL analysis for Stream Condition Index and Field Sampling.

Table 3.7.1: Method Detection Limits for LCL parameters

PARAMETER	METHOD	UNITS	MDL
Conductivity	EPA 120.1	uS	1.5
PH	EPA 150.1	units	0.71
Oxygen, Diss.	EPA 360.1	mg/L	0.24
Temperature	EPA 170.1	deg C	0.07
Alkalinity (Total)	EPA 310.1	mg/L	0.15
Ammonia	EPA 350.3	mg/L	0.009
BOD	EPA 405.1	mg/L	0.1
Chloride	EPA 325.3	mg/L	0.1
Chlorophylls	SM 10200-H	ug/L	0.16
Coliforms, fecal	SM 9222D	colonies/100ml	1 ct/100ml
Color (True)	EPA 110.2	CoPt	0.9
Nitrate	EPA 353.3	mg/L	0.010
Nitrite	EPA 354.1	mg/L	0.002
Nitrogen (Organic)	calculated	mg/L	0.075
Nitrogen (TKN)	EPA 351.4	mg/L	0.075
Phosphorus (Organic)	calculated	mg/L	0.003
Phosphorus (Orth)	EPA 365.2	mg/L	0.003
Phosphorus (Total)	EPA 365.2	mg/L	0.003
Solids (TDS)	EPA 160.1	mg/L	1.379
Solids (TSS)	EPA 160.2	mg/L	0.731
TN/TP	calculated	NA	0.075
Transparency	NA	feet	0.05
TSI	calculated	NA	0.075
Turbidity	EPA 180.1	NTU	0.11

Table 3.7.2: Laboratory and field QA/QC Checks

PARAMETER	METHOD	PREC. ^{1,6}	ACC. ^{1,6}	Fld/Lab/Equip	Standards	2 nd Source	Cont. Cal Std.	Matrix Spk	Fld/Lab Dups
		(%RSD)	(% Rec)	Blks/run	Per run	Std/run	Per Run	Per run	Per run
Conductivity	EPA 120.1	+/- 20	80-120	NA	3	1	1 every 4 hrs.	NA	5%
PH	EPA 150.1	+/- 20	80-120	NA	3	1	1 every 4 hrs.	NA	5%
Oxygen, Diss.	EPA 360.1	+/- 20	80-120	NA	NA	NA	1 every 4 hrs.	NA	5%
Temperature	EPA 170.1	+/- 20	80-120	NA	NA	NA	NA	NA	5%
Transparency	FDEP SOP	+/- 20	80-120	NA	NA	NA	NA	NA	5%
Alkalinity (Total)	EPA 310.1	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Ammonia	EPA 350.3	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
BOD	EPA 405.1	+/- 20	80-120	1/1/1	1	Glu/Glu	1/10 samples	NA	5%/5%
Chloride	EPA 325.3	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Chlorophylls	SM 10200-H	+/- 20	80-120	1/1/1	1	1	1/10 samples	NA	5%/5%
Coliforms, fecal	SM 9222D	1 CFU	NA	1/1/1	NA	Conf. test	Na	NA	5%/5%
Coliforms, total	SM 9222D	1 CFU	NA	1/1/1	NA	Conf. test	Na	NA	5%/5%
Color (True)	EPA 110.2	+/- 20	80-120	1/1/1	3	1	1/10 samples	NA	5%/5%
Nitrate+Nitrite	EPA 353.3	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Nitrite	EPA 354.1	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Nitrogen (TKN)	EPA 351.4	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Phosphorus (Orth)	EPA 365.2	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Phosphorus (Total)	EPA 365.2	+/- 20	80-120	1/1/1	3	1	1/10 samples	1	5%/5%
Solids (TDS)	EPA 160.1	+/- 20	80-120	1/1/1	2	2	1/10 samples	NA	5%/5%
Solids (TSS)	EPA 160.2	+/- 20	80-120	1/1/1	2	2	1/10 samples	NA	5%/5%
Turbidity	EPA 180.1	+/- 20	80-120	1/1/1	3	1	1/10 samples	NA	5%/5%



Table 3.7.3: Regulatory standards in the state of Florida

PARAMETER	METHOD	Regulatory Limit
Conductivity	EPA 120.1	Shall not be increased more than 50% above background or to 1275 mS
PH	EPA 150.1	6 – 8.5 units are considered acceptable
Oxygen, Diss.	EPA 360.1	Never less than 5.0 mg/L
Temperature	EPA 170.1	
Alkalinity (Total)	EPA 310.1	Not less than 20 mg/L as calcium carbonate
Ammonia	EPA 350.3	Unionized not greater than or equality to 0.02 mg/L
BOD	EPA 405.1	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
Chloride	EPA 325.3	Less than 10% above background
Chlorophylls	SM 10200-H	
Coliforms, fecal	SM 9222D	Never more than 800 nor a 200 monthly average or 400 in 10% of the samples
Coliforms, total	EPA 1604	Never more than 2400 nor a 1000 monthly average or 1000 in 20% of the samples
Color (True)	EPA 110.2	
Nitrate+Nitrite	EPA 353.3	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
Nitrite	EPA 354.1	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
Nitrogen (TKN)	EPA 351.4	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
Phosphorus (Orth)	EPA 365.2	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
Phosphorus (Total)	EPA 365.2	in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna.
SCI	FDEP SOP	Shall not be reduced to less than 75% of established background levels
Solids (TDS)	EPA 160.1	
Solids (TSS)	EPA 160.2	
TSI	calculated	If color is less than 40, then TSIs over 40 are considered potentially impaired
TSI	calculated	If color is greater than 40 then TSIs over 60 are considered potentially impaired
Transparency	FDEP SOP	Shall not be reduced by more than 10% compared to natural background
Turbidity	EPA 180.1	< 29 above background

3.8: Nutrients

Nitrogen and Phosphorus are the most important nutrients. They are usually responsible for the luxuriant growth of vegetation in lakes. Nitrogen and Phosphorus occur in various forms, or oxidation states, such as: ortho-phosphate, organic phosphate, ammonia, nitrate, nitrite and organic nitrogen. They are often presented together in groups such as inorganic nitrogen, oxidized nitrogen, total nitrogen, total kjeldahl nitrogen or total phosphate. These compounds are desirable in yards where they promote green lawns, but cause lakes to turn green too. In a waterbody they are not good.

Trophic state: Waterbody aging process. A natural aging process occurs in all waterbodies, causing them to change from oligotrophic to eutrophic over time, and eventually to fill in. People can accelerate the eutrophication process by allowing nutrients from agriculture, lawn fertilizers, streets, septic systems, and urban storm drains to enter lakes.



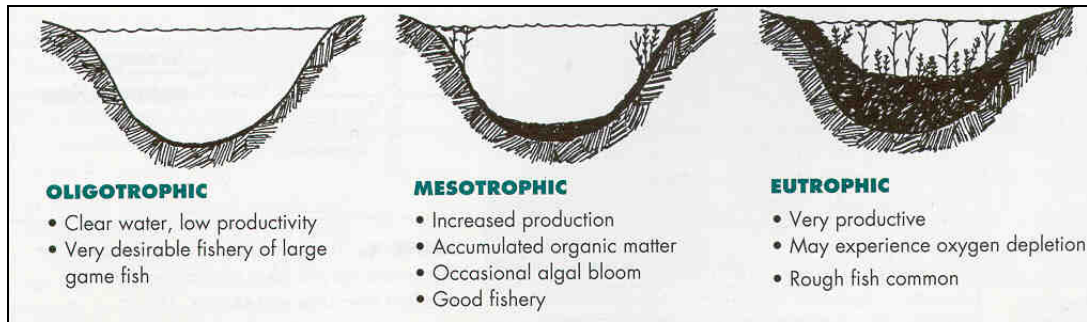


Figure 3.8.1: Depiction of the trophic status of a waterbody.

Oligotrophic: water is generally clear, deep, and free of weeds or large algal blooms. Though beautiful, they are low in nutrients and do not support large fish populations. However, oligotrophic waterbodies often develop a food chain capable of sustaining a very desirable fishery of large game fish.

Mesotrophic: waters lie between the oligotrophic and eutrophic stages. Devoid of oxygen in late summer, their hypolimnions limit cold water fish and cause phosphorus cycling from sediments.

Eutrophic and Hypereutrophic: water is high in nutrients and supports a large biomass (plants, algae and animals living in a lake). They are usually either weedy, subject to frequent algal blooms, or both. Eutrophic waters often support large fish populations, but are also susceptible to oxygen depletion. Small, shallow, eutrophic waterbodies are especially vulnerable to winterkill which can reduce the number and variety of fish. Rough fish are common.

The official nutrient regulations for the State of Florida for Class III Recreational Waters reads, “*In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in a natural population of aquatic flora or fauna*” (FAC 62-302.530). This rule is very difficult to apply or implement. There are currently no definitive nutrient criteria in the state of Florida but they are working on it.

3.9: Phosphorus

Phosphorus is an essential element for life. Phosphorus is necessary for the biosynthesis of adenosine triphosphate (ATP), the "energy currency" of the cell, and an essential biomolecule. When present in excess in aquatic systems, phosphorus can cause hypereutrophication. The symptoms of hypereutrophication include; dense aquatic plant growth, algal blooms, odors, and fish kills (which are ultimately caused by fluctuations in dissolved oxygen due to high plant and algae biomass). Under desirable oligotrophic conditions, phosphorus concentrations are typically undetectable in the water column.

Inorganic phosphorus is a form of phosphorus that is quickly absorbed by plants and translated into algal growth. Algae absorb inorganic phosphate in fractions of a second. Inorganic phosphorus can be a byproduct of the aerobic decay of organic matter by bacteria in the sediments. This process is called remineralization. It is a natural mechanism for recycling phosphate in the environment. Inorganic phosphorus is often found in urban stormwater. It is usually a major component of fertilizers and sewage. Wetlands, often termed nature's kidneys, are natural filters for nutrients. Development often drains or impairs wetlands and they no longer function as filters for stormwater runoff. Nutrients enter the waterbody. Ideally, inorganic phosphorus should be below detection level.

Total phosphorus includes organic and inorganic phosphorus and is found in natural waters. It is an integral part of living plants, animals, and their by-products, as well as their remains. Human sources of organic phosphorus could include human waste, animal waste, industrial waste, or human disturbance of the land and its vegetation. Most of the phosphorus found in our lakes is organic phosphorus. Lake water, if viewed under a microscope, has numerous microscopic bacterial, protozoan, and algal cells. Our worst lakes are suffering from nutrient enrichment as nutrient loading from stormwater enters our lakes.

To evaluate the trophic status of the LCL data according total phosphorus levels the Florida LAKEWATCH trophic classification was used (table 3.9.1). Total phosphorus data is graphically displayed in figure 3.9.1. Inorganic phosphorus data is graphically displayed in figure 3.9.2. Lafayette Sink (L02) and Lake Munson (all stations) are hypereutrophic or very degraded according to this criteria.

Table 3.9.1: Total phosphorus trophic classification, Florida LAKEWATCH

Oligotrophic:	less than 0.015 mg/L TP
Mesotrophic:	between 0.015 and 0.025 mg/L TP
Eutrophic:	between 0.025 and 0.100 mg/L TP
Hypereutrophic:	greater than 0.100 mg/L TP

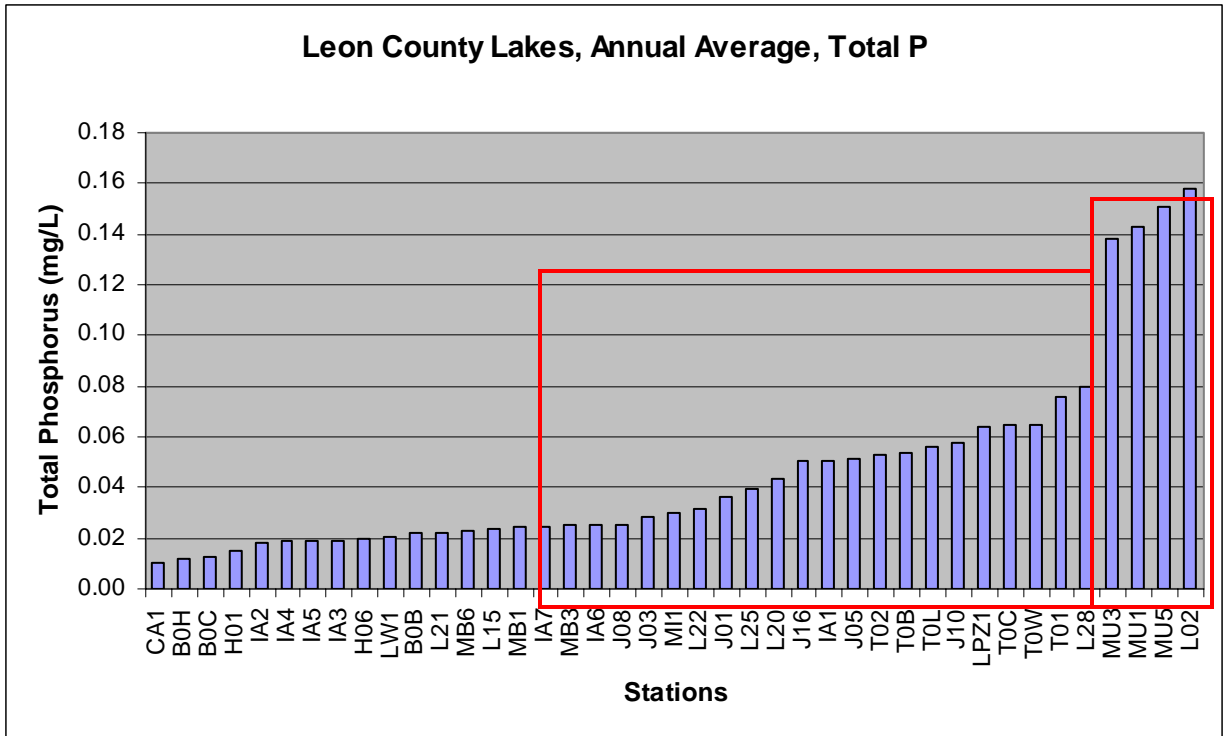


Figure 3.9.1: Average total phosphorus from all Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 10/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



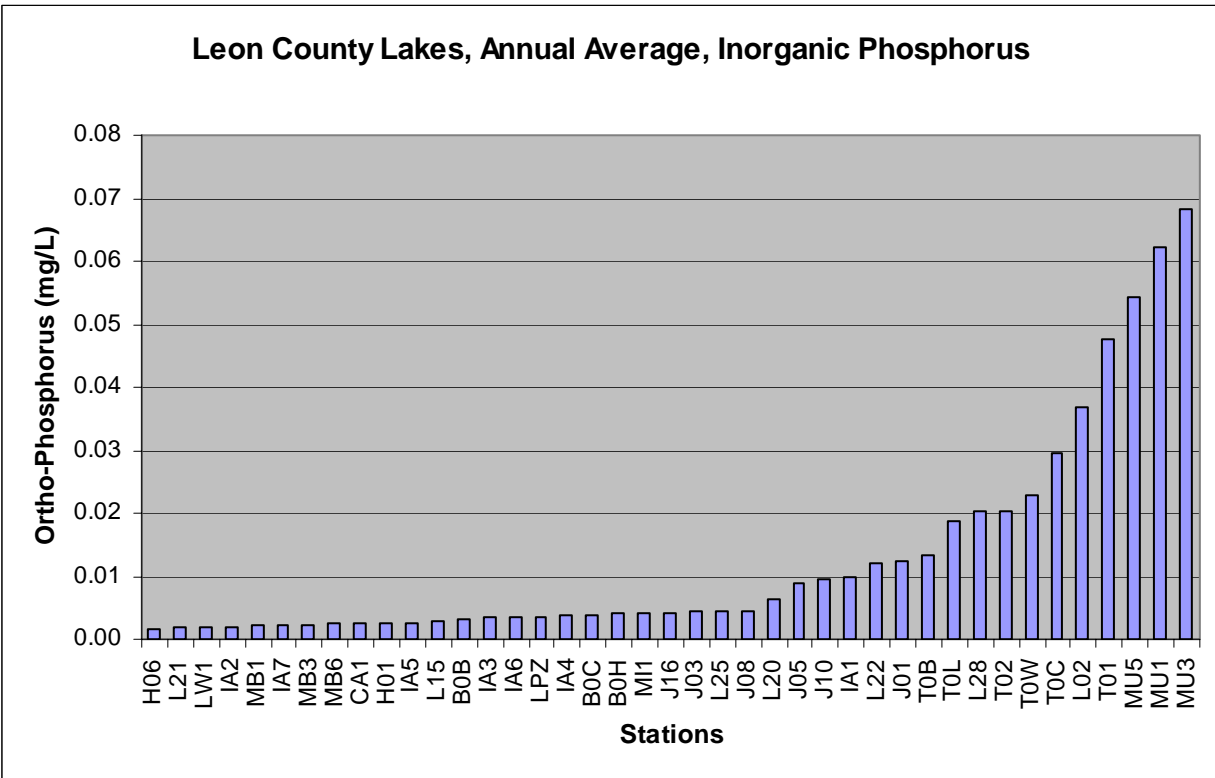


Figure 3.9.2: Average inorganic phosphorus from all Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.10: Nitrogen

Nitrogen is also a nutrient necessary for plant and animal life. It is used to make amino acids, the building blocks of proteins. It is a nutrient that promotes plant growth, which is undesirable in most waterbodies. Cultural eutrophication is the enrichment of water with nutrients. Places where the water is shallow and slow moving are vulnerable. If excess nutrients stimulate aquatic plant growth the entire ponds and streams can fill with vegetation. The most common symptom is the increasing frequency of algal blooms. Eventually, these blooms can become permanent and the water takes on a green pea soup appearance. In advanced stages the waterbody becomes anaerobic (the oxygen in the water is completely gone), and a distinct “rotten egg” smell ensues (sulfides are a product of anaerobic decay). Nuisance and toxic algae can become established, transforming the waterbody into quite a problem.

Nitrogen comes in many forms. Total oxidized nitrogen is a combination of nitrates and nitrites. It is the most easily assimilated form of nitrogen. These chemicals are indicative of wastewater contamination. High concentrations of nitrite are toxic. High



concentrations of nitrate cause newborn babies to turn blue. Reduced nitrogen is called ammonia. It is formed by anaerobic decay and is also common in commercial fertilizers. High concentrations of ammonia can be toxic to aquatic life.

Total nitrogen is found in natural waters and is an integral part of living plants, animals, and their by-products, as well as their remains. Total nitrogen includes all the forms of nitrogen plus organic nitrogen. Human sources of organic nitrogen include human waste, animal waste, industrial waste, or human disturbance of the land and its vegetation. Total nitrogen sampling indicates the presence of both organic and inorganic nitrogen.

The Florida LAKEWATCH trophic classification can be used to evaluate the data (table 3.10.1). Total nitrogen data is graphically displayed in figure 3.10.1. L22, the station near the Talquin STP and the Leon County Landfill, as well as Lafayette Sink (L02) are hypereutrophic, or very degraded, according to this criteria. Dissolved inorganic nitrogen data is graphically displayed in figure 3.10.2. Nitrate data is graphically displayed in figure 3.10.1. The highest nitrates occur in the Upper Ochlockonee River and Lake Talquin stations. This is probably the result of waste water discharge and agricultural fertilization in Georgia.

Table 3.10.1: Total nitrogen trophic classification, Florida LAKEWATCH

Oligotrophic:	less than 0.400 mg/L TN
Mesotrophic:	between 0.400 and 0.600 mg/L TN
Eutrophic:	between 0.600 and 1.500 mg/L TN
Hypereutrophic:	greater than 1.500 mg/L TN

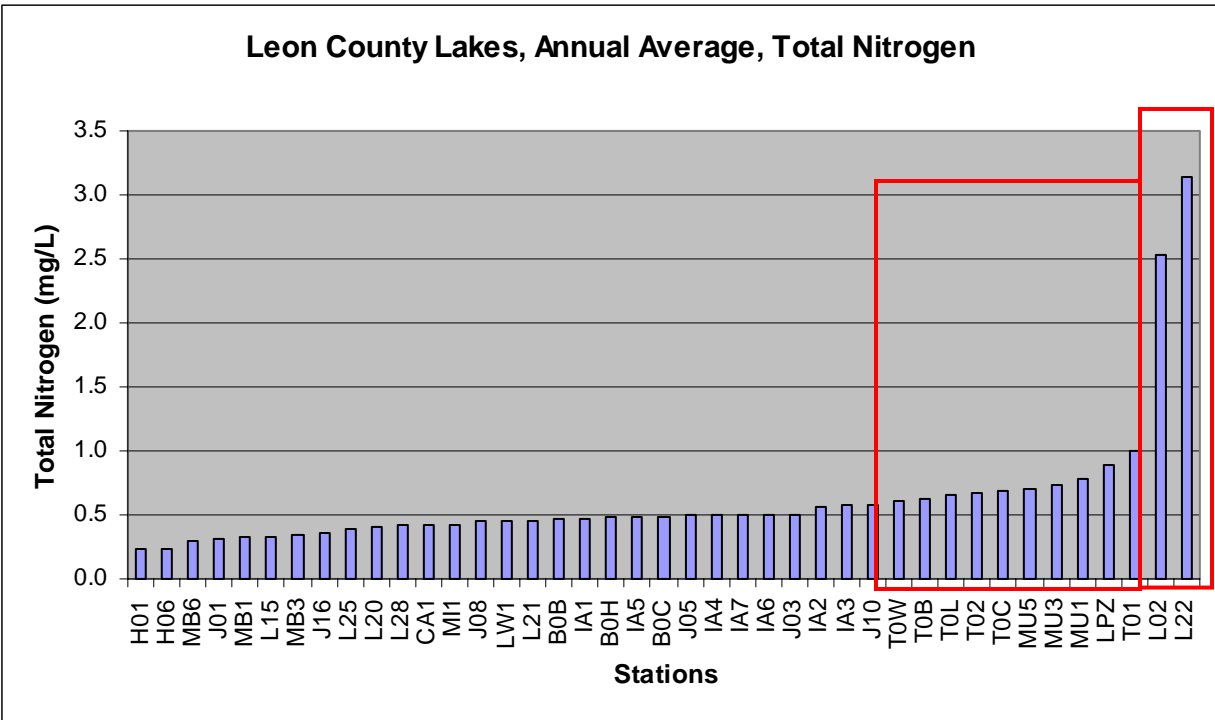


Figure 3.10.1: Average total nitrogen data from all Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



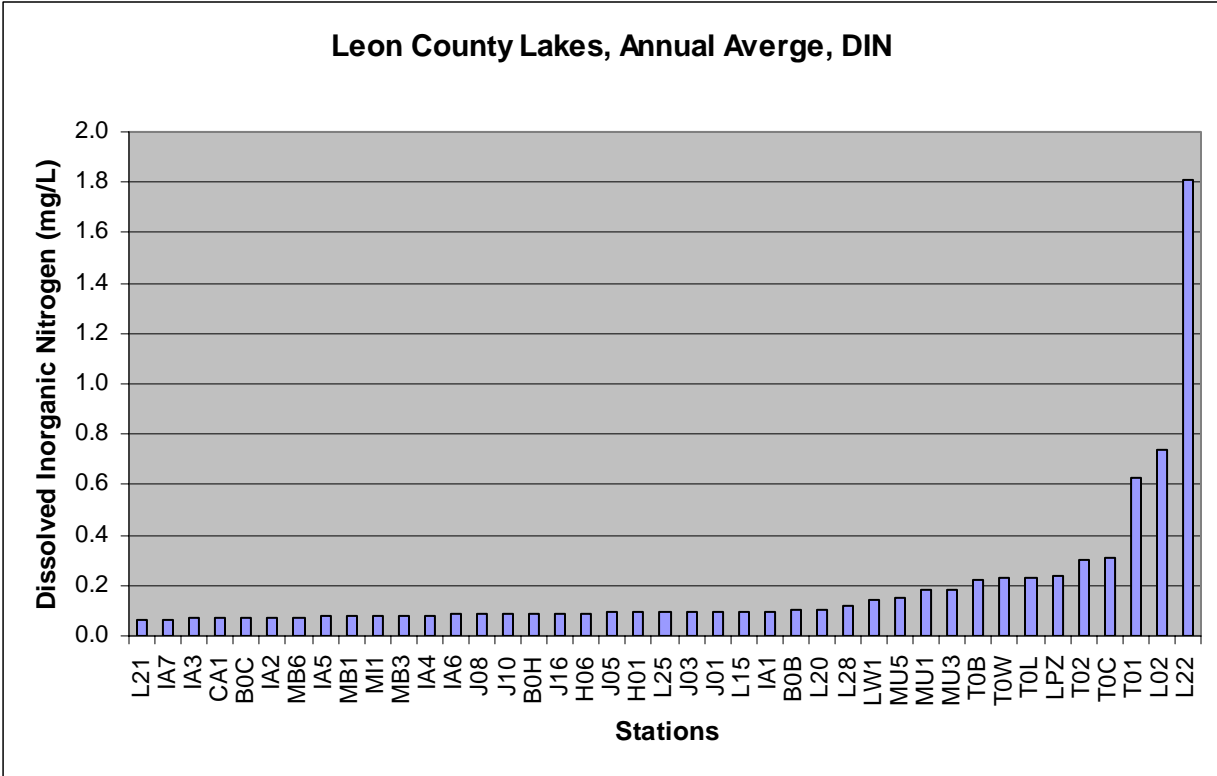


Figure 3.10.2: Average dissolved organic nitrogen data from all Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



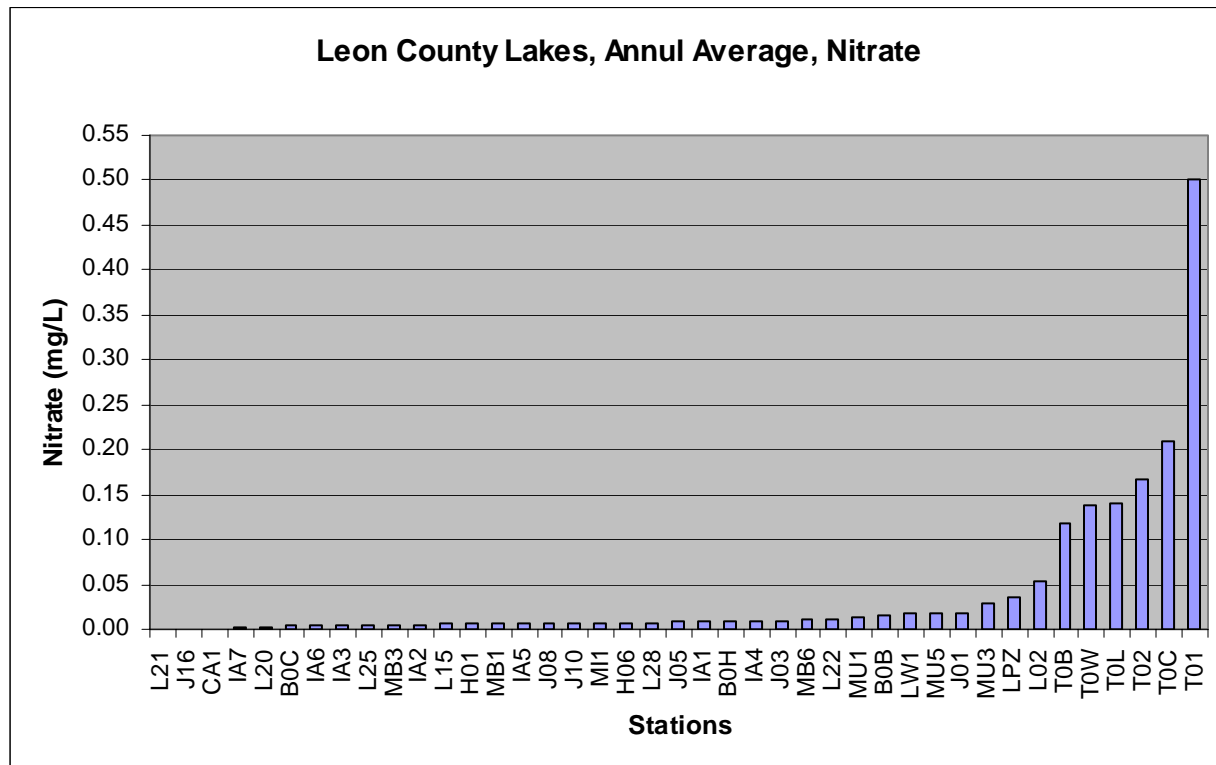


Figure 3.10.3: Average nitrate data from all Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.11: Limiting Nutrients

In aquatic systems an overabundance of nutrients can cause eutrophication. While they are not considered toxic, they can cause accelerated growth of aquatic plants and algae. The paradox is that we want nitrogen and phosphorus in our gardens yards to promote growth. We want a high yield of crops or a green lawn. The opposite is true in our waterbodies. Nutrients wash out of our fertilized yards and gardens. Soils contain nutrients and erosion adds them to our waterbodies. The nutrient in shortest supply controls the rate of growth. The TN/TP ratio can be used to determine if a certain nutrient might be limiting growth. Controlling this nutrient will be the most effective means to limit the growth of plants and algae in waterbodies. These results should be verified experimentally. If the N/P ratio is less than 10 the waterbody is considered nitrogen limited. If the N/P ratio is greater than 30 the waterbody is usually phosphorus limited. If the N/P ration is between 10 and 30 the waterbody is considered nutrient balanced (figure 3.11.1). Most of our lakes display a mixed nutrient limitation status.



Eliminating the limiting nutrient will have a significant impact on water quality. In some cases very polluted waterbodies may have so many nutrients that the nutrients limitation status may shift as natural levels are approached. In these instances the removal of both is recommended. Upper Lake Lafayette and Lake Munson may be in this category. Calculated results (such as these) should be confirmed by actual experimentation.

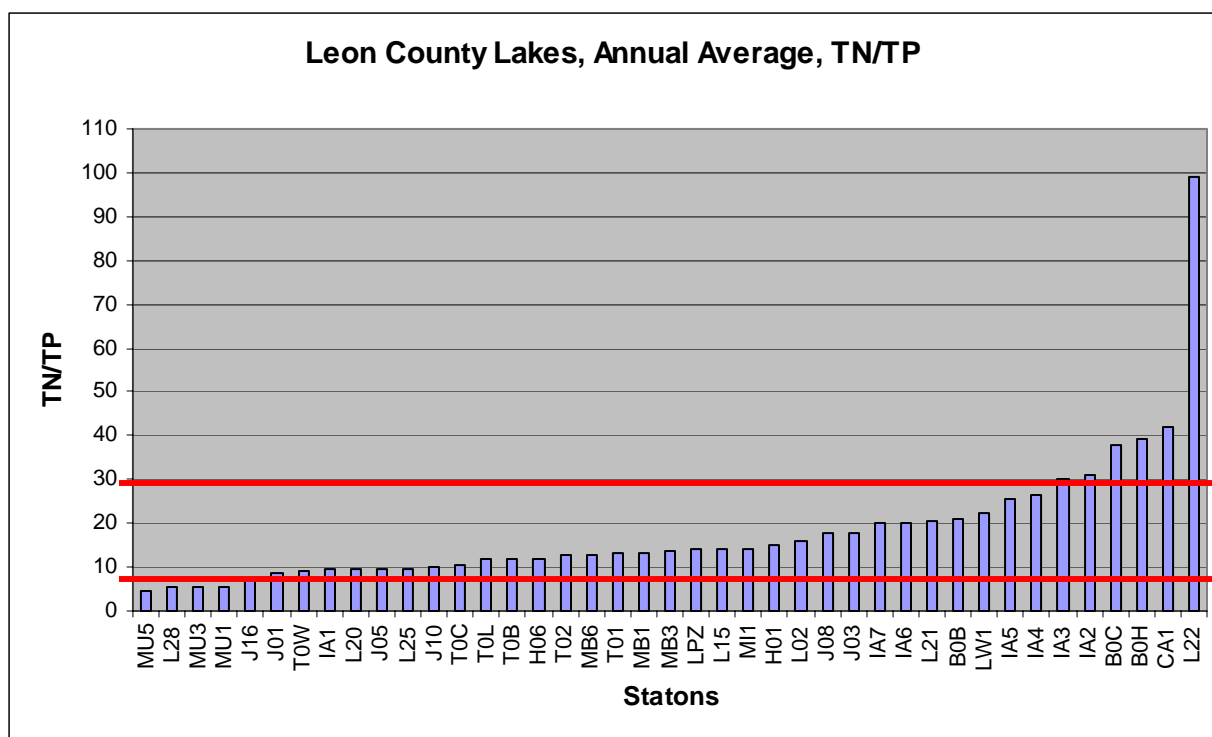


Figure 3.11.1: The average TN/TP ratios for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.12: True Color

Color is a significant parameter. It basically separates different types of aquatic habitats. Clear lakes, defined as having a color less than 40 PtCo units, usually have a neutral pH and enhanced aquatic plant growth because of the favorable aquatic light fields. Highly colored or tannic lakes tend to be acidic (due to tannic acid that leach out of vegetation, usually cypress). These lakes have less light penetration and can be temperature and dissolved oxygen stratified.

Lakes that are defined as clear have true color less than 40 PtCo. Lakes that are defined as tannic have true color greater than 40 PtCo (figure 3.12.1).



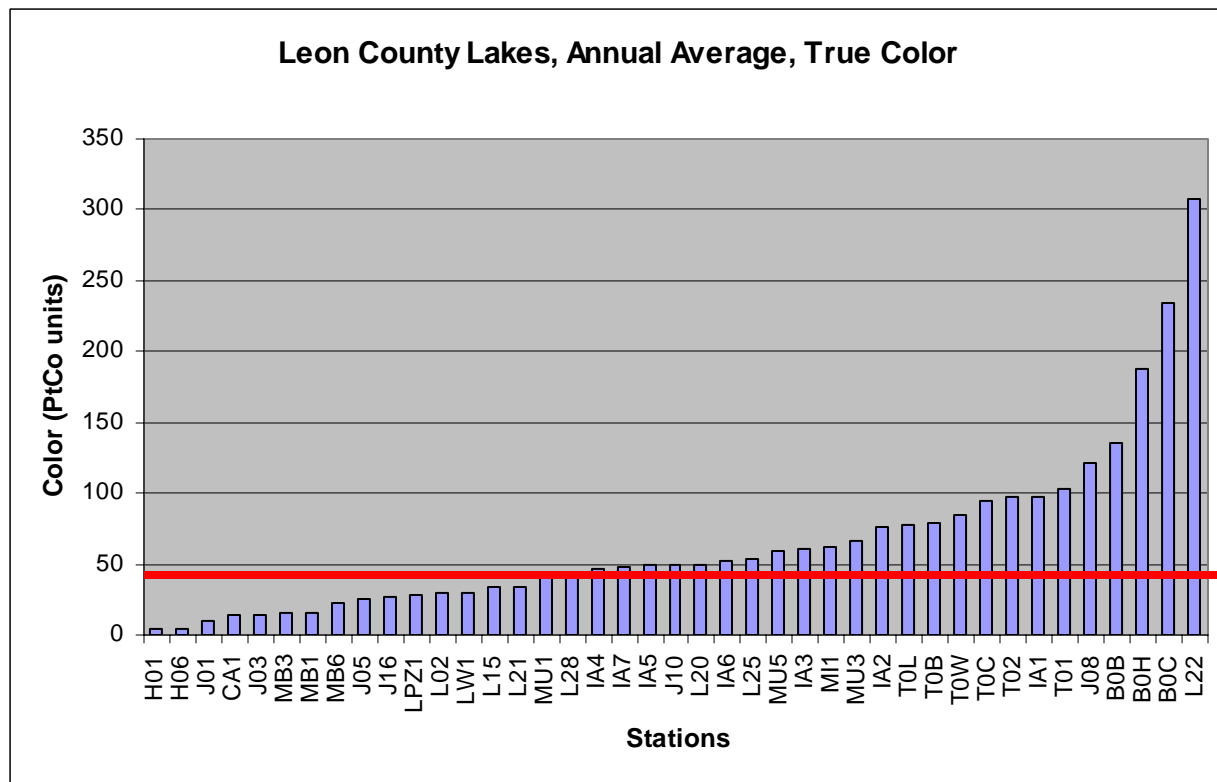


Figure 3.12.1: The average true color data for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.13: Chlorophyll

Chlorophyll is the green pigment plants utilize to convert radiant energy (sunlight) into chemical energy (sugars). This is termed primary productivity, the basis of the food chain. Most aquatic plants and algae contain chlorophyll. They commonly occur in large numbers with hundreds of thousands of cells present in a thimble full of water (about 1 ml). Chlorophyll is measured because it is a good indicator of the amount of algae present in water. High chlorophyll concentrations indicate nutrient enrichment or stress in the aquatic system. High chlorophyll concentrations usually appear green to the naked eye. Natural fluctuations or spikes in the chlorophyll concentrations are called algal blooms. These usually consist of a single species of algae. High chlorophyll concentrations for extended periods of time indicate serious problems. High chlorophylls indicate poor water quality. Unconsumed algae sink to the bottom and decay, using up the oxygen required by other plants and benthic organisms to survive and contribute to the silting in of a waterbody. The presence of too many nutrients, such as nitrogen and phosphorus stimulates algal blooms. Blue-green algae, or cyanobacteria, can contain harmful toxins.



Chlorophyll-a: the molecule that makes photosynthesis possible by passing its energized electrons on to molecules that will manufacture sugars. All higher plants, red and green algae, and cyanobacteria which photosynthesize contain chlorophyll -a.

Chlorophyll-b: present in higher plants (including the Chlorophyta, Euglenophyta, and green algae). Absent in other types of algae.

Chlorophyll-c: present in chromophytes and dinoflagellates. Lacks the phytol hydrocarbon tail in chlorophyll-a and -b.

Phaeophytin: chlorophyll lacking the central magnesium ion. This is thought to be chlorophyll derived from already dead plant material. By subtracting phaeophytin from the chlorophyll a concentration it is thought to give an estimate of living plant material. This assumption is disputed because phaeophytin can also be derived from chlorophyll-b.

Table 3.13.1: Chlorophyll a trophic classification, Florida LAKEWATCH

Oligotrophic:	chlorophyll less than 3 ug/L
Mesotrophic:	chlorophyll between 3-7 ug/L
Eutrophic:	chlorophyll between 7-40 ug/L
Hypereutrophic:	chlorophyll greater than 40 ug/L

The Florida LAKEWATCH chlorophyll trophic classification can be used to evaluate the data (table 3.10.1). Phaeophytin corrected chlorophyll data is graphically displayed in figure 3.13.1. Algal biomass data is graphically displayed in figure 3.13.2. L22 (Lower Lafayette near the Talquin STP and the Leon County Landfill), L02 (Lafayette Sink) and parts of Lake Munson are hypereutrophic or very degraded according to this criteria.

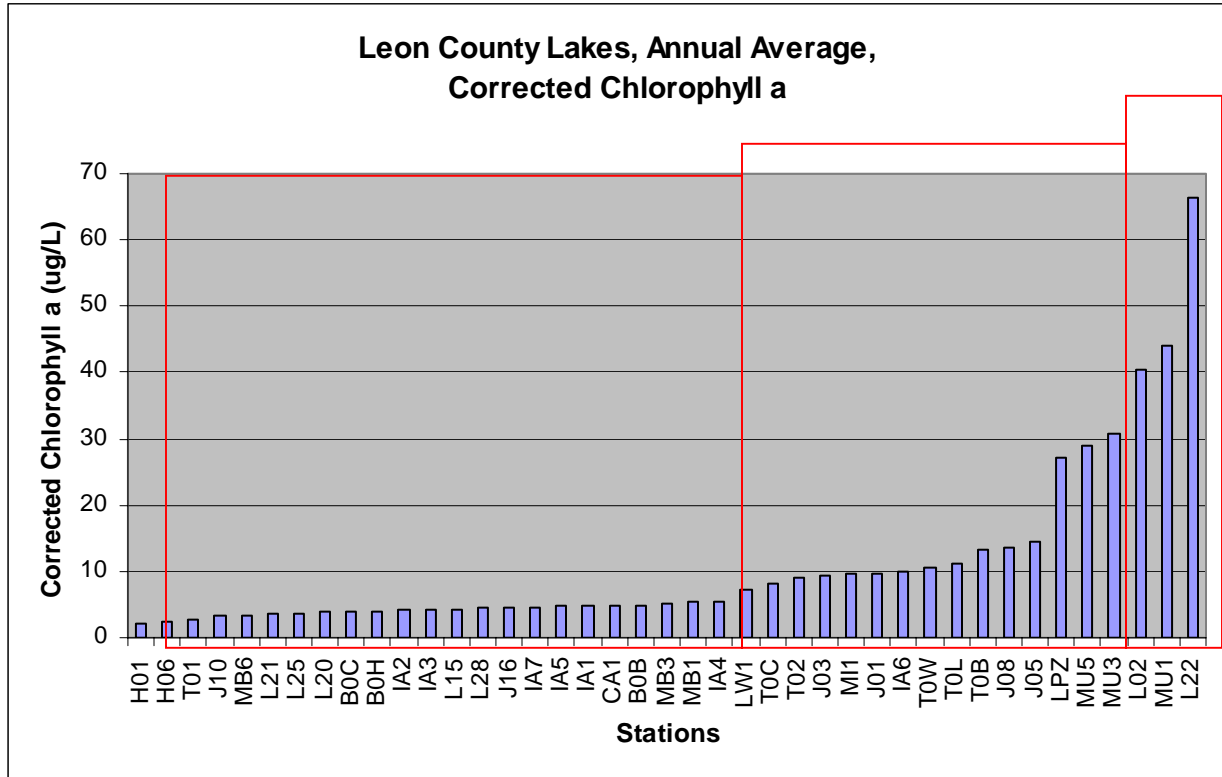


Figure 3.13.1: The average corrected chlorophyll-a data for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



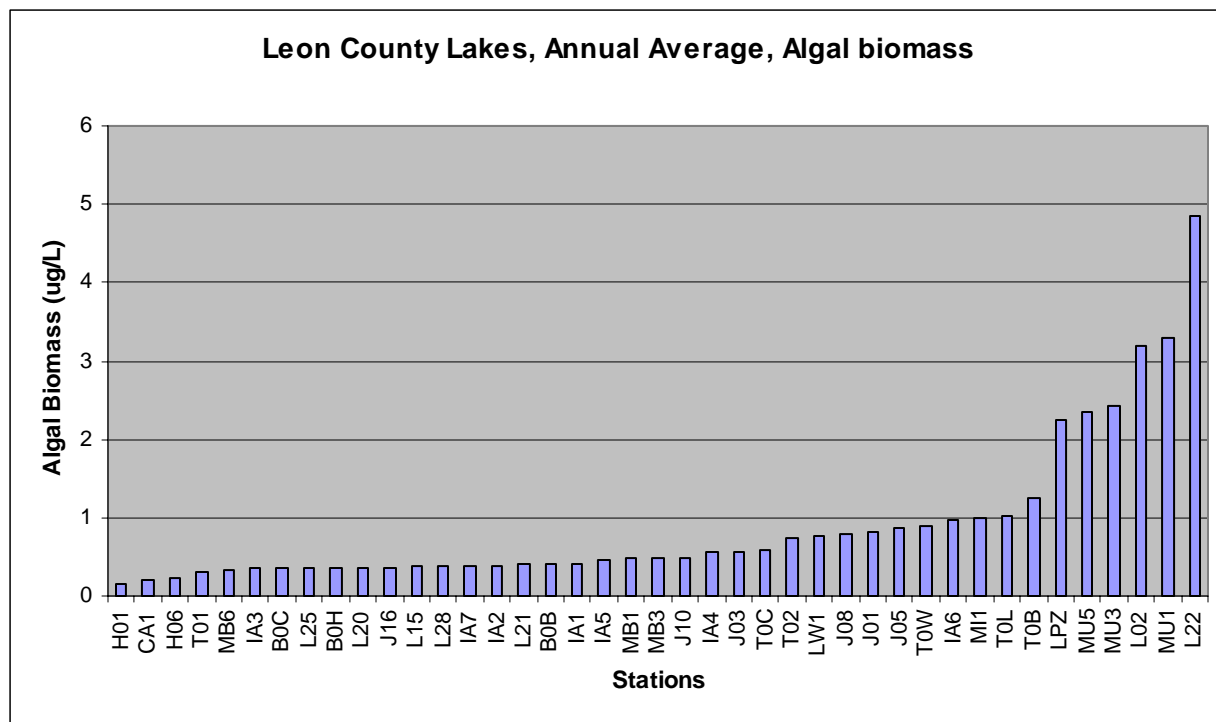


Figure 3.13.2: The average algal biomass for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.14: Trophic State Index (TSI)

There is no all-encompassing criterion to apply to measure how healthy a waterbody is. Unique and different water quality conditions characterize the numerous water bodies in Leon County. The most widely accepted method to evaluate water quality is the Trophic State Index (TSI), calculated from chlorophyll, total nitrogen and total phosphorus data preferably taken over various seasons and years. This differs from the single criteria Trophic State evaluations in that it brings together multiple parameters. Most often the Florida TSI is used to determine if a body of water is able to “support its designated use”. Some of our area’s lakes and rivers are ‘potentially impaired’ and are listed on FDEP’s 303D List. Many of these waterbodies will be studied and assigned a Total Maximum Daily Load (TMDL). Nutrient load reductions will be assigned to the waterbody and the pollutants flowing into the waterbody need to be removed.

The Trophic State Index is useful for evaluating the health of waterbodies and can be used to decide if a waterbody might be impaired. It does not account for the biomass of aquatic macrophytes, which can shade the water column (suppressing microalgae) and removing nutrients. These types of lakes will appear to be in good condition when evaluated in this manner.



The TSI rating is based on mathematical formulae involving concentrations of total nitrogen, total phosphorous, and chlorophyll a (table 3.14.1). The Trophic State Index is a numerical scale from 0 to 100. The true color is used to determine which TMDL scale is used. Clear lakes, have a true color less than 40 PtCo units. Clear waterbodies are considered potentially impaired at TSI values greater than 40 units. Tannic or colored waterbodies, have true color greater than 40 PtCo units, are considered potentially impaired at TSI values greater than 60 TSI (table 3.14.2). Monthly water quality data collected by the Leon County Lakes Ecology Program were averaged from 10/03 to 09/04. These values are presented graphically (figure 3.14.1). Some of our lakes are in poor shape according to this criteria.

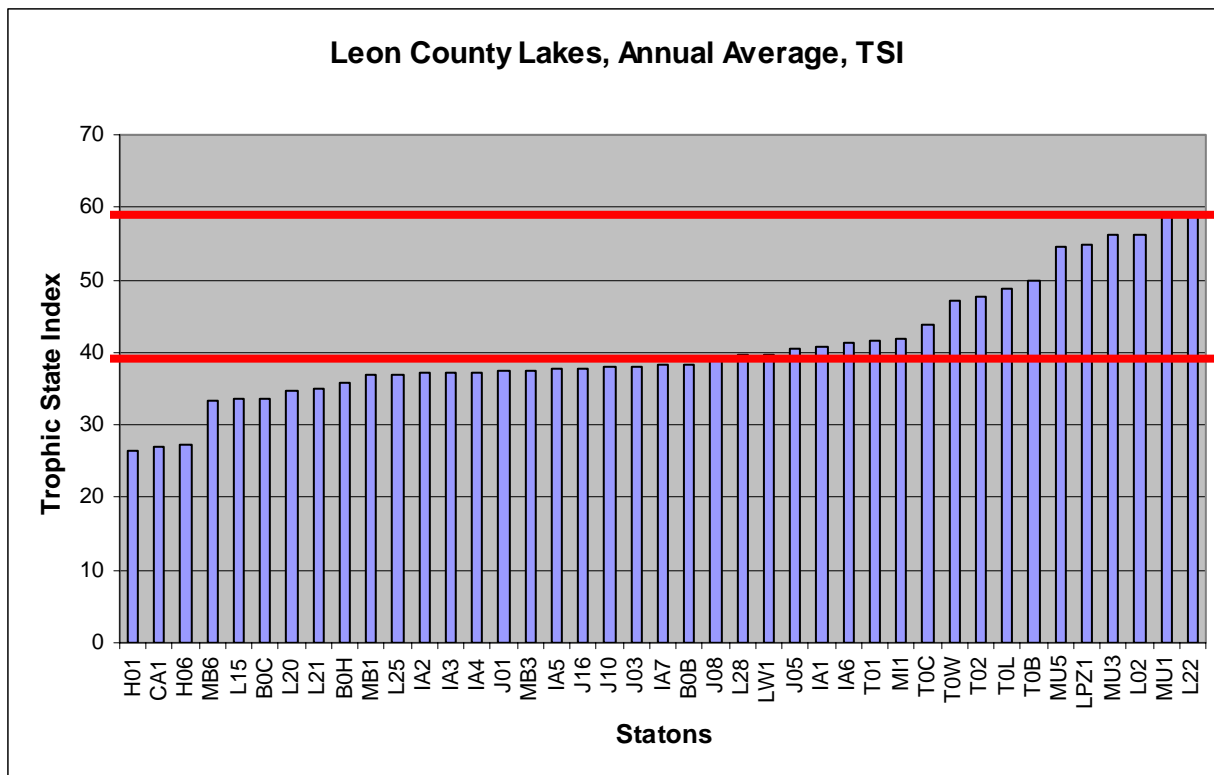


Figure 3.14.1: The average TSI data for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



Table 3.14.1: Trophic State Formula

Florida Trophic State Index Equations*

$$\text{TSI CHL a} = 10 \times (1.68 + 1.44 \times \text{LN}(\text{CHL a}))$$

$$\text{TSITP} = 10 \times (2.36 \times \text{LN}(\text{TP} \times 1000) - 2.38)$$

$$\text{TSITN} = 10 \times (5.96 + 2.15 \times \text{LN}(\text{TN}))$$

$$\text{TSITNB} = 10 \times (5.6 + 1.98 \times \text{LN}(\text{TN}))$$

$$\text{TSITPB} = 10 \times (1.86 \times \text{LN}(\text{TP} \times 1000) - 1.84)$$

$$\text{TSINUTR} = 0.5 \times (\text{TSITNB} + \text{TSITPB})$$

Phosphorus Limited Lakes (PLL) $\text{TN/TP} > 30$:

$$\text{TSIAVG} = 1/3 \times (\text{TSICHL a} + \text{TSITP})$$

Nitrogen Limited Lakes (NLL) $\text{TN/TP} < 10$:

$$\text{TSIAVG} = 1/3 \times (\text{TSICHL a} + \text{TSITN})$$

Nutrient Balanced Lakes (NBL) $> 10 \text{ TN/TP} < 30$:

$$\text{TSIAVG} = 1/3 \times (\text{TSICHL a} + \text{TSINUTR})$$

Where:

TSICHL a = Trophic State Index Based on Chlorophyll a

CHL a = Chlorophyll-a concentration (mg/m³)

TSITP = Trophic State Index Based on Total Phosphorus

TP = Total Phosphorus Concentration (mg/l)

TSITN = Trophic State Index Based on Total Nitrogen

TN = Total Nitrogen Concentration (mg/l)

TSITNB = Trophic State Index Based on Total Nitrogen Budget

TSITPB = Trophic State Index Based on Total Phosphorus Budget

TSINUTR = Trophic State Index Based on Total Nutrient Budget

TSIAVG = Average Trophic State Index

Table 3.14.2: TSI evaluation criteria

The TSI values are defined by FDEP as follow:

streams <20	Potentially not Impaired
Clear lakes <40	Potentially not Impaired
Tannic Lakes <60*	Potentially not Impaired
*Color > 40 PtCo Units	

*Streams with floating algal mats or annual mean chlorophyll a values exceeding 20 ug/L can also be considered impaired. Lakes with annual mean TSI increases (positive slope) or increases of more than 10 units over historic values are also potentially impaired (please see 62-303.351 and 62-303.352, FDEP, 2002 for additional information).

Florida Lake Management Society, TSI:

0 - 49 (BEST) Oligotrophic
50 - 59 (GOOD) Mesotrophic
60 - 69 (Questionable) Eutrophic
70 - Above (POOR) Hypereutrophic

City of Tallahassee Trophic State Index (TSI, this is based on the older 1996 305(b) rule which has been superceded by the 2002 rule):

0-59 “good and fully able to support designated use”
60-69 “fair and partially supports designated use”
70-100 “poor and does not support designated use”

3.15: Specific Conductivity

Conductivity is a measure of the electrolytes in water. Positively and negatively charged ions carry electric charge and cause water to conduct electricity. Conductivity is measured with an electrode in the water. Values above background levels indicate disturbance or pollution of the water body. Water quality standards for a Class III water body require that conductivity shall not be increased more than 50% above the background or 1275 uS, whichever is greater.

Lake Hall has a specific conductance of approximately 35 uS and will be used as a reference lake, the red line on this chart delineates the Water quality standards for a Class III water body in our area. Lake averages above this line are potentially impaired (figure 3.15.1).

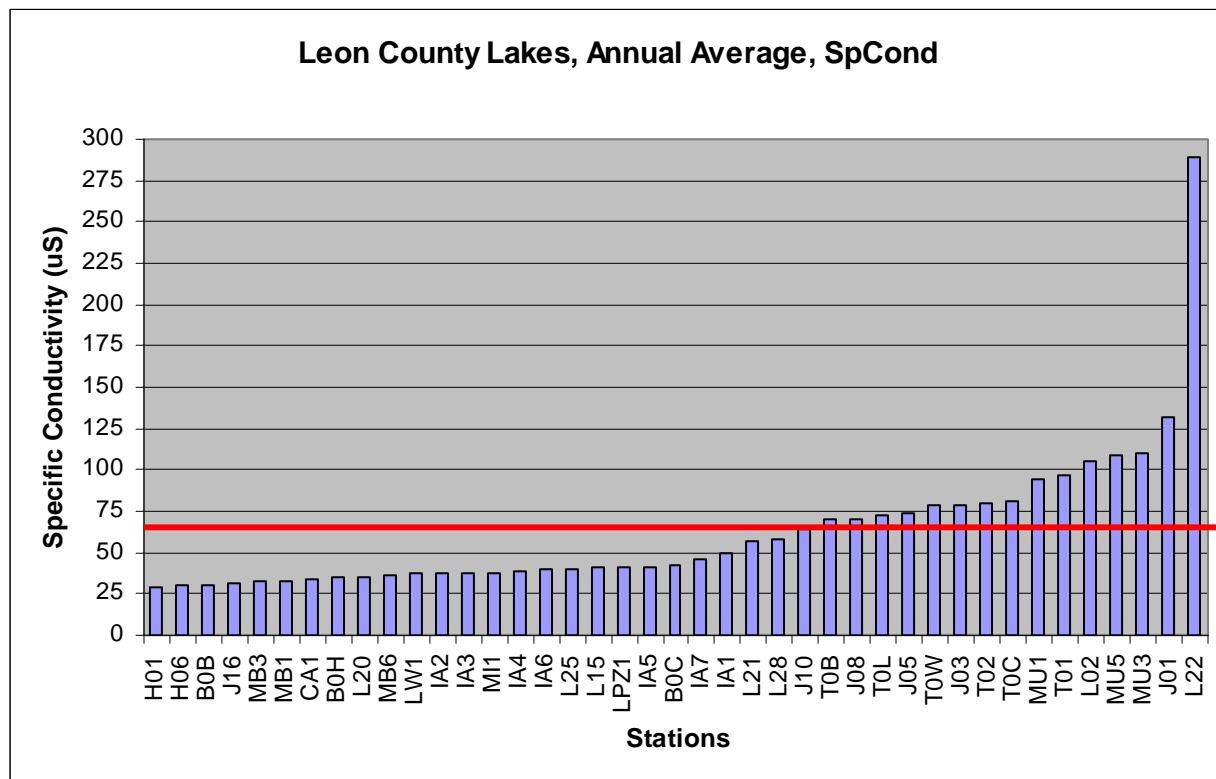


Figure 3.15.1: The average TSI data for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.16: pH

Water contains hydrogen ions, which are positively charged, and hydroxyl ions, which are negatively charged. The pH test measures the negative logarithm of the hydrogen ion concentration (or positive charges). Neutral water has exactly the same number of hydrogen and hydroxyl ions and has a pH of 7. If the water has a pH greater than 7 it is said to be basic. If the pH is below seven it is considered acidic. The normal pH of water in the United States falls between 6.5 and 8.5, although natural variation occurs. Changes in the pH value of water are important to most organisms. When organisms have adapted to a certain pH, death may occur even at a slight change. Extremely high or low pH values also make the habitat unsuitable for many organisms.

Anything above a pH of 8.5 or below 6 is considered to be within the water quality standards for a Class III waterbody. Basic waters can facilitate the remineralization of nutrients into the water column. High pHs can be caused by algal blooms. This appears to be happening at stations J03, J08 and J05 in Lake Jackson. Acidic waters can cause heavy metals to be released into the water when they otherwise would settle out into the



sediments. The heavy metals can accumulate in fish and other aquatic organisms, causing deformity in the young, thereby reducing their chance of survival. Heavy metal contamination can also result in health advisories for people eating the fish, as the metals can accumulate in their tissues and also affect their young. Water quality standards for a Class III Recreational Waterbody require that the pH should not vary more than 1 unit above or below natural background levels of coastal and fresh waters. Special conditions apply when the pH is below 6.5 or above 8.5. Tannins acidify the water and come from vegetation, particularly cypress trees. The more acidic the waterbody, the less productive it is.

The pH of Leon County’s waterbodies are not favorable but probably naturally that way. This rule is not particularly applicable in our area. Many of our lakes are naturally tannic and have acidic pHs (figure 3.16.1).

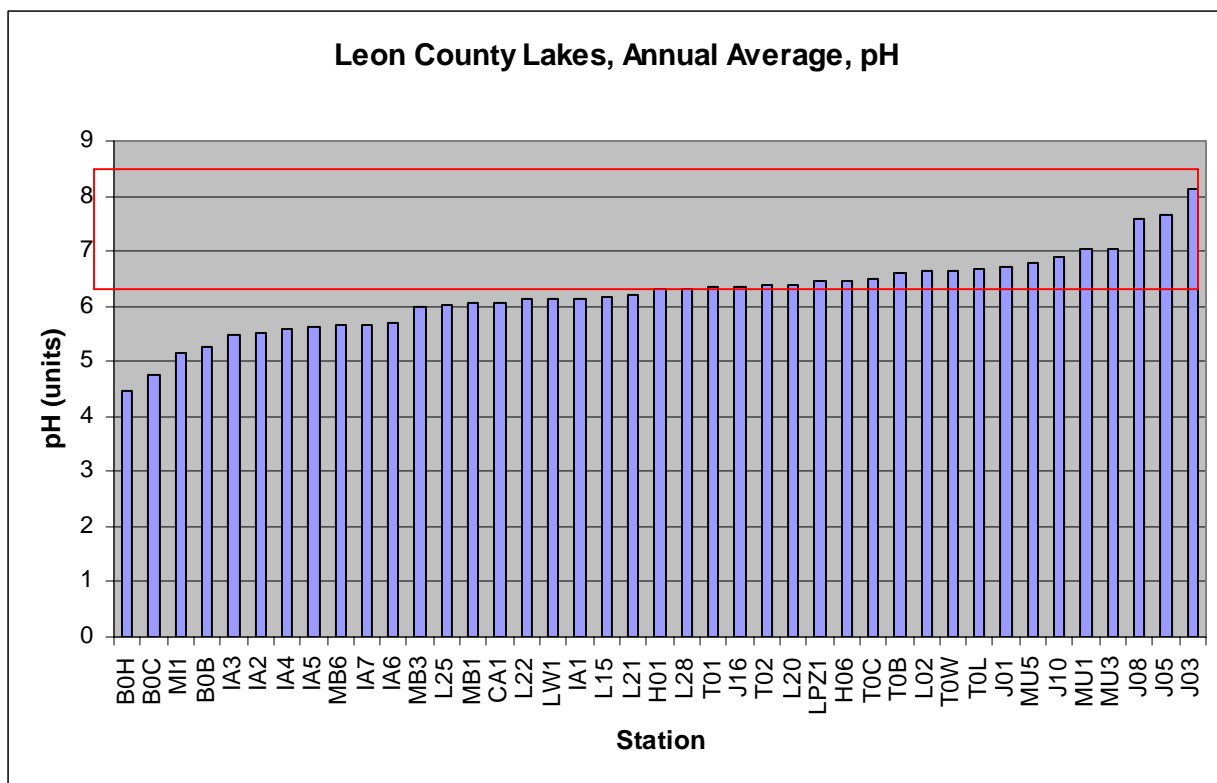


Figure 3.16.1: The average pH for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.17: Temperature

Average temperatures in the Leon County Lakes ran from about 18 degrees C to almost 25 degrees C. Lake Weeks is the warmest lake monitored. Parts of Lake Lafayette (L21) and eastern Lake Jackson (J16) were also rather warm. These areas are rather shallow and



have poor circulation rendering them vulnerable to solar heating. Lakes Miccosukee and parts of lake Lafayette were the coolest. They are deep and rather shaded. The average temperatures of our lakes are depicted graphically in figure 3.17.1.

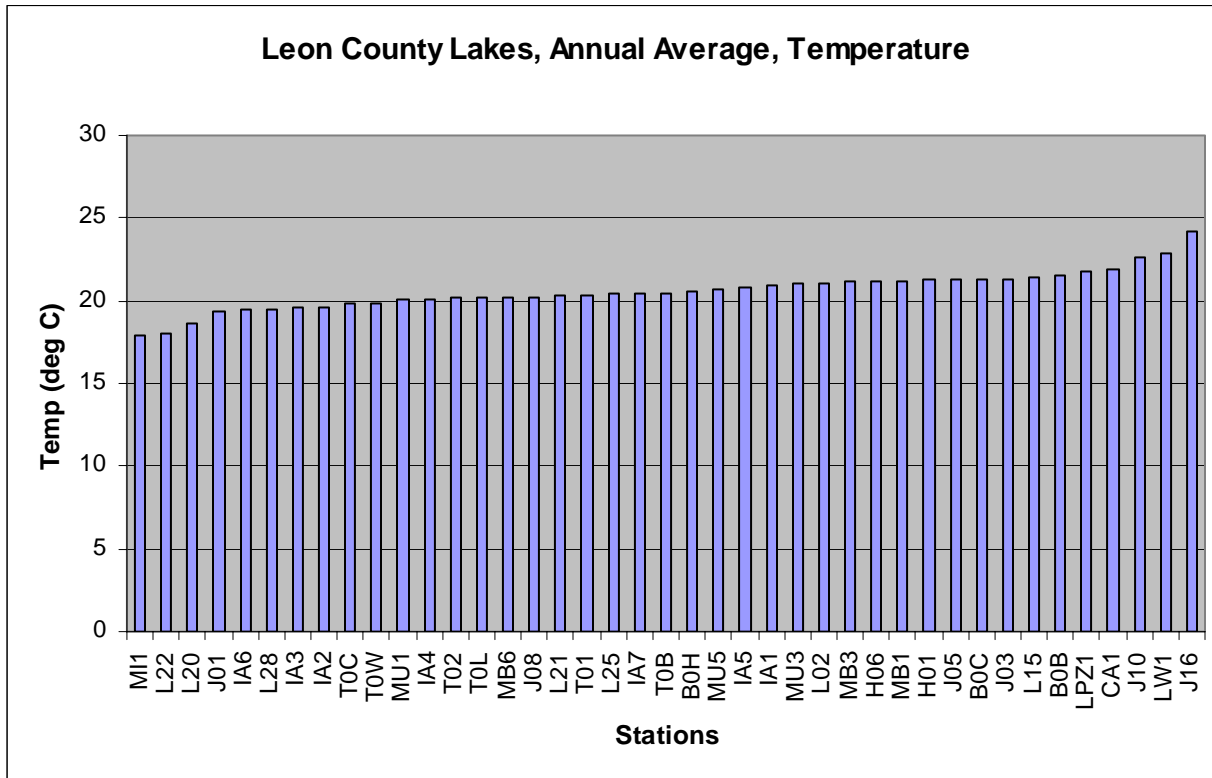


Figure 3.17.1: The average temperature for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.18: Dissolved Oxygen (DO)

Dissolved oxygen is essential for the maintenance of healthy waterbodies. Its presence indicates good water quality while its absence indicates pollution. In pristine waterbodies, most of the DO comes from the atmosphere. Waves and turbulence mix oxygen with the water. Submerged aquatic plants also deliver oxygen to the water through photosynthesis. The main factor contributing to the changes in DO occurring in impacted water bodies is the build up of organic waste. Organic waste is anything that once was living, plant or animal. Organic waste can enter a waterbody in many forms, such as sewage, urban or agricultural runoff, or discharge from an industrial facility. Plant clippings and animal waste can be transported into the waterbody with stormwater. Water quality standards for Class III Recreational Water require more than four milligrams per liter of dissolved oxygen in the water column. With less than this amount of oxygen in the water, aquatic



animals, such as fish, are thought to be under stress. The bottom water is more prone to oxygen depletion. The average dissolved oxygen of our lakes are depicted graphically in figure 3.18.1.

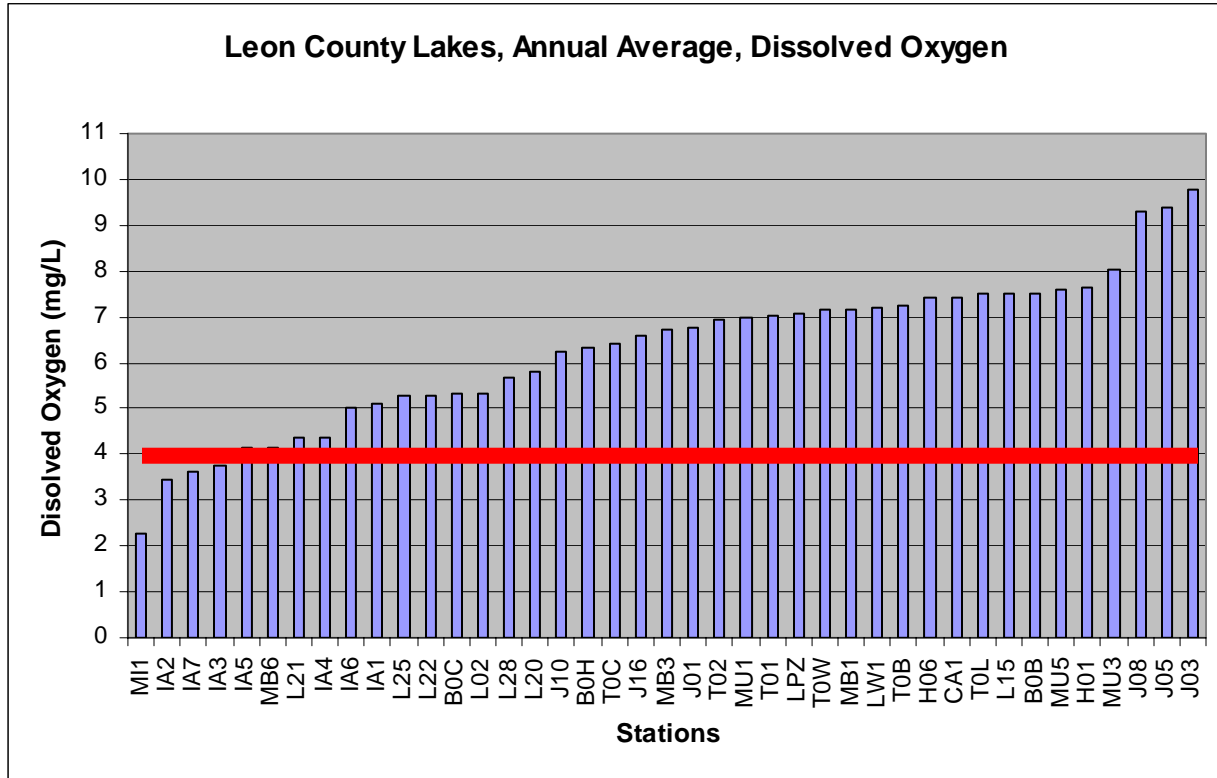


Figure 3.18.1: The average dissolved oxygen for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.19: Percent Saturation of Dissolved Oxygen (%DO)

Waters supersaturated with oxygen are harmful to aquatic life too. Oxygen toxicity at these levels is well documented, particularly in the vicinity of dams where the dissolved oxygen can actually come out of solution in the fish and their gills, covering them with air bubbles and impairing their function. The percentage of dissolved oxygen, when compared to the saturation concentration, is a very useful parameter. If the percent saturation is over 100% dissolved oxygen will leave the solution coating surfaces with oxygen bubbles. At the lower end of the percent saturation scale organisms become stressed. In Leon County, the Lakes that are super saturated with oxygen are polluted and overgrown with aquatic plants and algae, and is worst in southern Lake Jackson (figure 3.19.1).



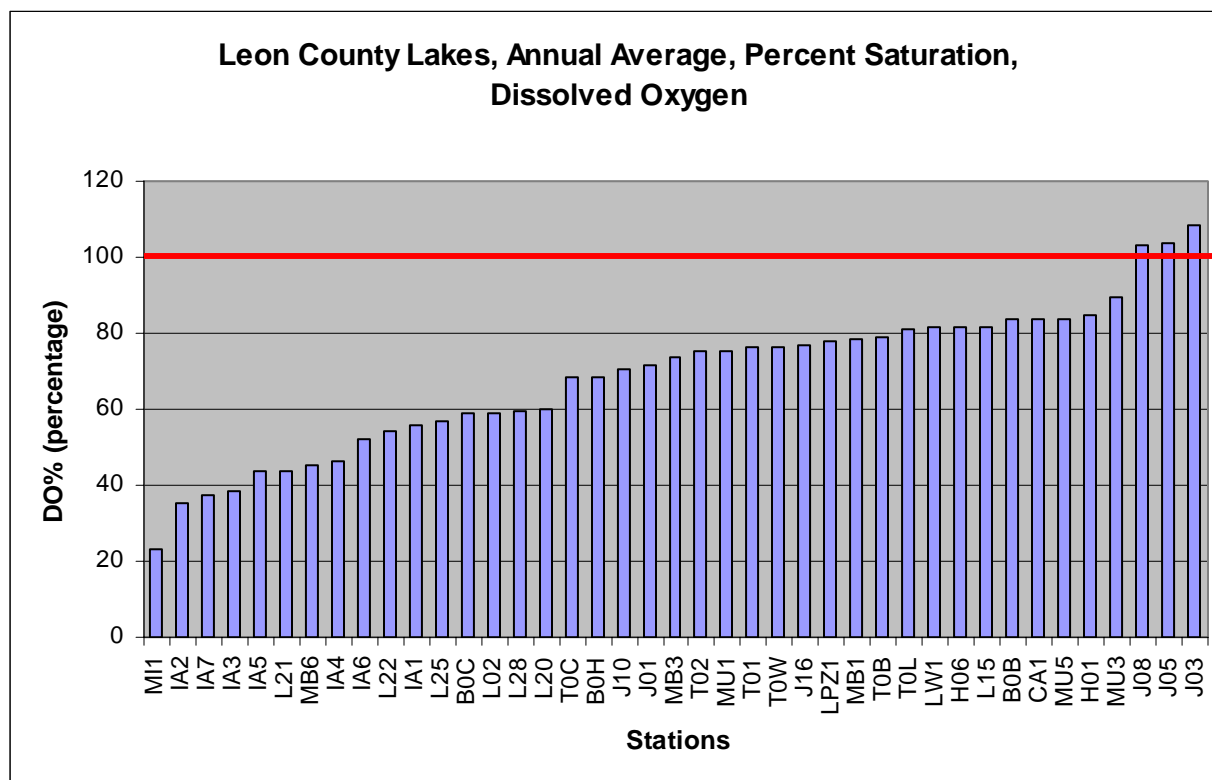


Figure 3.19.1: The average percent saturation of dissolved oxygen for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.20: Biochemical Oxygen Demand (BOD)

When organic matter decomposes, microorganisms feed upon this decaying material and can quickly use up the dissolved oxygen. Biochemical Oxygen Demand measures the amount of oxygen consumed by microorganisms in the water. This is a measurement of the oxygen that is consumed in a water sample.

BOD directly affects the amount of dissolved oxygen in rivers and streams. The more rapidly oxygen is depleted in the stream, the greater the BOD. High BOD equates with low dissolved oxygen: aquatic organisms become stressed, suffocate, and die. Sources of BOD include leaves and woody debris; dead plants and animals; animal manure; effluents from pulp and paper mills, wastewater treatment plants, feedlots, and food-processing plants; failing septic systems; and urban stormwater runoff.

Water quality standards for a Class III water body state that the BOD should not be increased to values that would cause dissolved oxygen levels to be depressed. The BOD is also a very good indicator of wastewater inputs as the bacteria and nutrients associated



with wastewater consume copious amounts of dissolved oxygen in the process of degradation within the waterbody. The average biochemical oxygen demand of our lakes are depicted graphically in figure 3.20.1. BOD is worst in Lakes Munson and Lafayette.

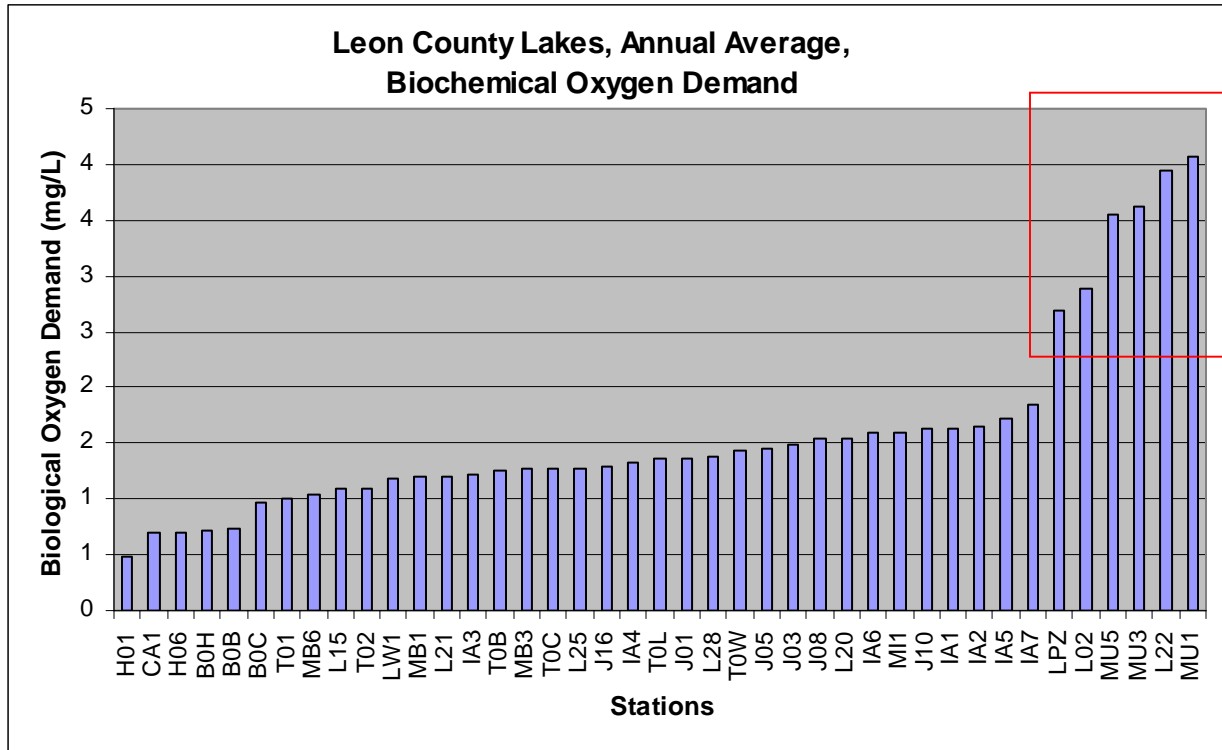


Figure 3.20.1: The average Biological Oxygen Demand for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.21: Turbidity

Turbidity is the measure of suspended particles in water. Erosion, wastewater, urban stormwater, bottom feeders (rough fish) and even algae can cause turbidity. Water loses its ability to support a diversity of aquatic organisms when turbidity reaches certain levels. Turbidity can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Particles of silt and clay will eventually settle to the bottom, causing a build up of sediment that can clog streams and fill in ponds. Water quality standards for Class III Recreational Waterbodies require that the turbidity be less than or equal to 29 NTUs above background conditions.

If Lake Hall is used as a background level, all lakes (annual average) were found to be within favorable levels (figure 3.21.1).



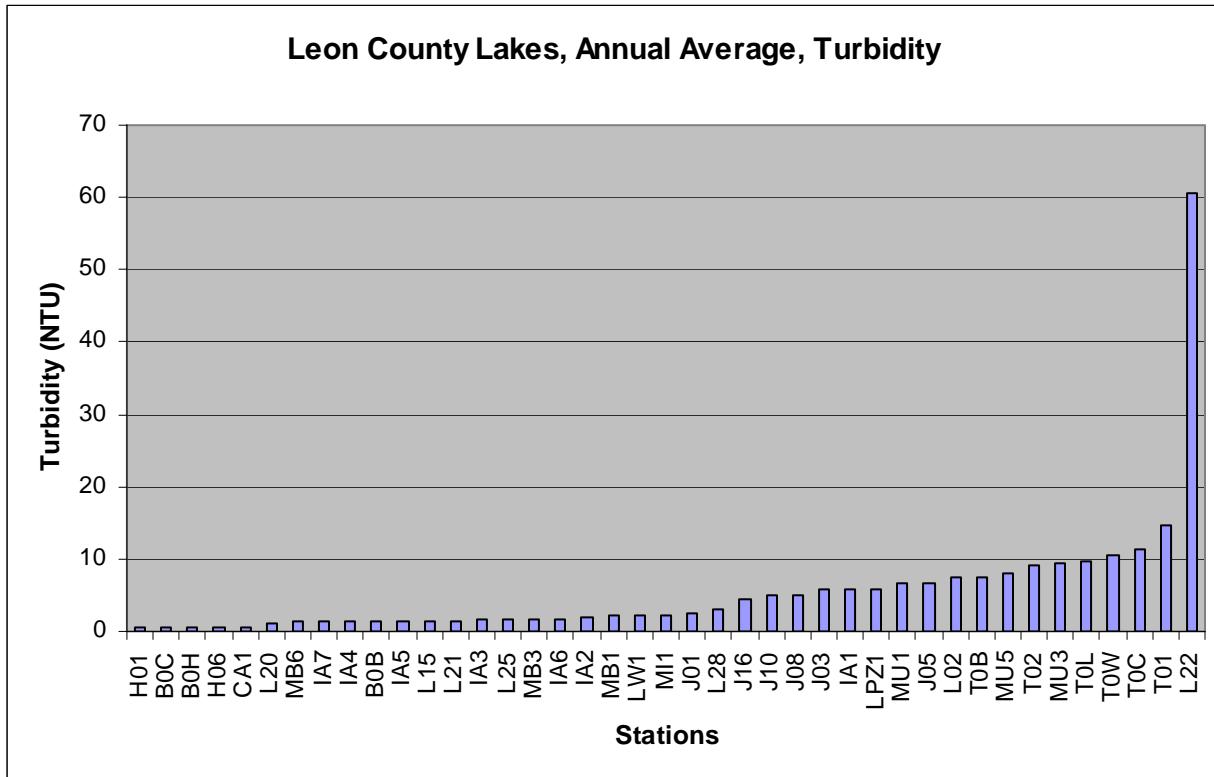


Figure 3.21.1: The average turbidity for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.22: Alkalinity

Alkalinity is the capacity of the water to neutralize acids, a property limited by the amount of carbonates, bicarbonates, hydroxides, and phosphates in the water. It is expressed in milligrams per liter of Calcium carbonate. Stormwater runoff typically carries a lot of alkalinity derived from the constituents of concrete and other dissolved ions. The Lakes of Leon County are generally soft water lakes filled from rainfall. Lake Hall will be used for background at 5 mg/L.

Lakes with elevated alkalinity generally pick up the alkalinity from stormwater running over concrete. Leon County’s groundwater is generally very alkaline since it flows through a carbonate aquifer. The low alkalinity is proof that Leon County’s Lakes are not filled with waters derived from the Floridan Aquifer. Water quality standards for a Class III water body require that alkalinity not be depressed below 20 mg/L. This regulation has little relevance concerning the Lakes of Leon County.

The alkalinity in Leon County is depicted in figure 3.22.1:



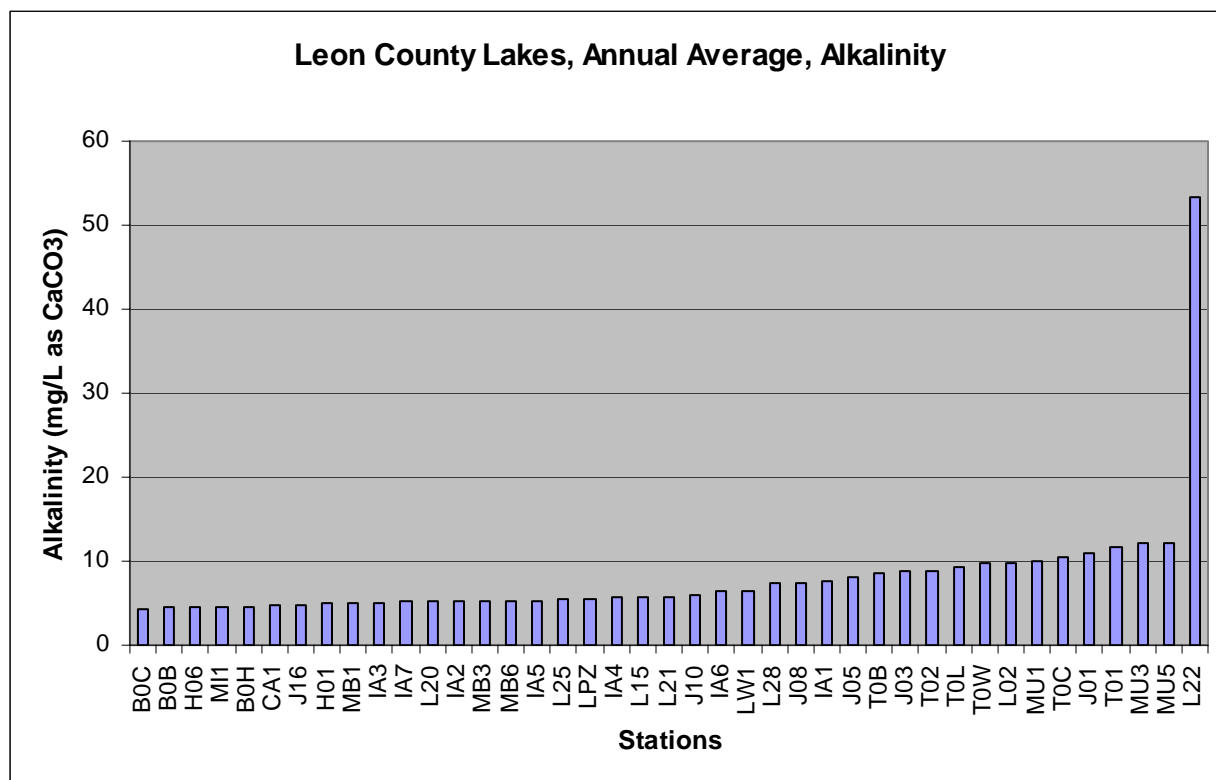


Figure 3.22.1: The average alkalinity for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.23: Chlorides

Chlorides are used as an indicator of human wastewater because human urine has a high quantity of salt in it. Physiologically we came from the seas and our bodily fluids have a similar chloride contents (salinity) to seawater. The biological treatment of human wastewater does not remove the chloride (salt). Measurements of chlorides above background levels usually indicate the presence of wastewater (except in coastal areas).

The Floridan Aquifer has an average chloride content of about 7 mg/L. The following stations are elevated in chloride content, to varying degrees. They may be receiving some wastewater inputs either from failed septic systems, municipal discharge, mixed sanitary and stormwater sewers (figure 3.23.1). L22 (near the Talquin STP and the Leon County Landfill), J01 (Maginnis Arm), Lake Munson and Lafayette Sink are the most elevated in chloride concentration. It is highly likely that all these stations are impacted with wastewater discharge.



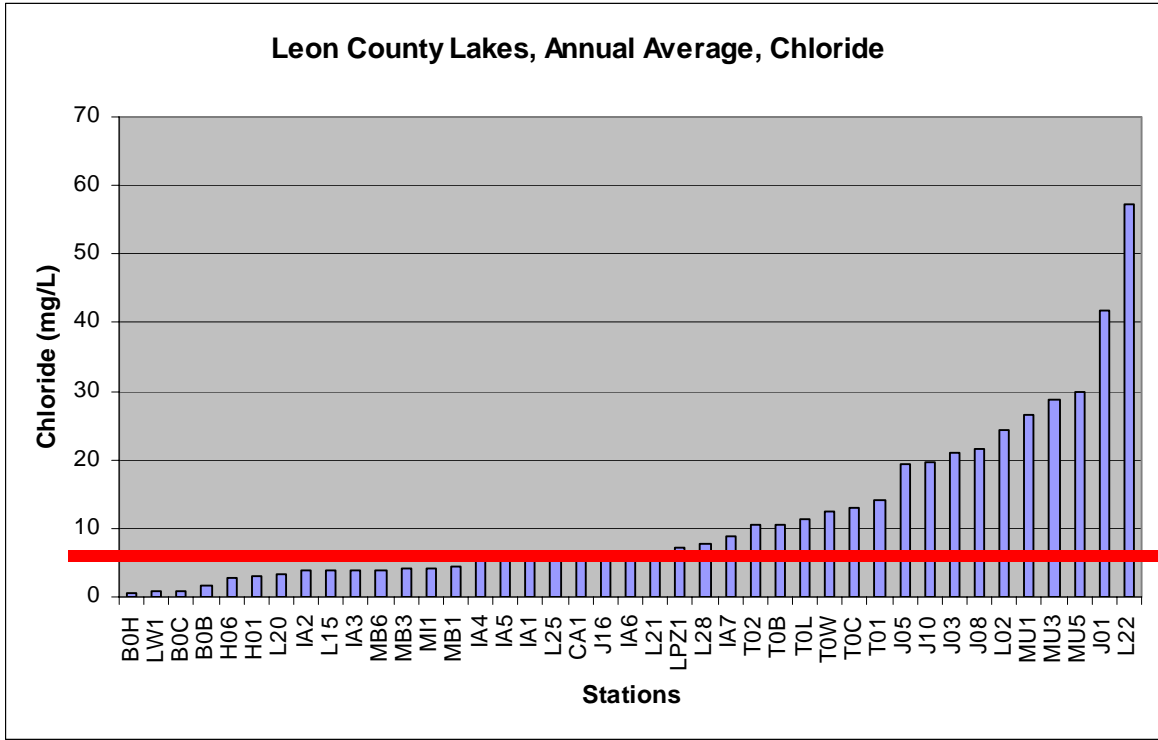


Figure 3.23.1: The average chloride for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.24: Total Suspended Solids (TSS)

This is a direct measurement of the particles that are suspended in the water column. It is usually closely correlated with turbidity. Suspended Solids are common in erosion associated with stormwater runoff. Suspended Solids settle in receiving bodies once the velocity of the water slows and can cause substantial silting or filling of Lakes. Suspended solids can also be produced by excess aquatic vegetation such as algae.

TSS is depicted in figure 3.24.1.



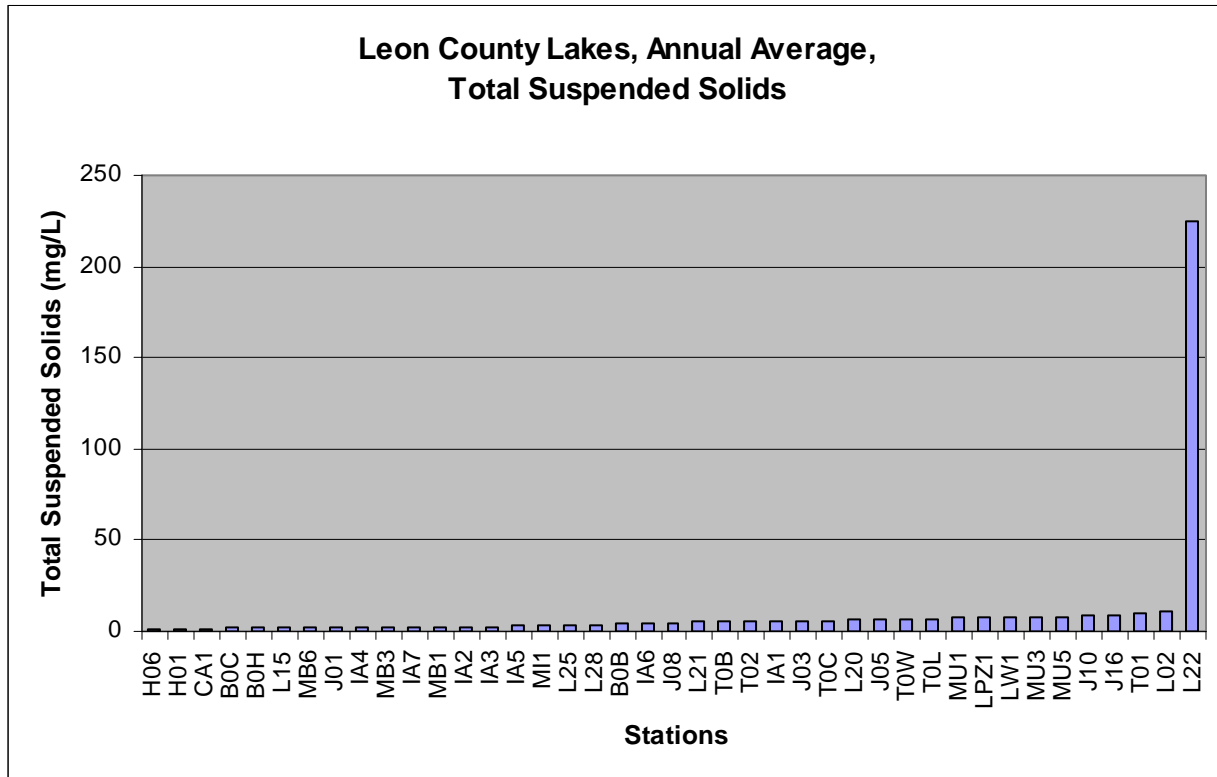


Figure 3.24.1: The average total suspended solids for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.25: Total Dissolved Solids (TDS)

Total Dissolved Solids are a measure of the solids in solution. Alkalinity and Specific Conductance are related measurements. Alkalinity assesses the calcium carbonate component of the dissolved solids. Specific conductance measures only the charged particles. Total Dissolved Solids is a measurement by weight.

Total Dissolved Solids is depicted in figure 3.25.1.



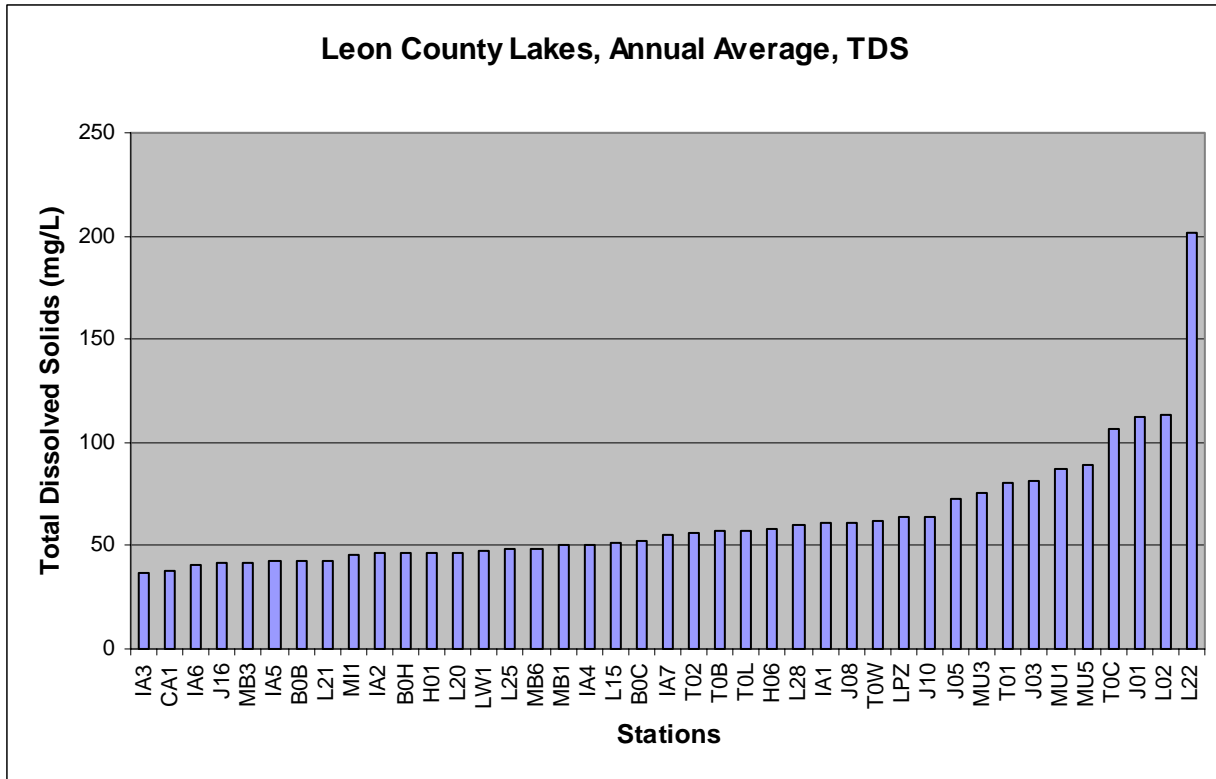


Figure 3.25.1: The average total dissolved solids for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.

3.26: Microbiology

Bacteria are a major human health concern. Certain strains of bacteria indicate the presence of fecal matter or sewage in water. These bacteria are normally present in the intestines of warm-blooded animals where they aid in digestion, but when found in water they indicate contamination. There are regulatory levels considered safe for these bacteria in surface waters (table 3.26.1). There are no accepted regulatory levels for viruses.

Certain types of bacteria indicate contamination by pathogens or disease producing bacteria or viruses. These bacteria can occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste and are often elevated following storms. Typhoid fever, viral and bacterial gastroenteritis and hepatitis are examples of waterborne pathogenic diseases that can infect humans that come in contact with contaminated water.



A group of microorganisms, total coliform bacteria, live in large numbers in the intestines of man and animals. Total coliform bacteria are present in all natural waters. They can cause ear infections, skin rashes, and eye irritation. Pathogenic organisms are commonly found along with total coliform bacteria. The monitoring of total and fecal coliform bacteria dates from the cholera era.

Fecal coliform bacteria are subgroup of total coliform bacteria. Swimming in waters with high levels of fecal coliform bacteria increases the chance of developing a fever, nausea or stomach cramps from swallowing disease-causing organisms, or from pathogens entering the body through cuts in the skin, the nose, mouth, or ears. Coliform bacteria only live for 5 to 10 hours once they leave the intestinal tract. Their presence implies recent contamination. Some examples of diseases and illnesses that can be contracted in water with high fecal coliform counts include typhoid fever, hepatitis, gastroenteritis, dysentery and ear infections.

A subgroup of fecal coliform bacteria is called *Escherichia coli* (*E. coli*). Fecal coliform bacteria are found in the feces of human beings and other warm-blooded animals. Fecal coliform by themselves are generally not pathogenic (a biological agent, such as a bacterium or virus, that can cause a disease). Pathogenic organisms include bacteria, viruses and parasites that cause diseases and illnesses.

Enterococci bacteria are a type of fecal streptococcus. Enterococcus bacteria also indicate fecal contamination of surface waters. Studies have shown that swimming associated gastroenteritis is related directly to the quality of the bathing water and that enterococci are the most efficient bacterial indicator of water quality. Enterococci are distinguished by their ability to survive in salt water, and in this respect they more closely mimic many pathogens than do the other indicators. Enterococci are typically more human-specific than other fecal groups. EPA recommends enterococci as the best indicator of health risk in salt water used for recreation and as a useful indicator in fresh water as well.

The annual averages for bacteria at LCL stations are depicted in figures 3.26.1-4.

Table 3.26.1: Guidelines used to interpret microbiological data

Fecal Coliform bacteria rating, Florida Department of Health Guidelines:

GOOD: 0-199 fecal coliform organisms per 100 ml of marine water

MODERATE: 200-399 fecal coliform organisms per 100 ml of marine water

POOR*: 400 or greater fecal coliform organisms per 100 ml of marine water

Enterococcus bacteria rating, Florida Department of Health Guidelines:

GOOD: 0-34 Enterococcus per 100 ml

MODERATE: 34-103 Enterococcus per 100 ml

POOR*: 104 or greater Enterococcus per 100 ml

*A Poor rating requires resampling prior to issuing a Health Advisory or Warning. This indicates that contact with the water at this site may pose an increased risk of infectious disease, particularly for susceptible individuals.

Fecal Coliforms guidelines, according to Florida Statutory Limits, 62-302.530 (6)

Counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages are expressed as geometric means based on a minimum of 10 samples taken over a 30 day period.

Total Coliforms guidelines, according to Florida Statutory Limits, 62-302.530 (7)

Counts shall not exceed a monthly average of 1000, nor exceed 1000 in 20% of the samples, nor exceed 2,400 on any one day. Monthly averages are expressed as geometric means based on a minimum of 10 samples taken over a 30 day period.

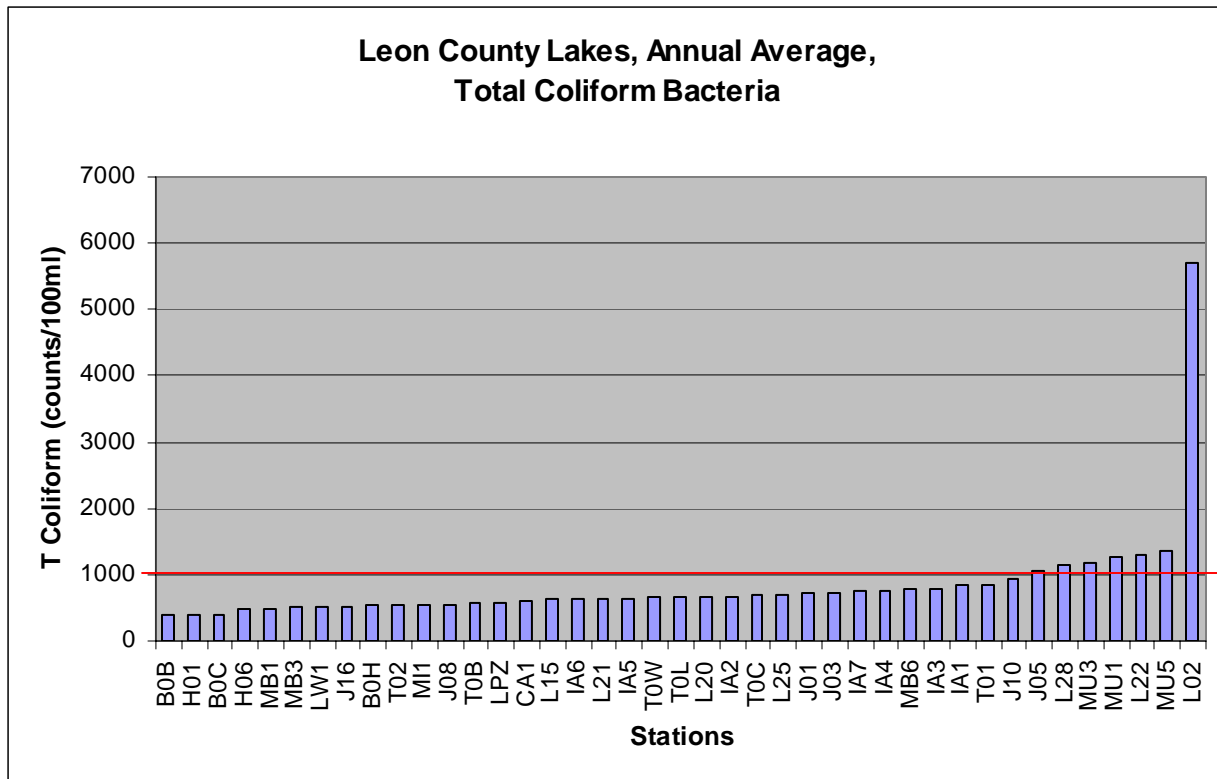


Figure 3.26.1: The average Total Coliform bacteria for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



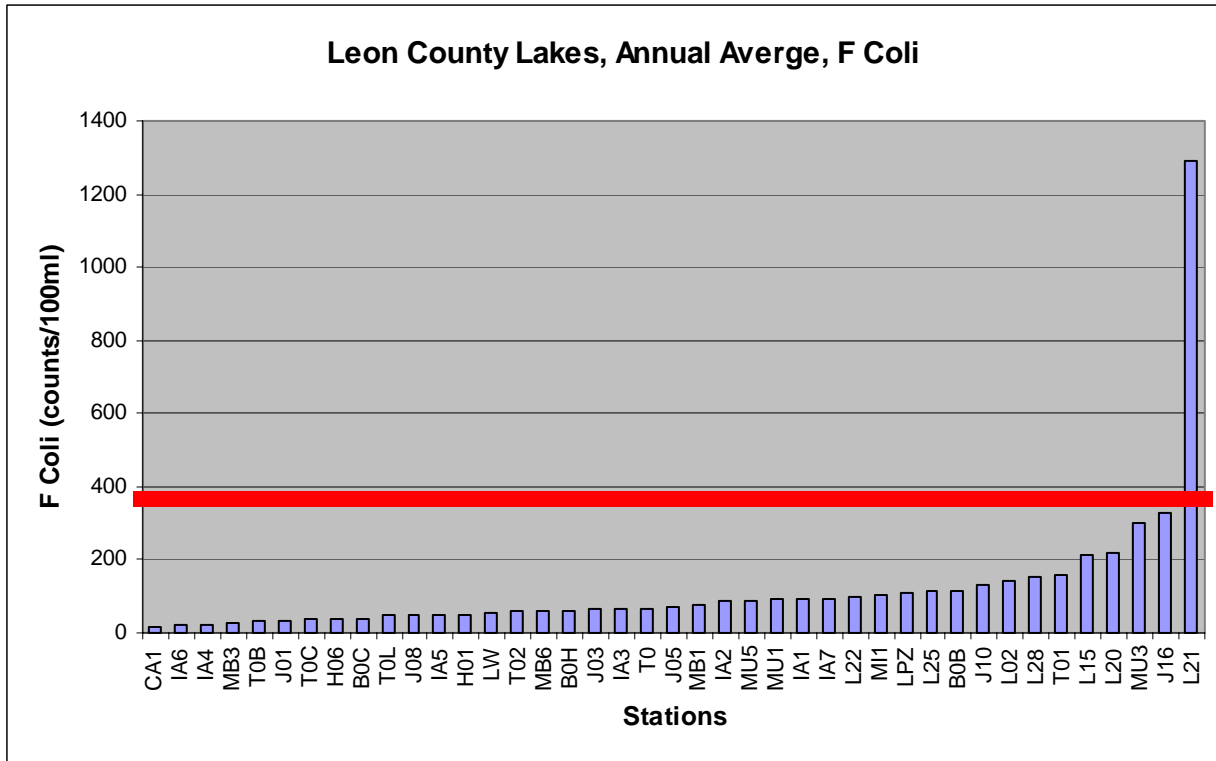


Figure 3.26.2: The average Fecal Coliform bacteria for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



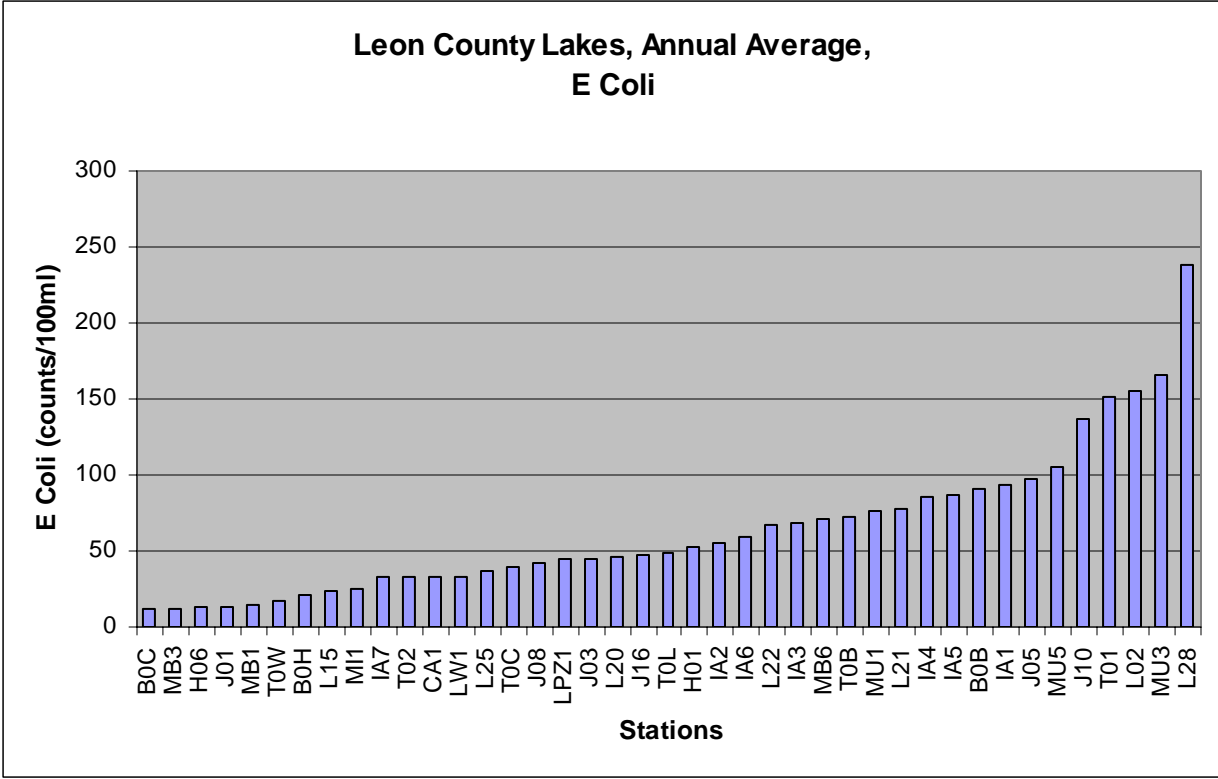


Figure 3.26.3: The average E. Coli bacteria s for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



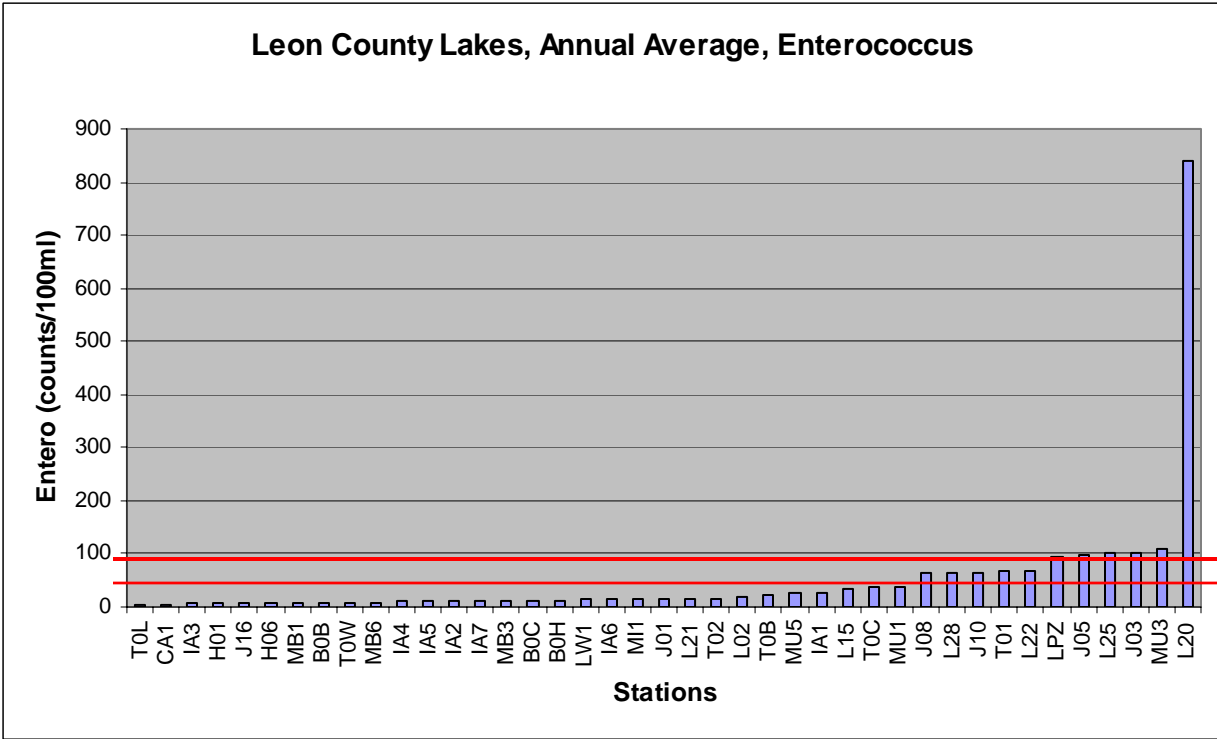


Figure 3.26.4: The average Enterococcus bacteria for all the Lakes sampled by the Leon County Lakes Ecology program. The data was averaged over the time period covered by this Annual Report from 09/04 to 05/06. This data was sampled and analyzed by McGlynn Laboratories Inc.



3.27: Statistical Analysis of Data

Cluster Analysis is a multivariate statistical technique that assesses the similarities between units or assemblages, based on the occurrence or non-occurrence of specific artifact types or other components within them. Data clustering is a common technique for statistical data analysis, which is used in many fields, including machine learning, data mining, pattern recognition, image analysis and bioinformatics. Clustering is the classification of similar objects into different groups, or more precisely, the partitioning of a data set into subsets (clusters), so that the data in each subset (ideally) share some common trait - often proximity according to some defined distance measure. Cluster analysis is a class of statistical techniques that can be applied to data that exhibits “natural” groupings. Cluster analysis sorts through the raw data and groups them into clusters. A cluster is a group of relatively homogeneous cases or observations. Objects in a cluster are similar to each other. They are also dissimilar to objects outside the cluster, particularly objects in other clusters.

The data set used is detailed in table 3.27.1. The clustering procedure is detailed in table 3.27.2. The result of this Cluster Analysis is depicted graphically as a ‘Tree Topology’ (table 3.27.3). The samples form "leaf" nodes to the right. Each step in the clustering process is represented by an "interior" node, which has descendents to its right. The two descendents of an interior node are the two clusters joined at that point. No attempt was made to represent proportional distances.

The actual distances between adjacent nodes can be found in table 3.27.4. These distances are proportional to the difference among the chemical constituents in the samples. Any pair of leaf nodes (i.e. samples) have an associated distance that can be determined by tracing along the tree from one node to the other, adding appropriate values from table 3.27.4. Since the concentration of analyzed constituents of the water was used in the cluster analysis, the difference between samples reflects the differences in chemical composition of the samples.

The cluster analysis had some interesting results. The relationship between stations and their spatial organization is significant. The grouping and spatial relationship of the data is significant. In general, waterbodies with better water quality seemed to separate to the top of the tree topology (figure 3.27.2).

The most distinct station, by far, was station L22, Cluster A1 at the bottom of the tree topology. Seepage from wastewater treatment ponds impacts station L22.

Another distinct station was J01, Cluster A3, in Meginnis Arm on Lake Jackson, which receives stormwater inputs from heavily urbanized areas in Tallahassee.

Three smaller clusters also separated out from the other stations as being somewhat distinct. The Lake Hall Cluster (A2) was probably discrete because of good water quality. Lake Hiawatha, Cascade and Carr also were a distinct cluster (A4). Again it is probably

the tannic nature of these lakes coupled with their good water quality that caused them to split out. The third small cluster (A5) was composed of Lake Bradford and Weeks. Again these are very tannic lakes but split off probably because seem to have compromised water quality. It is troubling that the Bradford Brooks Chain of Lakes did not cluster together and that Bradford clustered was more closely associated with a lake, which the residents feel, is impacted by the CoT Sprayfield.

The large cluster toward the bottom of the Tree Topology (B1) probably could be called the eutrophic cluster. This is composed of all the Lake Munson stations, All the Talquin stations, the Ochlockonee River stations, Lake Piney Z and Upper Lake Lafayette (Lafayette Sink). All of these areas have long been recognized as having compromised water quality either due to poor water quality from Georgia (Talquin and the Ochlockonee) or urban runoff (Lake Munson and Lafayette Sink. It is surprising that Lake Piney Z spit into this cluster but its recent history of severe algal blooms is an obvious symptom. It might be prudent to hope that these areas receive a TMDL soon.

The large cluster in the center of the Tree Topology (B2) might be taken to represent mesotrophic waters. These could be considered as being on the borderline between poor and fair water quality. This cluster includes the rest of Lake Jackson, several of the Lake Lafayette stations (L25, L28 and L20) and the slough between the Ochlockonee River and Lake Iamonia (IA1).

The largest cluster, B3 (toward the top of the Tree Topology) might be taken to represent an oligotrophic grouping. This includes all the Lake Iamonia stations (excluding the slough, IA1), all the McBride Stations and Lake Miccosukee. These lakes and Lakes Hall (A2) as well as Lakes Hiawatha and Cascade from the Bradford Brooks Chain of Lakes seem to have good water quality.

An interesting detail was that Lakes Jackson and Lafayette were the only discrete lakes that separated out into different clusters. This is due to the lakes being rather large being impacted by distinct stormwater streams.

Assuming some interpretive license there are some interesting elements regarding this cluster analysis. Distinct groupings of waterbodies might be interpreted in terms of the water quality in the lakes monitored. Lakes that clustered together and have similar water quality characteristics. It is also intriguing which waterbodies separated out:

- 1) The Bradford Brooks Chain of Lakes (excluding Lake Bradford)
- 2) Lake Iamonia
- 3) Lakes Carr, Hall, Miccosukee and McBride
- 4) Lake Lafayette (all stations excluding LPZ, L22 and L02)
- 5) Lake Jackson (all stations excluding J01)
- 6) Lake Bradford and Weeks
- 7) Lake Jackson (J01), Upper Lafayette (Lafayette Sink)
- 8) Lake Piney Z
- 9) Upper Ochlockonee River
- 10) Lake Talquin
- 11) Lake Munson
- 12) Lower Lake Lafayette (L22)

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Table 3.27.1: Data Matrix

All Leon County Lakes Ecology stations were included. All parameters were included in this cluster analysis (Temperature, pH, Specific Conductivity, dissolved oxygen, chlorophyll a, Chloride, DIN, Nitrate, TN/TP, Ortho-phosphorus, Turbidity, Alkalinity, Color, TSS, TDS, total coliform, E. coli, fecal coliform, BOD, TKN, TP, TSI. All regularly sampled Leon County Lake sampling stations were included in the analysis (B0B, B0C, B0H, CA1, H01, H06, IA1, IA2, IA3, IA4, IA5, IA6, IA7, J01, J03, J05, J08, J10, J16, L02, L15, L20, L21, L22, L25, L26, L27, L28, LPZ1, MB1, MB3, MB6, MI1, MU1, MU3, MU5, T01, T02 , T0B, T0C, T0L, T0W, LW1).

Table 3.27.2: Clustering procedure: Using Unweighted Arithmetic Average; The Distance/Similarity measure is Canberra Distance.

Step	A	B	Distance
1	TOW	TOL	0.05409137840484772
2	MB3	MB1	0.054606737213440074
3	IA3	IA2	0.06613631722654313
4	IA5	IA4	0.06924428619119673
5	MU5	MU1	0.07439435623115223
6	TOB	TO2	0.0785347685649224
7	1'	6'	0.08443195665610478
8	IA7	4'	0.08997235650478205
9	JO5	JO3	0.09021152661032575
10	MB6	2'	0.09075578839911029
11	5'	MU3	0.10939048580506755
12	8'	3'	0.1128513924317085
13	7'	TOC	0.12005637146012935
14	10'	L15	0.12032734135307133
15	MI1	IA6	0.1275349760655691
16	L28	L25	0.13039854777636734
17	15'	12'	0.13980494964681547
18	HO6	HO1	0.14807454695574176
19	JO8	9'	0.14933277485787494
20	J10	IA1	0.15458682270832852
21	BOH	BOC	0.15946004175582806
22	LW1	BOB	0.16505616379318502
23	16'	20'	0.1664222193370446
24	17'	14'	0.16679767014802158
25	24'	L21	0.17297533027321754
26	25'	22'	0.1829406666009227
27	23'	J16	0.18555830932070533
28	27'	L20	0.20078834679912183
29	26'	CA1	0.21159527519206042
30	11'	LO2	0.22123099969713725
31	29'	21'	0.22332866202455684
32	13'	TO1	0.23066373148963065
33	28'	19'	0.23945255153127187
34	30'	LPZ	0.2578842275752911
35	31'	33'	0.2616204940943546
36	35'	JO1	0.2907828572600104
37	32'	34'	0.2918309071733806
38	36'	18'	0.29821962388297213
39	37'	38'	0.37264799140437743
40	39'	L22	0.5404935745330921



Table 3.27.3: Tree Topology (edge lengths ignored)

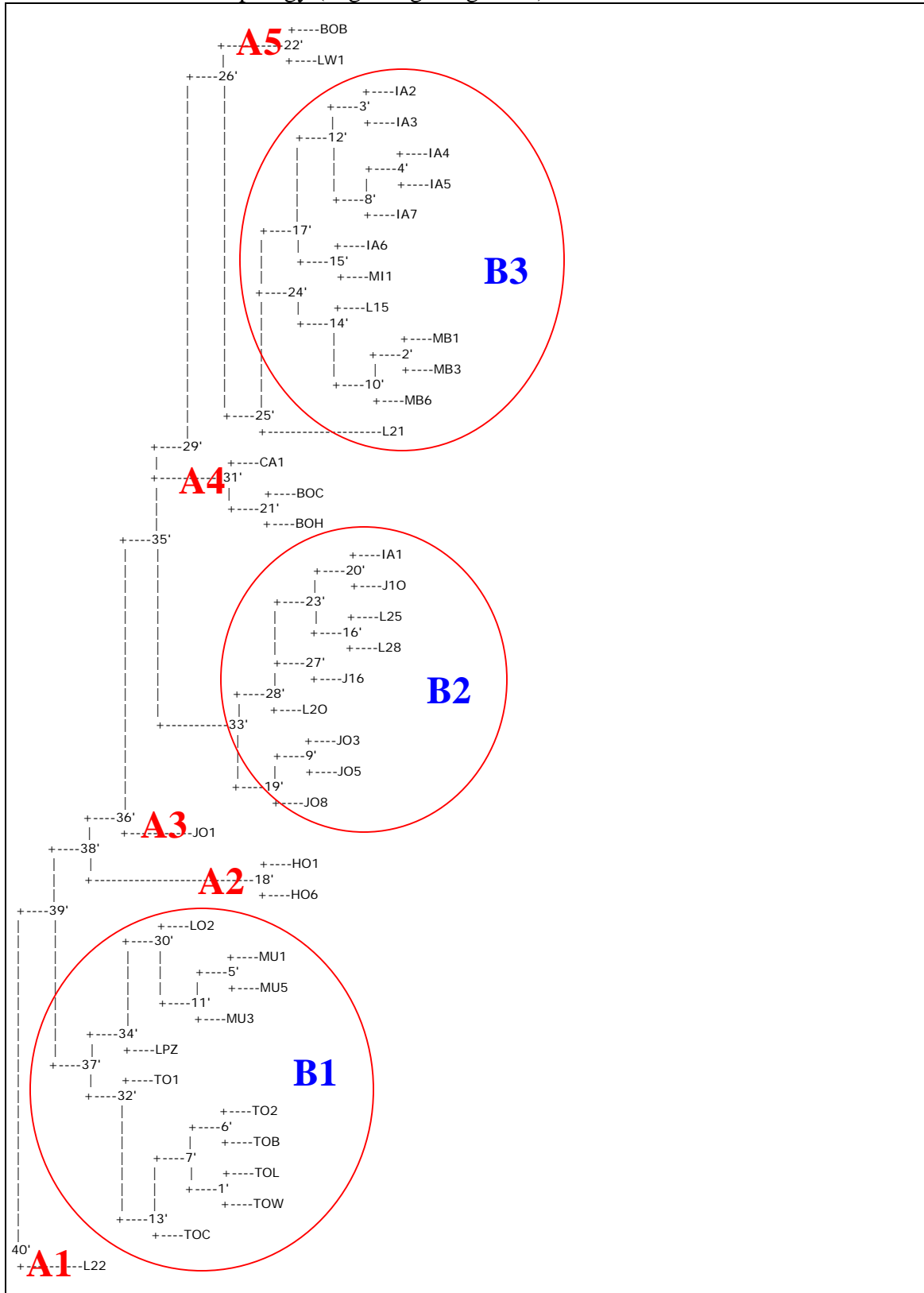


Table 3.27.4: distances between adjacent nodes

From	To	Length
40'	39'	0.08392279156435734
39'	38'	0.03721418376070265
38'	36'	0.0037183833114808607
36'	35'	0.014581181582827896
35'	31'	0.01914591603489889
31'	29'	0.005866693416248209
29'	26'	0.01432730429556886
26'	22'	0.00894225140386884
22'	BOB	0.08252808189659251
22'	LW1	0.08252808189659251
26'	25'	0.00498266816385258
25'	24'	0.003088830062597983
24'	17'	0.013496360250603051
17'	12'	0.013476778607553488
12'	3'	0.023357537602582683
3'	IA2	0.033068158613271566
3'	IA3	0.033068158613271566
12'	8'	0.011439517963463222
8'	4'	0.010364035156792663
4'	IA4	0.034622143095598364
4'	IA5	0.034622143095598364
8'	IA7	0.044986178252391026
17'	15'	0.006134986790623187
15'	IA6	0.06376748803278455
15'	MI1	0.06376748803278455
24'	14'	0.023235164397475125
14'	L15	0.06016367067653566
14'	10'	0.014785776476980518
10'	2'	0.01807452559283511
2'	MB1	0.027303368606720037
2'	MB3	0.027303368606720037
10'	MB6	0.045377894199555145
25'	L21	0.08648766513660877
29'	CA1	0.10579763759603021
31'	21'	0.03193431013436439
21'	BOC	0.07973002087791403
21'	BOH	0.07973002087791403
35'	33'	0.011083971281541372
33'	28'	0.01933210236607502
28'	27'	0.007615018739208251
27'	23'	0.009568044991830366
23'	20'	0.005917698314358039
20'	IA1	0.07729341135416426
20'	J10	0.07729341135416426
23'	16'	0.01801183578033863
16'	L25	0.06519927388818367
16'	L28	0.06519927388818367
27'	J16	0.09277915466035266
28'	L20	0.10039417339956092
33'	19'	0.04505988833669847
19'	9'	0.029560624123774595



Table 3.27.4, continued: distances between adjacent nodes

9'	JO3	0.045105763305162874
9'	JO5	0.045105763305162874
19'	JO8	0.07466638742893747
36'	JO1	0.1453914286300052
38'	18'	0.07507253846361518
18'	HO1	0.07403727347787088
18'	HO6	0.07403727347787088
39'	37'	0.04040854211549841
37'	34'	0.01697333979904475
34'	30'	0.018326613939076933
30'	LO2	0.11061549984856862
30'	11'	0.05592025694603485
11'	5'	0.01749806478695766
5'	MU1	0.037197178115576116
5'	MU5	0.037197178115576116
11'	MU3	0.054695242902533775
34'	LPZ	0.12894211378764556
37'	32'	0.030583587841874982
32'	TO1	0.11533186574481533
32'	13'	0.05530368001475065
13'	7'	0.01781220740201228
7'	6'	0.0029485940455911894
6'	TO2	0.0392673842824612
6'	TOB	0.0392673842824612
7'	1'	0.015170289125628532
1'	TOL	0.02704568920242386
1'	TOW	0.02704568920242386
13'	TOC	0.06002818573006467
40'	L22	0.27024678726654605

