Macroinvertebrate Program
2006 Annual Report

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Table of Contents

The Macroinvertebrate Program

1.1 **History**. In 1969, The Orange County Pollution Control Department's Biology Section created the Macroinvertebrate Program, with Jerrell Daigle working as principal biologist. Today the program exists as part of the Environmental Assessment Team within Natural Resources Management at Orange County Environmental Protection Division. Current benthologists include Jeff Darr, Lynn Denahan, Marcia Anderson, and Program Manager, Julie Bortles.

1.2 **Purpose**. For years it was thought that monitoring the quality of the water alone from a lake or stream was sufficient for assessing the overall health of any water system. However, biologists have shown that bioassessments of benthic macroinvertebrate communities within a lake or stream, along with ambient water monitoring, increases overall assessment accuracy, and provides direct information about the dynamics of actual living organisms within the aquatic system. Benthic means the organism is attached to the substrate, and macroinvertebrates are very small animals with no spine, average 1mm to 15mm in size, and usually in an instar or larval stage.

Macroinvertebrates, over other faunal types, are chosen to study for their strong physical attachment to the water bodies within the watershed. They are slow moving, sessile, or encased in their habitat, making them vulnerable to anthropogenic or natural disturbance, simply because they cannot quickly maneuver away from the changing conditions. Since they represent the bulk of the food chain for larger aquatic fauna, their health is a critical component to the overall health of the aquatic system.

The ambient water monitoring program, National Pollutant Discharge Elimination System (NPDES), and Total Maximum Daily Load (TMDL) permitting program incorporate indices and biometrics generated by the macroinvertebrate program. These include site Bioreconnaissance (BIORECON), Stream Condition Index (SCI), Lake Condition Index (LCI), Lake Variability Index (LVI), Shannon-Weaver diversity index (SWDI), Hulbert Index (HI), and the relative foraging characteristic percentages; (collectors, scrapers, clingers, shredders, filterers, sensitive, long-lived, tolerant, and predator species).

Data collected from the Macroinvertebrate program can also be used to support or contest findings reported by other agencies dedicated to monitoring and preserving our environment. Our 2006 data is used in the conclusion of this report to support findings about fundamental ecological relationships within our watersheds.

1.3 **Planning**. Each year, depending upon availability of equipment, personnel, site conditions, and weather conditions, approximately twenty-four sites, (lake and stream combined), are targeted for benthic macroinvertebrate sampling. To achieve an accurate analysis, ambient water sampling is scheduled close to or at the same time as the benthic sample, so the water chemistry can be paired with the biology. In addition to the target site schedule, the county's macro laboratory assesses five sites semi-annually in cooperation with the City of Orlando for the NPDES permit program.

2.1 **Training**. In March 2006, a new biological specialist, Jeff Darr was hired to organize and assume the responsibilities of the macroinvertebrate program. Initial training for a benthologist includes a heavy emphasis on systematic taxonomy, the field methods of the SCI, LCI, Biorecon, and ambient surface water sampling, and State DEP Standard Operating Procedures. Safe boater training, laboratory and field safety protocols, and MSDS training are also provided.

Increasing the accuracy of determining land usage, recording GPS coordinates for all our sample sites, and having lake bathymetry mapped for our water atlas became a high priority. Recruiting a biologist trained in Geographical Information Systems (GIS) was critical to achieve these goals. Land usage is calculated using GIS, Access, SQL, and VB programming. GIS training gained by other personnel during the year contributed significantly to the bathymetry and land acquisition goals. Having in-house personnel who are experienced in GIS diminishes any dependence on hiring outside consulting for GIS work.

Continuing training helps strengthen the staff's capability to increase accuracy in reporting. All four Benthologists attended a series of training sessions to increase their knowledge of field methods and protocols, and of species found in freshwater systems in Florida. In 2006, the following workshops and training sessions were attended by select personnel associated with the macroinvertebrate program:

- March, FDEP, Biocriteria meeting; Stream Assessment testing
- May, FAB, (Florida Association of Benthologists), Oligocheate taxonomy
- May, FLURISA (Florida Urban and Regional Information Systems Association), GIS Program Management
- September, FDEP, Biocriteria meeting; LVI (Lake variability study), Rapid periphyton assessment method, SCI determination at Reedy Creek.
- October, FDEP, Wetland Grass, Sedge, and Rush taxonomy training.
- December, FDEP, SCI training for new biologists.
- December, FAB, Annual meeting; Invasive species threat, proposed changes to the SCI laboratory method, DNA and systematics overview, youth outreach initiatives. Correlation study with site land use and bioassement results.

2.2 **Audits**. Auditing staff is important for expanding our capabilities as a program, reducing dependence on single individuals for audit requirements, and providing a degree of excellence and professionalism in the department. The following audit was earned during 2006:

- Marcia Anderson passed a successful habitat assessment audit in March, 2006

3.1 **Improvements**. The invertebrate program has undergone numerous changes of personnel over the past years. Even though strict adherence to state SOP guidelines were always followed, frequent changes in personnel can produce inevitable side effects. There was a lack of continuity of specimen storage protocols, record-keeping inconsistencies, reporting style differences, incorrect calculation of certain indices over a two-year period†, and inattention to the care of our macroinvertebrate library.

In addition to fixing problems, new technology was sought to increase the accuracy of our datasets and reporting. Since reporting styles prior to 2006 varied greatly, standardization of reporting became a high priority. To make easier comparisons of data in the future, in order to recognize biological health and community trends, the purchase of a bug database was authorized.

Marquis Consulting Services was used to create, install and tailor a database that would report all critical indices generated by the LCI, SCI, and BIORECON methods. The new database would also keep an electronic library of our confirmed macroinvertebrate reference collection. The advantage of using the *BugsMadeEZ* database is that it is currently used by more than 3 other local agencies for their macroinvertebrate programs. Maintenance of the code, and an assurance of accuracy of calculations are key features included in the agreement with Marquis Consulting Services.

The cataloging and storage of field samples was in poor condition prior to 2006. A new database was created to catalog and track the location of all slides and vials within a sample, for all future samples. The new biologist created the database and standardized procedure, for storage protocols. Included in the *Benthic Library Control* database is the ability to track individual slides or vials if they happen to be separated from the sample, e.g. for confirmation, or round robin activities, oversized, etc. Also included in the storage database is the ability to make mass updates, and queries, and the ability to easily move and update sample locations.

Critical to analysis of field methods, is having greater accuracy in determining land use in a watershed. Previously, surrounding land use at a site was estimated by visual inspection or by viewing an aerial photograph. Instituting GIS solutions to determine actual watershed land usage surrounding a site has increased our accuracy in reporting physical and chemical data parameters.

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† From Feb 2004 to March 2006, in a small number of reports, a natural logarithm was used in error within a species diversity calculation, when a logarithm base 2 should have been used. A vague description written in the state SOP on how to count taxons in the Hulbert index also caused discrepancies in reporting. This was by no means a reflection on the biologist(s) at the time; the program calculation was embedded and setup incorrectly by a former employee. These discrepancies have all been corrected for 2006. There are very few reports prior to 2006 that may contain these errors, and they are currently being reviewed and recalculated if necessary.

4.1 **Cooperative Improvements**. To provide credibility and portability of data across agency boundaries, group accord is essential when interpreting Standard Operating Procedures. By standardizing the interpretation, the data then can be easily compared, and be more useful to a department who needs the data.

FABOA (Florida Association of Benthologists of Orlando Area) was established in late fall of 2006 to address the common concerns and issues of field and laboratory personnel involved in benthic analysis of the Central Florida watersheds. The team was created by Eric Pluchino of FDEP, Julie Bortles of Orange County EPD, and Marianne Pluchino and Gloria Eby of Seminole County Storm Water Management. This sub-committee has been proven to be very effective in enhancing the integrity of the SOP methodology. This is done by the sharing of ideas, field and lab experiences, pressing concerns, and brainstorming issues. When individuals share specific features and tendencies of their watershed, it can offer unique insight into a problem or irregularity occurring in someone else's watershed.

Included in the directives contained in the State SOP, cross-agency quality control measures should be performed regularly to insure consistency in lab identifications. One of the first products to come out of the FABOA meeting is the establishment of regular DEP Macro-invertebrate Taxonomic Round Robin Resolution exercises between members of FABOA. In November, the first exchange of field samples was initiated, along with an SOP on how to perform the quality control. A Round Robin exercise is when different agencies identify each other's specimens to measure consistency of the taxonomic identifications. The taxonomist would identify the taxa to the lowest practical taxonomic level, write down the identifications on a paper, and mark the species for exchange only with a reference number. A taxonomist from a different agency would then identify the specimens, and comment on the original identifications in a Round Robin report form.

Orange County Florida, The City of Orlando, and The Florida Center for Community Design and Research, have created a partnership with The University of South Florida to produce an online water atlas available to the public to view status and health of most water systems around Central Florida. The macroinvertebrate program is compiling report briefs on the health of biological communities within sampled sites, called *Bioviews*. Each *Bioviews* publication will be linked to its water body on the atlas site. This publication is a brief 2-3 page 'snapshot' of the lake or stream, and will publish all the major indices and results of pertinent water chemistry related to the health of the water body.

5.1 **Recalculation of Reports**. A calculation error, and an error in an SOP interpretation were found in a small number of reports from February 2004 to March 2006. All reports from 2006 have been corrected, and all prior in that time frame are being reviewed for accuracy. The discovery of both errors was found only when we started talking with other agencies, and comparing results with each other. This is an advantage of having groups like FABOA. The calculation error was discovered when we all upgraded to the *BugsMadeEZ* software, and noticed the discrepancies in test calculations. The logarithm error simply wasn't noticed since the base of a natural logarithm is very close to a logarithm base 2. The errors effected the calculation of the Shannon-Weaver diversity index, and the Hulbert sensitivity index.

So far the correction in both indices is so minute, that it hasn't changed any site's health category. We don't anticipate any measurable changes in SCI scores, and only very slight changes in LCI scores. In general, the errors produced slightly lower scores. The correction will produce slightly better scores. If any score moves a site into a new health category, the report will be reevaluated; however, this is not anticipated.

5.2 **Establishing Benchmarks**. Recent historical data is incomplete and many sites were not sampled due to lack of personnel. The unreported data before 2006 is still in the process of being properly recorded, and stored. Historical comparisons will not be featured in this report due to lack of portable data. Broad temporal comparisons will be noted however in the results section. The 2006 data will serve as a benchmark to future temporal trend analyses.

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6.1 **Sampling Data**. In 2006, twenty-seven samples were processed through the macro-invertebrate program. Orange County EPD staff collected samples from seventeen sites. The City of Orlando staff collected ten samples, from five sites. Twelve SCI's, fourteen LCI's, and one Biorecon, were performed. All but two of The City of Orlando LCI assessments scored in the 'poor' category, and all but one SCI assessment scored in the 'poor' category††. All Orange County lake assessments, but two, scored in the 'Very Good' category. Our bio-reconnaissance site LWE (Elba-Campo way), failed for testing for a new sample site. If the changes proposed to the SOP for the SCI are adopted, it will change the fail/pass thresholds for the biorecon as well††.

Table 6.2 features all of the pertinent physical and chemical parameters usually effecting benthic macroinvertebrate health. The table includes all the diversity, sensitivity, and condition indices, along with the dates and site locations with their prospective analysis, scores, habitat assessments, and score interpretations. In Table 6.2, most of our lakes were shown to be slightly alkaline, and our streams were shown to be slightly acidic.

Figure 6.3 features the LCI and SCI scores on a chart to illustrate the general condition of bioassessment sites, from poorest to best. It's important to note that all the City of Orlando sites improved during the year. Ten (71%) of our lake sites scored in the "Very Good" category, three (21%) scored in the "Good" category, and one site (7%) scored in the "Poor" category. Two (17%) of our stream sites scored in the "Fair" category, ten (83%) scored in the "Poor" category. The interpretation of the SCI chart might be confusing to the general public since the labels (e.g. Good, Fair, Poor) used for interpretation are required by SOP, and do not consider the water system's designated use. **(See below)**††.

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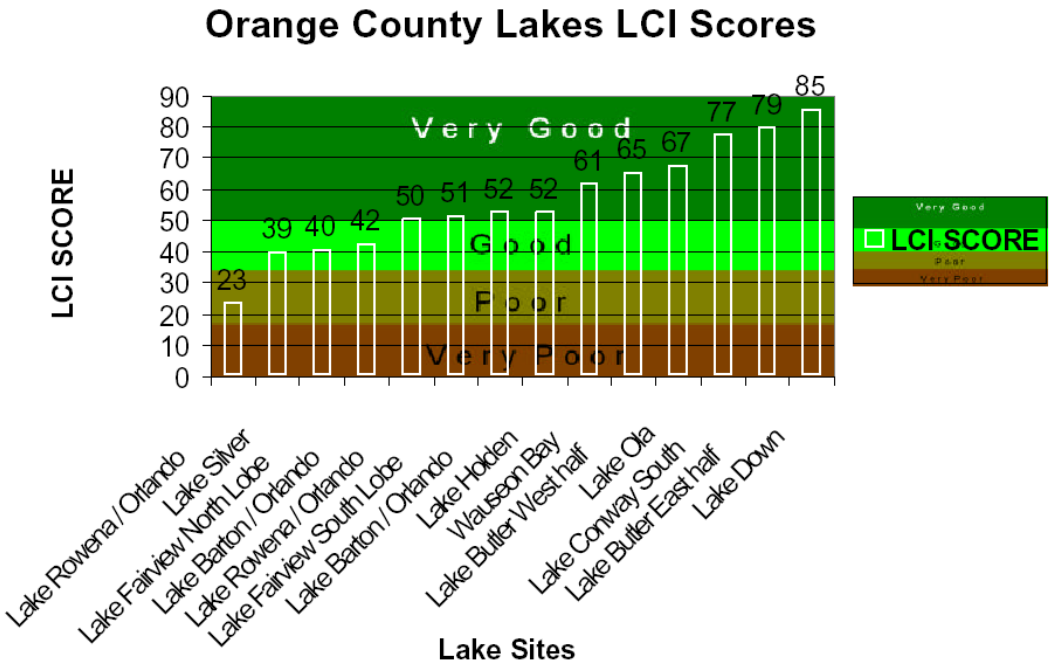
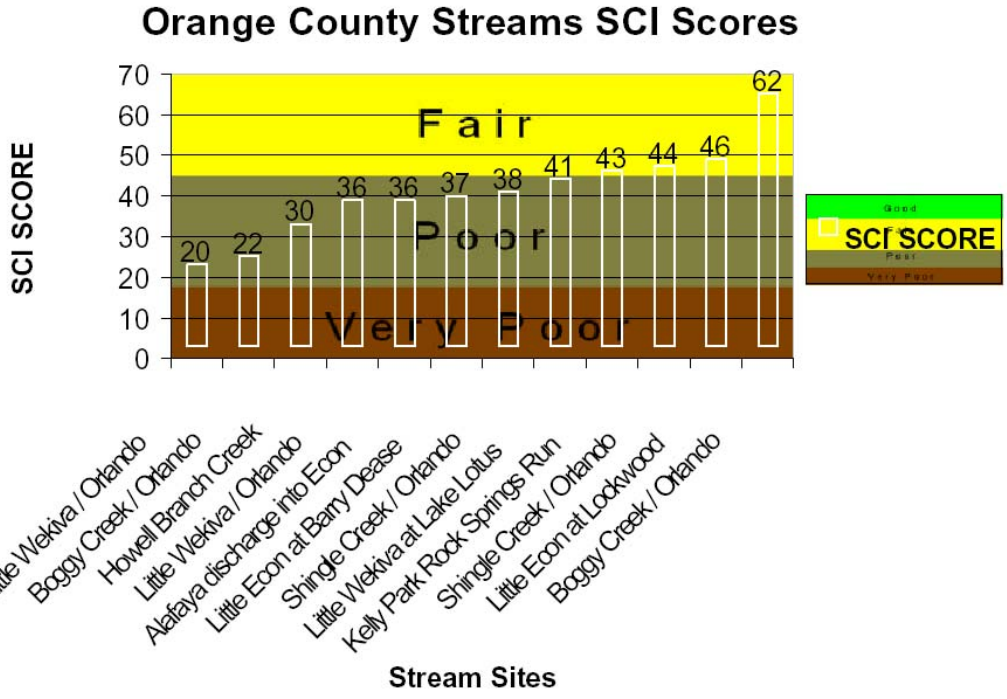
†† During the Annual meeting of FAB in December, new SCI metrics and interpretations were proposed by FDEP for changes to the SOP for 2007. It was decided that the interpretation boundaries set for the February 2004 SOP were too generalized, and were based on fractions of means averages instead of a more natural index such as the aquatic life index. The new proposal will divide the interpretation boundaries along a 95% confidence interval associated with the BCG (Biological Condition Gradient) curve. The labels used for the interpretation were chosen arbitrarily in 2004, but now correspond directly to the categories represented in the aquatic life index (ALI). The proposal is to change the categories to category 1 means "outstanding" and is correlated with AL1; sections 1 and 2 along the BCG curve. Category 2 means "meets designated use" and is correlated with AL2; section 3 along the BCG curve. Sites in this category may experience a change in structure, but their function remains the same. Category 3 means "does not meet designated use" and is correlated with AL3-4; section 4-6 on the BCG curve. Sites in this category have experienced both a major change in structure and function, and are representative of partially recovered canals, hyper-eutrophic systems, and urban ditches. A change in the target number of individuals sub-sampled has been proposed for the 2007 SOP SCI to limit the variability found in the current procedure. These measures should adequately reflect the true condition of stream sites, and eliminate broad variability, and arbitrary labels and selection of interpretation categories.

6.2 2006 Biomonitoring Site Statistics

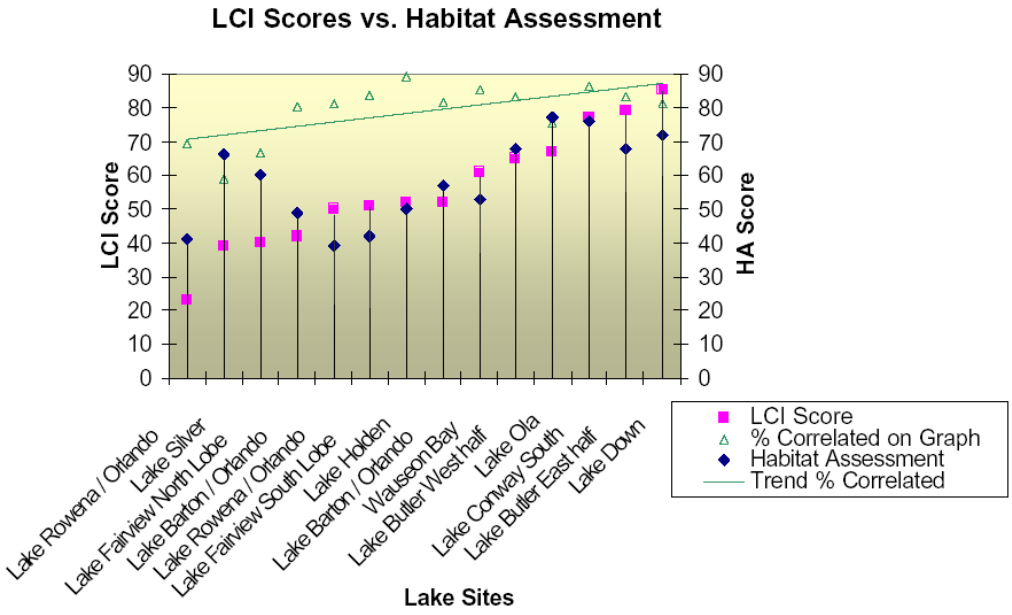
Date	Site	Site Location	Basin	Analysis	Score	Interpretation	HA	SWDI	HI	DO	pH	Sp Cond
2/22/06	O-SCO	Shingle Creek / Orlando	Shingle Creek	SCI	38	Poor	23	3.760	7	4.1	7.9	270
3/1/06	O-LWO	Little Wekiva / Orlando	Little Wekiva	SCI	36	Poor	81	3.710	6	7.1	7.0	210
3/13/06	O-HB34	Lake Rowena / Orlando	Howell Branch	LCI	23	Poor	41	0.806	2	11.3	9.0	205
3/15/06	O-LE2	Lake Barton / Orlando	Little Econ	LCI	52	Very Good	57	3.927	9	8.6	7.7	129
3/21/06	O-BCO	Boggy Creek / Orlando	Boggy Creek	SCI	22	Poor	117	2.410	9	6.2	7.2	179
4/7/06	LWD	Little Wekiva at Lake Lotus	Little Wekiva	SCI	41	Poor	86	4.190	9	4.5	6.8	295
5/3/06	BC9	Lake Conway South	Boggy Creek	LCI	77	Very Good	76	4.183	11	7.7	7.4	231
5/19/06	LWE	Little Wekiva at Elba Campo	Little Wekiva	BIOREC	3	Fail	97	n/a	n/a	n/a	n/a	n/a
6/9/06	CC9	Lake Down	Cypress Creek	LCI	85	Very Good	72	3.788	13	7.3	7.4	244
7/6/06	CC4-B	Lake Butler West half	Cypress Creek	LCI	65	Very Good	68	3.677	9	7.6	6.8	215
7/6/06	CC4-A	Lake Butler East half	Cypress Creek	LCI	79	Very Good	68	3.627	15	7.6	6.8	215
7/17/06	O-SCO	Shingle Creek / Orlando	Shingle Creek	SCI	44	Poor	53	4.170	12	1.4	7.7	218
7/25/06	CC21	Wauseon Bay	Cypress Creek	LCI	61	Very Good	53	3.839	10	6.8	7.8	223
8/2/06	BC14	Lake Holden	Boggy Creek	LCI	52	Very Good	50	3.575	7	7.8	7.0	319
8/7/06	O-LWO	Little Wekiva / Orlando	Little Wekiva	SCI	20	Poor	82	2.520	9	3.0	7.8	209
8/17/06	A29	Lake Ola	Lake Apopka	LCI	67	Very Good	77	3.499	14	7.1	8.4	257
9/6/06	O-LE2	Lake Barton / Orlando	Little Econ	LCI	42	Good	49	3.725	8	7.3	7.4	136
9/11/06	O-HB34	Lake Rowena / Orlando	Howell Branch	LCI	50	Very Good	39	3.376	7	7.4	7.9	177
9/26/06	BWAA	Kelly Park Rock Springs Run	Big Wekiva	SCI	43	Poor	117	3.464	5	2.3	7.3	259
10/9/06	O-BCO	Boggy Creek / Orlando	Boggy Creek	SCI	62	Good	118	3.569	11	3.9	6.7	145
10/17/06	LET	Little Econ at Barry Dease	Little Econ	SCI	37	Poor	115	3.817	8	5.2	6.9	202
10/18/06	LW18	Lake Silver	Little Wekiva	LCI	39	Good	66	2.697	7	7.7	7.7	176
10/31/06	LES	Little Econ at Lockwood	Little Econ	SCI	46	Fair	87	3.183	4	7.0	7.1	258
11/15/06	BE I	Avalon tributary at Live Oak	Big Econ	SCI	36	Poor	123	2.851	3	7.2	7.6	647*
11/29/06	HB C	Howell Branch Creek	Howell Branch	SCI	30	Poor	57	3.219	8	4.5	6.2	202
11/30/06	LW28	Lake Fairview North Lobe	Little Wekiva	LCI	40	Good	60	3.135	7	8.3	7.0	186
11/30/06	LW29	Lake Fairview South Lobe	Little Wekiva	LCI	51	Very Good	42	3.044	6	8.4	7.1	164

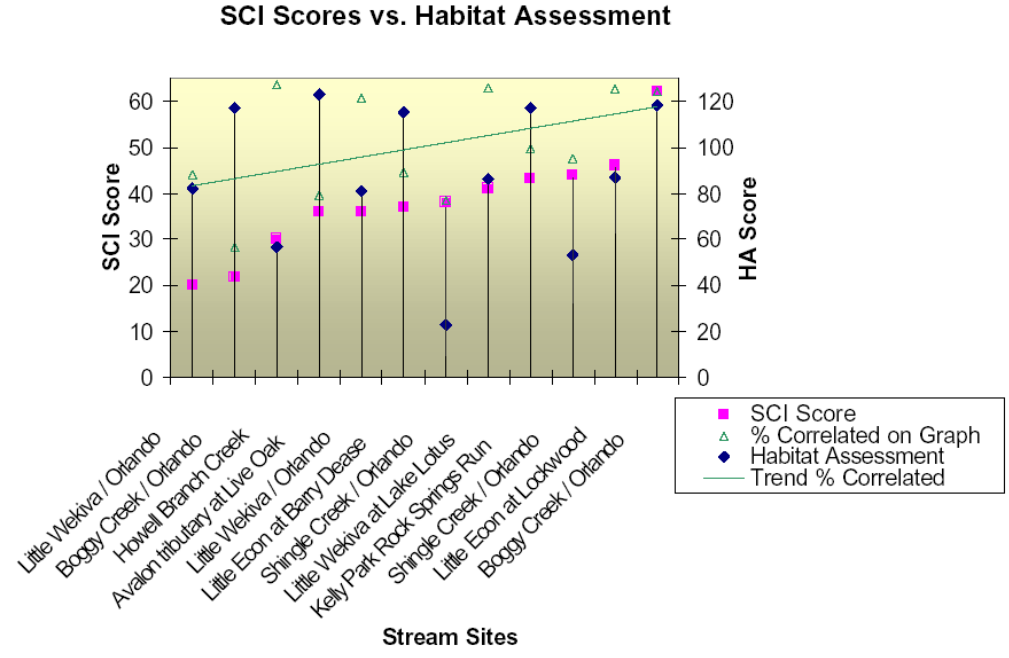
HA = Habitat Assessment
SWDI = Shannon Weaver Diversity Index
HI = Hulbert Sensitivity Index
DO = Dissolved Oxygen Level mg/L
pH = Acidity/Alkalinity (<7 Acid, >7 Alkaline)
Sp Cond = Conductivity/Salinity µmhos/cm
*actual conductivity (647) effluent from treatment plant wetland sheet flow



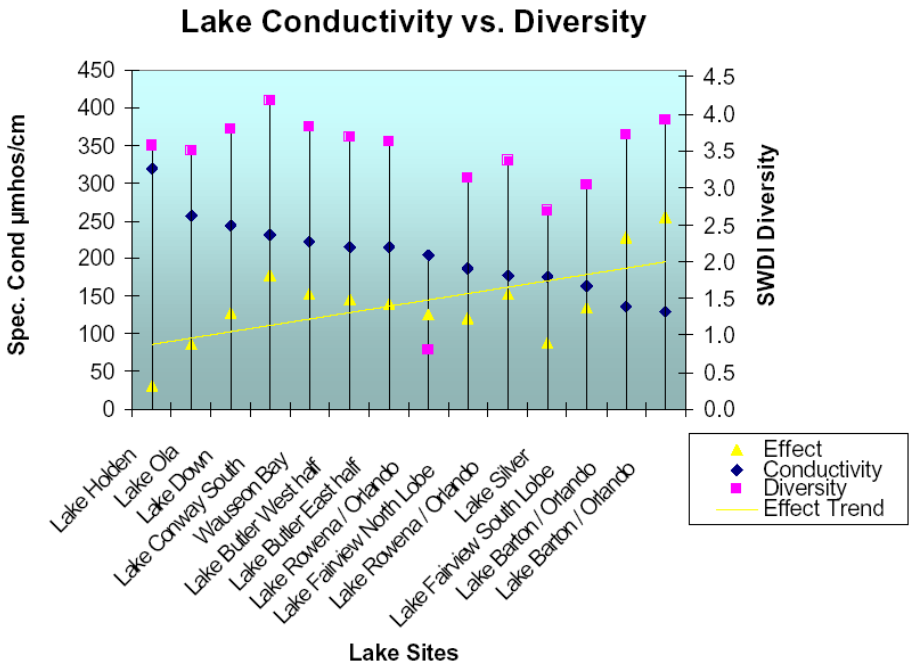


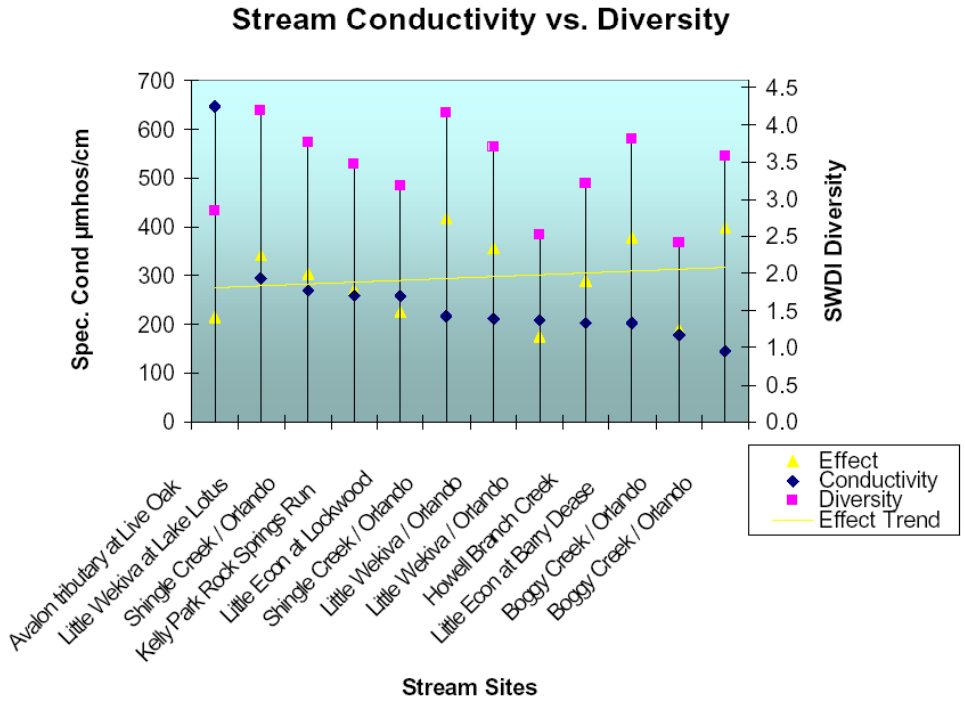
6.4 Condition Index vs. Surrounding Land Use

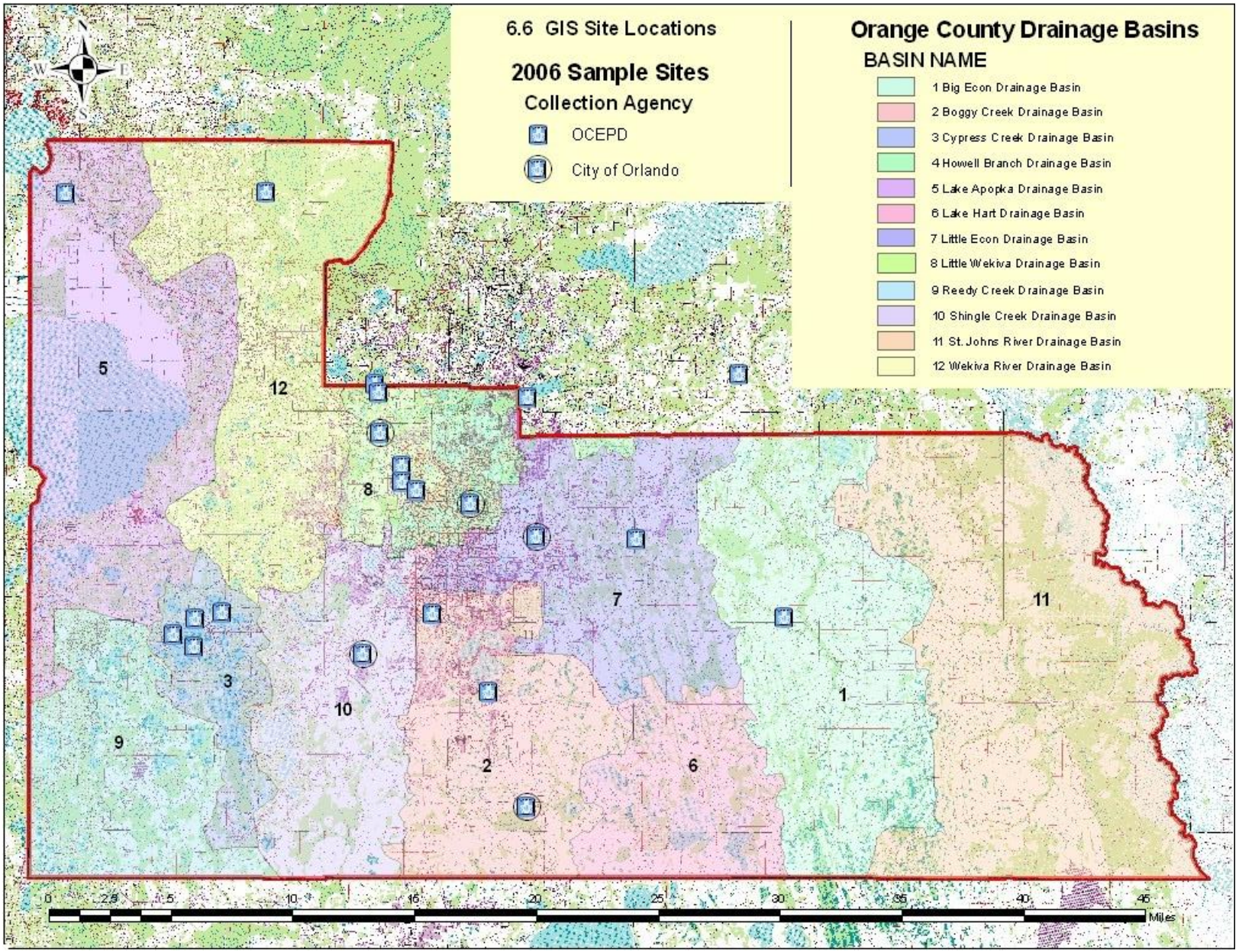




6.5 Water Conductivity vs. Species Diversity







7.1 **Discussion**. Many studies over the years have looked at the effect of land use on condition index scores, and the effect of conductivity on species diversity. Our 2006 data supports the findings of two local studies about these relationships.

Laura Line, of Water & Air research, Inc., Gainesville, FL presented a bio reconnaissance study report on the Alachua County streams at the 2006 Annual FAB meeting in December. She compared healthy, suspect, and impaired streams and found a direct correlation between stream quality and surrounding land use designation. Dave Karlen, of the Hillsborough County Environmental Protection Commission presented a study on diversity of species in the Tampa Bay area. Karlen discovered that there was a negative correlation between increasing water conductivity and species diversity, a conclusion also previously supported by FDEP. The data from our 2006 sites supports the conclusions of both studies.

In figure 6.4, the LCI scores show a direct correlation to Land Use around the water system. The green line is the trend illustrating how closely habitat scores coincide with SCI scores. The graph shows a positive correlation trend for our lake sites for habitat and SCI scores.

The SCI graph shows a mild positive correlation for our stream sites for habitat and SCI scores; however, there is variability in the habitat scoring. This may be due to inaccurate habitat assessment scoring at the site. It is recommended that Orange County biologists score the Orlando sites independently, because there are changes in the habitat scoring at the same Orlando sites for different times of the year. Although in some circumstances water quality and macroinvertebrate populations can change suddenly, habitat conditions seldom improve that quickly.

Land Use distribution was determined by using GIS software, using a 2004 LandUse/Land Cover data layer. The area calculated was clipped from the land cover data layer as a large square containing the first quartile of the watershed on all sides of the assessment site. Habitat scoring is performed by SOP at the sample location and closely reflects this land use. Correlation was performed using Spearman's rank correlation coefficient, as site locations are non-linear, and require a monotonic function to describe their relationship. The trend line in figure 6.4 supports Line's conclusions about land use and site quality.

Figure 6.5 illustrates the relationship between water conductivity and species diversity. Both Lake and Stream sites show an inverse relationship between conductivity and species diversity. The yellow triangles illustrate the net effect that the conductivity has on the diversity at each site. If conductivity is close to diversity, the effect drops. If there is wide separation of the two variables, the effect increases. Effect is calculated on a percentage of the fluctuation of these variables, and is plotted as a percentage of graph height. The trend line in figure 6.5 supports Karlen's conclusions, about conductivity and species diversity potential.

7.2 **Conclusions and Planning**. Temporal comparisons of site history will not be featured due to incomplete, or missing datasets. Recalculations of reports back to February 2004 are necessary to present accurate comparisons[†]. When all data from the archives are properly documented, temporal trends of our watersheds can then be analyzed. An emphasis on Stream Condition Indices, Lake Variability Indices, and prospective bio-reconnaissance sites will be the focus for fieldwork in 2007. Our outreach and training in 2007 will center on cooperative interaction between government agencies, specialized taxonomic training, surface water sampling training, and community partnerships and commitments.

8.1 **Literature Cited**

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