RAMROD KEY

WATER QUALITY STUDIES 2001--2002

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RAMROD KEY WATER QUALITY STUDIES – 2001-2002

SUMMARY

The Program

The purpose of this report is to summarize results of water quality sampling to date and consider how they affect the environmental initiatives of Breezeswept Beach Estates Civic Association (BBECA) of Ramrod Key. Over the years BBECA members have reported periodic problems in the canal system related to bothersome jellyfish, surface scum and floating seaweed, and sedimentation. It was believed that such problems could be reduced by increasing the tidal flushing of the canals and reducing stagnation by installation of a larger culvert connecting the canal system to the open tidal waters of Newfound Harbor. However, before supporting such a project, BBECA believed it necessary to first study the existing water quality of the canals. After completion of this study, eligible Ramrod Key voters approved installation of a new large culvert (Nov.5).

In 2001 BBECA organized an extensive water quality sampling program for the 17 canals of the subdivision and for adjacent Newfound Harbor. BBECA worked on one program with the Nature Conservancy of the Florida Keys (TNC) and Florida International University (FIU) and on a second with the University of Florida Institute of Fisheries and Aquatic Sciences (IFAS) Lakewatch/Coastal Team. The first phase of our sampling program – which is reported here -- commenced on March 20, 2001 and ended on May 18, 2002

BBECA collected samples which were analyzed for nitrogen (N), phosphorous (P), and chlorophyll (CHL) by the two universities. Various environmental conditions were also recorded, including tides, weather, and water transparency. Simultaneously, BBECA measured dissolved oxygen in the waters of the canals and in Newfound Harbor. Also on two occasions BBECA sampled for pathogenic bacteria. In addition, BBECA measured tidal flows in the canals and through an existing small culvert that connects the canal system to Newfound Harbor.

In this report we classify the year's sampling results for nutrients by three categories which relate the effects of nutrient pollutants in the water-- nitrogen (N) phosphate (P) -- to levels of growth of algae and other floating microplants (phytoplankton) -- measured by amounts of plant pigment, chlorophyll (CHL). The classifications are as follows:

Oligotrophic; Very low level, low amounts of pollution

Mesotrophic; Moderate level, medium amounts of pollution

Eutrophic; Higher level, higher amounts of pollution

Review of Data

Neither the data for the canals nor open waters show signs of ecological distress from excessive amounts of P and N nutrients. The same is true for algae and other phytoplankton which are at rather low levels according to the CHL measurements. For P, N, and CHL, the total number of measurements taken was 448. Of which 85 % were in the oligotrophic (low levels of pollution) category, 10 % were mesotrophic (medium levels of pollution), only 5 % were eutrophic (higher levels of pollution), and none were hypertrophic (high levels of pollution).

Water transparency, which is another index of pollution, was high enough in both canals and open water that the bottom was visible in all but two cases, meaning that we rarely found a disappearance depth with the Secchi Disk (used to measure transparency). This indicates a low level of pollution induced algae and other phytoplankton.

Dissolved oxygen (DO) in all canals and open waters of Newfound Harbor that were sampled averaged above the State standard of 4.0 (PPM). Canals averaged 6.5 PPM and open waters 8.25 PPM. For the whole study, only 5 out of 110 samples (5.5 %) were substandard, which is well within the range of tolerance. This indicates that despite the closed nature of the canals, sufficient DO exists to support a healthy ecosystem. Also it indicates that the open waters of Newfound Harbor have sufficient DO.

Limited sampling by BBECA and the University of Florida for pathogenic bacteria -- fecal coliform and enteroccus -- was encouraging in that bacterial index levels in two samplings were significantly below State standards for safe recreational water.

Conclusions

Increasing tidal flow from open water to the canal system of Breezeswept Beach Estates subdivision would benefit water quality of the canal system, as recommended by a water quality task force for the Florida Keys (EPA, 1999). This would correct design deficiencies by the developer of the subdivision which was built in the early 1960's.

While BBECA would like to see the highest possible water quality in the subdivision's canal system, the present water quality status is good enough so there should not be a problem in increasing the flow from the canals to the open water. That is, our canal water will not pollute Newfound Harbor if released in greater quantity such as will happen when the new larger culvert (4x8 ft) recently approved by Breezeswept Subdivision voters is installed to improve tidal exchange.

While the water quality effects of about 250 canalside homes in the subdivision appear to be less than expected, canal residents of the subdivision should continue to protect water quality by not disposing of liquid or solid pollutants into the canals and by ensuring optimum operation of their wastewater systems. It is particularly important to avoid disposal of organic and toxic materials in the canals and to use detergents that are low in phosphate.

INTRODUCTION

In an effort to determine the actual condition of the waters surrounding the Breezeswept Beach Estates subdivision of Ramrod Key (the part of the island lying south of US 1) the Breezeswept Beach Estates Civic Association (BBECA) organized an extensive water quality sampling program for our 17 canals and adjacent Newfound Harbor. BBECA worked on one program with the Nature Conservancy of the Florida Keys (TNC) and Florida International University (FIU) and on a second with the University of Florida Institute of Fisheries and Aquatic Sciences (IFAS) Lakewatch/Coastal Team. The first phase of our sampling program – which is reported here -- commenced on March 20, 2001 and ended on May 18, 2002

During a full year of one program -- March 20, 2001 to March 30, 2002 -- BBECA conducted water quality sampling in cooperation with TNC and FIU. Samples were taken weekly at two stations at Ramrod, one on a canal – and one on the open bay water of Newfound Harbor (see Appendix 1 for locations).The samples were frozen and sent to the FIU lab for testing for nitrogen, phosphorous, and chlorophyll (results in following sections).Various environmental conditions were also recorded.

Also, during one year in a second program -- June 16, 2001 to May 18, 2002 -- BBECA conducted water quality sampling in cooperation with IFAS. Samples were taken monthly for six stations at Ramrod Key -- three inside the Breezeswept subdivision's system of 17 canals, and three in the open bay water of adjacent Newfound Harbor (see Appendix 1 for locations). Similar to the TNC/FIU program, the samples were frozen and later sent to the Univ. of Florida laboratory for testing for nitrogen, phosphorous, and chlorophyll (results in following sections). Environmental conditions – such as weather, sea state, tide, and water clarity -- were also recorded during times of collection.

In addition to the nutrients -- dissolved phosphorous (P) and nitrogen (N) compounds – and chlorophyll (CHL) concentrations, measurements were made of dissolved oxygen (D.O.); and two types of bacteria. Additional observations were made of wind, sunlight strength, water currents, water temperature, water clarity (transparency), and tide level. BBECA plans to continue monitoring water quality in cooperation with Univ. of Florida commencing in August, 2002.

The purpose of this report is to summarize results of the water quality sampling to date and consider how they affect the environmental initiatives of BBECA and what further actions are indicated. Over the years BBECA members have reported problems in the canal system related to bothersome jellyfish, surface scum and floating "weed", sedimentation and shallowing, and other nuisances.It is believed that such problems can be minimized by increasing the tidal flushing of the canals and reducing stagnation by installation of a new large capacity culvert connecting the canal system to the open tidal waters of Newfound Harbor. However, before suporting such a project, BBECA believed it necessary to first study the existing water quality of the canals through chemical tests.

This report is divided into three main sections: Section I – Bacteria and Oxygen (p. 5); Section II – Nutrients and Chlorophyll (p.13); and Section III --Water Flows (p. 20). Appendices A1 to A5 follow Section III.

Of particular interest to BBECA is how the water quality data compare with State standards for oxygen and bacteria, two parameters of interest for which the State has set specific standards that would be involved in permit review by government agencies, when the County applies for permission to install the new culvert. State standards are defined by Florida Administrative Code, Sect 62-302). The Assocation is also interested in what priority should be given to providing central sewage for our subdivision.

BBECA's hope was that we could find guidelines from government or science that would tell us whether our waterways were in balance, ecologically. Unfortunately, we could find no ecological equation into which we could enter our data on P, N, CHL, oxygen, bacteria, water transparency, etc. and interpret our findings in a holistic way. So we were limited to looking at the parameters separately for the most part, which is not an optimum outcome.

The BBECA water quality team comprised the following: Joe Frey (retired book bindery owner), Dick Schuerger (retired nuclear operations engineer), Joe Beuchat (computer specialist), Ron Poller (auto shop owner), John Clark (retired marine biologist) and Terry Maddeaux (govt. information assurance manager). Robert Geh and Chris Hawkins commented on the manuscript of this report, for which we are grateful. We wish to acknowledge the very timely assistance of our project contacts, Brad Rosov of The Nature Conservancy of the Florida Keys and Dan Willis of The University of Florida, Department of Fisheries and Aquatic Sciences who also prepared the data presentations shown in the Appendices. We are also grateful for the extensive sample analyses done by the Florida International University and University of Florida labs.

SECTION I – BACTERIA AND OXYGEN

BACTERIAL INDICATORS

A variety of microbes are found in coastal waters, some benign and some pathogenic. Some of them are naturally occurring and some coming from wastewater and rain runoff. The usual approach to determining the general abundance of pathogenic microbes in coastal waters has been to measure the amounts of coliform bacteria therein. More recently, measurement of enterococcus bacteria has come into favor for coastal waters.

University of Florida Tests

On September 21, the University of Florida/IFAS team took six samples from Ramrod locations to their lab in Gainesville and determined the concentrations of fecal and total coliform bacteria in Ramrod Key waters – three samples were from the canals and three from adjacent Newfound Harbor (see Appendix 1 for locations). The measure for coliforms is Most Probable Number (MPN) in 100 milliliters (ml) of water sampled. The State regulatory standard for fecal coliforms is a maximum allowable amount of 400 MPN in 10% of samples but never to exceed 800 MPN in any one sample.

The Florida Healthy Beaches program uses the following categories:

Good = 0-199 fecal coliforms per 100 ml
Moderate = 200-799 fecal coliforms per100 ml
Poor = 800+ fecal coliforms per 100 ml

The average of our three canal samples was 25 MPN of fecal coliform, considerably below the 400 MPN State limit and at the safe end of the "good" category for the beaches program. The average of our 3 bay samples was even lower at 3.3 MPN. These measures indicated that Breezeswept waters had low bacterial contamination. (See Appendix 2).
A caveat is in order: the sampling was all done in only one day at the end of the summer and thus is what medical science calls a "soft end point", indicative rather than definitive. But the clear suggestion is that it is not likely that we have a major problem with disease causing microbes in Ramrod waters.

Synagro Lab Tests

On July 31, 2001, the BBECA team collected three representative samples from the Breezeswept canal system and transported them to the "Synagro Inc." lab in Key West. The Association asked for enterococcus bacteria determination (as well as fecal coliform) because this bacterium is believed to be a better indicator of disease transmission potential for salt water by many experts and by EPA. Synagro used an index number of Colony Forming Units or CFU per 100 ml but this is basically equivalent to the MPN index. Synagro uses a reference standard of 35 CFU maximum for safe marine waters. (See Appendix 3).

The Florida Healthy Beaches program uses the following categories for enterococcus (see page ahead for fecal coliform standards):

Good = 0-34 MPN per 100 ml
Moderate = 35-103 MPN per 100 ml
Poor = 104+ MPN per 100 ml

For enterococus, the average for the canals was 20 CFU, safely below the Synagro reference standard (max. 35 CFU). So compared to either this standard or the Healthy Beaches category (good = less than 35 MPN), the Synagro readings indicate that Breezeswept canals have enterococcus bacterial levels lower than prescribed limits.

For fecal coliform, the average for Ramrod canals was also 20 CFU which is considerably below the State standard of a maximum of 800 MPN and at the safe end of the healthy beaches program's "good" category of 0-199 MPN. A caveat: the Synagro samples were all taken on only one day and so must be considered a "soft end point", indicative not definitive. Yet they do not evidence a major problem with bacterial contamination levels in Ramrod canals or effect on open waters if a new culvert releases canal water outside. BBECA plans to expand the enterococcus survey in the future.

DISSOLVED OXYGEN

Background

In studying water quality, dissolved oxygen content (DO) is important because environmental regulators pay more attention to it than to many other parameters, largely because there is a regulatory standard for DO-- a prescribed minimum amount – 4.0 parts per million (PPM) for our "Class III" waters. Regulatory standards do not exist for parameters such as nitrogen, phosphorous, or chlorophyll, and otherwise exist only for pathogenic indicating bacteria (see section ahead). Any project proponent must show that the project will not diminish DO below the 4.0 PPM standard in the surrounding waters.

DO levels also serve as an important index to ecological health of coastal waters. At very low levels, sealife can virtually suffocate. Government has decided that 4.0 PPM should be safe. But ecologically, greater than 4.0 PPM of DO could be advantageous; i.e, D.O at 5.0 PPM or above may be optimum for sealife. We don't know the answer because this is an unexplored area of science. We do know that when the system is in balance, exchange of oxygen from air-to-water will raise DO towards its maximum level of saturation in water (which varies with temperature and salinity of the water). But whether in our waters, there is an *upper* limit of DO above which negative effects could occur is an open question. Many of our DO readings appeared to be near the maximum level of saturation.

In addition to oxygen recharge from the atmosphere, metabolism of marine biota has a strong effect. The basic biotic cycle affecting dissolved oxygen is that sea plants produce oxygen by photosynthesis when sunlight penetrates the water. But under a night sky they cannot photosynthesize and produce oxygen. During nighttime, much of the oxygen produced in the daytime is used up by the metabolic actions of bacteria and other biota.

The DO cycle -- from high in the afternoon to low at night -- can be as extreme as a difference of 8- 9 PPM from morning to evening in our waters. This is the typical cycle of events in nature, but the extremes can be modified by human activity – discharge of wastes, blockage of water flow, silt flow into the water, etc.

Results of Program with Nature Conservancy and F.I.U.

As part of the TNC/ FIU sampling program, we measured dissolved oxygen content at the two designated stations during our weekly samplings starting in June, 2001. For this purpose BBECA purchased a direct-reading DO meter called a Sentry I (Sentry Products, Inc). The data from these DO readings are attached as Tables 1A and 1B. Sampling locations are shown in Appendix 1 as stations 138 and 139.

In the TNC/FIU program we took samples as close to weekly as possible. The readings were taken at low/slack tide, as prescribed for the program, and varied from 7:00 AM to 7:40 PM. Because the Sentry meter was not available until June, 2001, our number of samples is lower for the Spring period.

At the open water station (No. 138), DO fell slightly below the State standard of 4.0 PPM twice out of 33 samples -- once in the summer (at 3.7) and once in the winter (at 3.5). Both were AM readings and both are permissible amounts under the regulatory averaging system. This station is characterized by wider day/night swings than the canal station (see below) -- open water readings ranged from a low of 3.5 to a high of 14.5 over 12 months, a difference of 11.0 PPM . The average for the open water station was about 9.0 PPM.

At the canal station (No. 139) readings varied from 4.5 to 10.0, a difference of 5.5 PPM. No substandard readings were obtained in the canals out of the 24 samples, the lowest being an AM reading of 4.5 PPM. Overall average for the canal station was a bit over 7.0 PPM , which was 2 PPM lower than for the open water station.

Seasonal averages for the two stations show an interesting difference. At the canal station, D.O. was lowest in Summer and highest in Winter. At the open water bay station, D.O. was lowest in Winter and highest in Fall .

In reference to the BBECA proposal to increase tidal water exchange between canals and the bay by installing a new large culvert, it appears that any increased outflow from the canals will not have a polluting effect on the bay; that is, not a significant lowering of DO in Newfound Harbor or seaward below the current regulatory standards.

Results of Program with University of Florida/IFAS

Along with the periodic sampling, we measured dissolved oxygen content at the six stations in the UF/IFAS program starting in June, 2001, using the same direct-reading dissolved oxygen (D.O.) meter mentioned above (Sentry I). The data from these D.O. readings are attached as Tables 2A and 2B. Sampling locations are shown in Appendix 1.

At the 3 open water stations of Newfound Harbor readings ranged from a low of 3.6 to a high of 11.0, a difference of 7.4 PPM. DO fell below the State standard of 4.0 PPM once out of 27 samples (Summer, AM, @ 3.6). Readings taken before noon were lower than those taken after noon, as expected. Most readings were taken about midday – 11:00 AM to 2:00 PM.

At the 3 canal stations, readings varied from 2.3–11.0, a difference of 8.7 PPM. Two substandard readings were obtained in the canals out of 26 samples, the lowest being an AM reading of 2.3 PPM. Readings taken before noon were lower than those taken after noon, as expected, except for the winter readings.

Seasonal averages for the two stations show an interesting difference. At the canal stations, D.O. was lowest in Summer and highest in Winter. At the open water stations, in Newfound Harbor, D.O. was highest in Spring and lowest in Summer. Overall average for the canals was about 6.0 PPM while the average for the bay was about 7.5 PPM

In comparison, the TNC/FIU trends were the same for the canals – lowest in Summer and highest in Winter (see above). But were different from open water trends, which were lowest in Winter and highest in Fall. The difference can be explained by the fact that the single TNC/FIU open water station was near the shore edge, while the 3 TNC/FIU stations were a distance from the shore, where conditions could be expected to be somewhat different.

In reference to increasing the tidal water exchange between canals and the bay, it appears that any increased outflow from the canals will not have a polluting effect on the bay; that is, not a lowering of D.O. below the standard of 4.0 PPM in Newfound Harbor or seaward.

Table 1A

TNC/FIU STATION 138 -- OPEN WATER – D.O. IN PPM

March 20, 2001 to March 30, 2002

	Readings	Range	Mean
Summer			
AM	5	3.7-8.5	5.6
PM	9	6.5-14.5	11.1
Both	14	4.0-14.5	9.1
Fall			
AM	1	8.7	8.7
PM	7	8.5-14.0	10.3
Both	8	8.5-14.0	10.1
Winter			
AM	4	3.5-9.5	6.9
PM	4	6.0-9.8	7.9
Both	8	3.5-9.8	7.4
Spring			
AM	--	--	--
PM	3	7.0-11.2	9.4
Both	3	7.0-11.2	9.4

Table 1B

TNC/FIU STATION 139 -- CANAL – D.O. READINGS IN PPM

March 20, 2001 to March 30, 2002

	Readings	Range	Mean
Summer			
AM	2	4.5-5.5	5.0
PM	5	6.0-8.0	7.0
Both	7	4.5-8.0	6.5
Fall			
AM	1	5.2	5.2
PM	5	6.1-8.8	7.7
Both	6	5.2-8.8	7.3
Winter			
AM	6	6.5-8.2	7.2
PM	4	6.9-10.0	8.5
Both	10	6.5-10.0	7.7
Spring			
AM	--	--	--
PM	1	7.5	7.5
Both	1	7.5	7.5

Table 2A

UNIVERSITY of FLORIDA/IFAS – OPEN WATER -- D.O. READINGS IN PPM

June 8, 2001 to May 18 2002

	No. Readings	Range	Mean
Summer			
AM	3	3.6 - 8.2	5.3
PM	3	5.9 - 9.0	7.5
Both	6	3.6 - 9.0	6.4
Fall			
AM	3	6.0 – 6.5	6.3
PM	3	8.4 - 9.0	8.2
Both	6	6.0 – 9.0	7.4
Winter			
AM	3	7.0 - 8.6	7.9
PM	3	8.0 – 8.2	8.1
Both	6	7.0 - 8.6	8.0
Spring			
AM	6	7.0 – 7.9	7.4
PM	3	9.0 – 11.0	9.7
Both	9	7.0 – 11.0	8.2

Table 2B

UNIVERSITY of FLORIDA/IFAS --CANALS – D.O. READINGS IN PPM

July 1, 2001 to May 18, 2002

	No. Readings	Range	Mean
Summer			
AM	2	2.3 - 3.5	2.9
PM	3	4.0 - 5.5	4.5
Both	5	2.3 - 5.5	4.8
Fall			
AM	3	4.0 - 6.1	4.9
PM	3	6.0 - 8.5	7.2
Both	6	4.0 - 8.5	6.1
Winter			
AM	3	6.5 - 8.2	7.2
PM	3	6.0 – 6.5	6.3
Both	6	6.0 - 8.2	6.8
Spring			
AM	6	4.5 - 6.8	5.8
PM	3	5.5 – 11.0	7.8
Both	9	4.5 - 11.0	6.4

SECTION II – NUTRIENTS AND CHLOROPHYLL

INTRODUCTION

Aquatic plants and floating algae (along with other phytoplankton) are valuable and important elements in marine ecosystems. They are the basis of the food chain which leads from smaller micro-plant eating creatures all the way up to the large predators of the sea. In optimum abundance marine plants are beneficial and create DO. When in excessive abundance they may create negative effects such as algal overgrowth or uptake of DO under dark skies (as discussed above). An accepted method for determining the amount of floating algae and other phytoplankton in the water is to measure the amount of chlorophyll (CHL) in the water -- CHL is the green pigment found in plants. Amounts of CHL can be used to determine the abundance of algae (and other phytoplankton) and thus provide a measure of "primary productivity" as well as an indication as to whether optimum or sub-optimum amounts are present. This study measured type "a" chlorophyll.

Algae and other marine plants require chemicals in the water – particularly nitrogen (N) and phosphorous (P) nutrients -- in order to prosper. But too little or too much N or P in the water leads to negative effects by reducing the growth of plant life (like algae) or by causing excessive growth. Therefore the amounts of P and N present and cycling through the ecosystem can be used as a measure of algal growth and general ecological health. This measure of plant growth is often difficult to apply because of ecological complexities, so researchers and managers often just measure the amounts of P and N nutrients dissolved in the water as an ecological indicator, even though these values only tell a part of the story. So, amounts of P and N chemicals in the water are often used to indicate something about nutrient balance in canals, bays, and nearshore waters.

While government has not set regulatory standards for P, N, or CHL (as they have for DO and bacteria), scientists have established presumptive "trophic" categories which indicate the effects of various amounts of algae in the water, as measured by the level of CHL in the water body, and also the ecological effects of various levels of P and N nutrients in the water. These provide guidelines to the potential biological productivity of water bodies.

For P and N, the guidelines are applicable more or less equally to lakes or coastal waters (UF/IFAS, 2000). But recently, research has shown that coastal phytoplankton hold less CHL per biovolume than lakes. Conversion factors to salt water are available while this finding is still under refinement (Hoyer, 2002)..

So for our purposes we are using a recommended interim trophic standard for CHL (Hoyer, et al, 2002) as shown below along with the P and N categories (all given in micrograms/liter or ug/l):

Oligotrophic -- Very low level -- less than 1 for CHL, 15 for P, & 400 for N

Mesotrophic -- Moderate level – 1-2 for CHL, 16-25 for P; 400-600 for N

Eutrophic -- High level – 2-10 for CHL, 26-100 for P, 600-1500 for N

Note: No samples measured were recorded at an extreme category of "Hypertrophic" in the BBECA studies reported below, so it is not listed.

A problem in comparison was created by different ways of measuring because TNC/FIU used micromoles (uM) and U.Fla used micrograms/liter (ug/L) for P and N. Conversion of TNC/FIU data to ug/L has been used in this summary to facilitate comparison using the following conversion factors: for P, uM x 31 = ug/L; for N, uM x 14 = ug/L.

The BBECA team recognizes the importance of water transparency (clarity) as an important ecological factor and we did make measurements with a Secchi Disc device on all of our samplings. But with rare exceptions the water was clear all the way to the bottom; i.e., we could see the disc on the bottom in 3 – 10 feet (the range of depths at sampling stations). Therefore, we were unable to identify disappearance points. However, from this we also conclude that the waters in and around Ramrod Key, including our canals, are clear and permit light to penetrate through the water column to the bottom encouraging growth of plant life year around.

RESULTS WITH NATURE CONSERVANCY/FIU

Locations and Schedule

As explained on page one, from March 20, 2001 to March 30, 2002, BECA collected water quality samples in cooperation with The Nature Conservancy and Florida International University (TNC/FIU). Samples were taken weekly at two stations one on a canal – and one on open water. The samples were frozen and sent to the FIU lab for testing for nitrogen (N), phosphorous (P), and chlorophyll (CHL).

Detailed data and an initial report by The Nature Conservancy (TNC) are presented in Appendix 4. The data were collected at the following two places:

Station 138 -- Open water of Newfound Harbor (see Appendix 1 for location). Designated as a "natural/unobstructed, open water, shoreline site". 47 samples.

Station 139 -- Ramrod Block 15 canal (see Appendix 1 for location). Designated as a typical canal site. 44 samples.

Summary for Station 138, Open water

The average value of Nitrogen (TN) for all 47 samples was 359 ug/l which falls into the oligotrophic range (less than 400 ug/L). 34 of the individual samples were in the oligotrophic range; 10 were in the mesotrophic range (400-600 ug/L); and 3 were in the eutrophic range (600-1500 mg/L)

The average value of Phosphorous (TP) for all 47 samples was 8.37 ug/L which falls into the oligotrophic range (less than 15 ug/L). 43 of the individual samples were in the oligotrophic range, 4 in the mesotrophic range (15-25 ug/L), and none in the eutrophic range (26-100 ug/L).

*The average value of chlorophyll (*CHL) for all 47 samples was 0.44 ug/L which falls into the oligotrophic range (less than 1.0 ug/L). 44 of the individual samples were in the oligotrophic range, 2 in the mesotrophic range (1.0-2.0 ug/L), and 1 in the eutrophic range (2-10 ug/L).

Summary for Station 139, Typical canal

The average value of nitrogen (TN) for all 44 samples was 397 ug/l which falls barely into the oligotrophic range (less than 400 ug/L). 27 of the individual samples were in the oligotrophic range; 11 were in the mesotrophic range (400-600 ug/L); and 6 were in the eutrophic range (600-1500 mg/L).

The average value of phosphorous (TP) for all 44 samples was 11.5 ug/L which falls into the oligotrophic range (less than 15 ug/ L). 37 of the individual samples were in the oligotrophic range, 3 in the mesotrophic range (16-25 ug/L), and 4 were in the eutrophic range (26-100 ug/L).

The average value of chlorophyll (CHL) for all 44 samples was 0.44 ug/L which falls into the oligotrophic range (less than 1.0 ug/L) – 43 individual samples were in the oligotrophic range and 1 in the mesotrophic range (1.0-2.0 ug/L).

Discussion

The data for Stations 138 and 139 (273 measurements) show no signs of ecological distress. In fact, one might interpret the P and N readings as indicating that the Ramrod canal and open water marine ecosystems appear to be reasonably healthy insofar as nutrient amounts are concerned. However, with 96 % of CHL measurements in the oligotrophic category-- a sign of low levels of algae and of biological productivity – one might conclude that the ecosystem is undernourished with nutrients or that other ecological factors are inimical to algal productivity. The relation of available P and N nutrients to productivity is typically complicated by ecological factors; e.g., rates of recycling of nutrients and take up of nutrients by macrophytes (larger marine plants) and mangroves which are abundant in the waters of Ramrod Key.

RESULTS WITH UNIVERSITY OF FLORIDA/IFAS

Locations and Schedule

As explained on page 1, from June 16, 2001 to, May 18, 2002, BBECA collected water quality samples in cooperation with the University of Florida/IFAS Lakewatch/Coastal program. Samples were taken monthly at six stations -- three inside the subdivision's 17 canals, and three in the open bay water of Newfound Harbor. Similar to the TNC/FIU program, the samples were frozen and later taken to the Univ. of Florida lab for testing for nitrogen, phosphorous, and chlorophyll. The results are presented in Appendix 5 and summarized in Table 3 below (at the time of this writing we were awaiting analysis of the final sample, that for May18).

Summary for Canals -- Stations 1,2,3

The average value of nitrogen (TN) for all 30 samples was 377 ug/L which falls into the oligotrophic range (less than 400 ug/L). 17 of the individual samples were in the oligotrophic range; 13 were in the mesotrophic range (400-600 ug/L); and none were in the eutrophic range (600-1500 mg/L).

The average value of phosphorous (TP) for all 30 samples was 11.1 ug/L which falls into the oligotrophic range (less than 15 ug/ L). 25 of the individual samples were in the oligotrophic range, 4 in the mesotrophic range (16-25 ug/L), and 1 was in the eutrophic range (26-100 ug/L).

The average value of CHL for all 24 samples was 1.4 ug/L which falls into the mesotrophic mid-range (1.0-2.0 ug/L). 19 individual samples were in the oligotrophic range (1.0 ug/L or less), 1 in the mesotrophic range (+1.0-2.0 ug/L), and 3 in the eutrophic range (2.0-4.0 ug/L).

Summary for Open Waters – Stations 4,5,and 6

The average value of total nitrogen (TN) for all 33 samples was 285 ug/L which falls into the oligotrophic range (less than 400 ug/L). 29 of the individual samples were in the oligotrophic range; 4 were in the mesotrophic range (400-600 ug/L); and none were in the eutrophic range (600-1500 ug/L).

The average value of total phosphorous (TP) for all 33 samples was 6.5 ug/L which falls into the oligotrophic range (less than 15.0 ug/ L). All 33 of the individual samples were in the oligotrophic range.

The average value of CHL for all 25 samples was 0.6 ug/L which falls into the oligotrophic range (1.0 ug/L or less). All 25 individual samples were in the oligotrophic range.

Table 3. Average amounts of P, N, and CHL (in ug/L) for each station for all UF/IFAS samples (see App 1 for station locations).

Stations 1-3 – Ramrod Canals (average each station)

Station	P	N	CHL
1	12.8	389	1.4
2	11.3	374	1.5
3	9.1	366	1.4
Mean	11.1	377	1.4
Range	7-27	200-490	1-4
No.Samples	30	30	24
Oligotrophic	25	17	19
Mesotrophic	4	13	1
Eutrophic	1	0	3

Station 4-6. Open waters of Newfound Harbor (average each station)

Station	P	N	CHL
4	6.3	329	0.6
5	6.1	296	0.4
6	7.0	230	0.7
Mean	6.5	285	0.6
Range	3-14	150-440	0-1
No.Samples	33	33	25
Oligotrophic	33	29	25
Mesotrophic	0	4	0
Eutrophic	0	0	0

Discussion

Neither the data for the canals nor open waters show signs of ecological distress from excessive amounts of P and N nutrients. The same is true for algae and other phytoplankton which are at low levels according to the CHL measurements. For P, N, and CHL, the total number of measurements taken was 175. Of which 85 % were in the oligotrophic category, 10 % were mesotrophic, and 5 % were eutrophic.

PERSPECTIVE

Regarding fauna, no survey was made, but the open water area of Newfound Harbor appears to have an abundance of snapper, barracuda, blackfin shark, pinfish, and other species, plus extensive grass beds. Birds are plentiful. Also, the canals appear to have an abundance of snapper, sergeant major, small barracuda and tarpon, pinfish, and other species. Fish kills have not been reported in recent years. These subjective observations indicate a favorable habitat for marine life.

Why there can be abundant fauna in the Ramrod ecosystem even with low algal abundance, may be because much of the primary productivity (plant life) may be owing to the amount of macrophytes (larger plants) including seagrass, and extensive fringing mangrove along the canals and shores of the open water of Newfound Harbor.

Another indicator of ecological function is the acceptable amount of dissolved oxygen in the canals and open water (see Section I). The daily swings of DO appear quite normal – lower in the morning and higher in the afternoon. The presence of macrophytes and mangroves may have an effect.

While the canals have water quality acceptable in the regulatory sense, they still show somewhat higher readings for N, P, and CHL than the open water, as one might expect. But these differences alone are not sufficient to draw a major distinction between the two water bodies in water quality. Both could be seen as favoring the oligotrophic regime and bridging the mesotropic category.

Ecological theory calls for an appropriate balance of the nutrients, N and P. According to the accepted "Redfield ratio" (Redfield, 1958), the optimum balance for phytoplankton (including algae) would be 16 parts of N for every 1 part of P in the water, the ratio being 16:1. If the ratio is higher than this one assumes that phytoplankton, important to the primary production of a water ecosystem, is limited by phosphorous. In the Breezeswept canals we found an average ratio in ug/L of about 389/11 or 35/1 indicating that in the canal ecosystem bioproductivity is phosphorous limited. In the open waters of adjacent Newfound Harbor, we found an even higher ratio of about 326/7.5 or 43/1.

There are several explanations for the low concentrations of P in Ramrod waters, relative to N. For example, phosphorous is known to be removed rapidly from wastewater -- such as from septic tanks -- as it passes through carbonate structure such as that which underlies Ramrod Key (Cable *et al*, 2002). Also, marine sediments may absorb and store large amounts of phosphorous (Natl. Res. Council, 2000).

In simple terms you could say that both the bay and the canals are phosphorous deficient. This is the opposite of traditional belief that coastal systems are nitrogen deficient (NRC, 2000). However, extensive recent research in Florida (Hoyer, 2002) contradicts this and shows, as we have for Ramrod, that Florida coastal waters tend to be phosphorous limited. Therefore, adding more phosphorous to the water, up to the ratio of 16/1, would mean higher productivity, more algae, and lower water transparency, whereas adding more nitrogen would not. Conversely, reducing the amount of phosphorous would reduce algal blooms, whereas reducing nitrogen would not.

The message to be drawn from this for Breezeswept residents is to focus on reducing phosphorous discharge to the canals and bay; for example, by use of low phosphorous detergents. Laundry detergents should have zero percent P; dish washing machine detergents should a have low percentage of P (e.g., Palmolive Gel is best at 1.6 % P; "Cascade" granular is worst at 7.7 % P).

While water chemistry is encouraging and while algal growth and bacteria appear minimal, the Ramrod canal system still has problems of scattered scum and some floating grass brought in from the outside, along with sedimentation and shallowing, Areas of stagnation are still noticeable. These problems can be reduced by increasing tidal flows in the system, which also would compensate for additional development expected for the Breezeswept Beach Estates subdivision in the future. This subdivision was built in the earliest 60's when developers had little appreciation of environmental design.

SECTION III - WATER FLOWS

CULVERT FLOW ANALYSIS

Background

When created in 1960/61 the Breezeswept canal system had only one inlet (a navigable entrance channel) at the farthest (south) end of the system. In 1982, to improve tidal water exchange, the Civic Association (BBECA) installed a modest sized culvert at the farthest northeast end of the canal system to connect to the open water of Newfound Harbor (see Appendix 1 for location). While some improvement in water quality was noted after installation in 1982, many BBECA members now believe that it is not adequate to fully meet the need (200 more houses having been built in the ensuing 20 years). Therefore BBECA is now studying the possibility of installing a larger capacity conveyance in a location less susceptible to sedimentation.

A major problem is that the existing 164-ft long culvert tends to clog with sediment, reducing its flow, and is difficult to clean out. In August, 2002, BBECA engaged Technical Inspections, Inc to remove sediment (15 cu yds) and rock (2 ½ cu yds) from the pipe by suction. This increased the flow by almost double. The data below relate to the period before this cleanout took place.

Physical Setup

Culvert dimensions: The first section of the existing culvert (from canal end) appears to be a concrete pipe about 144 ft in length. The 43-inch inside diameter converts to about 11.24 sq ft cross section. If one assumes 50% blockage, the effective cross section has been 5.62 sq ft., with the culvert full and flowing.

The second section (to bay end) appears to be a 6-ft wide trench with natural (vertical) sides and bottom . It is covered over with preformed concrete slabs under 1-3 ft of fill and extending the last 20 ft, to where the culvert discharges to open waters. The vertical clearance inside this last section of the culvert – the distance from sediment on the bottom up to the underside of the slab – has been about 35 inches measured 5 ft back from the end of the culvert (effective cross section is about 17 sq ft). Clearly the first section with the smaller cross section controls tidal flows.

Block 3 Canal (1st canal in subdivision, where culvert enters): Average depth = 7 ft; width = 30 ft; so cross section = 210 sq ft.; total length of canal ca 1,000 ft. Therefore canal volume = ca 210,000 cu ft.

Entire canal system (17 canals including main canal): 3.7 miles total -- 2.7 miles for the 16 side canals (30 ft wide) and 1 mile for the main canal (48 ft wide). Ave depths: main canal = 6 ft, side canals = 7 ft. (overall depth say 6.5 ft at midtide). Capacity of system is about 4,000,000 cu ft.

Flow rates of Culvert

Assumptions: Flood and ebb tides occur at regular intervals of 5 to 7 hours each, twice per day. Tidal flow through the culvert is controlled by its effective cross section.

Observations: The flow speed through the culvert, as measured in January 2001 at the west end where culvert enters canal, at various stages of the tide are shown below in ft/sec along with the probable flow volumes in cu ft/sec:

1) Inflow (westerly) occurred on falling (ebb) tides at an average of 0.85 ft/sec. which corresponds to a volume of 4.77 cu ft/sec through the culvert. Note: Maximum inflow was 1.5 fps (on ebbing tide).

2) Outflow (easterly) occurred on rising (flood) tides at an average of 0.40 ft/sec which corresponds to a volume of 2.25 cu ft/sec through the culvert. Note: Maximum outflow was 0.9 fps (on flooding tide).

3) Net outflow would be westerly at about 2.53 cu ft/ sec (4.77 – 2.25 cu ft/sec) through the culvert for each of the two daily ebb tides.

Calculations:

1) At a potential *net* outflow rate of 2.53 cu ft/sec, the total *net* westerly discharge from the culvert was 54,648 cu ft per tide, or 109,300 cu ft per day for both tides.

2) 109,300 cu ft is equivalent to 52 % of the volume of the Block 3 (Trinidad) canal which would be the daily tidal exchange (or replacement rate) for this canal if it alone were affected.

3) 109,300 cu ft is equivalent to 2.7 % of the volume of the whole canal system which would be the overall daily tidal exchange rate.

Conclusion

1) Reciprocal tidal action pumps canal water in and out of the canal system with a westerly net flow through the culvert into the canal system at something like the flow rates estimated above.

2) To ensure that the canals are flushed at a better rate, an additional, larger, culvert will be installed by the County. This is deemed necessary even if regular cleanouts of the existing culvert will increase its flow.

Sediment in Culvert

East end of culvert: On April 11, 2002, BBECA took a sample (near the east end of the culvert) of the material that was partially blocking the culvert (about 50 % blockage). It appears that this heavy sediment extended some distance back up the culvert. Particle size analysis of the sediment was done using a special grain-size micrometer with the following results (by three size groups) from a sample of the material -- total weight of dried sample was 6 oz.:

Approximate particle sizes from east end of culvert.

Large Material

Sample Weight = 3 oz
Size: 15-60 mm; median 45 mm (1 ¾ in)

Medium Size Material

Sample weight = 1.5 oz
Size 3-14 mm, median 10 mm (3/8 in)

Small Size Material

Sample weight = 1.5 oz
Size 2-6 mm, median 4 mm (3/16 in)

Approximate particle size from artificial beach at east end of culvert

Beach Sand (from adjacent artificial beach), April 11, 2002

Size 0.4 – 0.5 mm median 0.45 mm (1/32 in)

West end of culvert: On May 17, 2002, "Synagro, Inc." attempted to remove material from the culvert (with little success) by using a high pressure water jet which was fed through by hose from the west entry of the culvert at the Block 3 canal. It was possible to sample the brownish particles that were forced out the west end of the pipe and deposited on the canal bottom.

Approximation of particle sizes from west end of canal near pipe entry

75 percent fine particles – 0.1-0.4 mm

25 percent larger particles – 0.5 – 6 mm.

Note on Tidal Water Movement in Main Canal

A typical type of surface current measuring device was employed (float attached to subsurface "sea anchor") to check water flow in the main Breezeswept canal. This gives a good reading for the first foot or two of depth. Rate of movement was clocked along a given length of canal. Measurements were made at mid-tide ebb and flood in April, 2001, on two occasions at the end of Dominica Ln. and one at the end of Martinique Ln.

Off Dominica (south end of main canal):

Ebb: Flows were measured at 0.42 fps and 0.50 fps (average = .46 fps, or about 0.3 mph)

Flood: Flows were 0.36 and 0.90 fps (average 0.63 fps or about .42 mph)

Off Martinique (north end of main canal):

Ebb: Flow was slight, not measurable.

Flood: Flow was 0.2 fps (about 0.13 mph).

RECENT MATTERS

Improved Flow Following Cleanout

While this report was in preparation, BBECA contracted for the first fully effective cleanout of the culvert since it was installed in 1982. Between August 19 and 21, "Technical Inspections, Inc" removed from the culvert, by suction, about 15 cubic yards of sand and gravel (see above for specifics on grain size) and, by hand, about 2 1/2 cubic yards of rock (in the range of 4–8 in diameter). This amount would correspond to an average deposit of 10-12 in on the bottom of the culvert pipe. Diver technicians, who worked inside the culvert, noted accumulations of 6 in to 22 ½ in of sediment on the bottom of the culvert prior to the cleanout. The 22 ½ in corresponds to an effective blockage of about 50% of the cross section of the culvert (as had been assumed in the calculations above).

The flow rate following the cleanout was greatly improved, going from a pre-cleanout maximum of 1.5 fps up to a maximum of 2.7 fps (measured on August 25, 2002, at 4:40 PM, 2 hrs before dead low tide). This is an increase of about 80% in the maximum tidal flow.

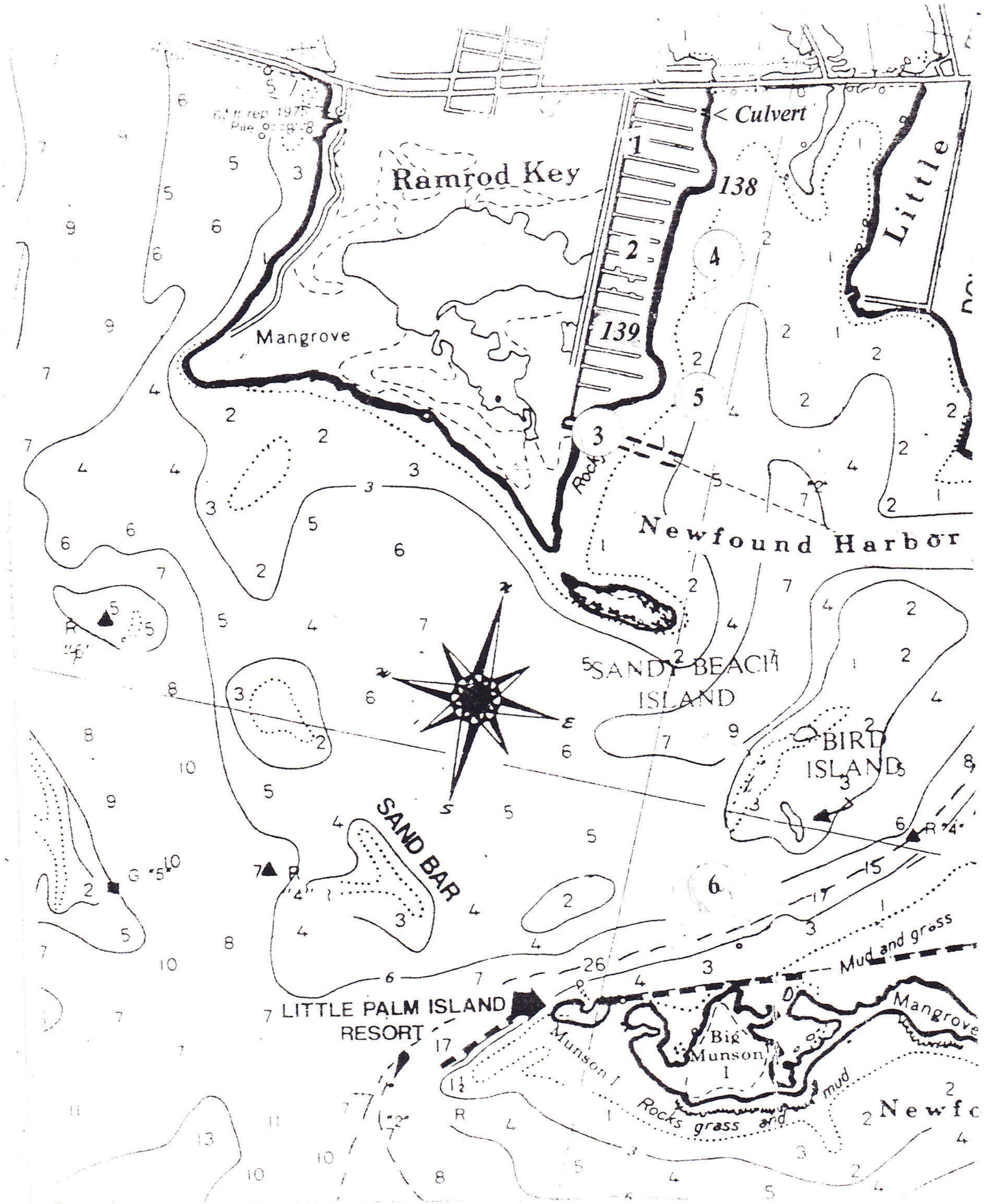
Perspective

With the information at hand, BBECA decided that if an additional, much larger, culvert were installed to augment the existing one, perhaps located several canals to the south, tidal exchange could be greatly improved. E.g., a 4 ft x 8 ft culvert (32 sq ft opening), could increase tidal flow by up to 3 – 4 times the present flow, with the existing culvert operating at full capacity. Therefore the daily exchange rate of water in the canals of the subdivision could *potentially* increase from 5 % to about 20 % if an additional large culvert were installed.

This would mean, by rough estimate, that the system would have the potential to flush every 9 days instead of every 37 days. However, these simple calculations lead to a "soft endpoint" which is to be confirmed by professional hydraulic studies. Paul Lin Associates (2002) conducted a *preliminary* flow analysis for BBECA using a computerized model of the Breezeswept canal system and concluded that there would be a potential increase in tidal flushing of around 3.5 times. Therefore, BBECA began work with the County Engineer on a plan to install a 4 ft x 8 ft culvert to supplement the existing smaller culvert. On September 4, 2002, the County Commission approved a referendum that allowed canalside residents to vote for or against a one-time tax levy to pay for the project. In the November 5th election the referendum was approved by 61 percent of voters and the initial phase (study and design) was commenced.

WATER QUALITY STUDIES 2001—2002

APPENDICES



Breezeswept Beach Estates subdivision on Ramrod Key and adjacent waters and islands. TNC/FIU sampling stations are shown as nos.1-6. Univ of Florida sampling stations are shown as nos. 138 and 139.

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences
Department of Fisheries and Aquatic Sciences

Florida LAKEWATCH

P. O. Box 110600, Gainesville, FL 32611 352-392-4817 Fax: 352-392-4902
Citizen Message Line: 1-800-LAKEWATCH (525-3928) E-mail: lakewat@ufl.edu

October 4, 2001

The Florida Administrative Code (FAC), Section 62-302.530 defines criteria for both total and fecal coliform bacteria for Class III waters. The FAC states that total coliform bacteria shall not exceed a count or Most Probable Number (MPN) of 1,000 bacteria per 100 milliliters of water in 20% or more of the samples examined during any month, nor exceed a MPN of 2,400 at any individual station. The FAC also states that fecal coliform bacteria shall not exceed a MPN of 400 in 10% or more of the samples, nor exceed a MPN of 800 at any individual station.

The table below lists the estimated MPN of total and fecal coliform bacteria per 100 milliliters of water in Ramrod on 9/21/01.

Lake	County	Station	Total Coliforms (MPN)	Do Totals Exceed FAC Criteria?	Fecal Coliforms (MPN)	Do Fecals Exceed FAC Criteria?
Ramrod	Monroe	1a	100	No	10	No
Ramrod	Monroe	1b	520	No	70	No
Ramrod	Monroe	2a	210	No	10	No
Ramrod	Monroe	2b	130	No	0	No
Ramrod	Monroe	3a	240	No	20	No
Ramrod	Monroe	3b	360	No	40	No
Ramrod	Monroe	4a	0	No	0	No
Ramrod	Monroe	4b	0	No	0	No
Ramrod	Monroe	5a	0	No	0	No
Ramrod	Monroe	5b	10	No	0	No
Ramrod	Monroe	6a	70	No	10	No
Ramrod	Monroe	6b	30	No	10	No

Note: a and b are duplicate samples at same location.

Total coliform bacteria counts for Ramrod on 9/21/01 ranged from 0 to 520 MPN. Total coliform bacteria exceeded 1,000 MPN in 0% of the samples. To calculate this percentage add up the number of times the MPN exceeds 1000 in the "Totals Coliform" column and divide by the total number of samples collected. **Total coliform bacteria did not exceed 2,400 at any one station. Total coliform bacteria were within the acceptable range as defined by the Florida Administrative Code (FAC), Section 62-302.530.** If total coliform bacteria were not within the acceptable ranges as defined by the FAC, then further testing is recommended.

Fecal coliform bacteria counts for Ramrod on 9/21/01 ranged from 0 to 70 MPN. Fecal coliform bacteria exceeded 400 MPN in 0% of the samples. To calculate this percentage add up the number of times the MPN exceeds 400 in the "Fecal Coliform" column and divide by the total number of samples collected. **Fecal coliform bacteria did not exceed 800 at any one station. Fecal coliform bacteria were within the acceptable range as defined by the Florida Administrative Code (FAC), Section 62-302.530.** If fecal coliform bacteria were not within the acceptable ranges as defined by the FAC, then further testing is recommended.

It is important to remember that results could differ over the course of a year based on varying environmental factors such as changes in water temperature, rainfall, and algae blooms. If you would like any further information, please feel free to call us with your questions or comments.

Synagro of Florida
Davis Water Analysis
89111 Overseas Highway
Tavernier, FL 33070
(305) 296-3826 * Fax 296-8582

LABORATORY RESULTS

Date of Sample: July 31, 2001

Sample Taken By: Joe Frey

Facility: Breezeswept Beach Estates

Sample ID:	Barbuda	Fecal Coliform	20 CFU/100 ml
		Enterococcus	20 CFU/100 ml
Sample ID:	Kinekede	Fecal Coliform	< 20 CFU/100 ml
		Enterococcus	36 CFU/100 ml
Sample ID:	Gersan	Fecal Coliform	< 20 CFU/100 ml
		Enterococcus	< 4 CFU/100 ml

Methods: SM 9222 D. & SM 9230 C.

Florida Department of Health Bureau of Laboratories Certified Laboratory Environmental Lab E85222

FLORIDA BAY WATCH

FIXED-STATION WATER QUALITY DATA

FOR RAMROD KEY, FLORIDA

The Nature Conservancy in Cooperation with Florida International University and Breezeswept Civic Association

March, 2001 – March 2002

STATION	DATE	RAIN (MM)	TEMP (C)	SALINITY (PPT)	TOTAL N (uM)	TOTAL P (uM)	CHL A (ug/L)
138	20-Mar-01	0	27	41.6	24.53	0.35	0.20
138	24-Mar-01	0	27.5	41.8	27.97	0.36	0.20
138	31-Mar-01	0	25	40.8	21.57	0.32	0.22
138	8-Apr-01	0	29	35.8	26.93	0.29	0.09
138	16-Apr-01	0	30	33.4	26.38	0.20	0.25
138	21-Apr-01	0	26	37.2	24.93	0.28	0.32
138	29-Apr-01	0.03	22.5	34.6	25.16	0.29	0.24
138	5-May-01	0.1	29	41.1	9.53	0.19	0.02
138	13-May-01	0	23	41.4	8.56	0.28	0.11
138	20-May-01	0	32	47.5	11.84	0.23	0.06
138	28-May-01	0.5	26	46.4	15.62	0.33	0.06
138	3-Jun-01	0	34.5	43.3	16.74	0.30	0.46
138	8-Jun-01	0	33	40	63.36	0.62	0.16
138	18-Jun-01	0	33	44	58.28	0.67	3.48
138	25-Jun-01	0	28.5	38.2	49.83	0.62	1.15
138	30-Jun-01	3	34.5	36.5	42.61	0.25	0.72
138	7-Jul-01	20	30	38.8	26.16	0.10	0.68
138	14-Jul-01	0	32.5	39.8	29.80	0.11	0.23
138	21-Jul-01	0.4	32	37	29.38	0.14	0.68
138	30-Jul-01	0	36	35.8	36.50	0.17	0.05
138	6-Aug-01	0.2	32	37	16.41	0.14	0.24
138	12-Aug-01	0	34	41.7	16.79	0.15	0.37
138	19-Aug-01	0	33.5	38.9	17.89	0.23	0.09
138	25-Aug-01	0.2	32	39.6	14.57	0.16	0.38
138	1-Sep-01	0	34	39.1	18.73	0.13	0.20
138	9-Sep-01	0	28	39.3	22.65	0.18	0.66
138	15-Sep-01	3.5	30.5	40.3	21.49	0.17	0.58
138	22-Sep-01	0	29	35.8	17.41	0.19	1.23
138	30-Sep-01	3	29	35.8	24.60	0.16	0.57
138	13-Oct-01	0	28	36.7	40.75	0.19	0.27
138	22-Oct-01	80	29	30.4	34.59	0.18	0.45
138	28-Oct-01	0	22	30.4	35.84	0.14	0.33
138	10-Nov-01	0	24.5	33.9	21.86	0.32	0.37
138	18-Nov-01	0	25.5	35.6	14.09	0.22	0.29
138	1-Dec-01	0	26	37.2	12.11	0.17	0.32
138	9-Dec-01	45.2	26	26.5	44.68	0.56	0.84
138	22-Dec-01	0	22	34.5	26.60	0.15	0.06
138	1-Jan-02	55	23	30.8	39.91	0.15	0.35
138	7-Jan-02	0	19	30.8	37.92	0.12	0.27
138	13-Jan-02	0	26	33.2	16.72	0.24	0.58
138	21-Jan-02	0	24.5	32.6	15.93	0.32	0.55
138	26-Jan-02	0	29.5	32	18.74	0.26	0.48
138	5-Feb-02	0	18	31.8	13.34	0.25	0.36
138	18-Feb-02	0	20	35.1	23.33	0.32	0.06
138	3-Mar-02	0	28	35.4	29.57	0.45	0.45
138	23-Mar-02	0	25.5	41	18.39	0.56	0.27
138	30-Mar-02	0.1	28	35.4	15.30	0.32	0.20
138 summary	avg	4.494	28.03	37.14	25.66	0.27	0.43
	S.D.	15.43	4.352	4.382	12.30	0.14	0.53
	STD err	2.250	0.635	0.639	1.794	0.021	0.077
	n	47	47	47	47	47	47

STATION	DATE	RAIN (MM)	TEMP (C)	SALINITY (PPT)	TOTAL N (uM)	TOTAL P (uM)	CHL A (ug/L)
139	21-Mar-01	0	25.5	36.9	35.79	1.32	0.65
139	2-Apr-01	0	26.5	37.3	29.13	0.35	NS
139	9-Apr-01	0	27.5	35.1	29.05	0.35	0.51
139	16-Apr-01	0	29.5	38.6	45.20	0.68	0.16
139	24-Apr-01	9	26.5	37.3	41.29	0.41	0.07
139	30-Apr-01	60	21.5	30.3	79.39	0.52	0.10
139	7-May-01	0	26.5	34.7	12.53	0.27	0.13
139	14-May-01	0	27	40.2	10.79	0.31	0.10
139	22-May-01	0	30.5	39	11.68	0.30	0.18
139	29-May-01	0.5	27.5	40.5	11.96	0.26	0.09
139	4-Jun-01	0	32.5	42.5	13.44	0.38	0.20
139	14-Jun-01	0	34.5	45.9	27.91	0.24	0.11
139	18-Jun-01	0.4	32.5	45.1	48.40	1.01	0.63
139	26-Jun-01	0	30.5	41.7	16.53	0.33	0.19
139	1-Jul-01	0.9	32.5	42.5	42.05	0.36	0.29
139	7-Jul-01	17	29.5	43.9	30.14	0.29	0.21
139	14-Jul-01	0	33.5	40.2	24.30	0.22	0.83
139	30-Jul-01	0	31.5	39.4	26.05	0.20	0.58
139	6-Aug-01	0	31.5	36.8	18.88	0.21	0.04
139	13-Aug-01	0	32.5	39.8	21.19	0.28	0.12
139	23-Aug-01	2.5	30.5	36.4	18.48	0.87	0.09
139	28-Aug-01	0.4	30.5	39	21.64	0.25	0.18
139	9-Sep-01	0	30	37.5	30.16	0.23	0.83
139	15-Sep-01	3.5	29	37.1	21.87	0.20	0.88
139	22-Sep-01	0	30.5	36.4	26.35	0.23	0.94
139	30-Sep-01	3	29.5	36	21.20	0.18	0.72
139	13-Oct-01	0	28.5	35.6	38.28	0.25	0.61
139	22-Oct-01	80	30	25.5	67.35	0.94	0.64
139	28-Oct-01	0	24	31.2	38.30	0.29	0.79
139	10-Nov-01	0	25	31.5	17.85	0.32	0.09
139	18-Nov-01	0	25	32.8	19.62	0.36	0.69
139	1-Dec-01	0	25	35.5	13.57	0.28	1.72
139	9-Dec-01	45.1	26.5	22.7	60.31	0.50	0.67
139	22-Dec-01	0	23	34.7	39.18	0.16	0.32
139	1-Jan-02	55	22	29.1	62.41	0.23	0.36
139	7-Jan-02	0	19	29.5	26.23	0.24	0.69
139	13-Jan-02	0	26	34.5	13.78	0.20	0.48
139	21-Jan-02	0	25	31.5	17.09	0.24	0.59
139	26-Jan-02	0	27	30.9	16.50	0.26	0.53
139	5-Feb-02	0	23	33.4	14.67	0.26	0.63
139	18-Feb-02	0	21.5	32.9	32.27	0.33	0.27
139	3-Mar-02	0	26	34.5	24.02	0.37	0.28
139	23-Mar-02	0	26.5	37.3	14.66	0.34	0.26
139	30-Mar-02	0.1	28	35.4	17.03	0.42	0.40
139 summary	avg	6.305	27.74	36.10	28.38	0.37	0.44
	S.D.	17.86	3.589	4.850	16.01	0.24	0.34
	STD err	2.692	0.541	0.731	2.414	0.036	0.051
	n	44	44	44	44	44	44

Preliminary Comparison of Stations 138 & 139 – March20, 2001- February 5, 2002

Introduction

As part of the Florida Bay Watch water quality monitoring program, two stations were chosen in Ramrod Key to determine the nearshore water quality of Breezewood Estates subdivision. Station 138 was designated as a natural/unobstructed shoreline sampling site. Station 139 was designated as a canal sampling site. Nutrient and chlorophyll-a samples were collected once a week for a period of one year. During each sampling event abiotic factors were recorded as well (i.e. temperature, salinity, turbidity).

Methods

See Florida Bay Watch Training manual

Results

A total of 47 and 44 samples were collected for station #138 and #139, respectively. At the time of this report, we have received the results for Total Nitrogen (TN), Total Phosphorus (TP), and chlorophyll-a (chl-a) for 43 of #138's 47 samples and 40 of #139's 44 samples. For station 138, TN values ranged from 8.56 to 63.36uM. TP values ranged from .10 to .67uM. Chl-a values ranged from .02 to 3.48ug/l. Ranges were similar for station 139: TN = 10.79 to 79.36uM, TP = .16 to 1.32, and Chl-a = .07 to 1.72ug/l. The temperature and salinity for the two stations were similar for both stations.

Station 138

The mean TN for all 43 samples was 26.03uM, or 365ug/l. A total of 13 (30.2%) TN samples exceeded Lakewatch's "oligotrophic" standard of 400ug/l. The mean TP was .2531uM, or 7.84ug/l. A total of 4 (9.3%) TP samples exceeded Lakewatch's "oligotrophic" standard of 15ug/l. The chl-a mean was .447ug/l, far below the "oligotrophic" limit of 3.0ug/l. One sample, however, was recorded above this standard (3.48ug/l on June 18, 2001). Higher levels of chl-a were observed during the rainy season compared to the dry season. There was no difference for TN and TP in the rainy/dry season comparison.

Station 139

The mean TN for all 40 samples was 29.01uM, or 406ug/l. A total of 16 (40.0%) TN samples exceeded Lakewatch's "oligotrophic" standard of 400ug/l. The mean TP was .3694uM, or 11.44ug/l. A total of 7 (17.5%) TP samples exceeded Lakewatch's "oligotrophic" standard of 15ug/l. The chl-a mean was .4523ug/l, far below the "oligotrophic" limit of 3.0ug/l. No individual samples exceed this limit. Samples taken in the dry season had higher levels of TP, TN, and Chl-a compared to the rainy season.

Station 138 vs 139

Station 139 (canal) had comparatively higher levels of TN and TP than station 138 (open water). Chlorophyll-a concentrations were extremely similar for the two stations. (see fig. 1)

Rainy Season vs. Dry season
Station 138 has similar nutrient water quality (TN and TP) when comparing the two seasons (rainy = May-Sept., dry = Oct.-April). Chl-a values were higher, however, during the rainy season. Station 139 experienced higher values for all parameters (TN, TP, Chl-a) during the dry season relative to the rainy season.

Discussion

The nearshore water quality in the Florida Keys has been an issue of great interest in recent years. The water quality within canal systems has been under greater scrutiny as the pressure for improved wastewater treatment systems has been increased. This study offers insight to the differences between the water quality within a canal and a nearby open water sampling station. Both sites give us an indication of the nearshore water quality surrounding Breezewood Estates on ramrod Key.

The amount of TN was, on average, greater in the canal (#139) compared to the open water station (#138). In fact, the mean TN value for station 139 exceeded Lakewatch's "oligotrophic" standard of 400ug/l. Station 138 was found to be within the limits of this standard. TP and Chl-a was found to be, on average, within the limits of the "oligotrophic" standards as well, however, many individual samples were well above the oligotrophic levels. It would be interesting to learn more about how Lakewatch implemented these standard levels.

Typically, increased amounts of rainfall yields a decrease in water quality. In this study, station 139 had elevated levels of TN, TP, and Chl-a during the dry season. This can be explained by an unusual weather pattern. The average rainfall 24 hours before sampling was about 10 times greater during the dry season compared to the rainy season for these two stations. Therefore, samples obtained during the "dry" season were in fact typical of "normal" rainy season samples.

Note: After this comparison was written, the oligotrophic standard was lowered from 3.0 to 1.0 ug/L, based on recent studies (see text).However, this does not affect interpetation because all but one measure for chl-a (CHL) fell into the revised oligotrophic range.

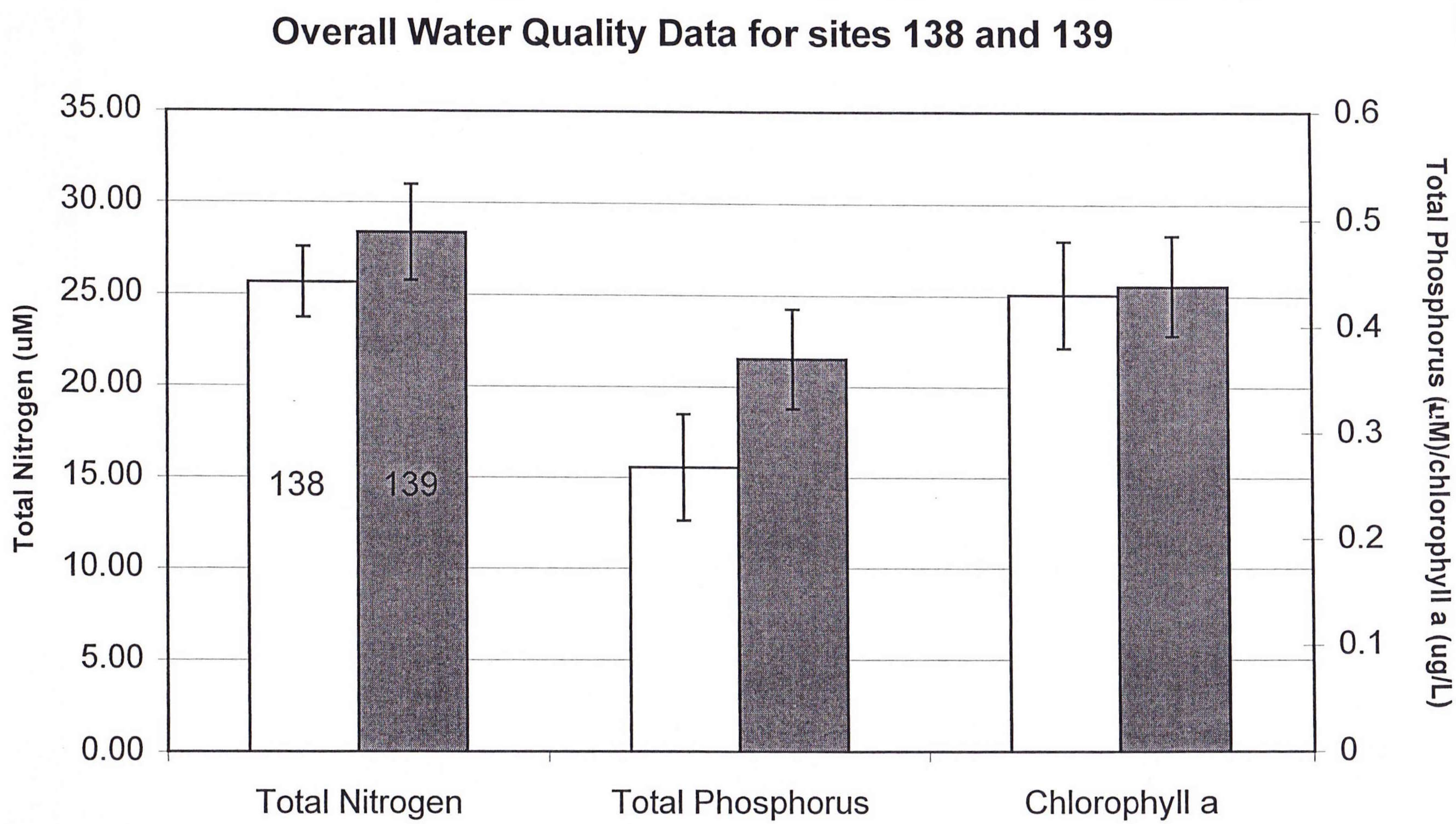


Fig.1. Averaged water quality data from Florida Bay Watch program (Mar.21.01-Mar.30.02) for sites 138 and 139. Error bars are +/- 1 S.E.

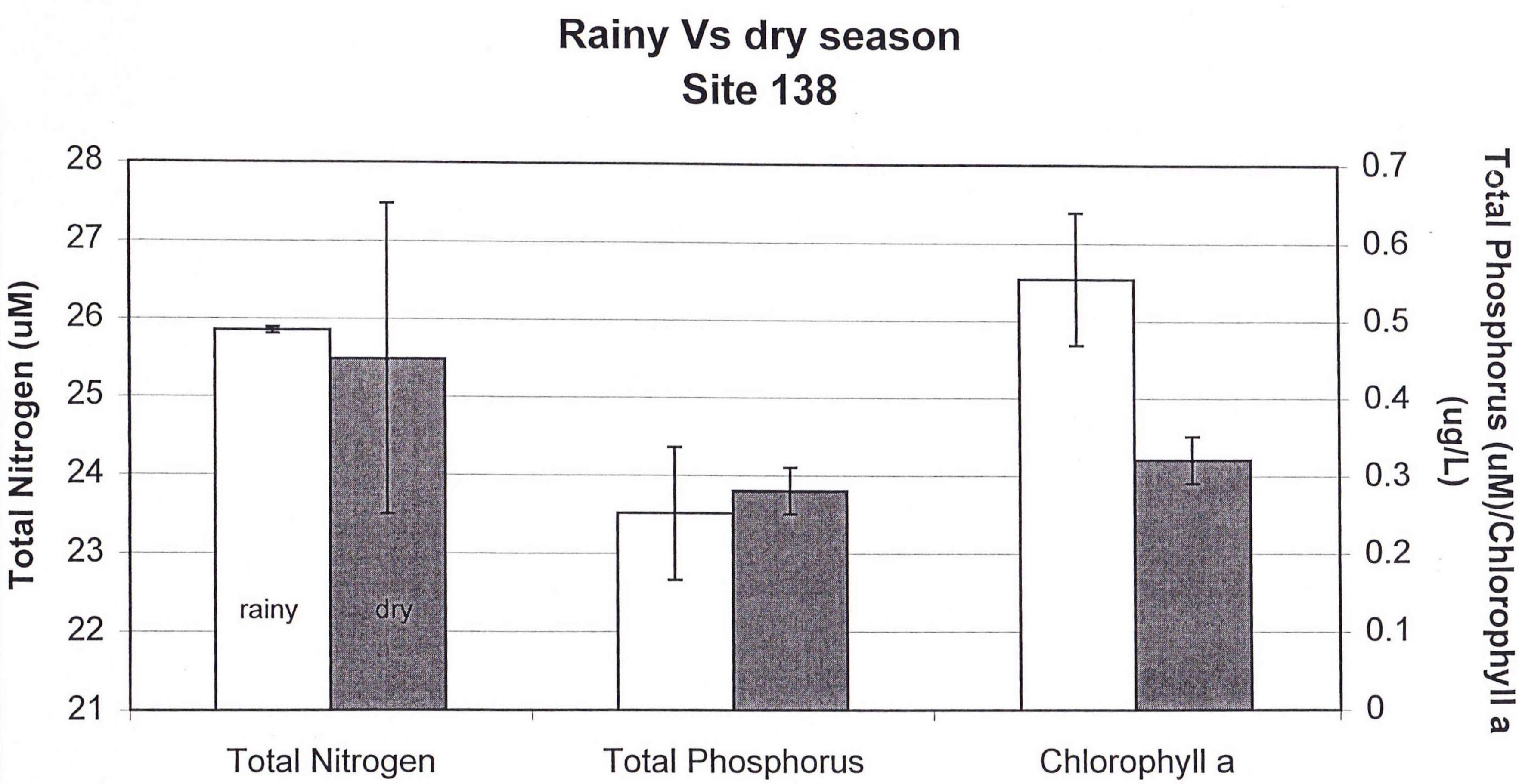


Fig.2. Water quality data for site 138. The data has been divided in a rainy (May-Sept) and a dry (Oct-Apr) season. Error bars are +/- 1 S.E.

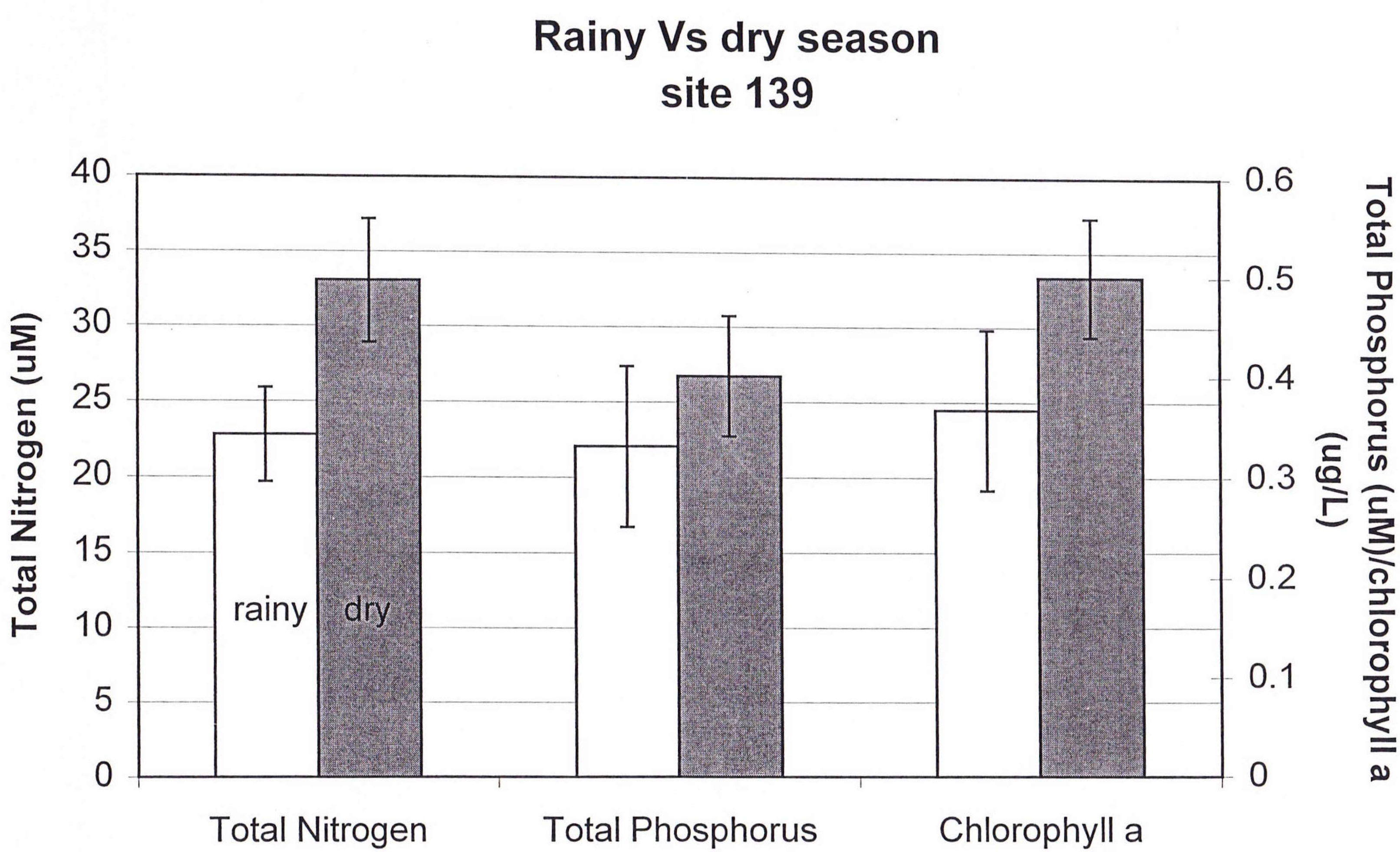


Fig.3. Water quality data for site 139. The data has been divided into a rainy (May-Sept) and a dry (Oct-Apr) season. Error bars are +/- 1 S.E.

UNIVERSITY OF FLORIDA

WATER QUALITY DATA

FOR RAMROD KEY, FLORIDA

The Institute of Fisheries and Aquatic Sciences in Cooperation with the Breezeswept Civic Association

June, 2001 to April, 2002

Ramrod Key-1 / Monroe County

Total Phosphorus ($\mu g/L$)

Date	Station 1
06-16-01	14
07-21-01	11
08-18-01	8
09-23-01	11
10-20-01	27
11-18-01	9
12-16-01	9
01-25-02	13
02-16-02	12
03-16-02	15
04-20-02	12

Total Nitrogen ($\mu g/L$)

Date	Station 1
06-16-01	470
07-21-01	350
08-18-01	360
09-23-01	450
10-20-01	470
11-18-01	270
12-16-01	240
01-25-02	380
02-16-02	460
03-16-02	410
04-20-02	420

Chlorophyll ($\mu g/L$)

Date	Station 1
06-16-01	3
07-21-01	1
08-18-01	1
09-23-01	2
10-20-01	1
11-18-01	1
12-16-01	1
01-25-02	1
02-16-02	.
03-16-02	.
04-20-02	.

Ramrod Key-2 / Monroe County

Total Phosphorus (µg/L)

Date	Station 1
06-16-01	18
07-21-01	18
08-18-01	8
09-23-01	.
10-20-01	9
11-18-01	9
12-16-01	8
01-25-02	9
02-16-02	.
03-16-02	13
04-20-02	10

Total Nitrogen (µg/L)

Date	Station 1
06-16-01	490
07-21-01	480
08-18-01	330
09-23-01	.
10-20-01	250
11-18-01	410
12-16-01	250
01-25-02	340
02-16-02	.
03-16-02	380
04-20-02	440

Chlorophyll (µg/L)

Date	Station 1
06-16-01	3
07-21-01	1
08-18-01	1
09-23-01	1
10-20-01	3
11-18-01	1
12-16-01	1
01-25-02	1
02-16-02	.
03-16-02	.
04-20-02	.

Ramrod Key-3 / Monroe County

Total Phosphorus (µg/L)

Date	Station 1
06-16-01	16
07-21-01	8
08-18-01	7
09-23-01	8
10-20-01	.
11-18-01	7
12-16-01	8
01-25-02	9
02-16-02	8
03-16-02	10
04-20-02	10

Total Nitrogen (µg/L)

Date	Station 1
06-16-01	450
07-21-01	310
08-18-01	400
09-23-01	400
10-20-01	.
11-18-01	340
12-16-01	200
01-25-02	350
02-16-02	410
03-16-02	410
04-20-02	390

Chlorophyll (µg/L)

Date	Station 1
06-16-01	4
07-21-01	1
08-18-01	1
09-23-01	1
10-20-01	1
11-18-01	1
12-16-01	1
01-25-02	1
02-16-02	.
03-16-02	.
04-20-02	.

Ramrod Key-4 / Monroe County

Total Phosphorus (µg/L)

Date	Station 1
06-16-01	8
07-21-01	6
08-18-01	4
09-23-01	3
10-20-01	8
11-18-01	4
12-16-01	6
01-25-02	7
02-16-02	7
03-16-02	8
04-20-02	8

Total Nitrogen (µg/L)

Date	Station 1
06-16-01	310
07-21-01	290
08-18-01	440
09-23-01	340
10-20-01	320
11-18-01	200
12-16-01	200
01-25-02	290
02-16-02	490
03-16-02	370
04-20-02	370

Chlorophyll (µg/L)

Date	Station 1
06-16-01	0
07-21-01	0
08-18-01	0
09-23-01	1
10-20-01	1
11-18-01	1
12-16-01	1
01-25-02	1
02-16-02	.
03-16-02	.
04-20-02	.

Ramrod Key-5 / Monroe County

Total Phosphorus (μg/L)

Date	Station 1
06-16-01	6
07-21-01	7
08-18-01	4
09-23-01	4
10-20-01	10
11-18-01	4
12-16-01	7
01-25-02	4
02-16-02	6
03-16-02	7
04-20-02	8

Total Nitrogen (μg/L)

Date	Station 1
06-16-01	420
07-21-01	220
08-18-01	360
09-23-01	330
10-20-01	300
11-18-01	230
12-16-01	190
01-25-02	250
02-16-02	270
03-16-02	320
04-20-02	370

Chlorophyll (μg/L)

Date	Station 1
06-16-01	0
07-21-01	0
08-18-01	1
09-23-01	1
10-20-01	1
11-18-01	0
12-16-01	0
01-25-02	0
02-16-02	.
03-16-02	.
04-20-02	.

Ramrod Key-6 / Monroe County

Total Phosphorus (µg/L)

Date	Station 1
06-16-01	12
07-21-01	6
08-18-01	4
09-23-01	7
10-20-01	5
11-18-01	3
12-16-01	4
01-25-02	6
02-16-02	5
03-16-02	11
04-20-02	14

Total Nitrogen (µg/L)

Date	Station 1
06-16-01	440
07-21-01	180
08-18-01	150
09-23-01	250
10-20-01	250
11-18-01	180
12-16-01	150
01-25-02	260
02-16-02	240
03-16-02	230
04-20-02	200

Chlorophyll (µg/L)

Date	Station 1
06-16-01	.
07-21-01	1
08-18-01	1
09-23-01	0
10-20-01	1
11-18-01	0
12-16-01	1
01-25-02	1
02-16-02	.
03-16-02	.
04-20-02	.