City of Sanibel Ambient and Storm Event Water Quality Monitoring Program Status and Trends 2002 Report

City of Sanibel
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Abstract: *Sanibel Island's water resources are significantly important in terms of both aesthetic and ecological value. Surface water quality on the island is continuously threatened by anthropogenic organic compounds, development, reduction of nutrient sinks and salt-water intrusion. This year's data (WY 2002) will be used as a baseline to track Sanibel's surface water quality. Although it is important to remember that it may not be possible to draw solid conclusions to the status and trends of the overall water quality with a single year of sampling, it is baseline information that will help fill in the gap between the water quality data collected by McPherson and O'Donnell of the United States Geological Survey (USGS) in their study Quality of Surface Water on Sanibel Island Florida, 1976–77.*

Eight sites were monitored monthly by Natural Resources staff from January –December 2002. Field parameters including temperature, dissolved oxygen, salinity, specific conductance and pH were taken within the water column at .50 meters from the surface using a Hydrolab Minisonde multiprobe.™ Grab samples were collected using an Alpha bottle™ at .50 meters from the surface. The samples were taken to the Cape Coral Lab for analysis. Lab parameters including nitrite, nitrate, total nitrogen, ammonia, total kjeldahl nitrogen, orthophosphate, as well as color, turbidity, chlorophyll-a, total organic carbon, total suspended solids and fecal streptococci were analyzed. Eight sites were chosen throughout the island in order to get an idea of the entire island's surface water quality. Sites were chosen based on their geographic location in relation to the Sanibel River. The sites were also chosen based on the location of sample sites used in the USGS study (McPherson and O'Donnell, 1979) for historical comparison.

The overall water quality on Sanibel appears to be "fair." We must remember that the Sanibel River is not truly a river and that the classifications setup for lakes and streams throughout the state may not be directly applicable since the Sanibel River is for most of the year a closed system with little to no flow. While dissolved oxygen concentrations at most of the sites decreased, in general the water quality conditions compared to those of the study performed by McPherson and O'Donnell show that there has been a significant decrease in salinity concentrations since the installation of the new water control structures at Tarpon Bay and Beach Road in 1995. The median concentrations of macronutrients have also decreased, especially at sites six, seven and eight. These sites had nutrient levels higher than that of the other sampling sites which indicates that the water bodies may be influenced by septic effluent or leaching from a sewage treatment plant settling pond. Pollution from the golf course maintenance facility on the north side of the Sanibel River may have also contributed to elevated levels of macronutrients at sites seven and eight, since fertilizers containing nitrogen are prepared at this site for distribution on the golf course. This site has obtained a permit to install an equipment wash down facility that retains the dirty water for off-site disposal. If it is determined that in spite of the improved wash down operation, this site is a pollution source, staff will work with the owners of the golf course to take additional steps to eliminate pollution discharge. It is important to note that the areas with the highest nutrient loadings and the poorest water quality of the eight sites sampled are also those areas with the highest intensity of development. Although these sites ranked the poorest among those sampled, the large reductions in nutrient loading from 1977 to present should be recognized. Future monitoring will provide a better data set in order to establish trends and to take into account seasonal variability.

Introduction:
Sanibel Island's water resources are significantly important areas of both aesthetic and ecological value. Surface water quality on the island is adversely affected by increases in anthropogenic organic compounds, development, reduction of nutrient sinks and salt-water intrusion. Previous studies on Sanibel have shown that Sanibel is susceptible to over-nutrification and salt-water intrusion through storm events and urban runoff (McPherson and O'Donnell, 1979). The island's geographic location in the Charlotte Harbor watershed coupled with its status as a "sanctuary island" makes water quality sampling on the island imperative.

This year's data (WY 2002) will provide a baseline to track Sanibel's surface water quality. Although it is important to remember that it may not be possible to draw solid conclusions to the status and trends of the overall water quality with a single year of data, this information will help fill in the gap between the water quality data collected by Mcpherson and O'Donnell of the United States Geological Survey (USGS) in their study Quality of Surface Water on Sanibel Island Florida, 1976–77. Analysis of this data will give us insight as to what changes have occurred over time with land use changes and determine if the island is affecting our surrounding waters.

Project Description:
Eight sites were monitored monthly by Natural Resources staff from January – December 2002. Field parameters including temperature, dissolved oxygen, salinity, specific conductance and pH were taken within the water column at .50 meters from the surface using a Hydrolab Minisonde multiprobe.™ Grab samples were collected using an Alpha bottle™ at .50 meters from the surface. The samples were taken to the Cape Coral Lab for analysis. Lab parameters including nitrite, nitrate, total nitrogen, ammonia, total kjeldahl nitrogen, orthophosphate, as well as color, turbidity, chlorophyll-a, total organic carbon, total suspended solids and fecal streptococci were analyzed.

Site Description:
Eight sites were chosen throughout the island in order to get an idea of the entire island's general surface water quality. Sites were chosen based on their geographic location in relation to the Sanibel River. The sites were also chosen based on those locations chosen in the USGS study, the Quality of Surface Water on Sanibel Island Florida, 1976 –77 (Mcpherson and O'Donnell, 1979) for historical comparison. (See Appendix A)

San WQ-1 - is located at N 026° 28' 25.53" W 082° 9' 53.88". The site is located at the end of Pine Tree Drive and is the most western site. The samples are collected from the boat dock on the vacant property on Dinkins Bayou.

SanWQ-2 - is located at N 026° 27' 58.36" W 082° 9' 35.92". The site is located at the end of Shearwater Drive in Heron's Landing II subdivision. The samples are collected from the end of the H.O.A. dock on Clam Bayou.

SanWQ-3 - is located at N 026° 26’ 50.85” W 082° 07’ 54.09”. The Site is located in Gulf Pines subdivision to the east of Gulf Pines Drive near the stage gauge for the Tarpon Bay weir basin. This site corresponds with # 65 (Mcpherson and O’Donnell, 1979).

San WQ-4 – is located at N 026° 26’ 15.66” W 082° 06’ 28.42”. The Site is located on the east side of Rabbit Road in the Sanibel River. This site corresponds with # 51 (Mcpherson and O’Donnell, 1979).

San-WQ-5 – is located at N 026° 26’ 19.71” W 082° 05’ 16.37”. The site is located on the south side of the Tarpon Bay Weir water control structure. This site is within the same area of site # 36 (Mcpherson and O’Donnell, 1979).

San-WQ-6 – is located at N 026° 26’ 14.51” W 082° 03’ 29.64”. The site is located on the west side of Casa Ybel Road in the Sanibel River. This site corresponds with # 28 (Mcpherson and O’Donnell, 1979).

San-WQ-7 – is located at N 026° 26’ 29.80” W 082° 02’ 47.03”. The site is located on the east side of Donax Road in the Sanibel River near the Donax Sewer Plant. This site corresponds with # 5 (Mcpherson and O’Donnell, 1979).

San-WQ-8 – is located N 026° 26’ 34.67” W 082° 02’ 23.87”. The site is located on the west side of Beach Road at the Beach Road weir on the west side of the weir. This site corresponds with # 1 (Mcpherson and O’Donnell, 1979).

Table 1. WQ Monitoring Parameters & Florida Standards Class III (Predominately Freshwater)

Parameter	Sampling Frequency	Florida Standard for Class III Waters
Temperature	Monthly	NA
Dissolved Oxygen	Monthly	>5mg/l
Dissolved Oxygen %	Monthly	NA
Salinity	Monthly	NA
Specific Conductance	Monthly	<1275 or 50% > background
pH	Monthly	>6<8.5
Nitrate (NO3)	Monthly	<1.0 mg/l
Nitrite	Monthly	<1.0 mg/l
Ammonia (NH3)	Monthly	≤ 0.02
Total Nitrogen (TN)	Monthly	<2.0 mg/l
Total Phosphorus (T-PO4)	Monthly	<0.46mg/l
Ortho Phosphorus (Ortho-PO4)	Monthly	<0.1mg/l
Color	Monthly	No Nuisance Conditions
Turbidity	Monthly	< 29NTU > background
Chlorophyll-a	Monthly	<10mg/l

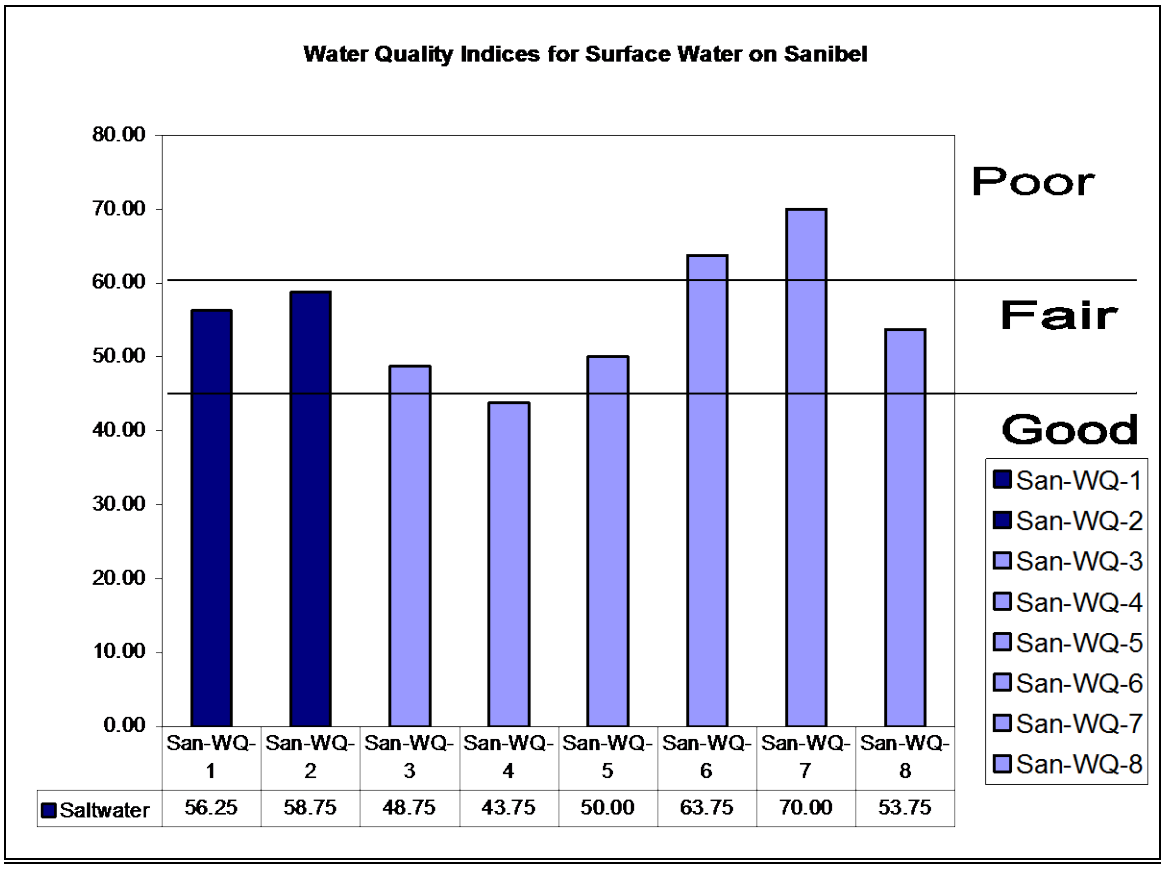
Total Organic Carbon	Monthly	NA
Total Suspended Solids	Monthly	<18
Fecal Streptococci	Monthly	<33/100ml

Table 2 Deviations from the State Standards WY 2002

Parameters	San-WQ-1	San-WQ-2	San-WQ-3	San-WQ-4	San WQ-5	San-WQ-6	San-WQ-7	San-WQ-8
Temperature	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	11	7	11	9	9	11	12	12
Dissolved Oxygen %	NA	NA	NA	NA	NA	NA	NA	NA
Salinity	NA	NA	NA	NA	NA	NA	NA	NA
Specific Conductance	NA	NA	NA	NA	NA	NA	NA	NA
pH	0	0	0	0	0	0	0	0
Nitrate (NO3)	0	0	0	0	0	0	0	0
Nitrite	0	0	0	0	0	0	0	0
Ammonia (NH3)	0	2	4	4	2	5	5	5
Total Nitrogen (TN)	0	3	0	0	1	2	1	0
Total Phosphorus (T-PO4)	0	0	0	0	0	0	2	0
Ortho Phosphorus (Ortho-PO4)	0	0	0	0	0	1	0	0
Color	NA	NA	NA	NA	NA	NA	NA	NA
Turbidity	0	0	0	0	0	0	0	0
Chlorophyll-a	0	2	0	2	0	1	3	1
Total Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA
Total Suspended Solids	10	10	1	1	2	1	2	0
Fecal Streptococci	5	2	4	5	4	9	11	7

Table 3. Florida Stream Water Quality Index (WQI) Values (Index based on Hand et al. 1988), *Appendix C*

San-WQ-1: WQI=56.25[4] (Fair)
San-WQ-2: WQI=58.75[4] (Fair)
San-WQ-3: WQI=48.75[4] (Fair)
San-WQ-4: WQI=43.75[4] (Good)
San-WQ-5: WQI=50.00[4] (Fair)
San-WQ-6: WQI=63.75[4] (Poor)
San-WQ-7: WQI=70.00[4] (Poor)
San-WQ-8: WQI=53.75[4] (Fair)



Trophic State Index (TSI):

The Trophic State Index (TSI) is commonly used to assess the water quality of freshwater lake systems. It is the measure of the degree of productivity in the water column. Eutrophication is the process in which a lake becomes nutrient enriched, which in turn alters the chemical, physical and biological characteristics of the lake. Most of the changes in the lake's characteristics result from increased plant production, which is in turn caused by increased levels of nutrients. The Florida Department of Environmental Protection (FDEP) uses the TSI values to assess a good, fair or poor rating to Florida lakes. TSI values for lakes: 0-59 corresponds to "good water quality," 60-69 is "fair" and values 70-100 indicate "poor" water quality. For estuaries: 0-49 corresponds to "good water quality," 50-59 is "fair" and values 60-100 indicate "poor" water quality (http://www.nrpcworld.com/aqua_trophic.html).

A lake that has low nutrient concentrations in the water column will typically have good water transparency because algae densities are low. These lakes are termed oligotrophic and are generally considered lakes with excellent water quality. Oligotrophic lakes tend to be deep with abundant oxygen and a small amount of organic material on the bottom. Lakes are assigned an oligotrophic status if the TSI values are less than 50.
(http://www.nrpcworld.com/aqua_trophic.html)

Lakes that have moderate nutrient levels and water quality characteristics are termed mesotrophic. Mesotrophic lakes will typically only have occasional water quality problems and are generally considered to have good water quality. Lakes are assigned a mesotrophic status if the TSI values are between 51-60.
(http://www.nrpcworld.com/aqua_trophic.html)

As nutrient concentrations increase in a lake, algae density increases and water transparency decreases. A lake with high levels of nutrients and planktonic algae is termed eutrophic. A eutrophic lake is highly productive and will have the potential for water quality problems resulting from severe algae blooms, which can deplete oxygen and form mucky organic layers on the bottom. Lakes are assigned a eutrophic status if the TSI are between 61-70 (http://www.nrpcworld.com/aqua_trophic.html).

Lakes that have reached advanced stages of the eutrophication process are termed hyper eutrophic. These lakes are characterized by persistent algae blooms, extreme fluctuations in dissolved oxygen and deep organic muck layers. Hypereutrophic lakes tend to be shallow and have mucky sediments from organic material, which is produced in the lake faster than it can be removed by the decomposition process. Lakes are assigned a hypereutrophic status if the TSI value is greater than 70.
(http://www.nrpcworld.com/aqua_trophic.html)

The Sanibel River is predominately freshwater, however during major storm events tidal flooding of estuarine or marine waters may influence it. Although it is possible to assign TSI values to the Sanibel River, other variables such as rainfall data (Appendix B) and major storm events should also be taken into consideration when evaluating the TSI values.

Stations San WQ-1 & San WQ-2 are water bodies, which are tidally influenced by marine waters and therefore must be evaluated differently than those of the other 6 sites. Since different water quality standards are applied to estuarine waters than that of freshwater, it is important that we separate these two sites for comparison sake.

Estuarine waters are nitrogen limited systems, which means that the primary productivity within the system is limited by the amount of nitrogen. Nitrogen is generally the primary limiting nutrient in the seaward portions of estuarine systems (Paerl, 1993). In these systems, nitrogen levels control the rate of primary production. If the system is supplied with high levels of nitrogen, algal blooms will occur. In contrast, a freshwater system such as the Sanibel River is phosphorus-limited meaning the primary productivity is limited by the amount of phosphorus the system gets. That is, if all of the phosphorus is used, plant growth will cease, no matter how much nitrogen is available.

Since the Sanibel River doesn't flow except during storm events where waters breach the water control structures (Tarpon Bay weir & Beach Road weir), it is hard to classify it as a river. It is mainly influenced by runoff collected within the Sanibel River Basin and for this reason is better classified as a long lake or freshwater bayou.

The criteria for evaluating the TSI are nutrients, i.e., total phosphorus and total nitrogen, Secchi depth and Chlorophyll-a. Secchi readings were not initially in the water quality monitoring plan, however was added later to determine a TSI value for the eight monitoring sites. It is important to note that only a single secchi reading was taken in May of 2003 to apply the index to get an idea of the trophic states of each sampling site. These index values should not be used for management decisions, but rather a tool to rank the water bodies until more data is collected.

Status:

San WQ-1 –Station 1 had a WQI of 56.25 (fair) and a TSI of 34.45 (oligotrophic). Although this site did have a low TSI value, it was most likely due to the timing of the secchi reading. Since it was only taken in May at the peak of the dry season when the clarity of the water is highest, the reading was 1.2 meters, which is higher (clearer) than it would be during the middle of the wet season which would reduce the average secchi depth and increase the TSI value. Wet season concentrations of TKN were almost twice that of dry season concentrations. The Florida's surface water quality standards were exceeded 11 times for dissolved oxygen, 10 times for total suspended solids and 5 times for fecal streptococci.

SanWQ-2 –Station 2 had a WQI of 58.75 (fair) and a TSI of 55.66 (mesotrophic). Florida's surface water quality standards were exceeded 7 times for dissolved oxygen, 2 times for ammonia, 2 times for chlorophyll-a, 10 times for suspended solids and 2 times for fecal streptococci.

SanWQ-3 –Station 3 had a WQI of 48.75 (fair) and a TSI of 41.61 (oligotrophic). Florida's surface water quality standards were exceeded 11 times for dissolved oxygen, 4 times for ammonia, 1 time for suspended solids and 4 times for fecal streptococci.

San WQ-4 –Station 4 had WQI of 42.50 (good) and a TSI of 51.79 (mesotrophic) Florida's surface water quality standards were exceeded 9 times for dissolved oxygen, 4 times for ammonia, 2 times for chlorophyll-a, 1 time for suspended solids and 4 times for fecal streptococci.

San-WQ-5 –Station 5 had a WQI of 50.00 (fair) and a TSI of 43.29 (oligotrophic) Florida's surface waters quality standards were exceeded 9 times for dissolved oxygen, 2 times for ammonia, 2 times for suspended solids and 4 times for fecal streptococci.

San-WQ-6 –Station 6 had a WQI of 62.50 (poor) and a TSI of 57.15 (mesotrophic). Florida's surface water quality standards were exceeded 11 times for dissolved oxygen, 5 times for ammonia, 1 time for ortho-phosphorus, 1 time chlorophyll-a, 1 time for total suspended solids and 9 times for fecal streptococci.

San-WQ-7 –Station 7 had a WQI of 68.75 (poor) and a TSI of 65.57 (eutrophic). Florida's surface water quality standards were exceeded 12 times for dissolved oxygen, 5 times for ammonia, 2 times for total phosphorus, 3 times for chlorophyll-a, 2 times for suspended solids and 11 times for fecal streptococci. Although the WQI is in the poor

range, when compared with the data collected by McPherson and O'Donnell there has been significant reductions in nutrient loading from 1977. In comparison, TN in the 1976-77 study, the range was (2.1-8.7mg/l) with a mean of (4.8 mg/l) compared to TN for 2002 the range was (0.10-4.00mg/l) with a mean of (1.65mg/l). A 34.4% decrease in Total Nitrogen concentrations. For TP in the 1976-77 study, the range was (.26-3.2mg/l) with a mean of (1.8mg/l) compared to TP for 2002 the range was (0.10-0.58mg/l) with a mean of (0.23). A 12.78% decrease in Total Phosphorus concentrations.

San-WQ-8 – Station 8 had a WQI of 52.50 (fair) and a TSI of 52.71 (mesotrophic). Florida's surface water quality standards were exceeded 12 times for dissolved oxygen, 5 times for ammonia, 1 time for chlorophyll-a, and 7 times for fecal streptococci.

Trends:
Low dissolved oxygen concentrations were observed at all of the 8 sampling sites. The overall chloride concentrations (salinity) at the Sanibel River stations were considerably lower than those recorded by McPherson and O'Donnell. The levels of macronutrients were similar to those observed with the exception of sites seven and eight.

Site two (San-WQ-2) which is located in Clam Bayou had the second highest dissolved oxygen concentrations. This is probably do to the large surface area of the bayou and the overall shallow water depth and oxygen production through photosynthesis by macro algae and macrophytes. Although the bayou is presently a closed system, it still continues to show signs of its highly productive past.

Site four had the overall highest (best) ranking for water quality values during the 2002WY. This may be due to depth and width of the water body at which the sample was taken as well as the relatively low development density and the large tracts of conservation lands in the interior of the island to the east and the west, that have the potential to reduce urban runoff.

Sites 6 and 7 ranked on the Water Quality Index (WQI) as poor water quality. Both sites had DO levels below the state's standards for at least eleven out of the twelve sampling events. Fecal streptococci levels and nutrient levels were also higher than that of the other sampling sites which indicates that the river at these locations may be influenced by septic effluent or leaching from a sewage treatment plant. Runoff from the washing of the golf course maintenance equipment at the Beachview maintenance area along the north side of the Sanibel River may also be contributing to elevated levels of macronutrients at sites seven and eight since the equipment washed at this location is used to distribute nitrogen based fertilizers. It is also important to note that the areas with the highest nutrient loadings and the poorest water quality of the sites sampled are also those areas with the highest development intensity. Although these sites ranked the poorest, the large reductions in nutrient loading from 1977 to present should be recognized.

Discussion:
It is important to note that all of the sites experienced low dissolved oxygen concentrations with the lowest being sites 1,3,6,7, & 8. The low DO concentrations may

be attributed to the lack of flow within each of the sampling sites, low photosynthetic oxygen production by aquatic plants during the day and high bacterial oxygen consumption. It is quite possible with changes in technology and calibration standards that WQ monitoring instrumentation has gotten more precise and that may be why we are seeing such large differences in DO readings. In order to determine the actual dissolved oxygen concentrations, a 24-hr study would be necessary to profile the changes in DO levels that correspond with photosynthesis and respiration of macro algae and macrophytes. Chemical oxygen demand (COD) and biological oxygen demand (BOD) sampling would also help to isolate the causes of the low DO concentrations.

The spikes macronutrients in particular total nitrogen and total kjeldahl nitrogen, tend to follow months with high rainfall, which indicates that runoff of fertilizers from nearby residential developments may be contributing to increased nutrient loads within the river basin.

Summary & Conclusions:

The overall water quality on Sanibel appears to be "fair." We must remember that the Sanibel River is not truly a river and that the classifications setup for lakes and streams throughout the state may not be directly applicable since the Sanibel River is for most of the year a closed system with little flow except during major storm events.

While dissolved oxygen concentrations at most of the sites decreased, in general the water quality conditions compared to those of the study performed by McPherson and O'Donnell show that there is a significant decrease in salinity concentrations since the installation of the weirs at Tarpon Bay and Beach Road in 1995. The median concentrations of macronutrients have also decreased, especially at sites six, seven and eight. These overall reductions in macronutrients are important to note. Since 1977, Sanibel has seen significant land use changes. The acquisition of properties along the Sanibel River corridor by the Sanibel-Captiva Conservation Foundation and the City along with the conversion to central sewer are most likely responsible for the overall reduction in macronutrients. Future monitoring will provide a better data set in order to establish trends, determine if we are, in fact, seeing decreases in macronutrients and to take into account seasonal variability.

References:

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