

# MOBILE BAY SUB-ESTUARY MONITORING PROGRAM REPORT

Bon Secour River / Intracoastal Waterway / Oyster Bay  
Sub-Estuary

*Mobile Bay National Estuary Program*

*Alabama Department of Environmental Management*

*Gulf of Mexico Program*

*US Environmental Protection Agency*



# **Mobile Bay National Estuary Program**

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Prepared for the Mobile Bay National Estuary Program

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# Contents

<i>Acronyms</i> .....	<i>iii</i>
<i>List of Tables</i> .....	<i>iv</i>
<i>List of Figures</i> .....	<i>iv</i>
<i>Executive Summary</i> .....	<i>v</i>
<i>Introduction</i> .....	<i>1</i>
<i>Methods</i> .....	<i>2</i>
<i>Geographical Information</i> .....	<i>18</i>
<i>Results and Discussion</i> .....	<i>19</i>
<i>Conclusion</i> .....	<i>23</i>
<i>References</i> .....	<i>26</i>

## Acronyms

ADEM	Alabama Department of Environmental Management
ADCP	Acoustic Doppler Current Profiler
ADPH	Alabama Department of Public Health
BMP	Best Management Practice
CCMP	Comprehensive Conservation Management Plan
DISL	Dauphin Island Sea Lab
DO	Dissolved Oxygen
EPA(USEPA)	Environmental Protection Agency
GPS (DGPS)	(Differential) Global Positioning System
GSA	Geological Survey of Alabama
HAB	Harmful Algal Bloom
HUC	Hydrologic Unit Code
MBNEP	Mobile Bay National Estuary Program
NCA	National Coastal Assessment (Coastal 2000)
MDN	Mercury Deposition Network
NEP	National Estuary Program
NOAA	National Oceanic and Atmospheric Administration
NADP	National Atmospheric Deposition Program
NPDES	National Pollution Discharge Elimination System
NPS	Non-Point Source
NRCS	National Resource Conservation Service
NTU	Nephelometric Turbidity Units
PAHs	Polycyclic Aromatic Hydrocarbons
QAQC	Quality Assurance Quality Control
SAV	Submerged Aquatic Vegetation
TMDL	Total Maximum Daily Load
USACE	US Army Corps of Engineers
USFDA	US Food and Drug Administration
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WQ	Water Quality
WWTP	Waste Water Treatment Plant

## *List of Tables*

Table 1. Guidance Values for ERM and ERL (Long et al, 1995).....	8
Table 2. Bon Secour Sampling Stations.....	13
Table 3. NCA Water Quality Index.....	21

## *List of Figures*

Figure 1. Hydrologic Unit Codes (HUC) of the study area.....	4
Figure 2. National Atmospheric Deposition Program.....	9
Figure 3. Research vessel “ <i>R/V Tensaw</i> ” at anchor on School House Creek.....	11
Figure 4. Ten Foot tender used to access narrow tributaries.....	11
Figure 5. Map of Sampling Locations.....	12
Figure 6. Boat Mounted ADCP.....	13
Figure 7. ADCP with custom mount.....	13
Figure 8. Tetra Tech Mobile Bay Model Grid.....	14
Figure 9. Hydrologic Modification through Channel Dredging.....	16
Figure 10. Baldwin County Projected Growth 2000-2020.....	17
Figure 11. Grassed stormwater conveyance near Bon Secour River’s source.....	18
Figure 12. Storm water drainage from Foley, Alabama.....	18
Figure 13. Water Quality Index.....	22
Figure 14. Sediment Water Quality Index.....	22
Figure 15. Total Mercury Wet Deposition for 2005.....	23
Figure 16. ADEM Composite Fish Tissue Data 2005 for Large Mouth Bass at BSR-1....	24
Figure 17. Coastal Long-Term Trend Stations.....	25

## *Executive Summary*

In 2005 the Mobile Bay National Estuary Program (MBNEP) initiated a monitoring program within the Sub-Estuarines of Mobile Bay. The project area consisted of portions of Mobile Bay and adjoining waterbodies in coastal Alabama. This report covers actions initiated by the MBNEP in an agreement between the Alabama Department of Environmental Management (ADEM) and the Dauphin Island Sea Lab pursuant to an appropriation by the Environmental Protection Agency (EPA) and on behalf of the MBNEP.

This report describes the findings of the first of several sub-estuaries that will be evaluated for the monitoring program. The Bon Secour River / Intracoastal Waterway / Oyster Bay Sub-Estuary in southwestern Baldwin County (Southeastern Mobile Bay) is the first sub-estuary to be evaluated under this program. Subsequent studies will be conducted in the Bayou la Batre and Dog River sub-estuaries.

The program also provided support for components of the Mobile Bay National Estuary Program Plan (August 2000) and was consistent with the MBNEP Comprehensive Conservation and Management Plan (CCMP). Further, it was designed to fulfill the needs of the ADEM by using departmental personnel and procedures. In this way, data generated by the MBNEP will supplement ADEM monitoring. Thus, both agencies benefit from the collaborative effort.

To be consistent with ADEM procedures, the data was analyzed using the standard operating procedures of the department. The data was compared to use criteria for differing waterbody classifications as set forth by the ADEM. Sections 305(b) and 303(d) of the federal Clean Water Act direct states to monitor and report the condition of their water resources. Alabama's Final Methodology for Use Support Determinations (Applicable Prior to 2006 Integrated Report), established a process to assess the status of surface waters in Alabama relative to the beneficial uses assigned to each waterbody.

Data collected for the MBNEP by Federal, State, and/or Local agencies have the same goal of measuring estuarine conditions. While data cannot be directly compared due to differing methodologies, NEPs are able to choose methods that best address their environmental concerns. Both State and Federal methodologies were used in the assessment of the sub-estuary, ADEM water quality standards (assessment and listing methodology) and EPA's National Coastal Assessment (NCA).

Alabama's assessment and listing methodology establishes a process, consistent with EPA guidance, to assess the status of surface waters in Alabama relative to the designated uses assigned to each. This methodology is not intended to limit the data or information that the State considers as it prepares an integrated water quality assessment report. Rather, it is intended to establish a rational and consistent process for reporting the status of Alabama's surface waters relative to their designated uses. A description of designated uses for each classification in the sub-estuary is discussed later in this report.

The NCA water quality index and sediment quality index applies water and sediment quality indicators and ranked them as good, fair, or poor. In the NCA water quality index for a site to be ranked as good, it could have no more than one indicator rated as fair. For a site to be ranked as fair, it would have one indicator rated as poor or two or more indicators rated as fair. A site would be ranked as poor if it had two or more indicators rated as poor. The water quality index and indicators are as follows:

#### *NCA Water Quality Index*

Good = No more than one indicator rated as fair

Fair = 1 indicator rated as poor or two or more indicators rated as fair

Poor = two or more indicators rated as poor

#### *NCA Water Quality Indicators*

-Total nitrogen (TN) Good = < 0.02 mg/L Fair = 0.02 – 0.04 mg/L Poor = >0.04 mg/L	-Chlorophyll-a Good = < 5 µg/L Fair = 5 – 20µ g/L Poor = >20µg/L	-*Water Clarity Good = > 10% Fair =5 – 10% Poor = <5% *Comparison of percent light penetration at a depth of 1.0 meter
-Total phosphorus (TP) Good = < 0.4 mg/L Fair = 0.4 – 0.8 mg/L Poor = >0.9 mg/L	-Bottom dissolved oxygen Good = > 5 mg/L Fair = 2 – 5mg/L Poor = >2 mg/L	

Sediment samples were also collected and compared to ecological response levels developed by Long et al (1995); in which response levels of detrimental effects are divided into three ranges: rare, occasional, and frequent. These ranges are defined by two threshold concentrations known as Effects Range Median (ERM) and Effects Range Low (ERL). ERM and ERL values were published for many of these contaminants and are used as guidelines for contamination by the EPA (NCA) as well as Alabama. ERM is the concentration which would result in adverse effects in 50 percent of the studies examined. ERL is the concentration which would result in adverse effects in 10 percent of the studies examined. Sediment quality index and indicators per site:



### *NCA Sediment Quality Indicators*

Good= No ERM exceeded and <5 ERL concentrations exceeded

Fair=5 or more ERL concentrations exceeded

Poor = An ERM concentration exceeded

### *NCA Sediment Quality Index (per Region)*

Good = <5% of estuary is in poor condition

Fair = 5/15% of estuary is in poor condition

Poor = >15% of estuary is in poor condition

### Conclusion

With the exception of School House Creek and Gulf Intracoastal Waterway (ICWW) it was observed that all of the sampled tributaries to Bon Secour River and sampling locations on the river had values that failed to meet ADEM water quality criteria. Based on National Coastal Assessment water quality index, the lower half of Bon Secour River/Intracoastal Waterway/Oyster Bay Sub-Estuary is “Fair” while the upper half is “Poor”.

Based on nitrogen and chlorophyll data, nutrient loadings to the sub-estuary appears to be moderate to high. Phosphorous does not appear to be a factor. Of the 13 sampling stations, eight exceeded the NCA “Poor” threshold for nitrogen for a poor rating of 61.5% (based on number of stations). Twelve exceeded the NCA “Poor” threshold for chlorophyll for a 92% poor rating. None of the stations exceeded the poor threshold for phosphorus.

John Lehrter in his study of nutrient loads to tidal river estuarine systems of Mobile Bay observed high chlorophyll-a concentrations in conjunction with relatively low nitrogen and phosphorous concentrations. A possible explanation was longer than normal residence time and resuspension of phytoplankton. The measured tidal flows discussed later in this report could provide insight into the aforementioned residence times and resuspension.

While there were ERL exceedances for sediment metals, no location exceeded the criterion (<5 ERL), and none of the locations had an ERM exceedance. Also, no location had an exceedance of PAHs or Pesticides. Thus, each site received a “Good” for Sediment Contaminants and a “Good” for the overall Sediment Contaminants by Estuary or Region Criteria.

## Introduction

In 2005 the Mobile Bay National Estuary Program (MBNEP) initiated a monitoring program within the Sub-Estuarines of Mobile Bay. The project area consisted of portions of Mobile Bay and adjoining waterbodies in coastal Alabama. This report covers actions initiated by the MBNEP in an agreement between the Alabama Department of Environmental Management (ADEM) and the Dauphin Island Sea Lab pursuant to an appropriation by the Environmental Protection Agency (EPA) and on behalf of the MBNEP.

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The program also provided support for components of the Mobile Bay National Estuary Program Plan (August 2000) and was consistent with the MBNEP Comprehensive Conservation and Management Plan (CCMP). Further, it was designed to fulfill the needs of the ADEM by using departmental personnel and procedures. In this way, data generated by the MBNEP will supplement ADEM monitoring. Thus, both agencies benefit from the collaborative effort.

To be consistent with ADEM procedures, the data was analyzed using the standard operating procedures of the department. The data was compared to use criteria for differing waterbody classifications as set forth by the ADEM. Sections 305(b) and 303(d) of the federal Clean Water Act direct states to monitor and report the condition of their water resources. Alabama's Final Methodology for Use Support Determinations (Applicable Prior to 2006 Integrated Report), established a process to assess the status of surface waters in Alabama relative to the beneficial uses assigned to each waterbody.

Data collected for the MBNEP by Federal, State, and/or Local agencies have the same goal of measuring estuarine conditions. While data cannot be directly compared due to differing methodologies, NEPs are able to choose data and methods that best fit their environmental concerns. Both State and Federal methodologies were used in the assessment of the sub-estuary, ADEM water quality standards (assessment and listing methodology) and EPA's National Coastal Assessment (NCA).

## Methods

### *Water Quality Monitoring*

Standardized methods were used in this project, to assure consistency, quality, and reliability of data and results generated by this program. These methods were developed for use by the ADEM as the Standard Operating Procedures (SOPs) and are specified in the Quality Assurance Management Plan (QAMP, 2003).

The MBNEP coordinated the Sub-Estuary monitoring effort with ADEM's ambient monitoring program. The ADEM conducted water quality monitoring within the aforementioned sub-estuaries by agreement with the MBNEP and simultaneously through the ADEM Ambient monitoring program. The total effort involved the following:

ADEM established 8 judgmentally located sampling locations within the sub-estuary and 5 judgmentally located sampling locations near major tributaries sampled quarterly. The ADEM Water Quality Branch also requested that 5 of the 13 stations be sampled on a monthly basis in 2005 in addition to the quarterly sampling for the MBNEP.

In-situ data was collected at each site with a water quality meter. Dissolved Oxygen (mg/l), Temperature (C), pH, Salinity (ppt), Specific Conductance (mS/cm) and Depth (m) were measured with a YSI® 650MDS and 600QS multiparameter water quality datasondes. Light penetration was measured using a photometer and a standard Secchi disk. Photic zone was calculated by lowering the photometer until a depth of 1% of the sub-surface was reached. Flow data was collected using a vessel mounted ADCP Doppler flow meter. 72 hour diurnal *in situ* water quality data were collected at 3 locations (BRSND1, SND2 and SND3) using a water quality data logger.

Composite water samples were collected through the Photic Zone of the water column from each sampling location. After collection, the samples were preserved in the field and the Chain of Custody was maintained at all times. Laboratory parameters analyzed at each monitoring location included:

#### Turbidity

- Total Suspended Solids
- Total Dissolved Solids
- Ammonia
- Total Nitrogen (TN)
- Total Phosphorus (TP)
- Dissolved Reactive Phosphorus, (ortho-phosphate)
- Total Kjeldahl Nitrogen (TKN)
- Chlorophyll-a
- 5-day Carbonaceous Biochemical Oxygen Demand (CBOD5)
- Hardness
- Pathogens

Sediment was collected once at each monitoring location and analyzed for the following:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Silver
- Tin
- Zinc
- Antimony
- Iron
- Manganese
- Selenium
- Polynuclear Aromatic Hydrocarbons (PAHs)
- Pesticides (DDD, DDE, DDT, Dieldrin, Heptachlor, BHC)

Sediment samples were collected at each station from subsamples of composited surficial sediment collected with a 0.052m<sup>2</sup> modified stainless steel Ponar sampler. The upper 2-3 cm was taken from the Ponar sampler with a stainless scoop. Samples were composited in a stainless bucket (on ice) with subsamples taken for individual parameters (metals, PAHs, & Pesticides).

#### *Use Classification*

Though the waterbodies are listed separately and with different use classifications, the ICWW connects all three. This study incorporated the exchange and included it in the evaluation. It should be noted that the “SH” or “Shellfish Harvesting” for Bon Secour River is only for the designated portion west of a line drawn due north from the east bank of Bon Secour River. Figure 1 is a map of the 3 different 12-digit Hydrologic Unit Codes (HUC) of the study area.

<b>Waterbody</b>	<b>Use Classification</b>
Bon Secour River	*S / Fish & Wildlife
Intracoastal Waterway	Fish & Wildlife
Oyster Bay	**SH/ S / Fish & Wildlife

*\*S= Swimming & other whole body water-contact sports. \*\*SH = Shellfish Harvesting*

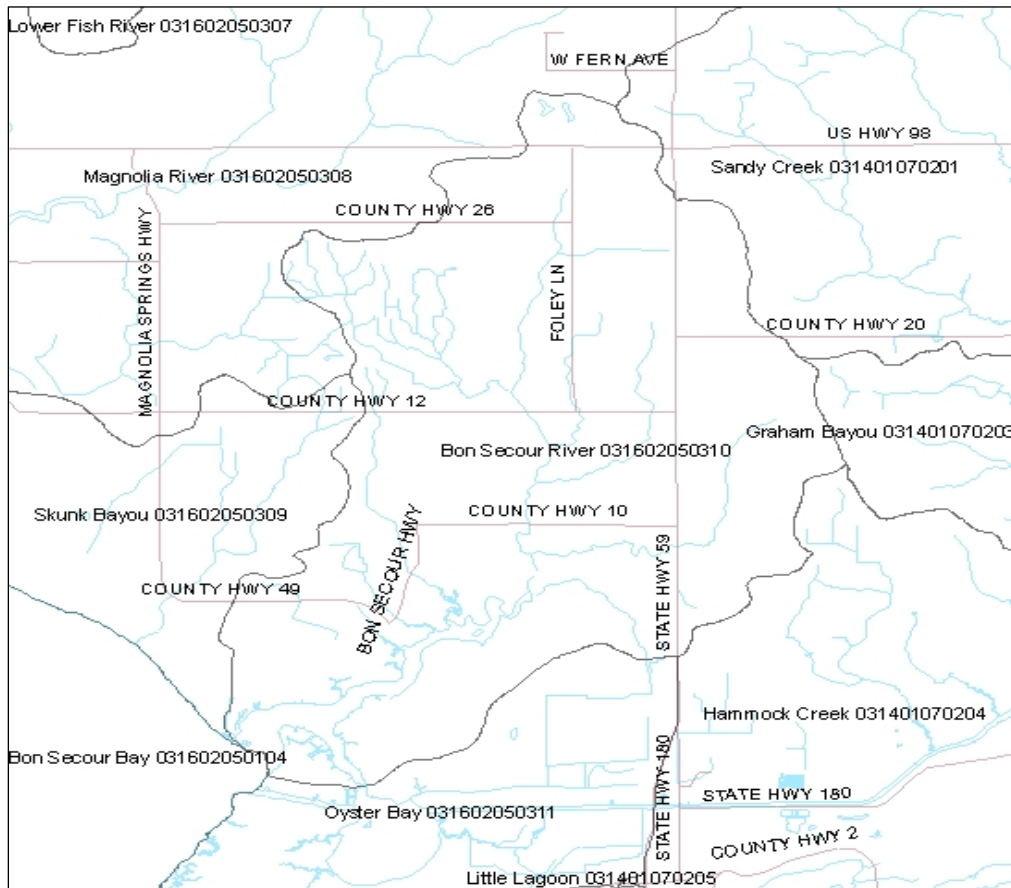


Figure 1. Hydrologic Unit Codes (HUC) of the study area.

There are three different use classifications in the sub-estuary. Bon Secour River has a use classification of “Swimming & Other Whole Body Water-Contact Sports” and “Fish & Wildlife”. These classifications are assigned to the whole of Bon Secour River from its mouth at Bon Secour Bay to its source with one exception. The South Fork of the Bon Secour River to the mouth of Bon Secour River west of a line from the drawn due north from the east bank of Bon Secour River carries the designations of “Shellfish Harvesting” and “Fish & Wildlife”. This area is the historic connection between Oyster Bay and Bon Secour River.

Oyster Bay is classified as “Shellfish Harvesting”, and “Fish & Wildlife”. The ICWW is classified as “Fish & Wildlife” only. These individual use classifications and their corresponding criteria should be viewed as separate for management purposes and when assessing whether a sampling location is supporting or not supporting its use classification. However, water freely exchanges between these three areas depending on tide and/or base flow and should be viewed together when assessing the overall health of the sub-estuary.

A description of designated uses for each classification promulgated by the ADEM is as shown below in italics:

*Swimming and Other Whole Body Water-Contact Sports (S)*

*The best usage of waters assigned this classification is for swimming and other whole body water-contact sports. Waterbodies assigned the S use, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports. The assessment process considers the available data and may include any fish consumption advisories, shellfish harvesting closure notices, chemical specific data, bacteriological data, biological community assessments, habitat assessments, periphyton assessments, beach closure notices and toxicity evaluations.*

*Shellfish Harvesting (SH)*

*The best usage of waters assigned this classification is the propagation and harvesting of shellfish (oysters) for sale or for use as a food product. Waterbodies assigned the SH use will meet the sanitary and bacteriological standards included in the National Shellfish Sanitation Program Model Ordinance, 1999, Chapter IV, published by the Food and Drug Administration, U.S. Department of Health and Human Services and the requirements of the Alabama Department of Public Health. The waters will also be of a quality suitable for the propagation of fish and other aquatic life, including shrimp and crabs.*

*Fish and Wildlife (F&W)*

*The best usage of waters assigned this classification includes fishing, the propagation of fish, aquatic life, and wildlife, and any other usage except swimming and water-contact sports or as a source of water supply for drinking or food-processing purposes. Waterbodies assigned the F&W classification will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs. In addition, it is recognized that these waters may be used for incidental water contact and recreation during June through September, except in the vicinity of wastewater discharges or other conditions beyond the control of the ADPH. These waters will, under proper sanitary supervision by the controlling health authorities, meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports during the months of June through September.*

Water quality data and information gathered from waterbodies with these designated uses are considered during the preparation of Alabama's Integrated Water Quality Report or §305(b) Report as per the Clean Water Act. Waterbodies that are not supporting their designated uses are added to the state's list of impaired waters or §303(d) after a Total Maximum Daily Load (TMDL) has been established. A TMDL limits the maximum amount of pollutants that may enter that waterbody via point sources, non-point sources, and/or natural sources.

Alabama's assessment and listing methodology establishes a process, consistent with EPA guidance, to assess the status of surface waters in Alabama relative to the designated uses assigned to each. This methodology is not intended to limit the data or information that the State considers as it prepares an integrated water quality assessment report. Rather, it is intended to establish a rational and consistent process for reporting the status of Alabama's surface waters relative to their designated uses.

The EPA guidelines for preparation of the §305(b) Water Quality Report to Congress offer the following guidance regarding use support determinations using conventional water quality parameters (i.e. dissolved oxygen, temperature, pH).

- Fully Supporting – For any one pollutant or stressor the criteria is exceeded in  $\leq 10$  percent of the measurements.
- Partially Supporting – For any one pollutant or stressor the criteria is exceeded in 11 to 25 percent of the measurements.
- Not Supporting – For any one pollutant or stressor the criteria is exceeded in  $> 25$  percent of the measurements.

For toxicants (i.e. priority pollutants, metals, chlorine, and ammonia) the guidelines suggest the following criteria.

- Fully Supporting – For any one pollutant, no more than 1 exceedance of acute or chronic criteria in a 3-year period based on 10 or more samples.
- Partially Supporting – For any one pollutant, acute or chronic criteria exceeded more than once in a 3-year period but in  $\leq 10$  percent of the samples based on 10 or more samples.
- Not Supporting – For any one pollutant, acute or chronic criteria exceeded in  $> 10$  percent of the samples based on 10 or more samples.

Water quality standards consist of three components: designated uses, numeric and narrative criteria, and an antidegradation policy. Data collected for the MBNEP (by Federal, State, and/or Local agencies), have the same goal of measuring estuarine conditions. While data cannot be directly compared due to differing methodologies, NEPs are able to choose data and methods that best fit their environmental concerns.

The National Coastal Assessment relies on 5 water quality indicators to estimate an estuarine Water Quality Index: Dissolved Inorganic nitrogen (DIN), Dissolved Inorganic Phosphorous (DIP), Chlorophyll a, water clarity, and bottom dissolved oxygen. During discussions with the EPA Gulf Ecology Division it was recommended that the criteria set for DIN and DIP was inappropriate for sub-estuary sampling due to lower salinity. It should be noted that although high salinity was recorded near the bottom (salt wedge), water quality samples were collected in the photic zone above the salt wedge. Therefore, TN & TP were substituted and criteria was amended from USEPA Recommended Values of TN & TP for Alabama Ecoregion 75 (USEPA 2000).

### *National Coastal Assessment's (NCA) \*Water Quality Criteria*

GOOD	FAIR	POOR
-Total nitrogen (TN) Good = < 0.02 mg/L Fair = 0.02 – 0.04 mg/L Poor = >0.04 mg/L	-Chlorophyll-a Good = < 5 µg/L Fair = 5 – 20µ g/L Poor = >20µg/L	-*Water Clarity Good = > 10% Fair =5 – 10% Poor = <5% *Comparison of percent light penetration at a depth of 1.0 meter
-Total phosphorus (TP) Good = < 0.4 mg/L Fair = 0.4 – 0.8 mg/L Poor = >0.9 mg/L	-Bottom dissolved oxygen Good = > 5 mg/L Fair = 2 – 5mg/L Poor = >2 mg/L	

\*Amended to correspond to EPA recommended values of TN & TP for Alabama Ecoregion 75 (USEPA 2000).

### *NCA Water Quality Index*

A water quality index, developed for the Gulf Coast by the U.S. EPA, was used to determine the condition of Alabama's coastal waters for the National Coastal Condition Report. At each sampling location, these indicators were ranked good, fair, or poor. For the water quality index, each of these rankings was used to determine an index ranking for the specific sampling point. For a site to be ranked as good, it could have no more than one indicator rated as fair. For a site to be ranked as fair, it would have one indicator rated as poor or two or more indicators rated as fair. A site would be ranked as poor if it had two or more indicators rated as poor.

### *NCA Sediment Contaminants*

Sediments were examined in Alabama's coastal waters for a total of 15 trace metals, 25 polynuclear aromatic hydrocarbons (PAHs), 21 polychlorinated biphenyls (PCBs), and 22 pesticides. Effects Range Median (ERM) and Effects Range Low (ERL) values were published for many of these contaminants by Long *et al* (1995), and are used as guidelines for contamination by the EPA (NCA) as well as Alabama. These values are shown in Table 3. ERM is the concentration which would result in adverse effects in 50 percent of the studies examined. ERL is the concentration which would result in adverse effects in 10 percent of the studies examined. These ERM and ERL values are used to assess sediment contamination. The Sub-Estuary Monitoring Program has adopted criteria similar to that of the EPA National Coastal Assessment (See Table 1).

### *National Coastal Assessment's (NCA) Sediment Contaminants Criteria*

	Good = No ERM exceeded and < 5 ERL concentrations exceeded
	Fair = 5 or more ERL concentrations exceeded
	Poor = An ERM concentrations exceeded



*\*Criteria for Assessing Sediment Contaminants by NEP Estuary or Region*



Good = <5% of estuary is in poor condition

Fair = 5-15% of estuary is in poor condition

Poor = >15% of estuary is in poor condition

\*Adopted from National Estuary Program Coastal Condition Report (USEPA) 2006

<b>Table 1. Guidance Values for ERM and ERL Long et al, 1995</b>		
<b>Metals ug/g (ppm)</b>	<b>ERL</b>	<b>ERM</b>
Arsenic (As)	8.2	70
Cadmium (Cd)	1.2	9.6
Chromium (Cr)	81	370
Copper (Cu)	34	270
Lead (Pb)	46.7	218
Mercury (Hg)	0.15	0.71
Nickel (Ni)	20.9	51.6
Silver (Ag)	1	3.7
Zinc (Zn)	150	410
<b>Analyte ng/g (ppb)</b>	<b>ERL</b>	<b>ERM</b>
Acenaphthene	16	500
Acenaphthylene	44	640
Anthracene	85.3	1100
Flourene	19	540
2-Methyl naphthalene	70	670
Napthalene	160	2100
Phenanthrene	240	1500
Benz(a)anthracene	261	1600
Benzo(a)pyrene	430	1600
Chrysene	384	2800
Dibenzo(a,h)anthracene	63.4	260
Flouranthene	600	5100
Pyrene	665	2600
Low molecular weight PAH	552	3160
High molecular weight PAH	1700	9600
Total PAHs	4020	44800
4,4'-DDE	2.2	27
Total DDT	1.6	46.1
Total PCBs	22.7	180

Table 3. Guidance Values for ERM and ERL (Long et al,1995).

### *Atmospheric Input Criteria*

ADEM operates several Particulate monitors throughout the state and 2 wet deposition monitors in Mobile and Baldwin Counties that are partially funded by the MBNEP. These monitors are part of the National Atmospheric Deposition Program (NADP). Data was evaluated on a regional basis, as opposed to individual monitors and are evaluations from NADP regional data.

Atmospheric inputs are pollutant emissions to the atmosphere that are either anthropogenic (human activities), natural, or re-emitted (transferred to the atmosphere from previously deposited pollutants).

Atmospheric loading to waterbodies can happen via dry or wet deposition of a pollutant either by direct or indirect deposition. Spatial and temporal limitations of monitoring networks as well as uncertainties and data gaps for specific pollutants make it difficult to report loading to waterbodies (See Figure 2).

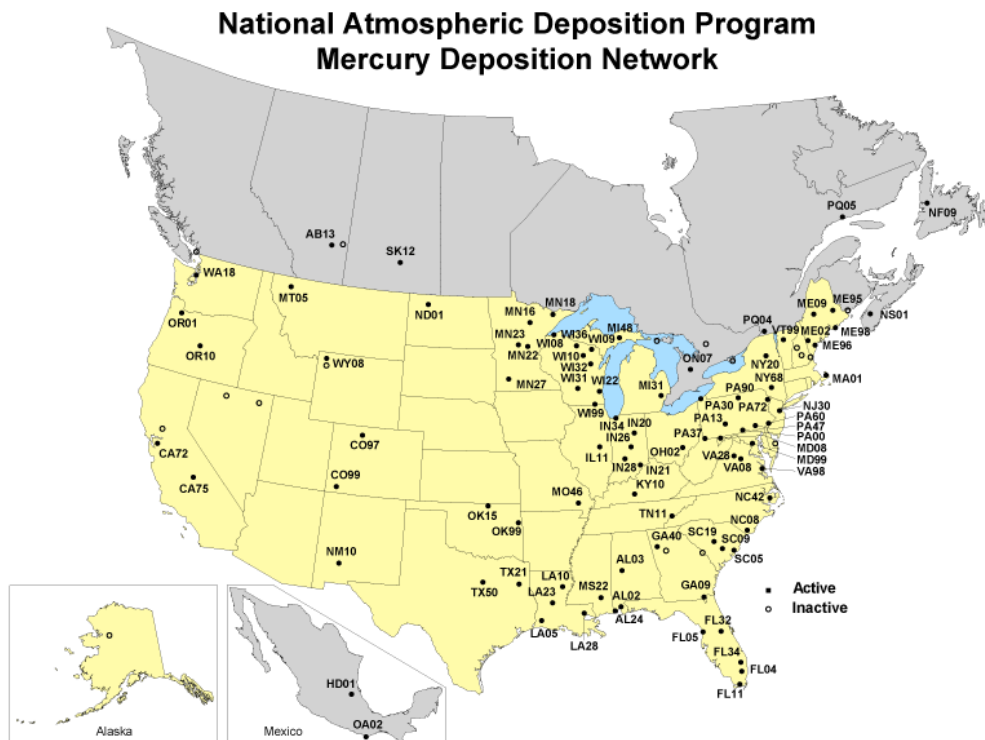


Figure 2. National Atmospheric Deposition Program.

### *Fish Tissue Monitoring*

The ADEM Fish Tissue Monitoring Program (FTMP) provides statewide screening of bioaccumulative contaminants in fish tissue, and provides the Alabama Department of Public Health (ADPH) with data needed for issuance, modification, or removal of fish consumption advisories in accordance with US Environmental Protection Agency (EPA) guidance levels. It should be noted that the ADPH began using the EPA guidance in 2005. Formerly, ADPH used Food and Drug Administration (FDA) guidance. ADEM collected fish at 2 sampling locations in the sub-estuary during 2005:

BSR-1: Bon Secour River in the vicinity of County Road 10 bridge.

BSB-1: In main channel near the confluence of Bon Secour Bay and Oyster Bay.

### *National Coastal Assessment's (NCA) Fish Tissue Monitoring*

Analyses for contamination were done using the whole body of the fish for the NCA program. Neither EPA nor FDA guidance criteria exist for whole body contaminants, therefore no comparison to consumption advisories can be made with these results. Contaminants are reported in the NCA report based on their presence or absence.

### *National Coastal Assessment's (NCA) Summarization of Indices for Overall Condition*

The overall condition of the sub-estuary is calculated by summing the scores for the available indices and dividing by the number of available indices. Good =5, Fair =4, 3, or 2 and Poor = 1. The NCA summarization is based on the following indices: Water Quality, Sediment Quality, Benthic Index, and Fish Tissue Contaminants. Enough data exists to calculate overall condition based on Water and Sediment Quality; however, Benthic samples were not included in the program. Also, ADEM fish tissue collection methods differ from NCA methods and a direct comparison cannot be made.

### *Sampling Platform*

A twenty -two foot gasoline powered research vessel (*R/V Tensaw*) with crew was provided by ADEM (See figure 3). Stations were located using Differential Global Positioning System (DGPS) receiver with accuracies of better than 10 meters. A 10 foot tender was also used in narrower creeks where the main vessel could not maneuver (See Figure 4).



Figure 3. Research Vessel “R/V Tensaw” at anchor on School House Creek.



Figure 4. Ten foot tender used to access narrow tributaries.

### *Analytical Requirements*

The ADEM gathered data collected from sub-estuary sample locations and compare it to ADEM’s Specific Water Quality Criteria as set forth in ADEM Administrative Code R. 335-6. As a part of its water quality assessment program, ADEM has created a use support methodology. The purpose of this protocol is to assess if a waterbody is supporting its use classification.

### *Data Management*

Measurements and observations were entered directly onto ADEM Field Sheets or in a bound Field Book. Field records were then transferred into the appropriate electronic format as required by the Mobile Bay NEP.

All raw data, field records, and laboratory reports were provided to the MBNEP. Request for data should be submitted to the MBNEP or to ADEM Public Records Officer, P.O. Box 301463, Montgomery, AL 36130-1463.

### *Monitoring Locations*

A total of 13 sampling locations were established: 5 near the mouths of major tributaries, 5 on the Bon Secour River, 1 at the mouth of Bon Secour River, 1 in the Intracoastal Waterway (ICWW), and 1 in the South Fork of Bon Secour River, a natural inlet connecting Bon Secour River and Oyster Bay (crossed by ICWW). Figure 3 is a map of sampling locations. Table 1 shows latitude and longitude coordinates for sampling locations.

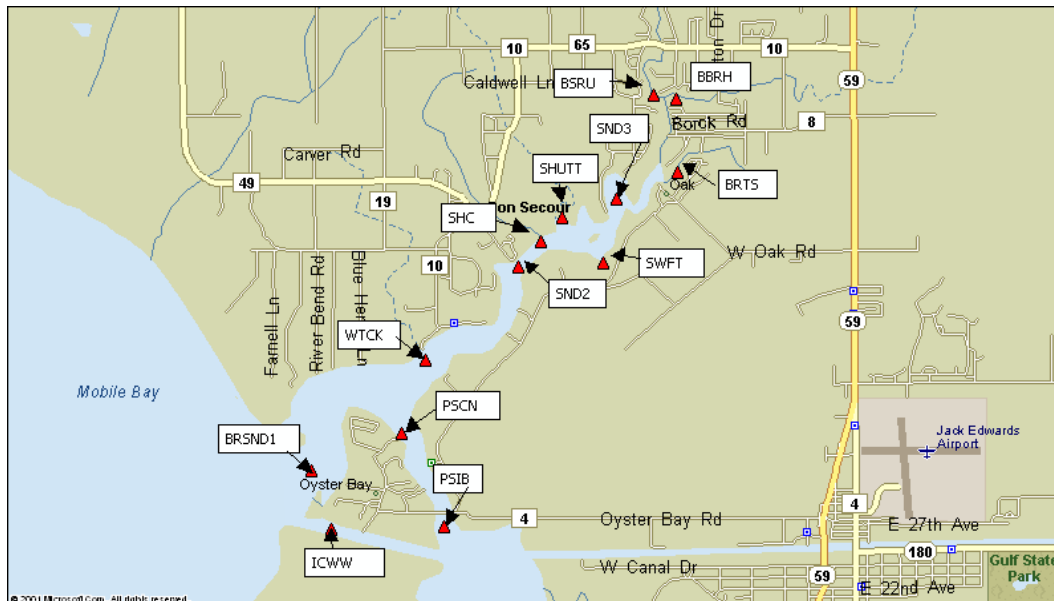


Figure 5. Map of sampling locations.

Station ID	Location Description	Latitude	Longitude
BRSND1	Mouth of Bon Secour River	30.2879	-87.7513
PSCN	Canal on Plash Island	30.2919	-87.7399
PSIB	Plash Island Bridge (South Fork)	30.2818	-87.7345
WTCK	Mouth of Witt Creek	30.2998	-87.7369
SHC	Mouth of School House Creek	30.3128	-87.7225
SHUTT	Mouth of Shutt Creek	30.3154	-87.7198
BSRU	Upper Reach of Bon Secour River	30.3287	-87.7082
BBRH	Mouth of Boggy Branch	30.3282	-87.7054
BRTS	Mouth of Brights Creek	30.3188	-87.7064
SWFT	Marsh near Swifts Landing	30.3105	-87.7146
SND2	Deployed Sonde #2	30.3099	-87.7255
SND3	Deployed Sonde #3	30.3229	-87.7071
ICWW	Mouth of ICWW	30.2815	-87.7487

Table 2. Bon Secour Sampling Stations.

### *Hydrologic Flow and Modeling*

Hydrologic flow data was collected at select sites to determine fresh water input and tidal exchange. A boat-mounted Acoustic Doppler Current Profiler (ADCP) was used to collect flow data during the study (see Figures 6 & 7). The flow data, along with in-situ data and samples collected from various media will be entered into a water quality model developed by the USEPA and a hydrologic model developed by Tetra Tech.



Figure 6. Boat mounted ADCP.



Figure 7. ADCP with custom mount.

Tetra Tech, Inc. was contracted in 2001 to develop a system of models for the entire Mobile Bay System in collaboration with USEPA. The models include a hydrologic and water quality model of the watershed that projects the flows and nutrient loads to the lower estuarine portion of the system, and a receiving water and water quality model for Mobile Bay.

Tetra Tech and EPA have utilized the Hydrologic Simulation Program in Fortran (HSPF) based watershed model, Loading Simulation Program in C++ (LSPC) for watershed simulation and the Environmental Fluid Dynamics Code (EFDC) and the Water Quality Analysis and Simulation Program (WASP) for three-dimensional dynamic flow and water quality simulations of Mobile Bay, respectively (See Figure 15). Once completed, the bay model can be employed to develop TMDLs and wasteload allocations for Mobile Bay. The model considers the effects of wind-driven residual transport, salinity intrusion, loadings and oxygen uptake from adjacent salt marshes, sediment oxygen demand, primary productivity, and point source discharge from municipal and industrial permits.

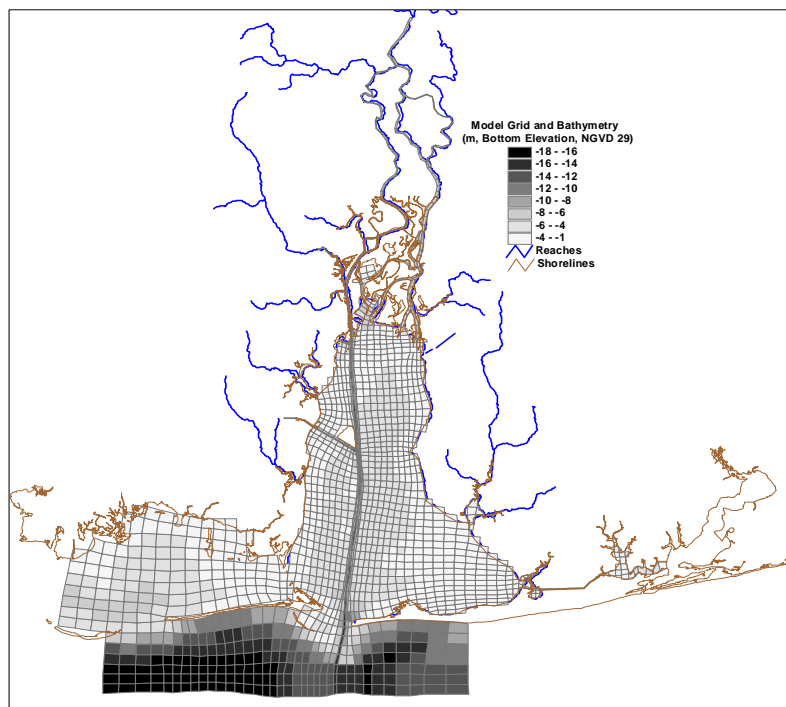


Figure 8. Tetra Tech Mobile Bay Model Grid.

### Geographical Information

The Mobile Bay and its estuaries are connected to the Gulf of Mexico and Mississippi Sound. The Mobile Bay watershed covers approximately 43,630 square miles including fresh water inputs. Mobile Bay experiences daily tidal exchanges with the Gulf of Mexico and Mississippi Sound. Waterbodies that have an open connection to the Mobile Bay estuary and meet the definition of an estuary are called sub-estuaries.

Nearly all of the Bon Secour River/Intracoastal Waterway/Oyster Bay Sub-Estuary lies within the Coastal Lowlands subdivision of the East Gulf Coastal Plain. The uppermost portion of the sub-estuary reaches the City of Foley. The surrounding topography of the sub-estuary is generally flat with gently undulating plains and little relative surface relief.

The Bon Secour River/Intracoastal Waterway/Oyster Bay Sub-Estuary is located on the eastern shore of Bon Secour Bay. Bon Secour Bay comprises the southeastern part of Mobile Bay. The Bon Secour sub-estuary proper is a shallow (with dredged channel), semi-enclosed coastal waterbody with an open connection to Bon Secour Bay (Mobile Bay), freshwater inputs from a tidal river and tributaries, and a natural connection to Oyster Bay that has been modified by the ICWW. Bon Secour is also connected to Wolf and Perdido Bays to the east via the ICWW.



### *Hydrologic Modifications*

Oyster Bay's only connection to open water (Bon Secour Bay) was via the South Fork of the Bon Secour River. Early explorers noted that Oyster Bay had a previous connection to another waterbody when an abandoned "long ditch" was discovered from Oyster Bay to Little Lagoon. This modification was presumably made by Native Americans for the purpose of crop irrigation (Chaudron 1902).

During the early part of the 20<sup>th</sup> Century, the advent of the Gulf Intracoastal Waterway (ICWW) provided another connection. The Perdido Bay to Mobile Bay (Bon Secour Bay) portion of the ICWW originally passed through the South Fork and into Bon Secour River. Later, the ICWW bypassed the South Fork and passed straight through to Mobile Bay. This created "Plash Island" and gave Oyster Bay a connection to Mobile Bay via the ICWW.

Figure 9 details hydrologic modifications in Bon Secour River as authorized by Section 107 of the River and Harbor Act of 14 July 1960. A dredge was performing maintenance on the channel during August 2005 during the study.





### *Climate*

The coastal region of Alabama is characterized by a humid subtropical climate with mild winters and warm summers. Average annual precipitation is 68.1 inches. Tropical cyclones or hurricanes are frequent in the Gulf of Mexico and landfall areas can experience wind damage and flooding that can alter shoreline and bathymetry.

### *Land Use*

Land use changes have increased in the sub-estuary; most recently are several developments along the north and south banks of the ICWW. Marinas, residential condominiums, and retail shops are either planned or are in various stages of construction along the ICWW. The Baldwin County Planning and Zoning Department has projected a growth rate for South Baldwin County at 87.73% by 2020 (See Figure 10). Figures 11 and 12 depict land uses that could potential impact the sub-estuary.

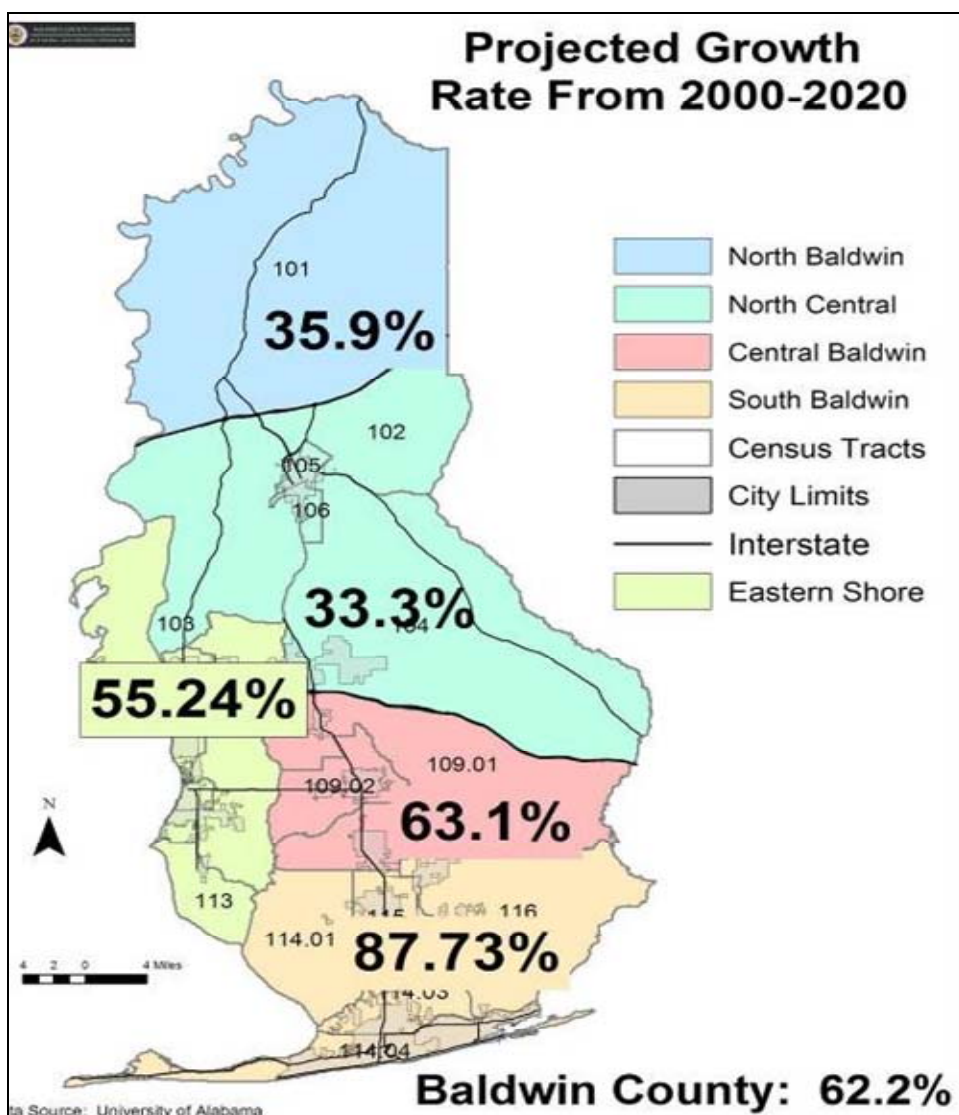


Figure 10. Baldwin County Projected Growth 2000-2020.





Figure 11. Grassed stormwater conveyance near Bon Secour River's source.



Figure12. Storm water drainage from Foley, Alabama.

### *Tidal Discharge*

Mobile Bay has a diurnal tidal cycle with one high and one low tide in a 24 hour period and two high and two low tides during neap tides and spring tides. With tidal in flow and out flow from the mouth of Mobile Bay (from the Gulf of Mexico) and the ICWW, Bon Secour Bay may experience tidal ranges greater than that of Mobile Bay due to sustained winds from the north, northwest, or west.

### *Point Source Discharges*

ADEM regulates point source discharges with 2 program types: National Pollution Discharge Elimination System (NPDES) and State Indirect Discharge (SID). Facilities with these permits must provide their own monitoring records or Discharge Monitoring Reports (DMRs) and subject to ADEM Compliance Sampling Inspections (CSIs). There are 5 permitted facilities in the sub-estuary. None of the 5 were in violation of their discharge permit requirements during the study:

Aquila Seafood	AL0002321
Billy's Seafood	AL0068497
Bon Secour Fisheries	AL0003298
Carson & Company	AL0048164
Shutt's Safe Harbour	AL00949638

There is only 1 permitted shipbuilding and repair facility in the sub-estuary, M & N of Alabama, Inc. ALG03-0061. During the study, no discharge violations were noted. Permitted facilities were not targeted but sample locations were positioned both upstream and downstream of discharge points to insure their impacts would be measured in the study.

### Results and discussion

While measuring flows, negative discharge data was recorded. This negative or incoming flow is caused by tidal hydraulics. Similar hydraulics were documented in a tidal study on the Jourdan and Pascagoula River estuary in Mississippi where ADCPs recorded flow reversal beginning near the bottom of the river. Freshwater is less dense than saltwater and will usually flow over the denser saltwater. Surface water continued to flow downstream until the force of the rising tide completely reversed all flow (Floyd, 1997).

The US Geologic Survey (USGS) and ADEM have conducted a set of 12 hour flow measurements for differing tidal conditions on the ICWW. This data will be incorporated into the ICWW portion of the bay model. Both the Neap-Tide and Spring-Tide events were monitored using 3 research vessels with ADCP flow meters. The R/V Tensaw was stationed at the western end of ICWW near Mobile Bay.

The R/V Perdido was stationed near the HWY 59 Bridge. The USGS vessel was stationed at the eastern end of the ICWW near Wolf Bay. Maximum flows for the neap tide study were in the 3,000 cfs range; 5,500 cfs for the spring tide study.

### *Water Quality*

With the exception of School House Creek and ICWW, it was observed that all of the sampled tributaries to Bon Secour River and sampling locations on the river had values which occasionally exceeded ADEM water quality criteria. The determination of whether these waterbodies are supporting their designated uses is made during the 303(d) list development or process.

Based on National Coastal Assessment water quality index, approximately half of the lower portion of Bon Secour River/Intracoastal Waterway/Oyster Bay Sub-Estuary is “Fair” while the upper half is “Poor”. (See Figure 21).

***Bottom Dissolved Oxygen*** Bottom Dissolved Oxygen (DO) concentrations were rated as “Good” for all stations. Bottom DO is usually lower than surface and mid-depth DO in coastal waters. However, DO >5 mg/l were observed along the vertical profiles (surface to bottom) at every station. Deployed data sonds (suspended at the expected mid-depth) at times recorded DO concentrations <5mg/l. These observations were made in conjunction with low water level and the datasond’s temporary submersion into bottom substrate.

***Total Nitrogen*** Total nitrogen concentrations divided Bon Secour River with 30.7% of the sites rated as “Fair” (in the lower portion), and 61.5% of the sites rated as “Poor” (in the upper portion), ICWW was rated as “Good” (7.8% of the sites).

***Total Phosphorus*** Total Phosphorous concentrations were rated as “Good” at each sampling location except Witt Creek which was rated as “Fair”.

***Chlorophyll-a*** Chlorophyll-a concentrations were “Poor” at every sampling location except ICWW, which was “Fair”. Concentrations were higher than expected but upon review, high chlorophyll-a results were observed at adjoining waterbodies. John Lehrter in his study of nutrient loads to tidal river estuarine systems observed high chlorophyll-a concentrations in conjunction with relatively low nitrogen and phosphorus concentrations. A possible explanation was longer than normal residence time and resuspension of phytoplankton. The measured tidal flows discussed earlier could provide insight into the aforementioned residence times and resuspension.

***Water Clarity*** Water Clarity was rated as “Good” at all sampling locations and is an indication that chlorophyll-a is not significantly reducing water clarity.

### *Sediment Contaminants*

While there were ERL exceedances for metals, no location exceeded the criterion (<5 ERL), and none of the locations had an ERM exceedance. Also, no location had an exceedance of PAHs or Pesticides. Thus, each site received a “Good” rating for Sediment Contaminants and a “Good” rating for the overall Sediment Contaminants by Estuary or Region Criteria. See Table 3. Figures 13 and 14 are a graphic representation of the findings.

Station	Bottom DO	Assessment	TN	Assessment	TP	Assessment	Chlor-a	Assessment	H2O Clarity	Assessment	WQIndex	Sediment
BRSND1	6.518		0.0296		0.11		22		1.95		Fair	Good
ICWW	6.74		0.0203		0.07		19.2		0.79		Good	Good
PSCN	6.345		0.038		0.77		23		1.08		Fair	Good
PSIB	7.23		0.029		0.07		35		0.495		Fair	Good
WTCK	6.6		0.0287		0.48		28		0.42		Fair	Good
SND2	5.45		0.133		0.13		37		0.92		Fair	Good
SHUTT	8.27		0.2		0.09		37		0.42		Fair	Good
SHC	7.48		0.278		0.1		30		1.35		Fair	Good
SWFT	7.05		0.147		0.13		66		1.41		Poor	Good
SND3	5.86		0.3156		0.12		46		0.45		Poor	Good
BRTS	7.115		0.353		0.12		76.5		0.3775		Poor	Good
BBRH	7.04		0.584		0.1		50		0.47		Poor	Good
BSRU	7.26		0.782		0.13		41		0.67		Poor	Good

Table 3. NCA Water Quality Index.

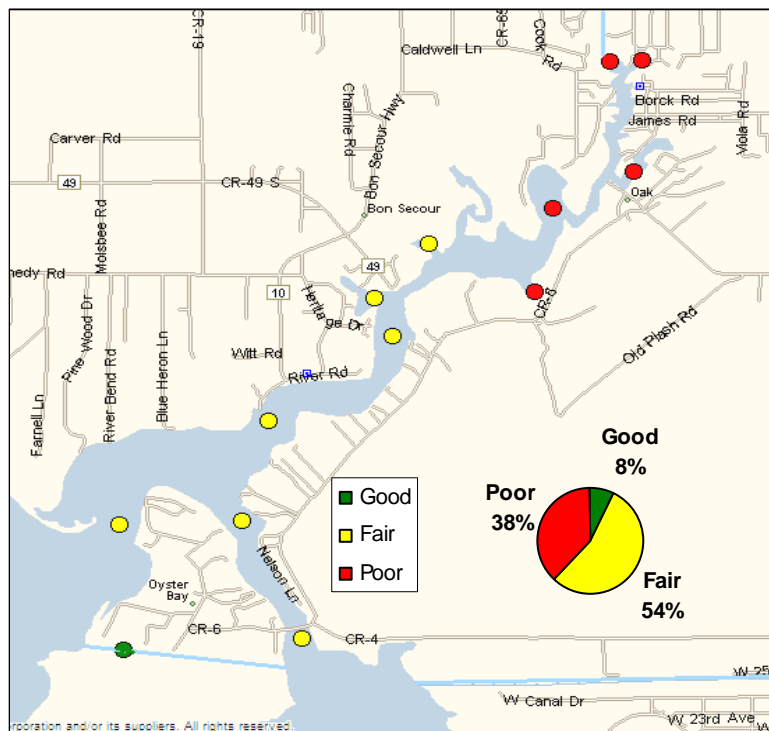


Figure 13. Water Quality Index.

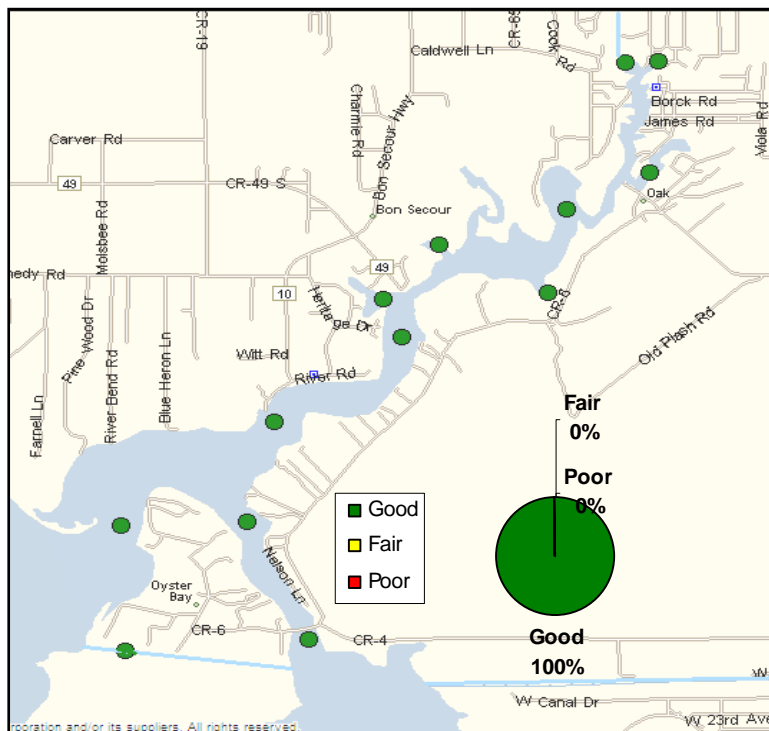


Figure 14. Sediment Quality Index

### Atmospheric Input

Data compiled by the National Atmospheric Deposition Program and Mercury Deposition Network in 2005 supports the incidence of atmospheric deposition and loading of mercury (Hg) to the sub-estuary (see Figure 21). Atmospheric mercury deposition in Mobile Bay is among the highest values measured in the country. This may, in large part, be the result of the abundant rainfall that this area receives.

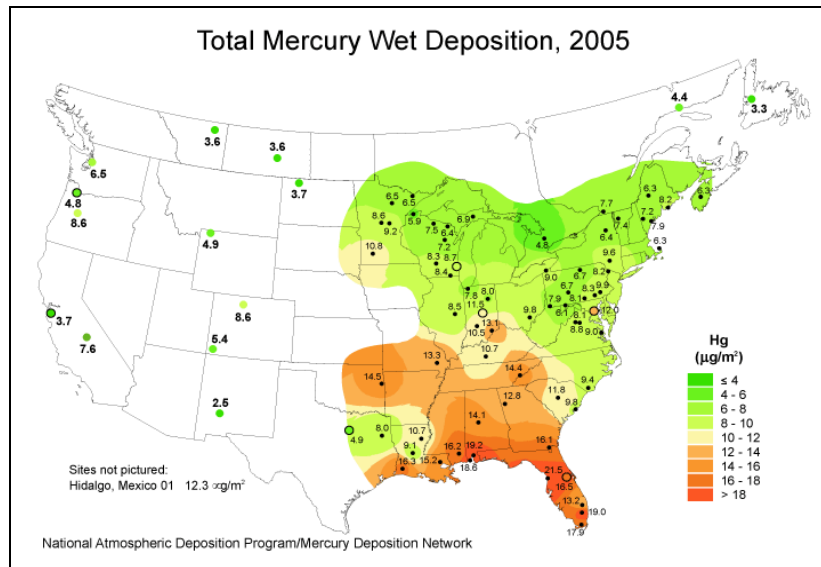


Figure 15. Total Mercury Wet Deposition for 2005.

### Fish Tissue Monitoring

Portions of Bon Secour Bay and Bon Secour River are on the draft 2008 §303(d) List. Cause of impairment for the bay is shellfish bed closures by the Alabama Department of Public Health (ADPH) as a result of pathogens. Cause of impairment for the river is mercury (Hg) as a result of atmospheric deposition. Atmospheric deposition is believed to be the source of impairment for the river based on fish tissue data collected in 2005 (see figure 21 and 22), which resulted in a “No Consumption” Advisory for Large Mouth Bass (*Micropterus Salmoides*), within the vicinity of County Road 10 bridge as issued by the ADPH. Draft TMDL dates for the bay and river are 2008 and 2013, respectively.

A No Consumption Advisory issued for any species is interpreted to mean that the fish sampled have been analyzed to show the presence of a contaminant in excess of FDA advisory levels. Consumption of any fish of this type from a specific waterbody may place the consumer at risk for harm from the contaminant. If an advisory had been issued for largemouth bass and not for channel catfish or black crappie, it would be advised that individuals should eat no largemouth bass, but consumption of channel catfish or black crappie is permissible without endangering health.



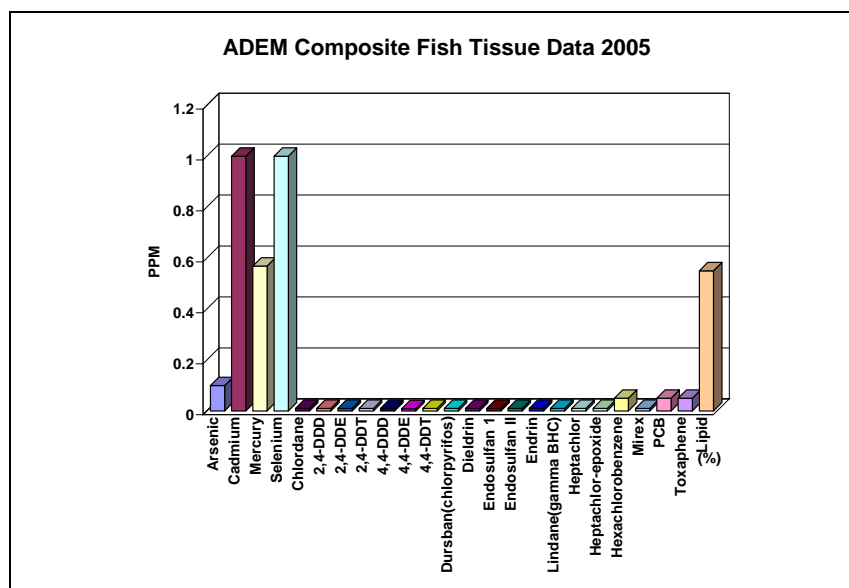


Figure16. ADEM Composite Fish Tissue Data 2005 for Large Mouth Bass at BSR-1.

## Conclusion

With the exception of School House Creek and Gulf Intracoastal Waterway (ICWW) it was observed that all of the sampled tributaries to Bon Secour River and sampling locations on the river had values that failed to meet ADEM water quality criteria. Based on National Coastal Assessment water quality index, the lower half of Bon Secour River/Intracoastal Waterway/Oyster Bay Sub-Estuary is “Fair” while the upper half is “Poor”.

Based on nitrogen and chlorophyll data, nutrient loadings to the sub-estuary appears to be moderate to high. Phosphorous does not appear to be a factor. Of the 13 sampling stations, eight exceeded the NCA “Poor” threshold for nitrogen for a poor rating of 61.5% (based on number of stations). Twelve exceeded the NCA “Poor” threshold for chlorophyll for a 92% poor rating. None of the stations exceeded the poor threshold for phosphorus.

John Lehrter in his study of nutrient loads to tidal river estuarine systems of Mobile Bay observed high chlorophyll-a concentrations in conjunction with relatively low nitrogen and phosphorus concentrations. A possible explanation was longer than normal residence time and resuspension of phytoplankton.

While there were ERL exceedances for sediment metals, no location exceeded the criterion ( $<5$  ERL), and none of the locations had an ERM exceedance. Also, no location had an exceedance of PAHs or Pesticides. Thus, each site received a “Good” for Sediment Contaminants and a “Good” for the overall Sediment Contaminants by Estuary or Region Criteria.

Further, ADEM is an active partner with the Gulf of Mexico Alliance (GOMA), and is currently participating in research with GOMA and other states to develop consistent guidelines and standards for the Gulf region. ADEM is continually monitoring Coastal Long-Term Trend Stations (see Figure 17). ADEM and the MBNEP are also working together on other programs in the Mobile Bay area.

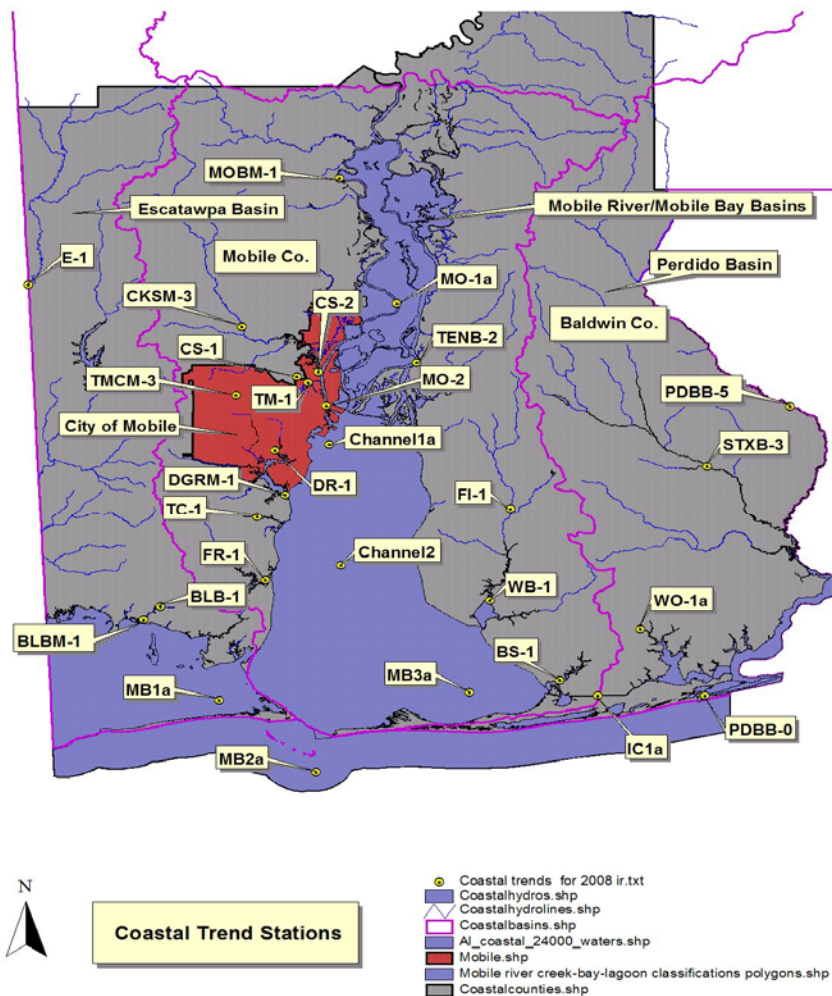


Figure 17. Coastal Long-Term Trend Stations.

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### **Policy of Non-discrimination**

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