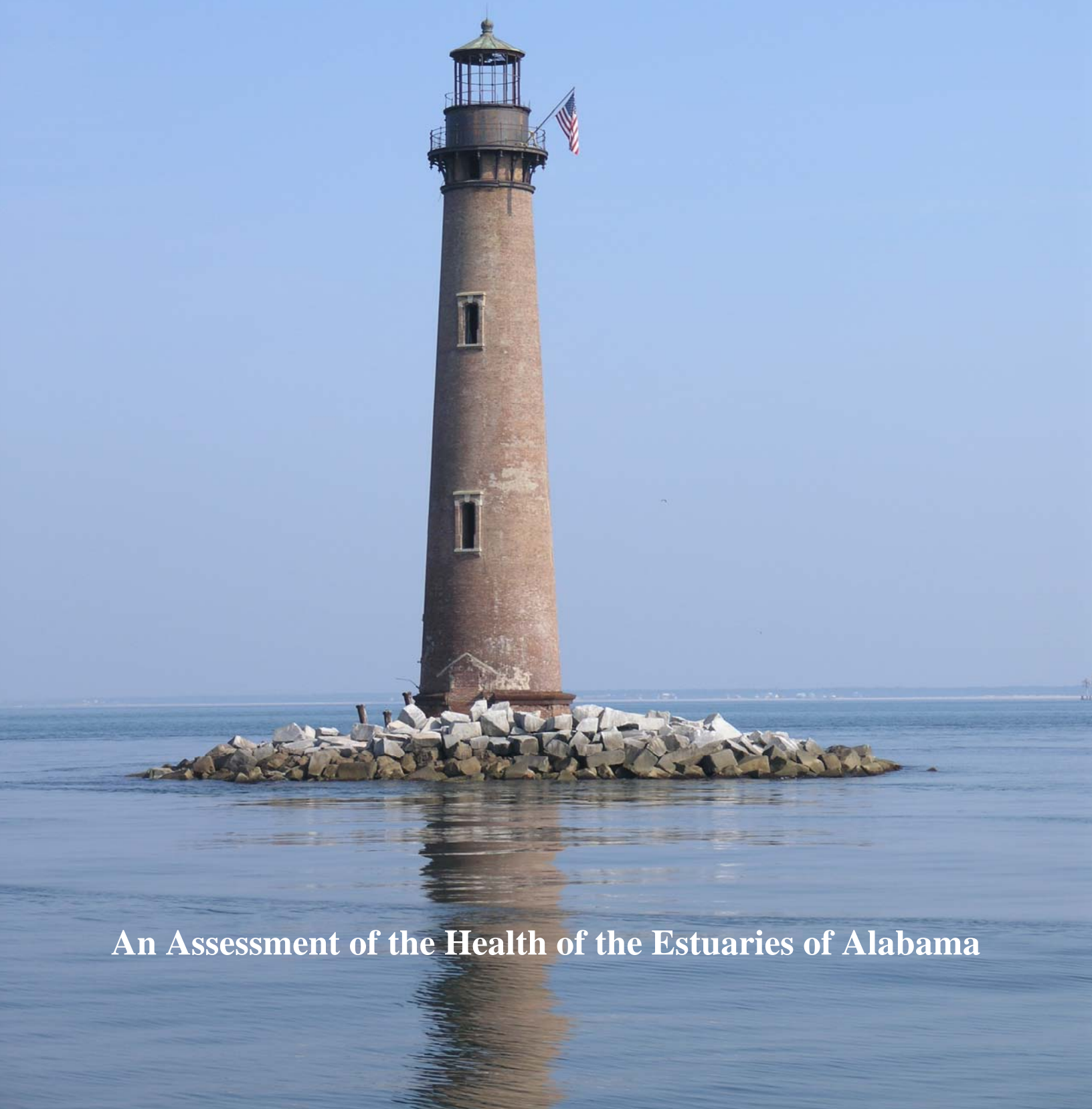




Alabama Department of
Environmental
Management

Field Operations Division
Mobile Field Office
Mobile, Alabama

National Coastal Assessment Alabama 2000-2004



An Assessment of the Health of the Estuaries of Alabama

Although the data described in this article have been funded wholly or in part by the U. S. Environmental Protection Agency through its NCA Program, it has not been subjected to Agency review, and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

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Cover photograph: Sand Island Light House, Alabama, taken by Leslie Hartman, ADCNR-MRD, June 1, 2006.

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The National Coastal Assessment Alabama 2000-2004

Final Report

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1 Introduction

Alabama estuaries cover an area of 610 square miles, including Mobile Bay, the fourth largest estuary on the North American continent. Mobile Bay drains a watershed of approximately 43,662 square miles, receiving an average of 460,000 gallons per second of freshwater.

The U.S. EPA's National Coastal Assessment (NCA) is a multi-year partnership with EPA's Office of Research and Development (ORD), EPA's Regional office, all coastal states, and selected territories. Alabama entered the program in 2000 and sampled through 2004. Samples were collected to determine water quality, sediment quality, and biota at fifty sampling locations, each to be revisited on a yearly basis. The NCA program is based on EPA's Environmental Monitoring and Assessment Program (EMAP), using a compatible probabilistic program and a common set of environmental indicators to survey each state's estuaries and assess their condition. These estimates can then be aggregated to assess conditions at EPA's regional, biogeographical, and national levels.

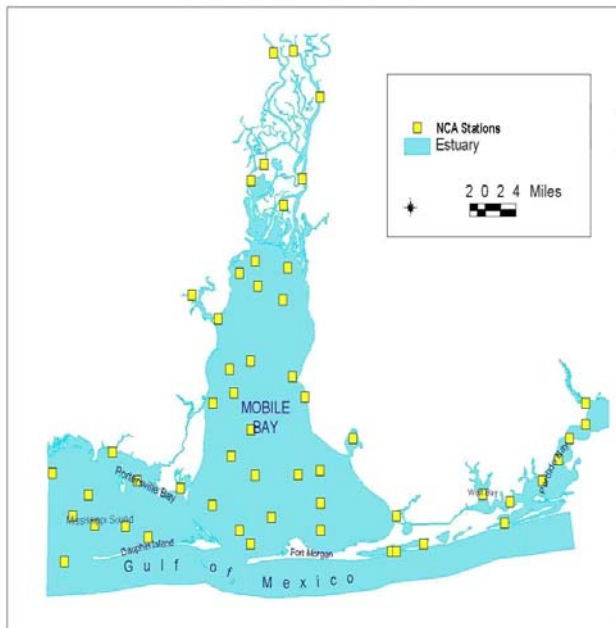


Figure 1-1 The estuaries of Alabama

1.1 Spatial Configuration

The goal of NCA is to make statistically unbiased estimates of ecological condition with known confidence. To approach this goal, a probabilistic sampling framework was established among the overall estuarine areas along the Alabama coast. Under this design, each sampling point is a statistically valid probability sample. Thus, percentages of estuarine area with values of selected indicators differing from established environmental guidelines can be estimated based on the conditions observed at the individual sampling locations. Statistical confidence intervals around these estimates also can be calculated. Moreover, these estimates can be combined with estimates from other states or regions that were sampled in a consistent manner to yield national estimates of estuarine condition.

Alabama's sampling design for the base sites consisted of partitioning the estuaries and rivers of the coastal area into hexagonal quadrates. Each hexagon covered 55.2 square kilometers and the grid was placed randomly over a map of the estuaries of the State of Alabama. Computer iterations were then performed to randomly select at least one site in each quadrate. This was repeated until all sampling locations were at a water location (some quadrates were only partially over the water).

Under the sampling design, the sites are fixed and were resampled each year. A 0.05 nautical mile proximity standard (0.02 nautical mile recommended), was required to ensure that samples were collected as close as possible to the planned station location. If the sampling event could not take place within 0.05 nautical miles (due to inadequate depth, safety concerns, etc.), an attempt was made to move the station to the nearest accessible point in a random direction within the estuary. When a station was moved, the State Manager was notified of the new location and the reason for its relocation. If a new location could not be found, the estuary was classified as unsampleable. GPS coordinates recorded in the field were compared to proposed station coordinates to assure that sample collection occurred within an acceptable distance of the proposed station location. Field site

audits were conducted during sampling seasons by the QA officer to determine compliance with the Quality Assurance Plan and Field Operations Manual.

1.2 Temporal Considerations

The sampling period for NCA was based on the EMAP-Estuary sampling effort. It was determined that if sampling was to take place only once per year, the ideal time to sample would be during the time frame in which the community structure is most stressed. Hypoxia is at its highest and the benthic community the most active during late summer. Therefore the index period was established to be July through mid-September.

2 Field Methods

2.1 Quality Assurance

The Alabama Department of Environmental Management (ADEM) followed EPA's National Coastal Assessment Coastal 2000 Quality Assurance Project Plan – 2000 (QAPP) and the National Coastal Assessment Quality Assurance Project Plan 2001-2004, U.S. EPA. 2001, for all sampling and data management activities related to NCA.

2.2 Water Column

The Water Quality Vertical Profile data sets are summaries of the physio-chemical properties of the water at a station at the time of sampling. All water quality samples were collected prior to sediment and fish tissue collections to avoid contamination of samples.

Dissolved Oxygen (mg/l), Temperature (C), pH, Salinity (ppt), Specific Conductance (uS/cm @ 25C), and Depth (m) were measured with a Sonde and Scout2 water quality data system manufactured by Hydrolab Corporation (2000-2002), and a 650MDS and 600QS manufactured by YSI Corporation (2003-2004). Light penetration was measured using a LI-1400 data logger manufactured by LI-COR. Secchi depth was also recorded. Observations were recorded vertically through the water column at the following intervals:

Shallow sites (< 2 m) – every 0.5-m interval
Typical depths (>2 <10m) – every 1-m interval and at 1.5m
Deep sites (>10 m) – every 1-m interval to 10m and then at 5-m intervals, thereafter, to near bottom, including 1.5m.

Two profiles were recorded at each station, one on the downcast (stopping for observations while lowering), and one on the upcast (stopping for observations while raising the instrument back to the surface).

The Water Chemistry results are summaries of the chemical properties of the water at a station at the time of sampling. A Kemmerer bottle was used to collect water samples from 0.5m below surface, mid column, and 0.5m above bottom. At the surface, samples were collected for Total Suspended Solids (TSS), Fecal Coliform, Chlorophyll A (field filtered), {Nitrite, Nitrate-Nitrite, Ammonia, and Ortho-Phosphate} - frozen. At mid-column, samples were collected for TSS, Total Dissolved Solids (TDS), Turbidity, Chlorophyll A (field filtered), Chlorophyll A (Lab filtered), {Nitrite, Nitrate-Nitrite, Ammonia, Ortho-Phosphate, Total Phosphate} –frozen, {nitrate-Nitrite, Ammonia, Total Kjeldahl Nitrogen, Total Phosphate} – H2SO4 preserved. At near bottom, samples were collected for TSS, Chlorophyll A (field filtered), {Nitrite, Nitrate-Nitrite, Ammonia, Ortho-Phosphate} – frozen.

2.3 Sediment and Benthic Community Collection

A 229 by 229mm stainless steel modified Ponar Grab was used to collect sediments. This grab sampled an area of 0.052m² and had a maximum depth of penetration in the sediment of 152 mm. A successful grab had relatively level, intact sediment over the entire area of the grab and a sediment depth of at least 7-10 centimeters. Unacceptable grabs included those containing no sediments, which were partially filled or had shelly substrates or grossly slumped surfaces. Grabs completely filled to the top, where the sediment was oozing out of the hinged top, were also unacceptable. Stainless steel utensils were used to remove the top 2-3 cm of sediment from a grab. The sediment was removed to a stainless steel bowl and placed in a cooler of ice to remain cold, but unfrozen. The grab sampler was rinsed with site water and re-deployed. This procedure

was repeated until the volume of sediment required for all contaminant, toxicity, and sediment characteristics analyses had been collected. The sediment was mixed with a stainless steel spoon until thoroughly homogenized, and aliquots were placed immediately into pre-cleaned glass jars (for organics and metals) or plastic containers (sediment toxicity and Total Organic Carbon (TOC)). The samples were immediately stored on ice following collection.

Analysis of TOC samples was performed at EPA-Gulf Breeze, FL for 2000, in subsequent years TOC samples were analyzed at Severn Trent Labs (Mobile, AL), all remaining contaminants were tested by ADEM. A total of 15 inorganic metals, 25 polynuclear aromatic hydrocarbons (PAHs), 21 polychlorinated biphenyls (PCBs), 22 pesticides, and TOC concentrations were measured at each of the stations sampled in Alabama for 2000-2004.

Sediment characteristics such as grain size and percent solids can have significant effects on the distribution of benthic species and on the concentrations and bioavailability of sediment associated contaminants. Higher percentages of sand, for example, may provide a greater number of microhabitats for interstitial species to exist and could increase sediment permeability allowing greater exchange of oxygen and nutrients at depth in the sediment (Hyland et al. 1991, Weston 1988). Finer substrates though, would have a greater concentration of organic matter allowing for a greater food supply for benthic organisms. Grain size was measured for NCA and reported as percent solids. Analysis was performed by ADEM using method SW 846 (160.3).

The standard 10-day sediment bioassay with the marine amphipod *Ampelisca abdita* (ASTM 1993) has been used to assess sediment toxicity in previous EMAP projects. *A. abdita* has been chosen by the EPA as the standard test organism for NCA. Stations were represented by one toxicity sample per station and were not replicated at field duplicate stations. Procedures followed the general guidelines provided by EMAP-E Laboratory Methods Manual (U.S. EPA 1995). This is an acute toxicity test, which measures the effect of sediment exposure on amphipod survival under static conditions. Approximately 4 L of surface sediments

(composite of upper 2-3 cm from multiple grabs) were collected for the assay from each station and stored in polyethylene jars at 4°C in the dark until testing. Tests were conducted with subsamples of the same sediment on which analyses of contaminants and other sediment characteristics were performed. Field samples were considered to be significantly toxic if mean survival in comparison to the corresponding negative control was < 80%.

A single benthic grab was collected at each station using a 0.052-m² modified Ponar grab sampler. Benthic grab characteristics were noted as quality, substrate type, and odor. Samples were then live-sieved with a 0.5-mm mesh screen. Material retained on the screen was placed in Nalgene containers, fixed in 10% buffered formalin with rose bengal (to facilitate subsequent sorting), and transferred to the laboratory for taxonomic identification and enumeration. Once samples were received in the laboratory, they were transferred from formalin to 70% alcohol. Samples were then processed to characterize the infaunal assemblages based on currently accepted practices in benthic ecology (e.g., Holme and McIntyre 1971) and on specific protocols described in the EMAP-E Lab Methods Manual (U.S. EPA 1995). Animals were sorted from sample debris under a dissection microscope. Sorted specimens were identified to the lowest possible taxon, i.e. the species level wherever possible.

2.4 Fish Tissue Collection

Samples of fishes and invertebrates were collected at each station with a 4.9-m otter trawl with 2.5 cm mesh wings and a 0.5cm liner in cod end towed against the current where possible. Tow duration was 10 minutes and speed was approximately 2-3 knots. Specimens to be analyzed for contaminants were immediately wrapped in clean aluminum foil, sealed in plastic storage bags, and placed on ice in the field. Samples were then frozen upon return to the lab. Sites 02 and 49 were not sampled for fish tissue each year due to obstructions in the water likely to cause vessel damage and gear loss. Sites 26 through 32 were sampled by electro shocking due to their being located in the Mobile River Delta. A minimum of five specimens per species was desired for a composite sample. Wherever possible, animals of similar sizes were used to

generate the sample composites. Target animals were identified as shrimp and drum species, with others used as necessary. All specimens were measured to the nearest millimeter total length, and examined for pathological abnormalities. Whole fish were used to make the composite sample (except 2004, where fish tissue carcasses and filets were tested separately). All contaminant analyses were performed by ADEM labs. A total of 13 inorganic metals, 25 polynuclear aromatic hydrocarbons (PAHs), 21 polychlorinated biphenyls (PCBs), and 22 pesticides were measured in each of the composite samples.

2.5 Field Observations

Once on station, observations were made characterizing the habitat. Sample date as well as arrival and departure time was recorded. Distance between anchorage and location entered into GPS was recorded to determine precision of navigational technique. Crew as well as weather conditions (skies, seas, wind direction and speed, and air temperature) were also recorded for each site. Habitat/water body type as well as submerged aquatic vegetation (SAV) and presence of marine debris were documented. Observations were also made characterizing the benthic sediment sample. Grab quality, substrate type and odor of sediment were recorded.

3 Discussion

Alabama was assigned fifty fixed stations to sample each year from 2000-2004 for a total of 250 site visits over 5 years. All stations were visited during this time. Stations were located using GPS and 94% were within 0.05 nautical miles of the chosen site. Those sites where sampling was performed outside of 0.05nm were due to proximity to land. Fish tissue trawls were performed at 96% of the stations. Unavoidable snags resulted in two stations not being trawled during the program. Of the 250 stations sampled in the program, target species were caught at 77.6% of the sites. Successful samples of water for nutrients were collected at all stations. Also, one hundred percent of the stations had successful sediment and benthic samples taken.

Results were reported in a file-maker program for in-situ data and excel spreadsheets for water, sediment, fish tissue, and benthic collections.

The average depth of stations was 3.4m and ranged from 0.3-14.2m, and the average Secchi depth was 0.9m.

The reference conditions used to determine condition in the estuaries of Alabama were obtained from the National Coastal Condition Report II - NCCRII, (U.S. EPA 2004). This system uses a stop light configuration to show visually whether a system is rated good, fair, or poor.

4 Results

4.1 Nutrients

Nutrient supply to coastal waters is a problem that affects estuaries as well as local communities. Nutrients affect aquatic ecosystems by causing eutrophication; the over-enrichment of the water column causing the overgrowth of algae. During an algal bloom, algae may produce excess amounts of oxygen during daylight hours and consume oxygen at night. When the excess nutrients that caused the bloom are gone, the algae die. Bacterial decomposition will consume available oxygen, lowering dissolved oxygen levels which, if the levels drop enough, will stress or kill fish and benthic organisms.

Nitrogen

Nitrogen, a major nutrient comes from many sources, natural and anthropogenic. Natural sources include animal waste and breakdown of vegetation. Human sources are more varied and potentially more damaging. They include point sources such as sewage and industrial plants, as well as non-point sources such as applied artificial fertilizers, urban run-off, atmospheric deposition, and confined animal feeding operations. For NCA, dissolved inorganic nitrogen (DIN) was measured in the water column to determine nitrogen levels. DIN concentrations were rated good for Alabama for all years of NCA, surface to bottom. An analysis of nitrogen concentration is presented in Figure 4-1.

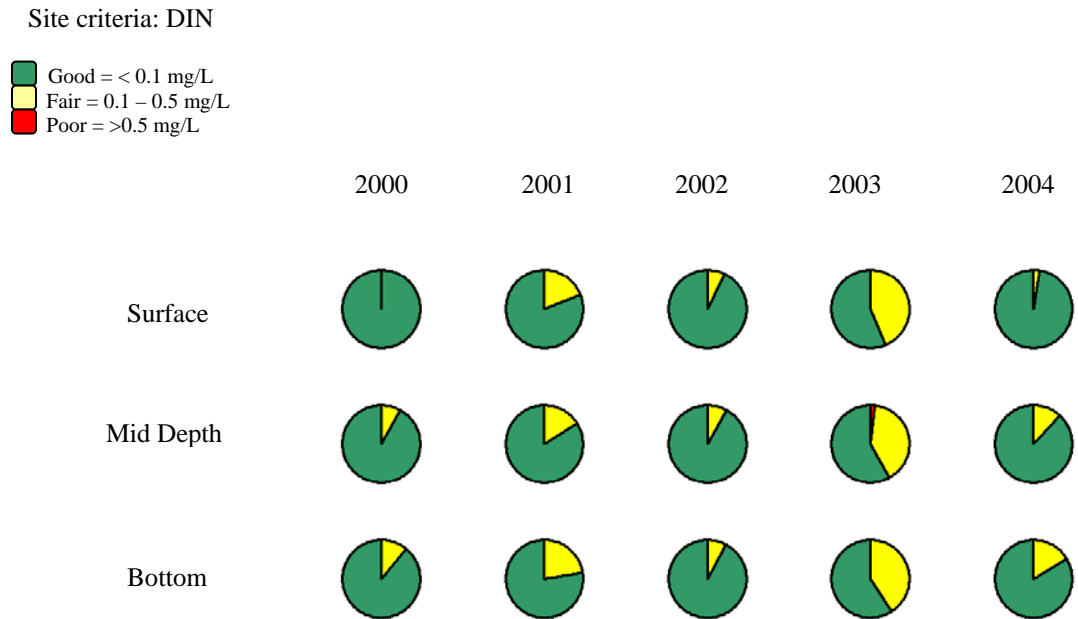


Figure 4-1 Dissolved Inorganic Nitrogen concentration in Alabama’s estuarine waters

Phosphorus

Another source of eutrophication, phosphorous is consumed by bacteria causing algal blooms in coastal waters, decreasing available oxygen for fish and benthic organisms. Phosphorous comes from many of the same sources as nitrogen, including urban run-off. A major source of phosphorous is fertilizer application; a significant amount of the phosphorous in fertilizer is lost due to run-off. Nearby creeks receive this phosphorous delivering it to

coastal estuaries. For NCA, Dissolved inorganic phosphorus (DIP) was measured to determine levels of phosphorus. Concentrations of DIP in Alabama’s waters were higher in 2000 and 2003. Dissolved inorganic phosphorus was rated good for Alabama for all years tested except 2000, where it was rated as fair. A comparison of DIP concentration is presented for Alabama’s coastal waters in Figure 4-2

Site criteria: DIP

■ Good = < 0.01 mg/L
■ Fair = 0.01 – 0.05 mg/L
■ Poor = >0.05 mg/L

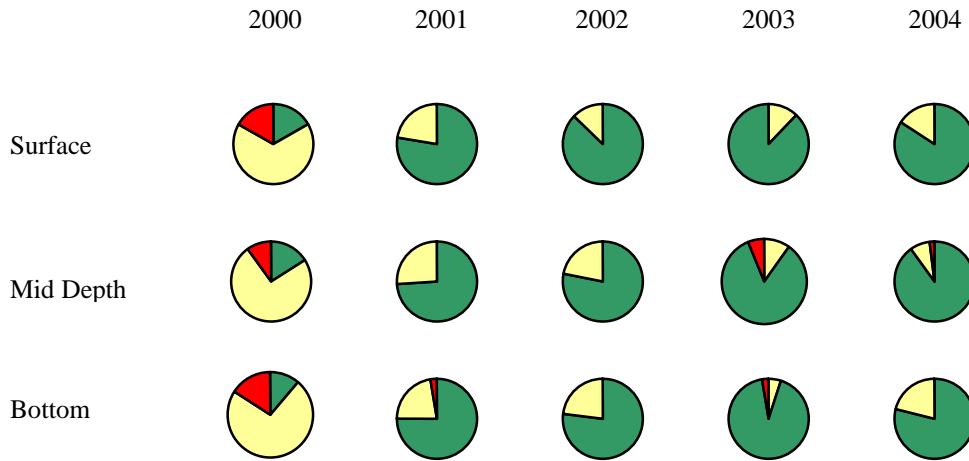


Figure 4-2 Dissolved Inorganic Phosphorus concentration in Alabama’s estuarine waters

4.2 Chlorophyll-a

Chlorophyll-a concentrations are measured to determine phytoplankton levels in the water column. High concentrations of phytoplankton may indicate an algal bloom, likely the result of high nutrient levels. Nutrient levels measured at the time of sampling may not be strongly correlated to the

presence of an algal bloom. This high level of phytoplankton may be the result of previously high levels of nutrients that have already dissipated. Chlorophyll-a was rated as fair for all years tested for NCA. A comparison of chlorophyll-a data is presented in Figure 4-3.

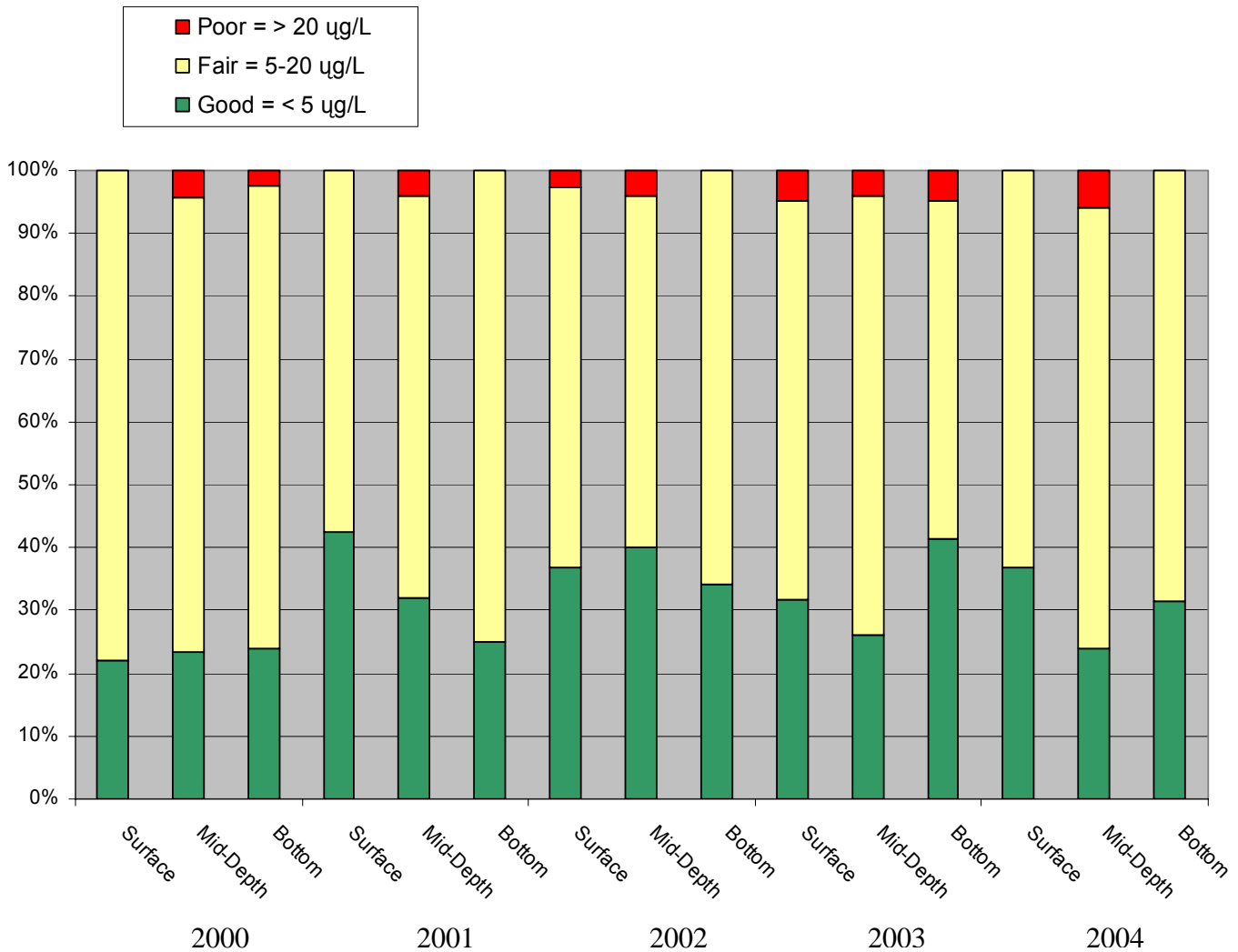


Figure 4-3 Concentration of Chlorophyll-a in Alabama’s estuarine waters

4.3 Water Clarity

Water clarity is essential for SAV beds as well as a valuable commodity for the tourism industry. Turbidity is an estimate of particulate matter in the water column and an indirect method for determining water clarity. High turbidity is not an indicator of poor water quality as estuaries are naturally turbid, but some areas can exceed an upper threshold of turbidity levels. Turbidity in the water column can be caused by various forms of suspended matter such as clay, silt, soluble organic matter, plankton, and other microscopic

organisms. Alabama’s estuaries carry a substantial load of this matter. Some turbidity is to be expected naturally and is not considered pollution; although non-point discharge may substantially increase this load. Water clarity can be measured with a light meter, which measures the light that reaches the surface of the water as well as the light that reaches a specific depth (light penetration). It can be measured using a Secchi disk which is an indirect measurement of sediment load and water clarity

through visibility of a disk in the water column. Water clarity can also be measured with turbidity measurements using nephelometric turbidity units (NTU). For NCA, ADEM used all three methods. For this report, light penetration at a standard depth of one meter was used to rate water clarity for each station. The following assessment of Alabama’s water clarity is based on the U.S. EPA’s approach for water clarity for NCA and is used as a reference. Light penetration of greater than ten percent was

considered good. Light penetration of five to ten percent was considered fair. And light penetration of less than five percent was considered poor. During the first three years of NCA and 2004, water clarity was rated good. Despite having more than 50% of the sites rated good, the water clarity in 2003 was rated as fair. This was due to 10% or greater of the sites for 2003 being rated as poor. The following diagram shows water clarity results for Alabama’s estuaries.

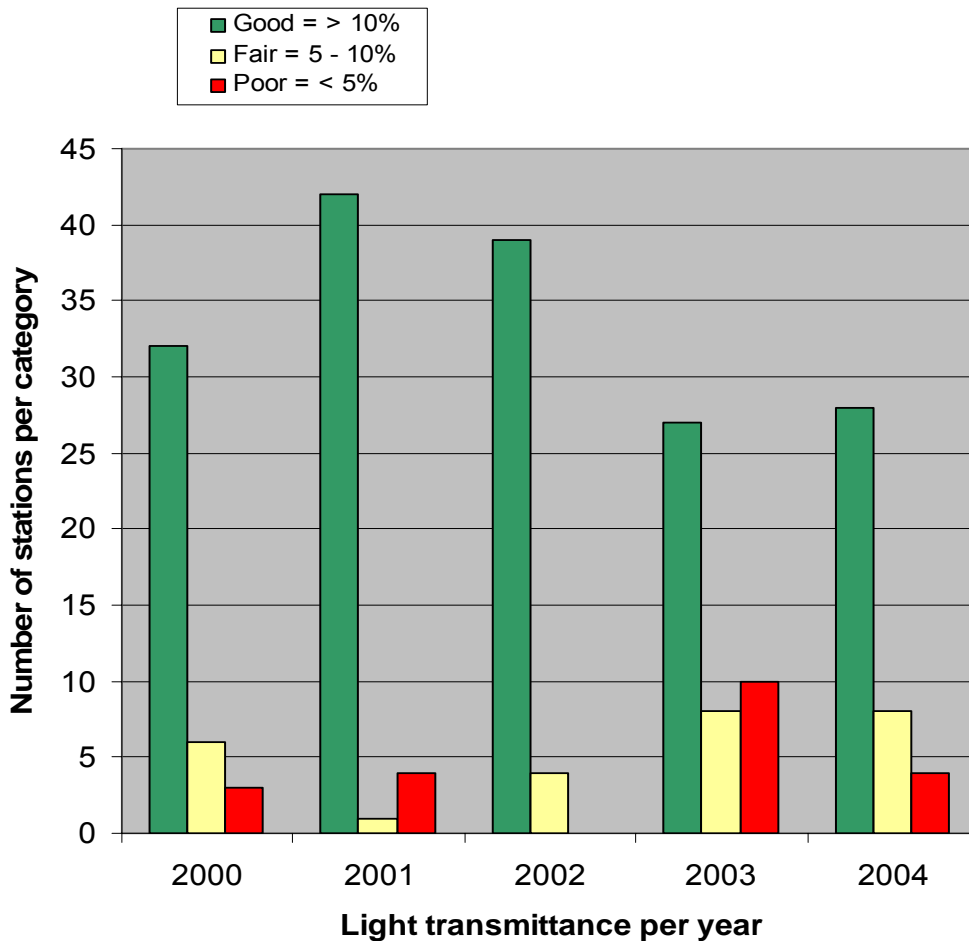


Figure 4-4 Water Clarity in Alabama’s estuarine waters. A comparison of percent light penetration at 1 meter of depth.

4.4 Dissolved Oxygen

Dissolved oxygen is one of the most important elements in an aquatic animal’s life. If oxygen levels get low, fish will leave the impacted area. Animals that aren’t as mobile, such as benthic organisms will be stressed, and if oxygen levels do not return to a higher level, will die.

Dissolved oxygen levels are dependant on many factors; both anthropogenic and natural. As mentioned earlier, high nutrient levels enrich a system and may cause an algal bloom. During an algal bloom production is increased to a level that depletes nutrients causing a rapid die-off of phytoplankton. Decaying organic mater will cause oxygen levels to drop. Causes for the eutrophication that starts this cycle include runoff from agriculture, lawns and golf courses, and domestic sewage. Mobile Bay has a natural occurrence of low dissolved oxygen called a “Jubilee” where under certain naturally occurring conditions water with low dissolved oxygen will be concentrated usually along the eastern side of Mobile Bay. Fish and shellfish, especially flounders, shrimp and crab, will swim to the surface at the shoreline seeking oxygenated water. These species can survive such an event if not caught by predators along the beach.



An algal mat in the Mobile River delta, approximately 2m²

For National Coastal Assessment, bottom dissolved oxygen is assessed with the following criteria. Bottom D. O. over 5mg/L is considered good, bottom D. O. 2-5mg/L is considered fair, and bottom D. O. less than 2mg/L is considered poor. Dissolved oxygen was rated as fair for the first four years of NCA and poor for 2004. Figure 4-5 shows a comparison of dissolved oxygen levels found during NCA.

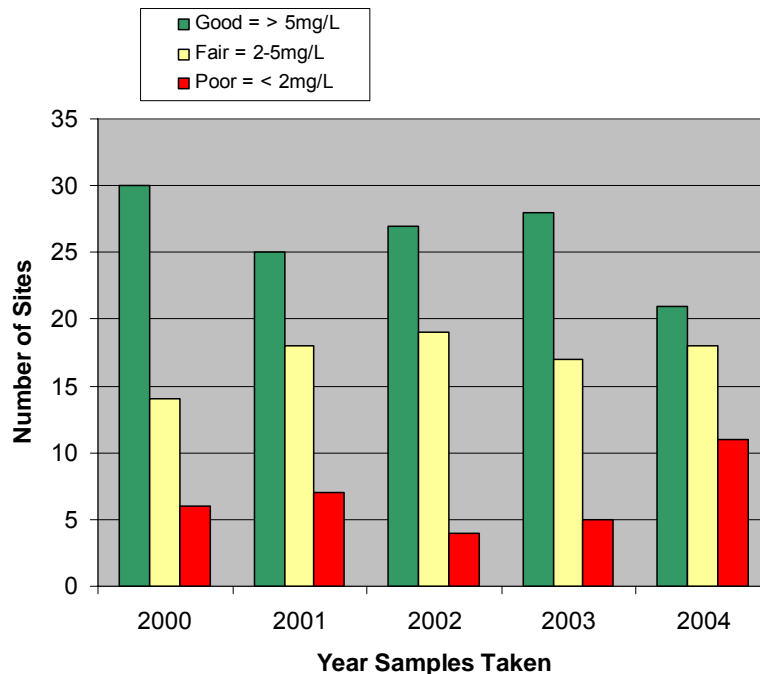


Figure 4-5 Dissolved Oxygen in the estuaries of Alabama

4.5 Water Quality Index

A water quality index, developed for the Gulf Coast by the U.S. EPA for the National Coastal Condition Report, was used to determine the condition of Alabama’s coastal waters. Five indicators were used in the index; dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), chlorophyll-a, water clarity, and dissolved oxygen. 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. The water quality index was fair to good for each of the first five years of NCA. Dissolved oxygen consistently contributed to the index being fair to poor. As noted above, Mobile Bay is noted for its occurrence of Jubilees which coincide with naturally occurring low dissolved oxygen episodes. Perdido Bay has also exhibited low dissolved oxygen levels. This may be attributable to the small bay mouth with limited flushing. Perdido Bay has also historically shown an elevated level of chlorophyll-a, this trend continued with NCA.

A water quality index for the estuaries of Alabama was calculated for the first five years of NCA and results are exhibited below.

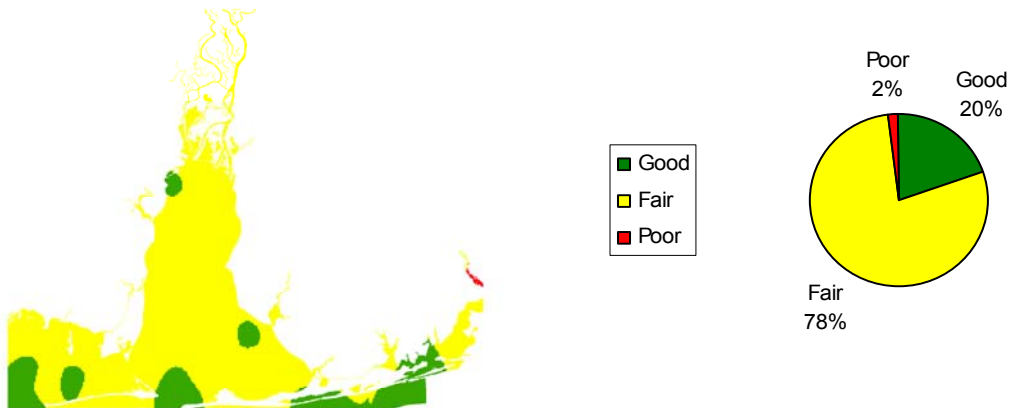


Figure 4-6 Water Quality Index 2000

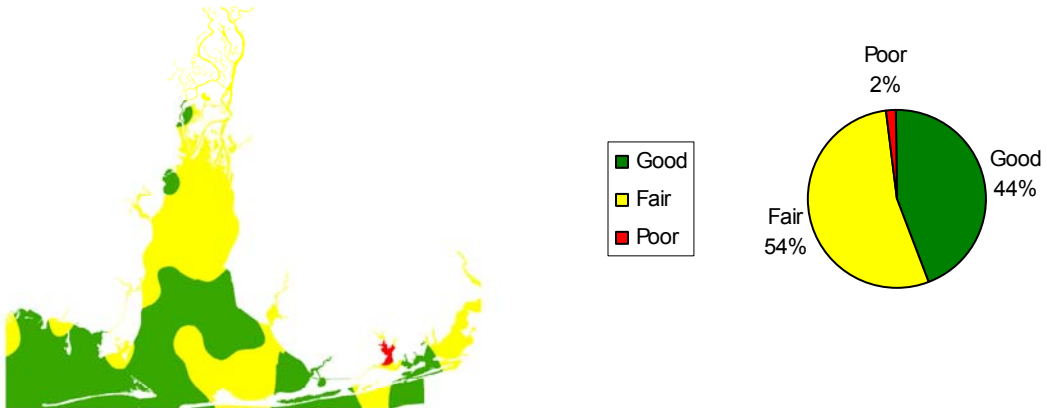


Figure 4-7 Water Quality Index 2001

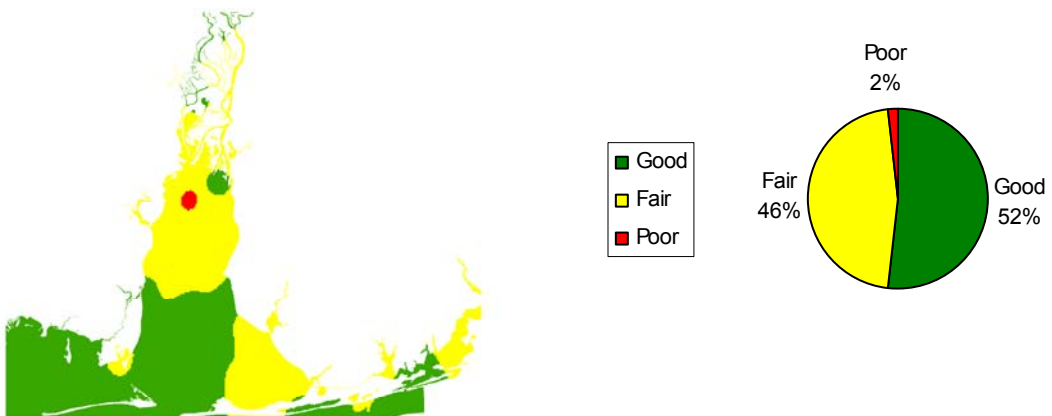


Figure 4-8 Water Quality Index 2002

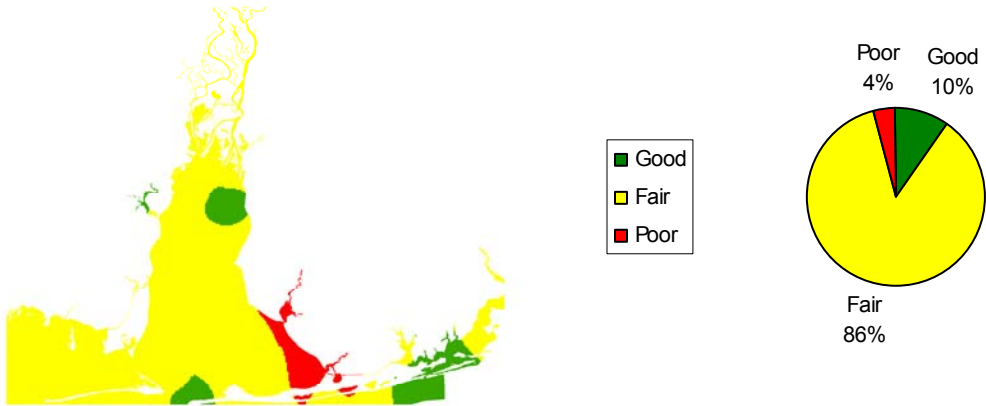


Figure 4-9 Water Quality Index 2003

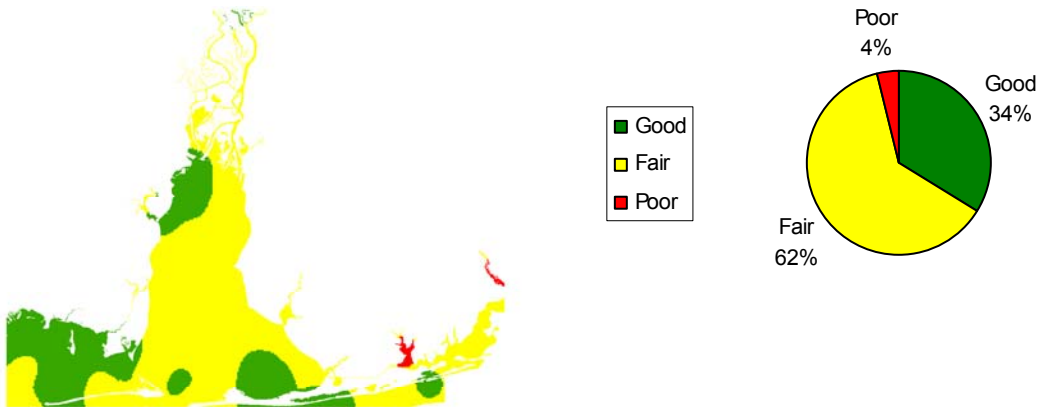


Figure 4-10 Water Quality Index 2004

4.6 Fecal Coliform Bacteria

Although fecal coliform measurements were not required for NCA, Alabama measured it as a supplemental indicator at its sites from 2000 – 2003. This was done so that data could be combined with the ALAMAP-Coastal program data. Fecal coliform is a bacterium that lives in

the intestinal tracts of animals and aids in the digestion of foods. It is used as an indicator for the presence of sewage. This sewage could be contaminated by other disease causing bacteria, such as Hepatitis A. Results are exhibited below.

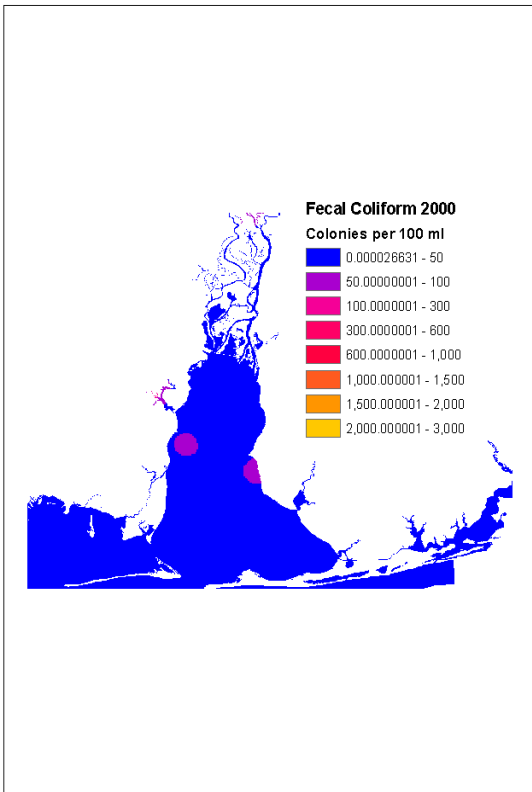


Figure 4-11 Fecal Coliform Results 2000

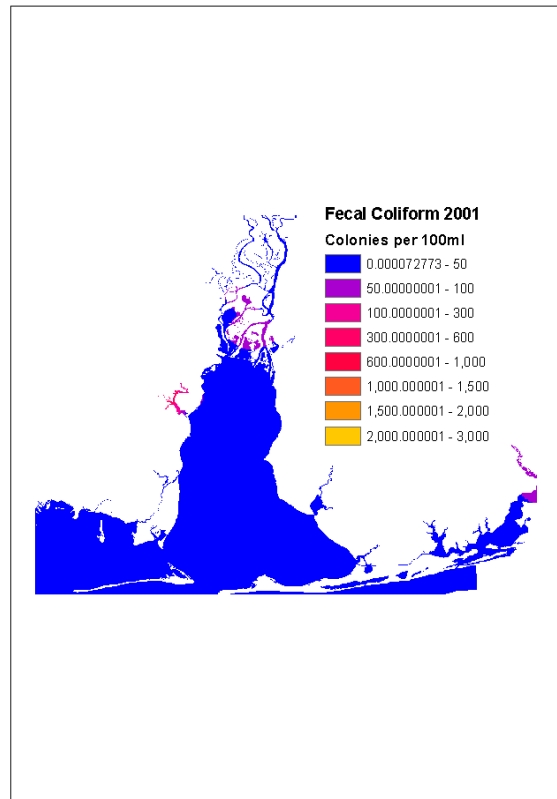


Figure 4-12 Fecal Coliform Results 2001

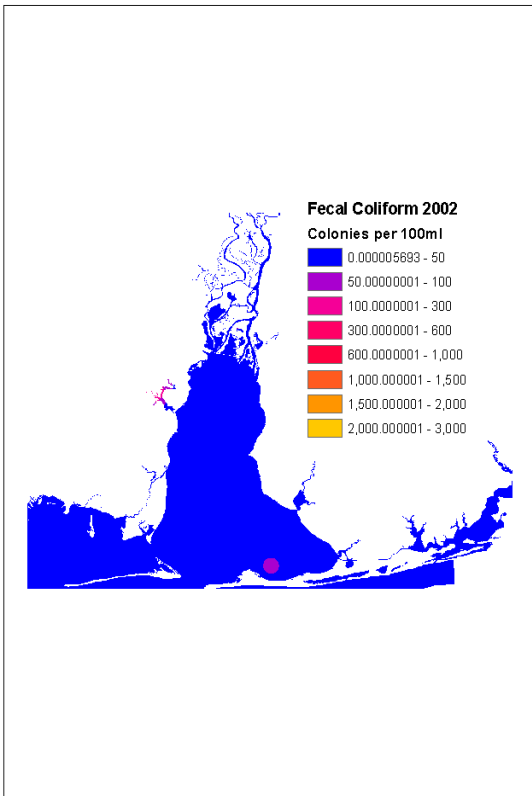


Figure 4-13 Fecal Coliform Results 2002

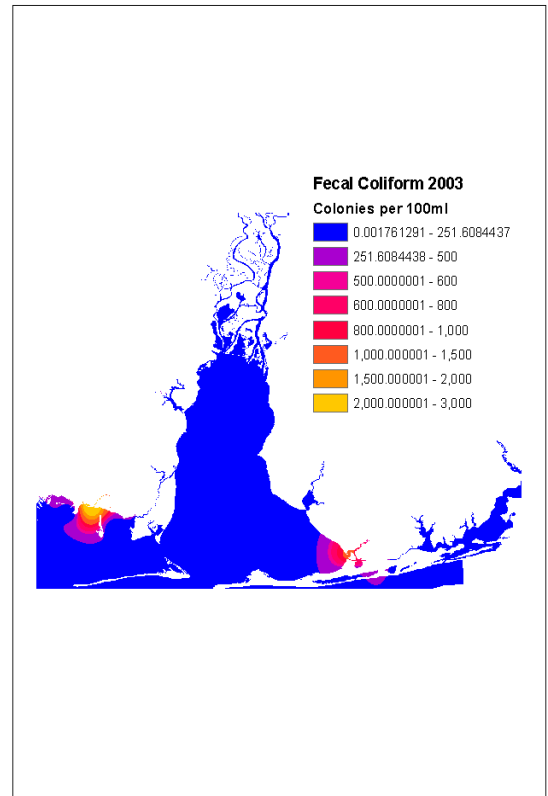


Figure 4-14 Fecal Coliform Results 2003

4.7 Sediment TOC

Sediment Total Organic Carbon (TOC) was measured to determine the amount of organic material occurring in the sediment. Organic material is an important food source for benthic organisms, but the decay of organic matter depletes dissolved oxygen supplies. The EPA's criteria for rating TOC concentrations, USEPA (2004), determine that concentrations of TOC above 5% are poor, concentrations of TOC between 2% and 5% are fair, and concentrations

below 2% are good. Alabama's sediment rated good from 2000 through 2004. Elevated levels of TOC were measured in Perdido Bay each year of the program. This elevation could be from upland runoff (anthropogenic sources) or the breakdown of dead plant and animal material, or both. Nearby Wolf Bay also experienced slightly elevated readings each year of the program. No other areas showed a trend of elevated readings.

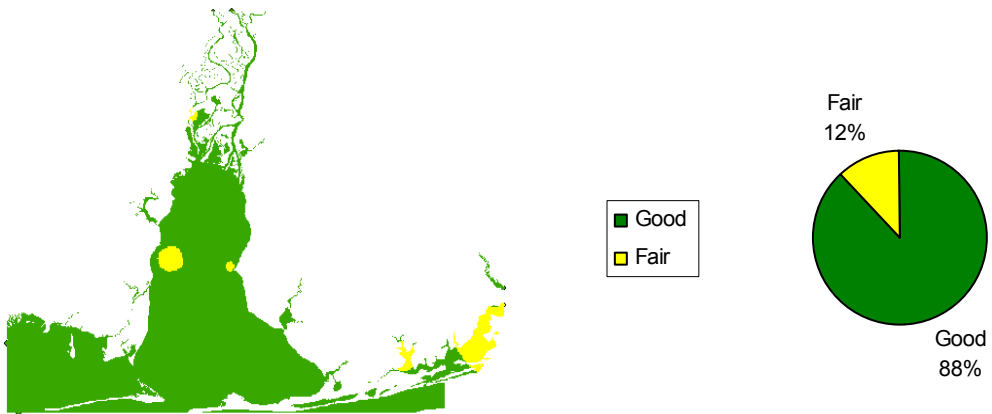


Figure 4-15 Sediment TOC 2000

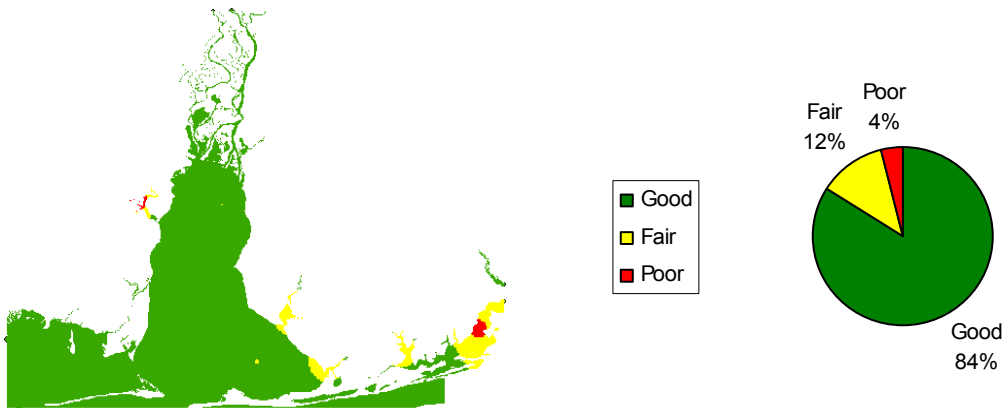


Figure 4-16 Sediment TOC 2001

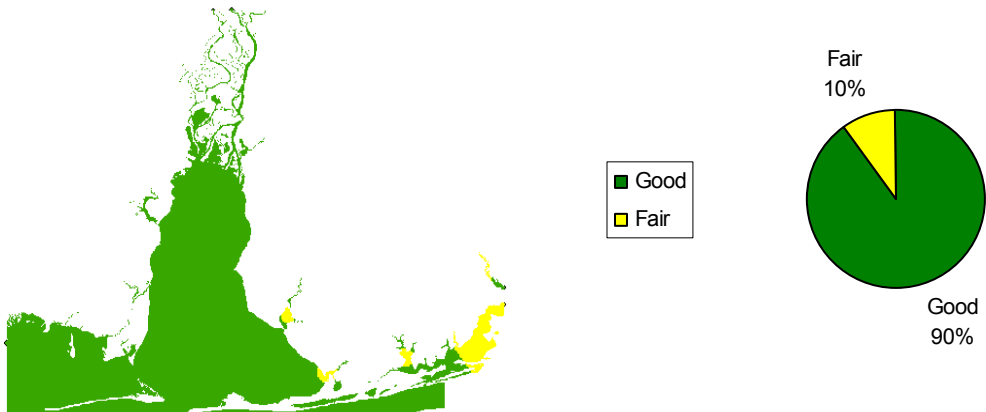


Figure 4-17 Sediment TOC 2002

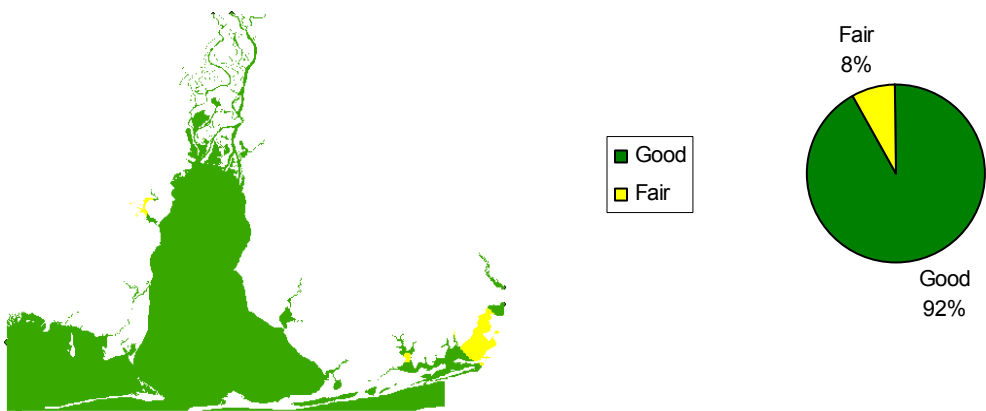


Figure 4-18 Sediment TOC 2003

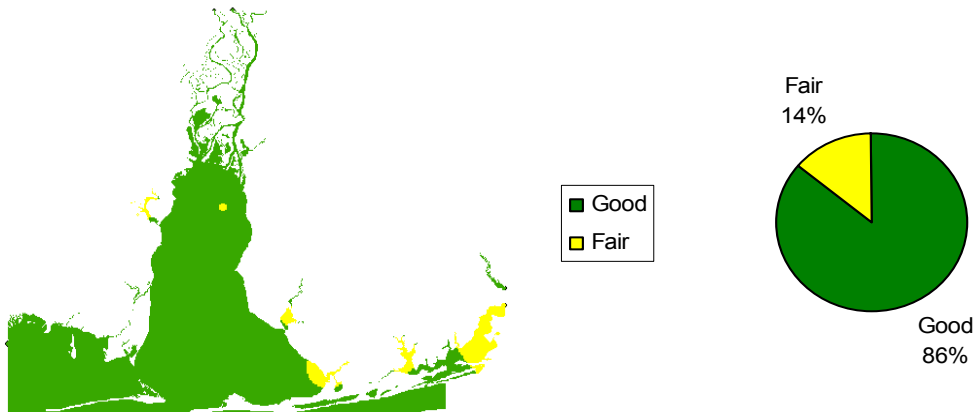


Figure 4-19 Sediment TOC 2004

4.8 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 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. These ERM and ERL values are used to assess sediment contamination. For a site to be rated good, no ERM concentrations should be exceeded, and less than five ERL concentrations are exceeded. For a site to be rated as fair, five or more ERL concentrations are exceeded. For a site to be rated as poor, an ERM concentration is exceeded for one or more contaminants. Alabama’s sediment was rated good for all five years of NCA.



Sediment sample being collected from Ponar



Figure 4-20 Sediment Contamination 2000

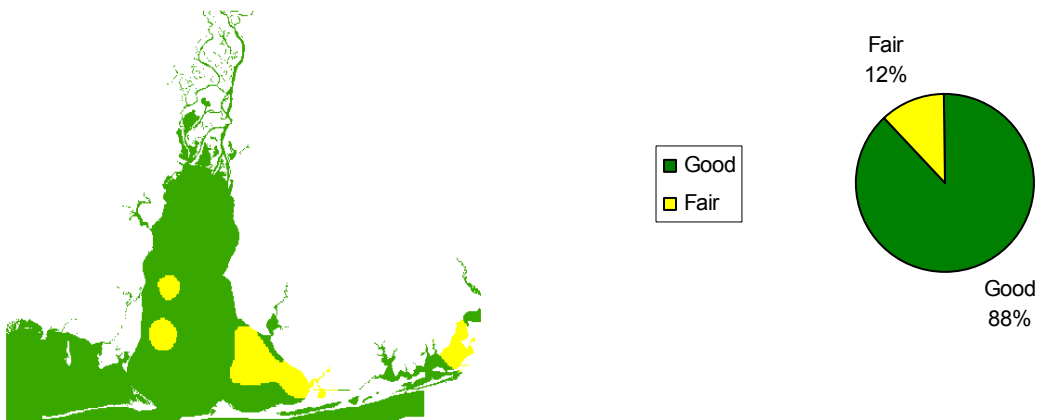


Figure 4-21 Sediment Contamination 2001



Figure 4-22 Sediment Contamination 2002

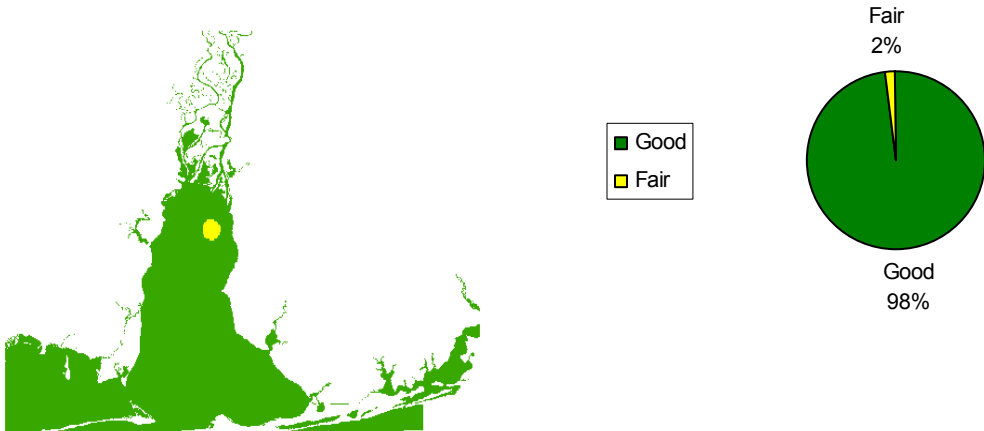


Figure 4-23 Sediment Contamination 2003

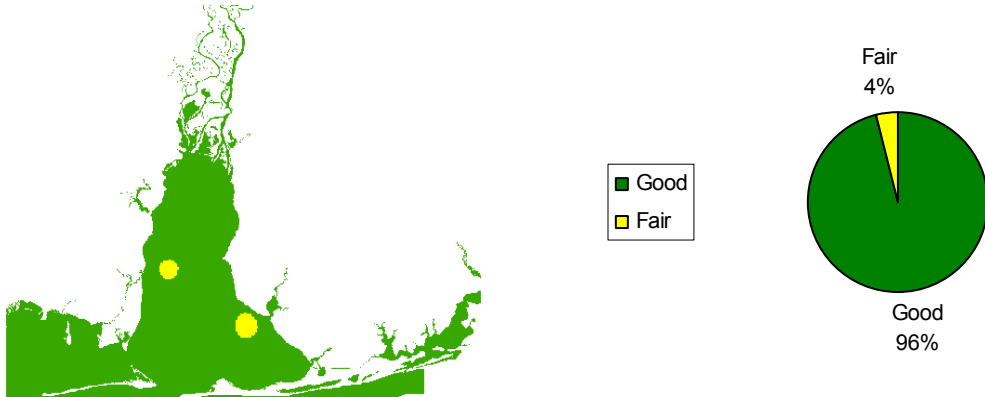


Figure 4-24 Sediment Contamination 2004

4.9 Sediment Toxicity

The marine amphipod *Ampelisca abdita* has been chosen by the EPA as the standard test organism for National Coastal Assessment. Stations were represented by one toxicity sample per station and were not replicated at field duplicate stations. Survival of organisms was measured relative to survival of organisms in the control sediment. If a station had greater than or equal to eighty percent survival, it was considered good. If a station had less than an eighty percent survival rate, it was considered poor.

Figures 4-25 through 4-29 show the results of these analyses below.

During 2004, thirteen of the fifty sites sampled for sediment toxicity were lost at the analytical lab due to hurricane Ivan. Results for the remaining thirty-seven sites were interpolated for 2004, without the missing data, and shown on the map below in figure 4-29. Blue dots indicate the sites where data were lost.



Figure 4-25 Sediment Toxicity 2000

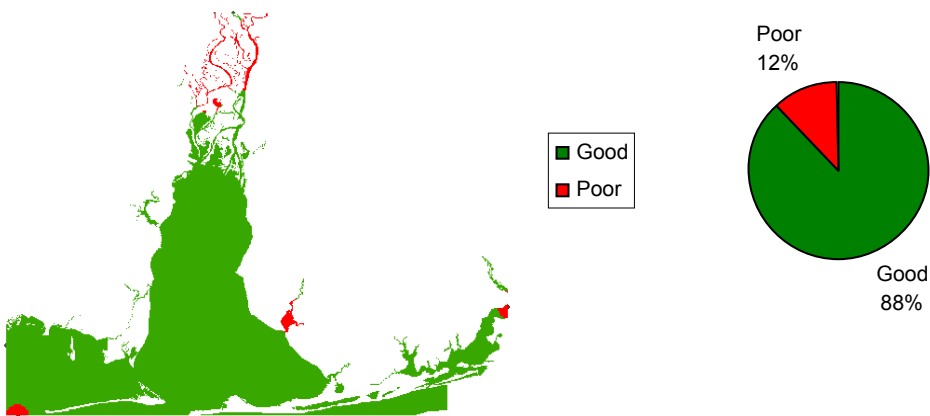


Figure 4-26 Sediment Toxicity 2001

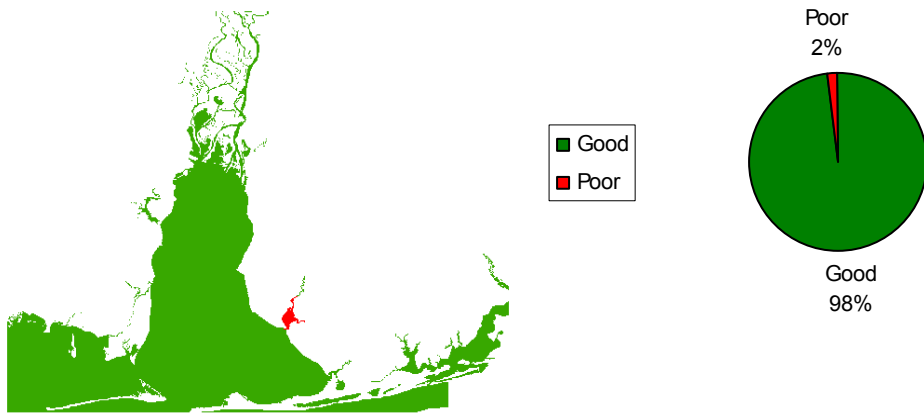


Figure 4-27 Sediment Toxicity 2002

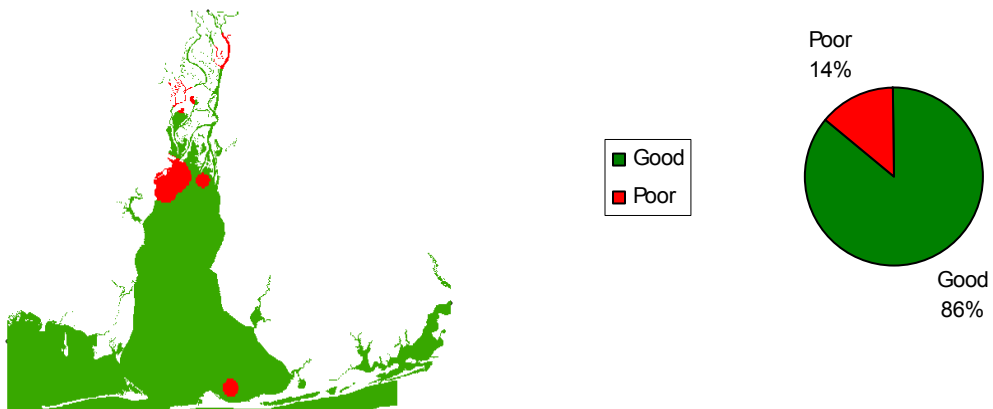


Figure 4-28 Sediment Toxicity 2003

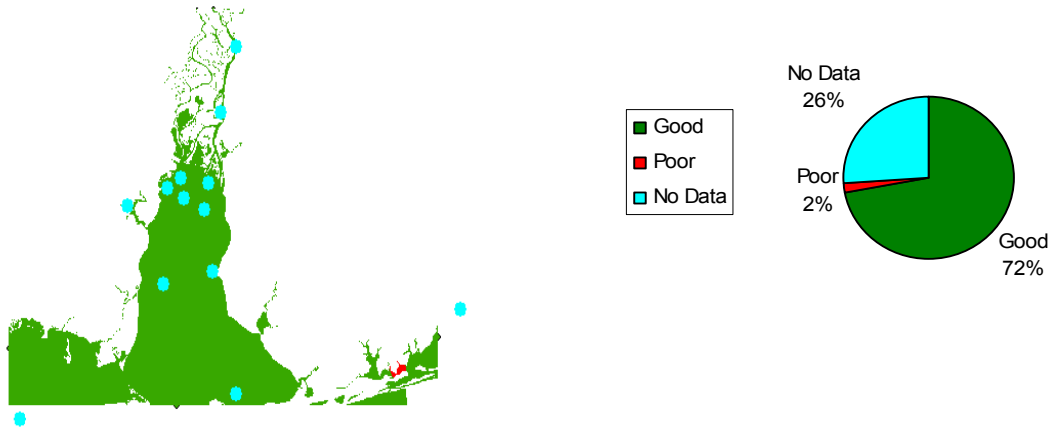


Figure 4-29 Sediment Toxicity 2004

4.10 Sediment Quality Index

A sediment quality index was used to gauge the effects of sediment condition on the estuaries of Alabama. Sediment quality is affected by several factors that work together to influence the benthic communities that live on or in the sediment. Total organic carbon (TOC) influences the amount of contamination sediments can hold. Sediment contaminants accumulate in the sediment and can affect the type of species living in the benthic community. The contamination may eliminate pollution sensitive species, allowing for proliferation of pollution resistant species, reducing diversity. The contaminant may eliminate all species or the contaminant may accumulate in the species present, becoming concentrated through bioaccumulation affecting species higher in the food chain - including humans. Toxicity is a measure of the effects of the sediment on the survival rates of a pre-determined species

(*Ampelisca abdita*). Even though a particular sediment may show elevated levels of contaminants, these contaminants may not have toxic effects on organisms. These three measures- TOC, contaminants, and toxicity were combined to create a sediment quality index. For a site to be ranked good, none of the individual components could be ranked as poor, and the sediment contaminants indicator had to be ranked good. For a site to be ranked as fair, no measures could be ranked as poor and the sediment contaminants indicator was ranked as fair. For a site to be ranked as poor, one or more of the components was ranked as poor. Overall sediment quality for Alabama was ranked as fair with 8% of samples ranking poor. Due to the lost sediment toxicity samples in 2004, Figure 4-34 shows the results of data interpolated without the thirteen lost samples. Blue dots indicate areas of missing data.

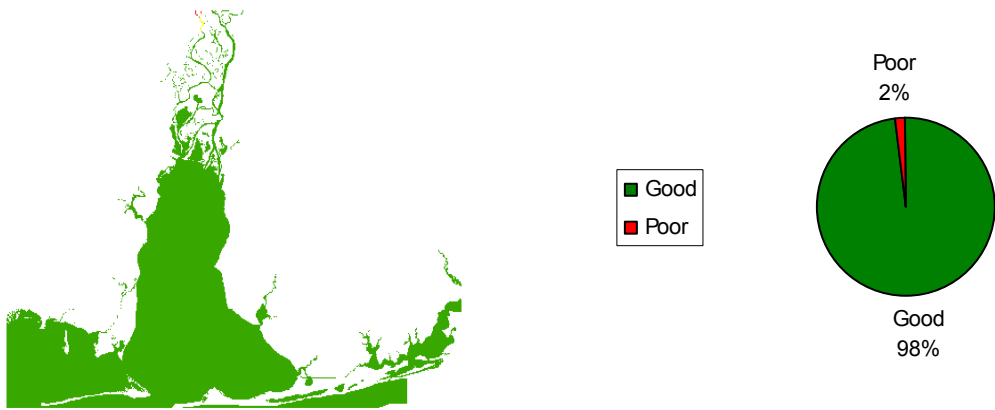


Figure 4-30 Sediment Quality Index 2000

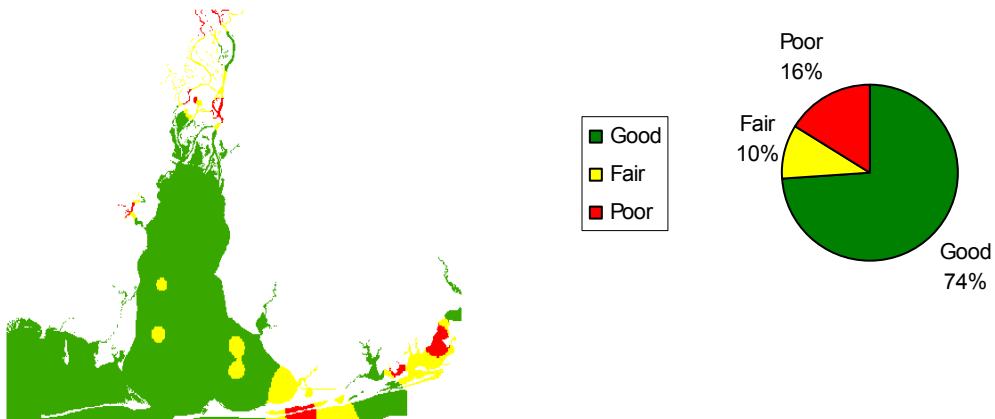


Figure 4-31 Sediment Quality Index 2001

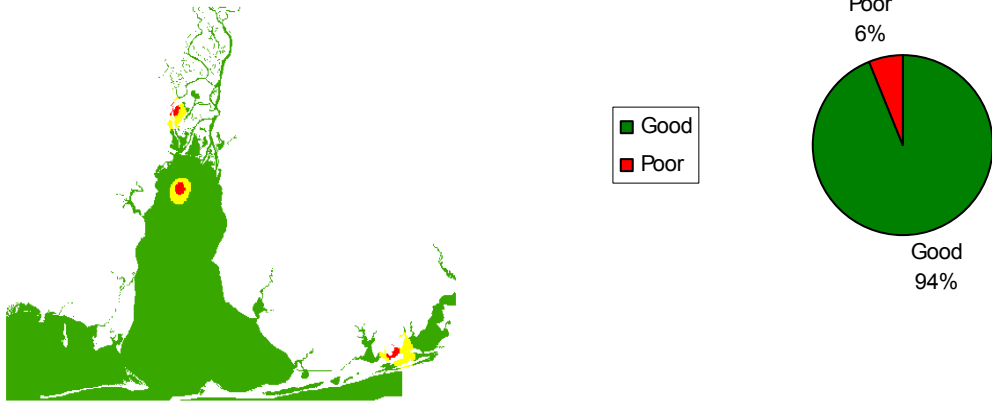


Figure 4-32 Sediment Quality Index 2002

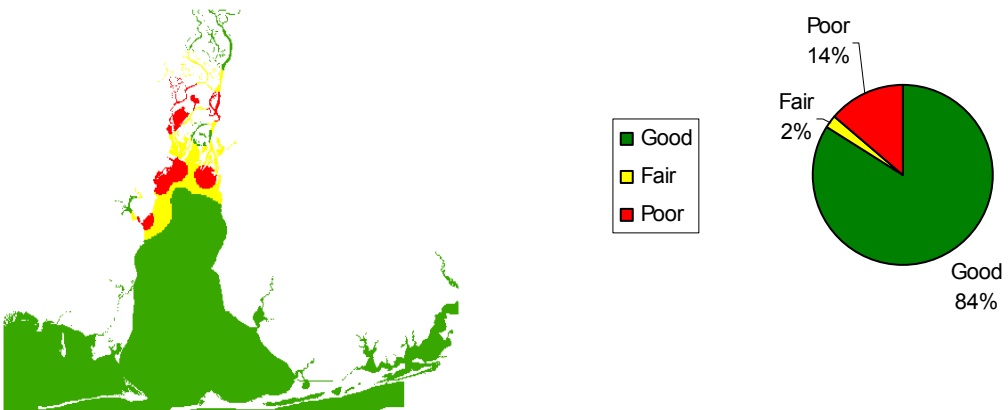


Figure 4-33 Sediment Quality Index 2003



Figure 4-34 Sediment Quality Index 2004

4.11 Benthic Index

Benthic communities can be influenced by chronic as well as acute conditions. Chronic conditions, such as sediment condition, will have long term effects on the composition of the benthic community. Acute conditions, such as low dissolved oxygen concentrations, will have short term effects on the benthic community, only causing temporary changes in benthic diversity. Alabama used a benthic index of condition for northern Gulf Coast Estuaries developed by Engle and Summers (1999). This

index applies discriminant analysis to combine expected species diversity with relevant abundances of pollution tolerant and intolerant species, to develop a benthic index that can be used by resource managers as an estimate of benthic community health.

The estuaries of Alabama ranked poor (>20% of sites ranking poor) each year of NCA, as shown below.

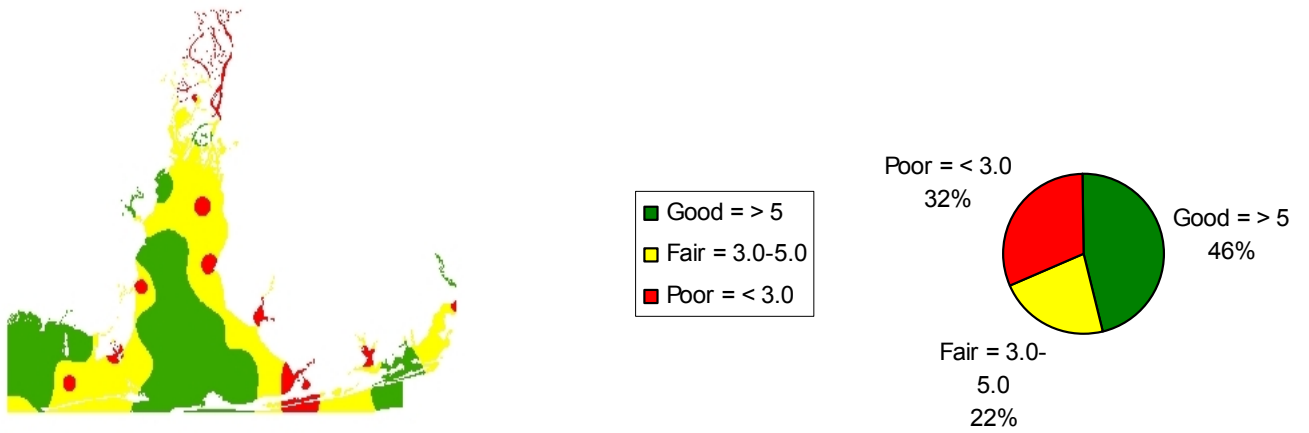


Figure 4-35 Benthic Index 2000

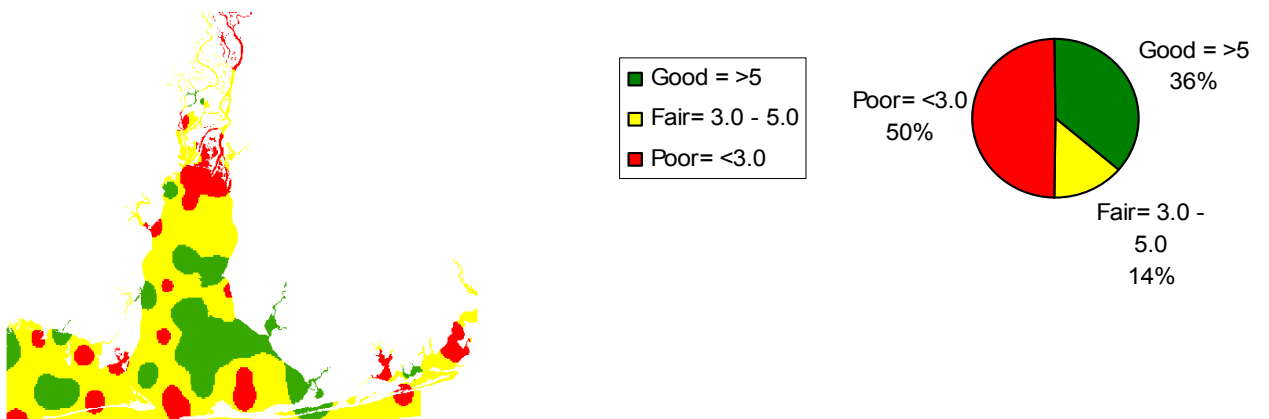


Figure 4-36 Benthic Index 2001

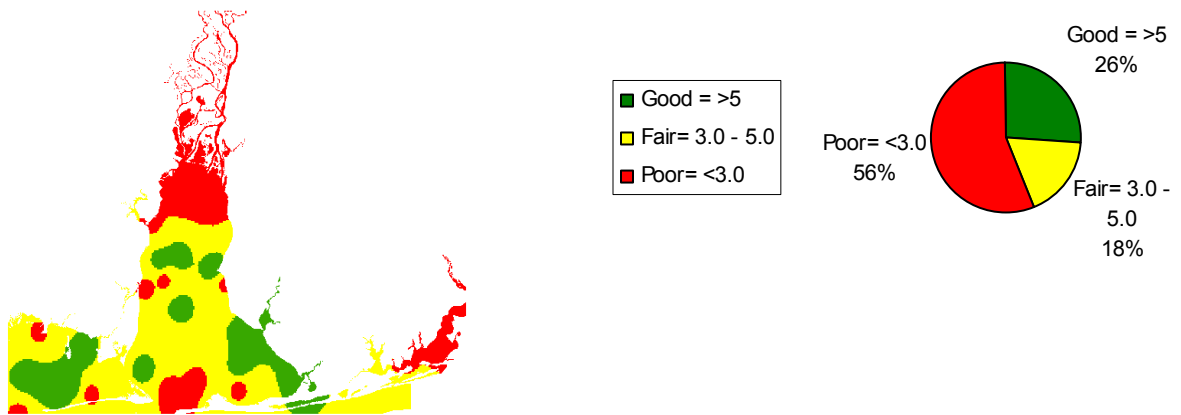


Figure 4-37 Benthic Index 2002

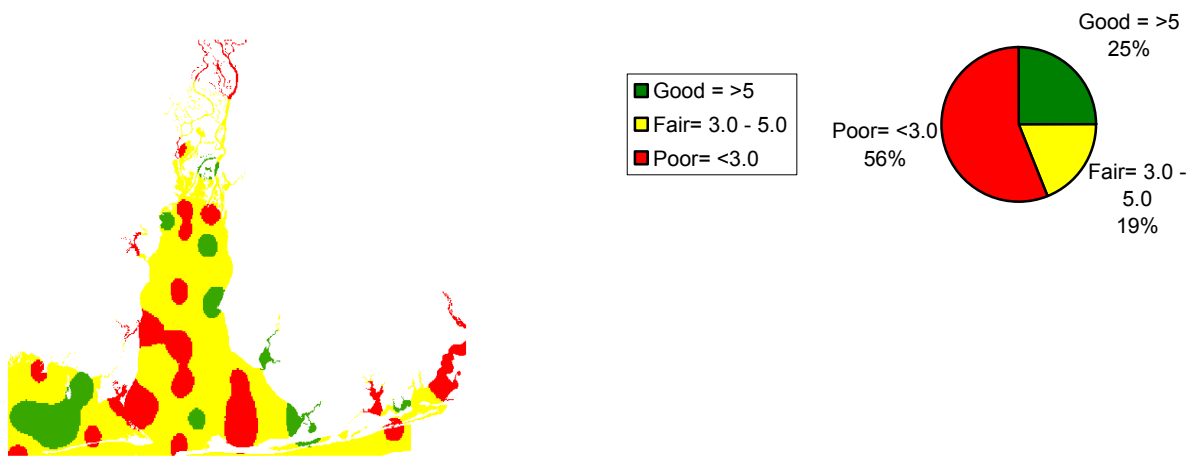


Figure 4- 38 Benthic Index 2003

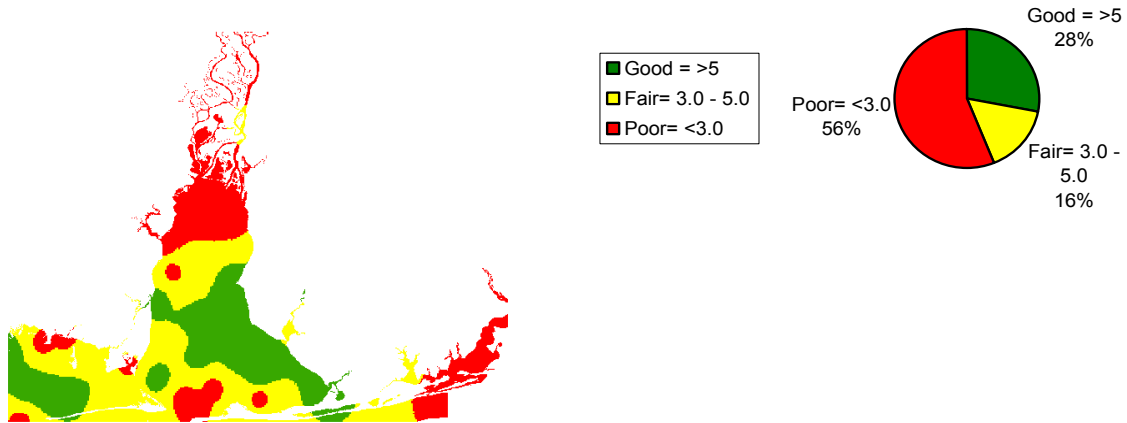


Figure 4-39 Benthic Index 2004

4.12 Fish Tissue Contaminants

Fish communities were sampled using a 16 foot lined otter trawl at all NCA stations in Alabama except six stations in the Mobile River Delta, where sampling occurred using electro-shocking equipment. All samples were examined for histopathology, identified and enumerated. Targeted species were collected and frozen for later tissue analysis. Preference was given for demersal fishes as well as predatory fishes as target species. Selected target species were then analyzed for contaminants including metals and organic compounds (PAHs, PCBs, and pesticides). These compounds, once consumed can accumulate in the body over time. Predation on contaminated fish will result in contamination of the higher trophic levels resulting in bioaccumulation. This bioaccumulation can be cause for concern among human populations consuming fish. Analyses for contamination were done using the whole body of the

fish. 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 listed based on their presence or absence. It should be noted that if a contaminant is present it is not necessarily in a concentration that would pose a risk; it is only in a concentration above the minimum detection limit. In 2004, tissue contaminants were measured in fillets and in carcasses. Contaminants of concern, (those listed in the Risk Guidelines for Recreational Fishers – U.S. EPA, 2000), are reported, if present, in the following sections.

Metals

Fish tissue samples were analyzed for 13 metals; arsenic, cadmium, mercury, and selenium are compared in the graphs below.

In 2000, fish were caught at 36 of the 48 stations, (two stations were not sampled due to snags). Due to multiple target species being collected at some sites, a total of 49 samples were collected.

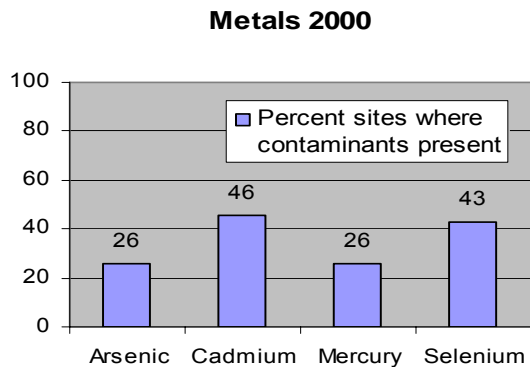


Figure 4-40 Metals Contaminants in Fish Tissue 2000

In 2001, fish were caught at 37 of 48 stations, (two stations were not sampled due to snags). Due to multiple target species being collected at some sites, a total of 69 samples were collected.

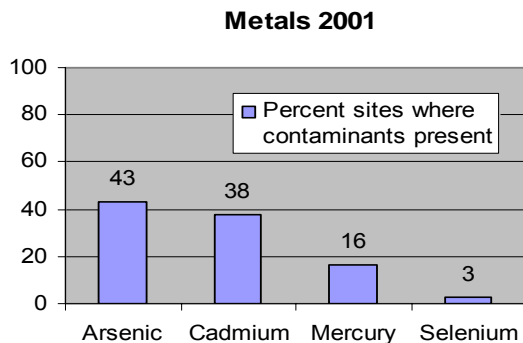


Figure 4-41 Metals Contaminants in Fish Tissue 2001

In 2002, fish were caught at 35 of the 48 stations, (two stations were not sampled due to snags). Due to multiple target species being collected at some sites, a total of 67 samples were collected.

Metals 2002

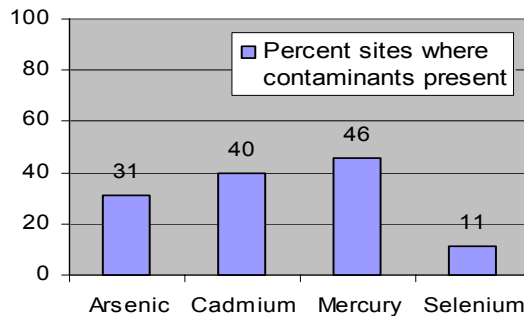


Figure 4-42 Metals Contaminants in Fish Tissue 2002

In the year 2003, fish were caught at 36 of the 48 stations, (two stations were not sampled due to snags). Due to multiple target species being collected at some sites, a total of 69 samples were collected.

Metals 2003

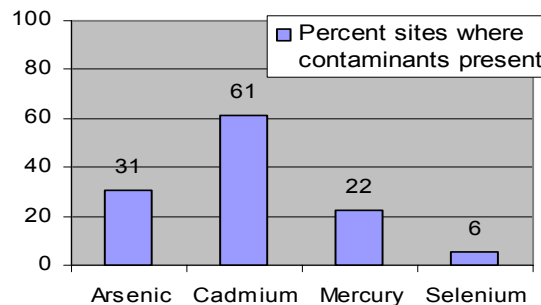


Figure 4-43 Metals Contaminants in Fish Tissue 2003

In 2004, fish were caught at 35 of the 48 stations, (two stations were not sampled due to snags). Due to multiple target species being collected at some sites, a total of 74 samples were collected.

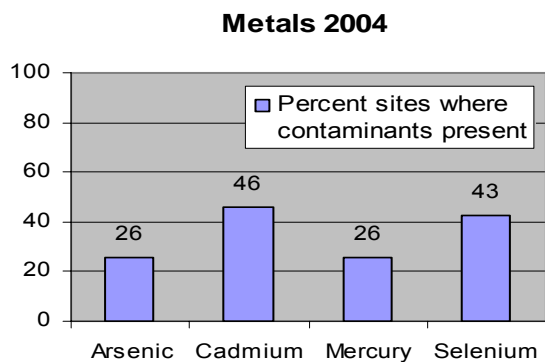


Figure 4-44 Metals Contaminants in Fish Tissue 2004

Organics

Fish tissue samples were analyzed for 25 polynuclear aromatic hydrocarbons (PAHs), 21 polychlorinated biphenyls (PCBs), and 22 pesticides, including DDT and its metabolites. Twelve contaminants of concern, as shown in the graphs below, are reported as percent sites where contaminants present. Contaminant levels, if present, were above minimum detection limits, not necessarily above consumption advisory levels. This comparison was not made due to the whole body analysis performed as opposed to analyses of fillets as in a fish tissue monitoring program.

In 2000, fish were caught at 36 of the 48 stations, with a total of 49 samples collected. Two stations were not sampled due to snags. Twenty-nine of the stations had a sufficient quantity of sample to be analyzed for organic compounds.

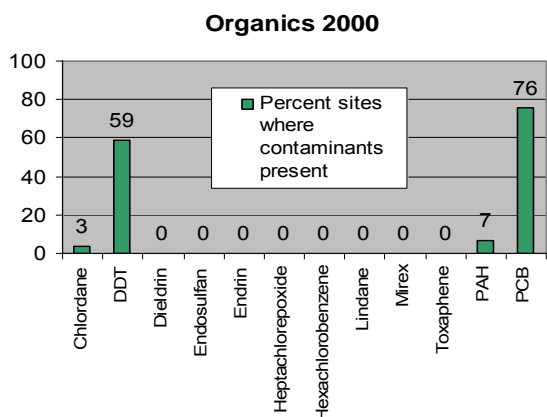


Figure 4-45 Organic Contaminants in Fish Tissue 2000

In 2001, fish were caught at 37 of the 48 stations, with a total of 46 samples collected. Two stations were not sampled due to snags. Thirty of the stations had a sufficient quantity of sample to be analyzed for organic compounds.

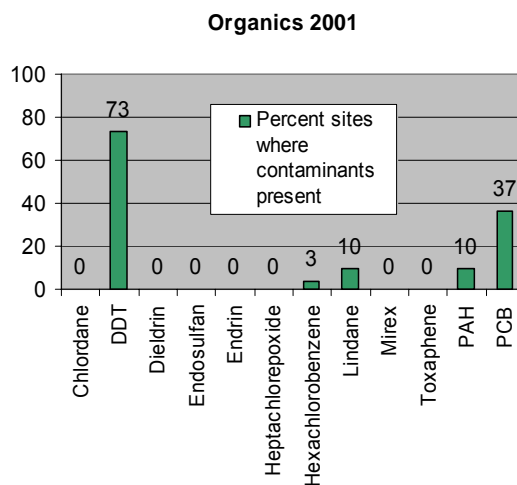


Figure 4-46 Organic Contaminants in Fish Tissue 2001

In 2002, fish were caught at 35 of the 48 stations, with a total of 67 samples collected. Two stations were not sampled due to snags. Twenty-nine of the stations had a sufficient quantity of sample to be analyzed for organic compounds.

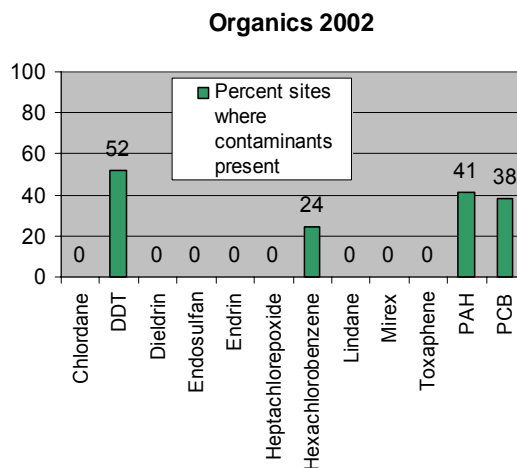


Figure 4-47 Organic Contaminants in Fish Tissue 2002

In 2003, fish were caught at 36 of the 48 stations, with a total of 69 samples collected. Two stations were not sampled due to snags. Twenty-four of the stations had a sufficient quantity of sample to be analyzed for organic compounds.

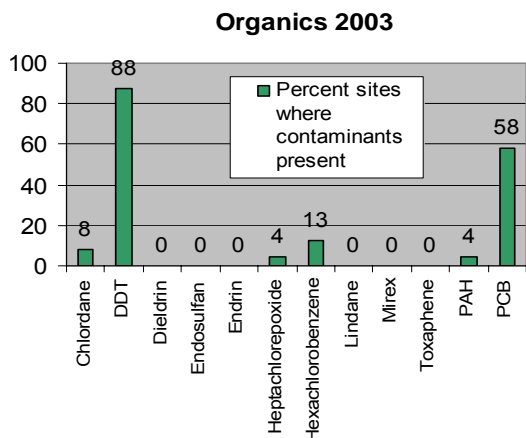


Figure 4-48 Organic Contaminants in Fish Tissue 2003

In 2004, fish were caught at 35 of the 48 stations, with a total of 74 samples collected. Two stations were not sampled due to snags. Thirty-six of the stations had a sufficient quantity of sample to be analyzed for organic compounds.

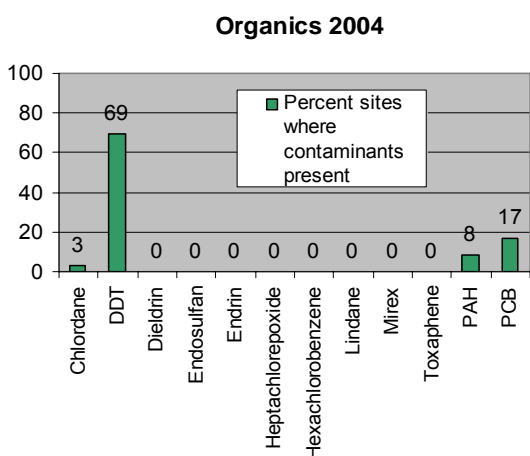


Figure 4-49 Organic Contaminants in Fish Tissue 2004

Several contaminants appeared to be present at a significant percentage of stations each year of NCA. Cadmium was present at measurable quantities (> 0.01 ug/g, or ppm) in 46.2% of samples analyzed over the five years of NCA

(Figure 4-50). The concentration of Cadmium appeared to increase going down Mobile Bay and into Mississippi Sound (Figure 4-51), and was most commonly found in Penaeid species of shrimp. Over the five years of NCA, Cadmium was found in 69.8% of Penaeid samples collected. Over the five years of NCA, Cadmium was found in 12% of non-Penaeid samples.

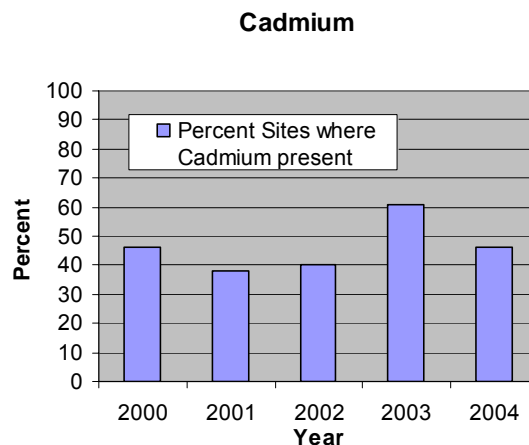


Figure 4-50 Percent stations where Cadmium Present in Fish Tissue

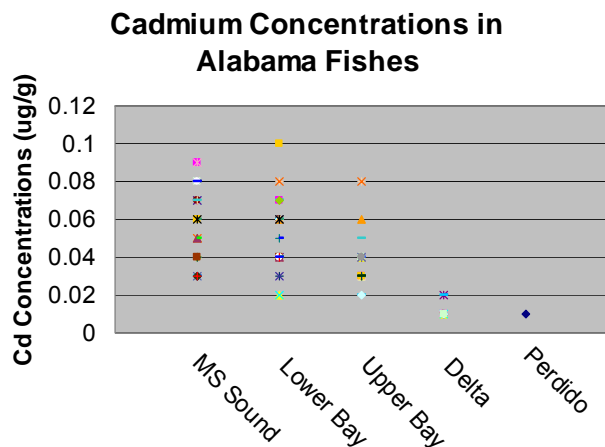


Figure 4-51 Concentration of Cadmium Found in Fish Tissue per Area 2000-2004

Mercury was found in quantities greater than 0.05ug/g (Minimum Detection Limit-MDL) in 27.2% of samples analyzed from 2000 – 2004, Figure 4-52. Mercury was most commonly associated with the Mobile Bay Delta with 79% of mercury containing samples coming from the Delta (Figure 4-53); with *Micropterus salmoides* and *Lepomis macrochirus* species representing the highest percentages. *M. salmoides* had mercury concentrations above MDL in 88.9% (16 of 18) of samples. *L. macrochirus* had mercury concentrations above MDL in 84.2% (16 of 19) of samples. Mercury was detected in 13.2% of all other samples.

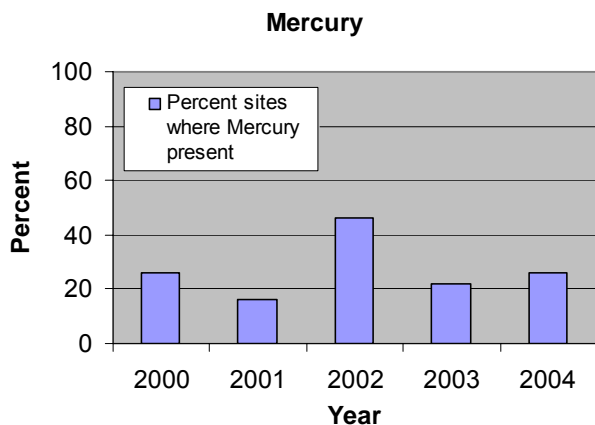


Figure 4-52 Percent stations where Mercury Present in Fish Tissue

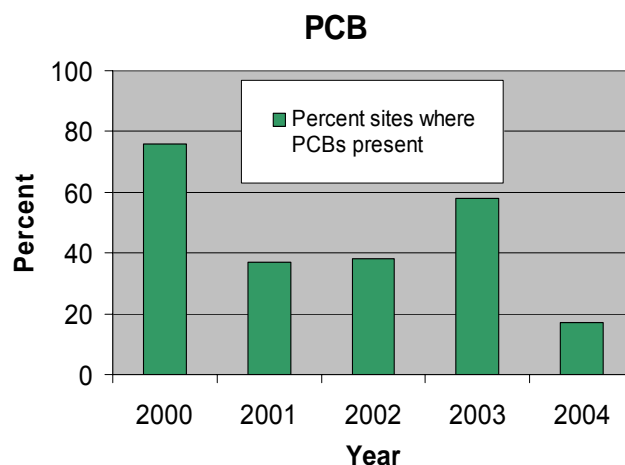


Figure 4-54 Percent Stations where PCB's Present in Fish Tissue

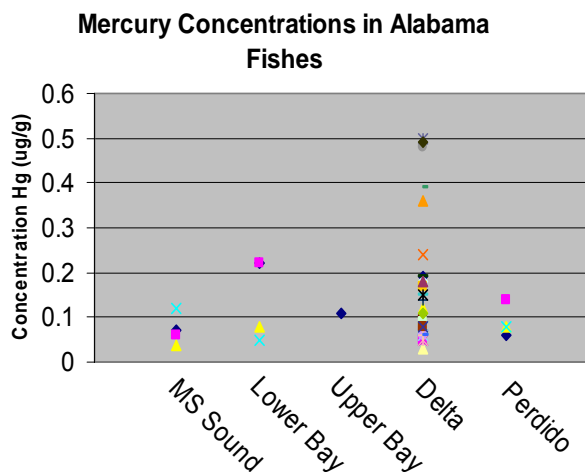


Figure 4-53 Concentration of Mercury Found in Fish Tissue per Area 2000-2004

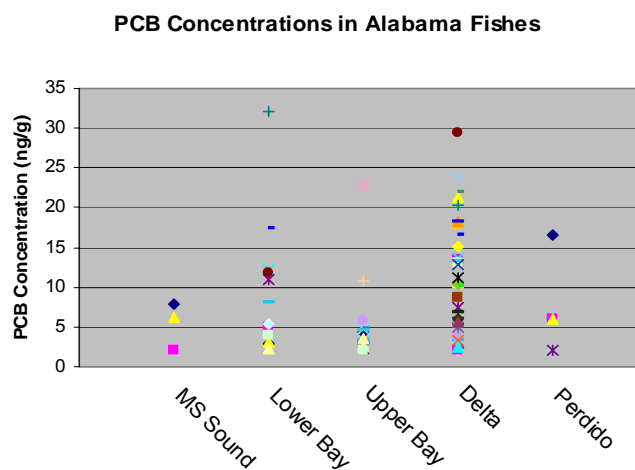


Figure 4-55 Concentration of PCBs Found in Alabama Fishes 2000-2004

Polychlorinated Biphenyls – PCBs were present at quantities greater than 2.00 ng/g (MDL of PCBs) in 37.7% of samples analyzed, Figure 4-54. Of the samples containing PCBs, 56.8% were collected in the Mobile Delta, 20.5% were in the Upper Mobile Bay, and 13.6% were in the Lower Mobile Bay. Figure 4-55 shows a comparison of the concentrations of PCB's found in each area of Alabama's estuaries.

Several species of fish showed concentrations of PCBs above MDL (>2.00ng/g). *Arius felis*, *Ictalurus punctatus*, *Lepomis macrochirus*, *Micropterus salmoides*, and *Mugil cephalus*, all contained detectable amounts of PCBs in at least 50% of the samples taken.

DDT as well as its metabolites DDD and DDE was measured in quantities greater than 2.00 ng/g (MDL) in 68.2% of the samples analyzed, Figure 4-56. The percentage of samples containing DDT were the highest in the Mobile Delta (47.3%), and Upper Mobile Bay (24.7%) and were lower moving down to the Lower Bay

(21%) and into Mississippi Sound (3.4%). Figure 4-57 shows a comparison of DDT concentration (ng/g) to localized areas of Alabama's estuaries.

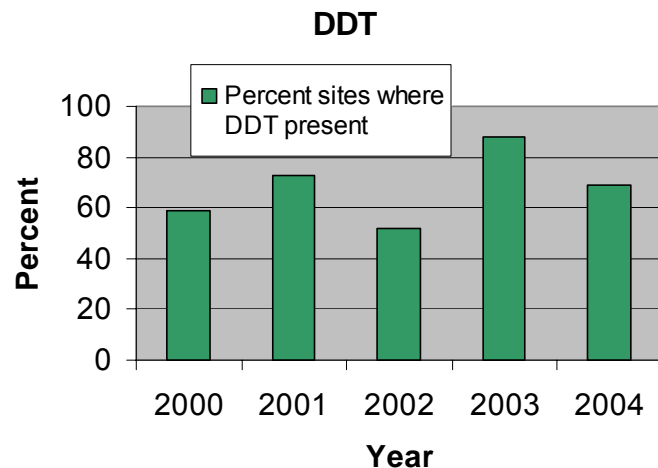


Figure 4-56 Percent Stations Where DDT Present in Fish Tissue

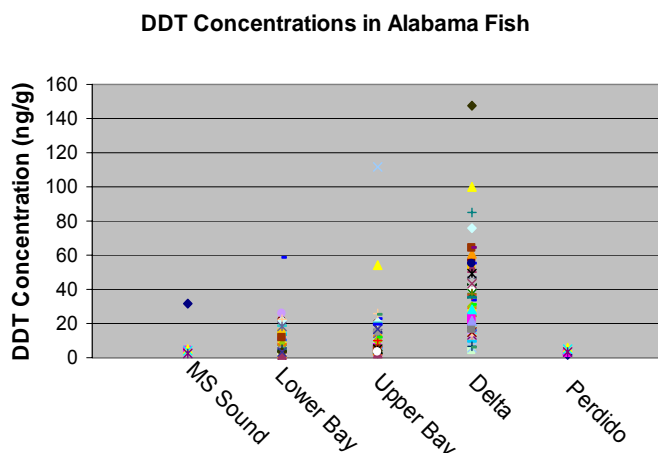


Figure 4-57 Concentration of DDT Found in Alabama Fishes 2000-2004

DDT levels above MDL ($>2.00\text{ng/g}$) were consistently detected in several species of fish during NCA. *Arius felis*, *Ictalurus punctatus*, *Lepomis macrochirus*, *Lepomis microlophus*, *Micropogonias undulatus*, *Micropterus salmoides*, and *Mugil cephalus* all contained detectable amounts of DDT in at least 50% of the samples taken.

5 Summary

The purpose of the National Coastal Assessment is to assess the “health” or condition of the coastal waters of Alabama and track changes in that status through time. It also provides the U. S. EPA with a data set that can be combined with and compared to other states data to assess the condition of the nation’s coastal waters. The estuaries of Alabama were assessed using the framework set forth by the U.S. EPA in the National Coastal Condition Report II (U.S. EPA, 2004). This framework can be used to determine the proportion of the state’s waters that are in good, fair, or poor condition in relation to the parameters measured.

Dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll-a, water clarity, and dissolved oxygen were used as indicators for a water quality index. This index was fair to good for all five years of NCA. Fecal coliform was used as a supplemental parameter from 2000-2003 to correlate data with existing sampling programs. In general all sites had good to fair ratings although an elevated trend (three of four years) was noticed in Halls Mill Creek. This area receives substantial runoff from the city of Mobile. TOC, sediment contaminants, and sediment toxicity were combined to create a sediment quality index. Alabama’s estuaries received a fair ranking using this index. Sediment quality index values were good for 2000 and 2004, fair for 2002 and 2003, but poor for 2001. Sediment toxicity was the major contributor to the poor value for 2001. Benthic communities were analyzed using a benthic index of condition. The benthic communities of Alabama’s estuaries were ranked as poor for each year of the program. Alabama’s estuaries are affected by many factors including rainfall (salinity fluctuations and sedimentation) and jubilees (low dissolved oxygen). Benthic communities are highly susceptible to these factors. This index may reflect inter-annual variations more so than historical trends. An effort to further calibrate the benthic index to Alabama’s estuaries may be beneficial in the future. Fish tissue was examined for metals and organic compounds. Analyses for contamination were performed using the whole body. There are no whole body risk guidelines for fish tissue so a statement of consumption risk can not be made, but several trends were noted. Detectable concentrations of PCBs, DDTs, and

Mercury were most common in the Mobile Delta, while concentrations of Cadmium were most frequently detected in the Lower Mobile Bay and Mississippi Sound. These Cadmium concentrations were commonly associated with Penaeid shrimp.

The index criteria used in this report are an effort to quantify data for a better understanding of the conditions of the estuaries of Alabama, and may be modified to better reflect those conditions as new data is gathered and new information comes to light.

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