



Alabama Department
of Environmental
Management

Field Operations Division
Mobile Field Office
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Alabama Monitoring & Assessment Program - Coastal

ALAMAP - Coastal

**A Report on the Condition of the
Estuaries of Alabama in
1993-1995: A Program in Progress**

**Alabama Monitoring &
Assessment Program -Coastal**

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**A Report on the Condition of the
Estuaries of Alabama in 1993-1995
A Program in Progress**

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Alabama Environmental Monitoring and Assessment Program: A Source of Information

ALAMAP-Coastal

The Alabama Department of Environmental Management (ADEM) has initiated an environmental monitoring and assessment program (ALAMAP-C) for Alabama's coastal waters. ALAMAP-C has conducted annual surveys of estuaries to measure various environmental attributes which can be interpreted or used as indicators of coastal water quality. The overall sample design and strategy for monitoring indicators of ecological condition was inspired by the U.S. Environmental Protection Agency's EMAP-Estuaries efforts in the Gulf of Mexico. The goal of this program is to provide information on the overall health of the estuarine environment and to track the health over time. ALAMAP-C has successfully completed sampling efforts during the summer months of 1993-1995 in all of Alabama's near-coastal waters. This report summarizes the assessment of the ecological condition of Alabama's estuaries based on these data.

ALAMAP-C measures condition of Alabama estuaries

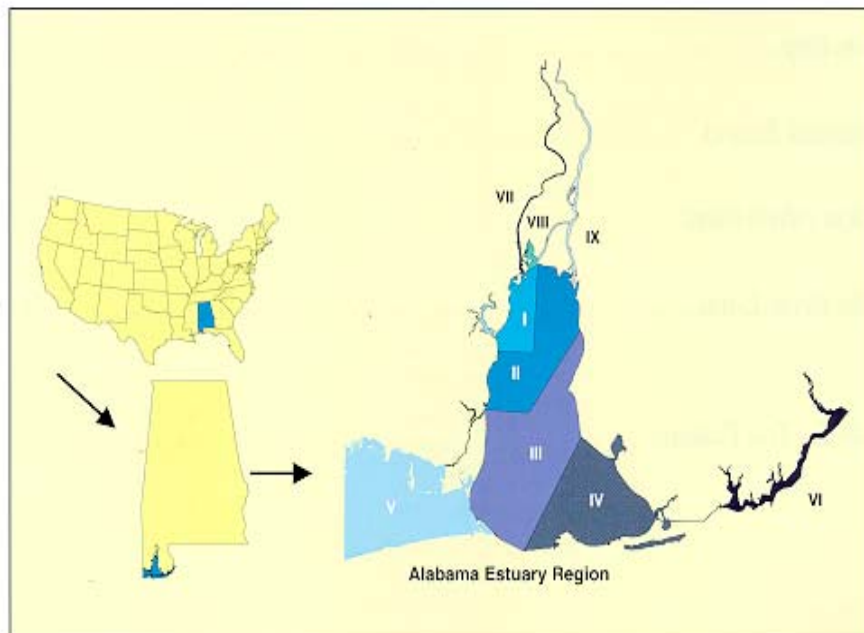
ALAMAP-C provides information on the ecological condition of Alabama's estuaries. Ecological health is being assessed by investigating the spatial distributions of physical, biological, and chemical indicators. ALAMAP-C determines what portions of estuaries support conditions that are favorable for both aquatic life and human use. ALAMAP-C also attempts to determine why certain areas may not be favorable for either aquatic life or human use.

Spatial Divisions Used by ALAMAP-C

The ALAMAP-C approach, during its developmental phase, placed all coastal waters, bays, estuaries, and tidal portions of rivers into defined areas for study. Alabama waters were divided into nine regions based on water use classifications. During the period 1993-1995, ALAMAP-C investigated the ecological condition of Alabama estuaries, including Mobile Bay, Perdido and Wolf Bays, the Alabama section of Mississippi Sound, and the tidal portions of the Mobile and Tensaw Rivers and delta system.

Coastal Waters Report Series

This report represents the first of a planned series of reports on the State of Alabama coastal waters based on the information collected by ALAMAP-C. As the program progresses, subsequent reports will seek to strengthen the statistical certainty and provide a series of documents portraying the changing conditions of Alabama's coastal waters. This report is not intended to be all-inclusive. Instead, it will characterize the condition of coastal waters by developing associations with environmental stressors and commonly accepted environmental indicators. In this initial report these characterizations will be limited to water and sediment quality and available biological data. Future reports may be expanded to include other ecological indicators such as contaminant residues in fish and shellfish.



Monitoring the Condition of Estuaries: ALAMAP-C

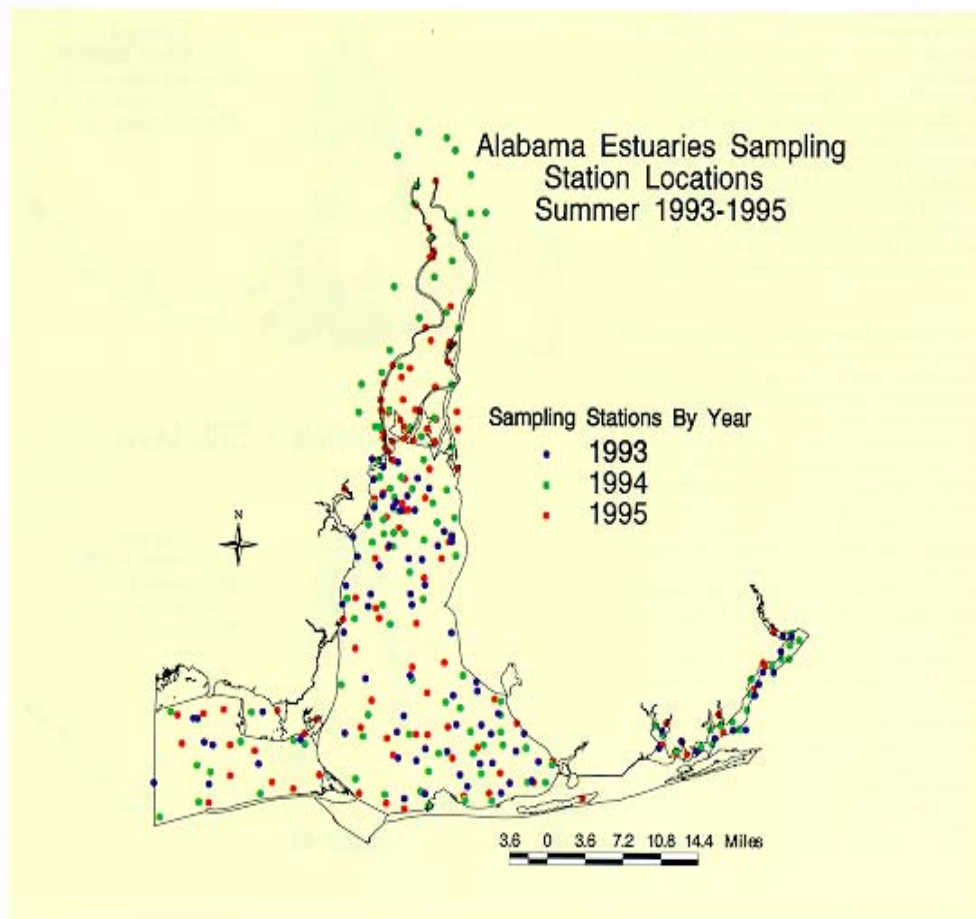
Sample Design

The statistical design used to select sampling sites in Alabama estuaries is based on EMAP's sample design for large estuaries. The estuaries of Alabama were divided into nine sub-regions based on water use classifications. A systematic grid, consisting of a set of points which, if connected, would form a series of adjacent equilateral triangles, is randomly placed over the coastal waters of Alabama. The base density of points in the grid is adjusted for each of the nine sub-regions. Each sampling point in each sub-region is representative of the hexagonal space surrounding that point. In this way, each resource is sampled in proportion to its geographical area. This sample design ensures strict adherence to requirements for probability sampling and allows the proportion of the area of a region that is affected by certain conditions to be estimated within given confidence limits.

Measurements taken by ALAMAP-C

All samples were collected during the summer months from 1993 through 1995 because ecological stressors are usually the greatest during this period. ADEM scientists collected bottom sediments to determine the number and type of benthic organisms present and to see if these sediments contained harmful chemical pollutants. Specialized equipment was used to measure salinity, temperature, pH, dissolved oxygen, depth, and secchi depth. Water column samples were taken and analyzed for bacteria, chlorophyll, turbidity, and nutrients (e.g., nitrogen and phosphorus).

A total of 355 sites were sampled during the three year period from 1993-1995. Not all regions nor all indicators were measured during all three years. This report summarizes the results of available information from 1993-1995 for Alabama estuaries. This includes water quality data for Regions I-VI from 1993-1995 and data for Regions VII-IX from 1994-1995. Bacteria levels were measured in all regions from 1994-1995. Benthic community data were only available for 1993. Sediment chemistry data were available for 1993-1994.



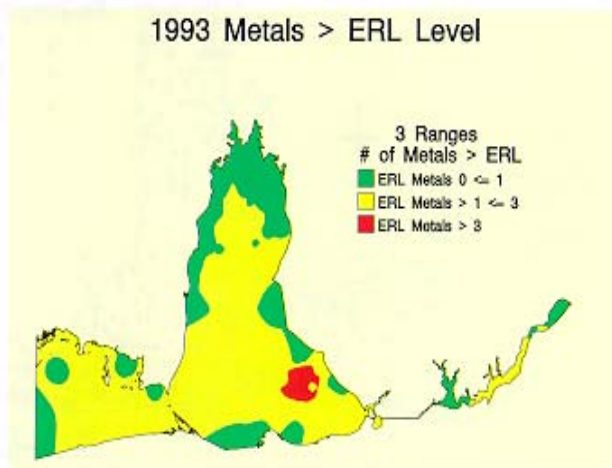
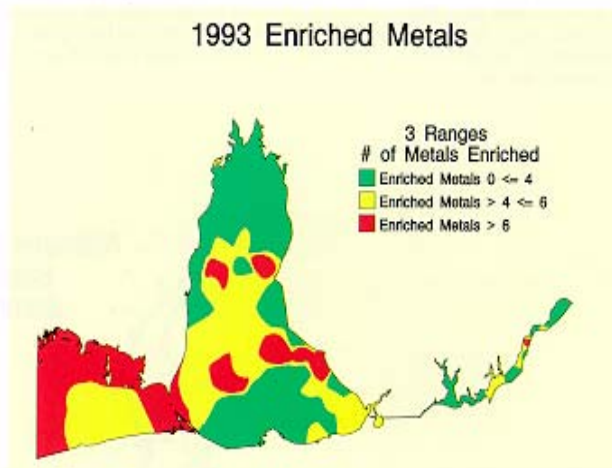
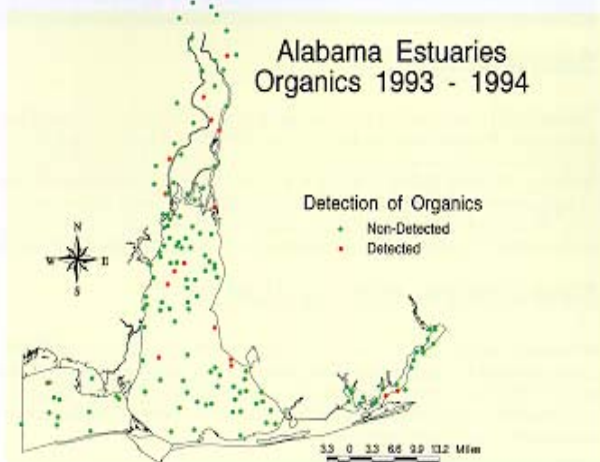
Sediment Quality

Sediment Chemistry

Contaminated sediments are viewed by the public as a major threat to estuarine ecosystems. In fact, contaminated sediments are often viewed as an indicator of poor estuarine condition even if the sediments are not toxic to estuarine plants and animals. ALAMAP-C has examined 213 sediment samples from Alabama coastal waters for 11 trace metals and 159 samples for 10 pesticides, including DDT and total PCBs. Contaminants seen in Alabama estuaries are characterized primarily by chemicals associated with urban runoff, ship building and repair, and industrial sources (e.g., chromium, zinc, DDT, and BHC).

In general, contaminant concentrations in sediments are at low to moderate levels throughout Alabama waters with some locally poor conditions. Indicators of sediment contamination include 1) the number of enriched metals, 2) the number of metal concentrations that exceed established guidelines, and 3) the number of organics with concentrations greater than their respective method detection limits. Sediments are considered to be enriched with metals if the concentration of any metal is greater than natural, background levels. To understand the potential impact that metal enrichment may have on the coastal ecosystem, the observed concentrations were compared to "Ecological Response" levels developed by Long et al. (1995). Ecological Response -Low (or ER-L) guidelines are based on literature reviews of sediment toxicity studies and suggest levels of contaminants that will result in detrimental ecological effects about 10% of the time.

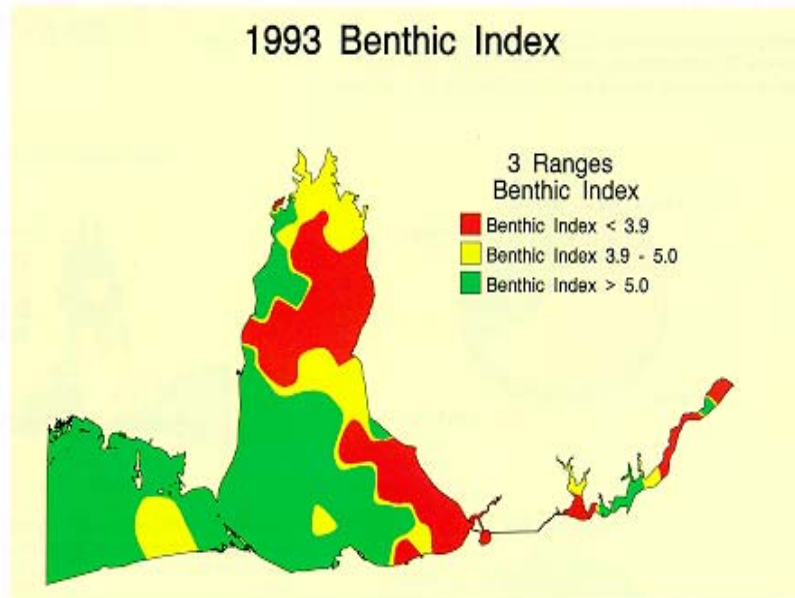
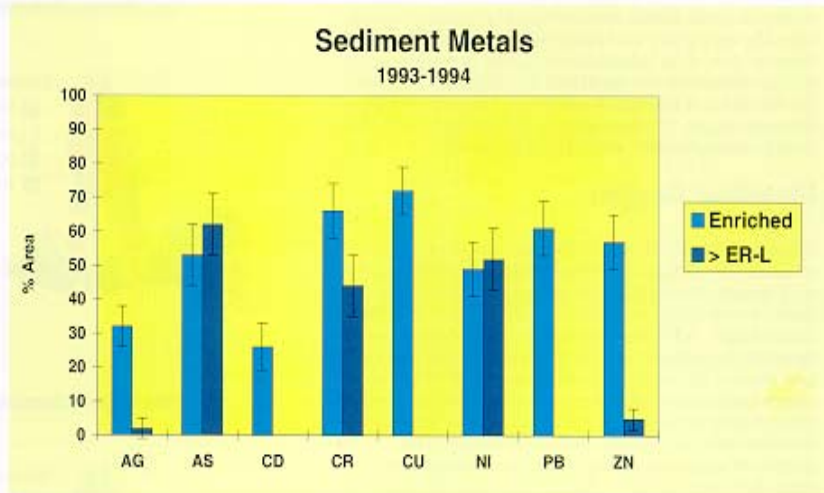
The proportion of estuarine area with contaminated sediments was consistent between years for Alabama waters overall. During 1993, 78% of the sediments showed nonexistent or slight metal enrichment, 99% of the sediments had very few metal concentrations above ER-L guidelines, and 97% of the sediments showed no detectable levels of organics. During 1994, 74% of the sediments showed nonexistent or slight metal enrichment, 96% of the sediments had very few metal concentrations above ER-L guidelines, and 98% of the sediments showed no detectable levels of organics. Only three out of eight metals (arsenic, chromium, and nickel) exceeded ER-L guidelines in a large portion of the estuaries. All of the eight metals measured showed enrichment in some portion of the estuaries with copper, chromium, and lead showing the greatest area of enrichment. In many cases, although a significant percent of the estuarine area was enriched with a certain metal, the concentrations were below the levels considered toxic to organisms. (Note: Due to analytical problems, mercury was excluded from all of the above summaries.)



Sediment Quality (cont'd)

Bottom Life

Sediment quality and water quality may also be indicated by the conditions of the organisms that live there. Benthic or bottom-dwelling invertebrates have often been used as indicators of both sediment and water quality in estuaries. EMAP-Estuaries has developed a benthic index of estuarine condition for the Louisianian Province (Gulf of Mexico estuaries). This index represents a linear combination of species diversity and the abundance of indicator taxa and has been used to discriminate between reference and degraded estuarine conditions (Engle, et al 1993). The benthic index is usually associated with hypoxia, contaminated sediments, or sediment toxicity. The benthic index is scaled from 1 to 10 with values greater than 5.0 representing good benthic conditions, values between 3.9 and 5.0 representing moderate benthic conditions, and values less than 3.9 representing degraded benthic conditions. ALAMAP-C applied this benthic index to the benthic data collected from Alabama estuaries in 1993. The benthic index indicated that 69% of the estuarine area was not degraded with respect to benthos.



In the absence of Federal or State sediment criteria, the authors have used references from the popular scientific literature to assist in the interpretation of these sediment data for this report. Reference to any particular set of values or contaminant level must not be construed as acceptance of, nor support for, the value as a Federal or State standard or criteria.

Water Quality

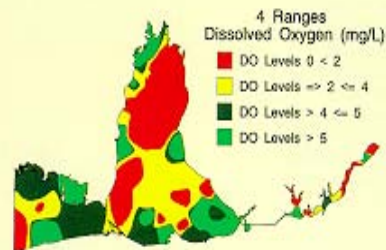
Although the major objective of this report is to describe the conditions of estuarine resources in Alabama using indicators of ecological health, certain characteristics of estuaries which are valued by society may not be covered by these indicators. However, four of the indicators collected by ALAMAP-C can provide information relevant to both the ecological condition and human use of estuaries in Alabama: 1) the concentration of dissolved oxygen, 2) water clarity, 3) concentrations of nutrients related to eutrophication, and 4) levels of bacteria.

Dissolved Oxygen

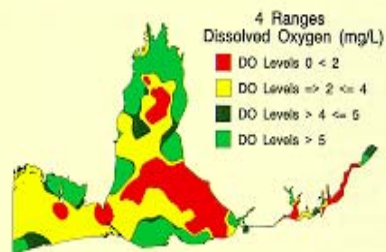
Dissolved oxygen (DO) is a fundamental requirement for all estuarine life. Alabama uses a threshold concentration of 4-5 mg/L (measured at the 5 foot or mid water depth) to set its water quality standard for most water use classifications applicable to coastal waters. A DO concentration of 2 mg/L, however, is thought to be extremely stressful to most estuarine organisms. Low levels of dissolved oxygen (hypoxia) or a complete lack of oxygen (anoxia) most often occur in bottom waters and severely impact benthic organisms. These conditions may accompany severe bacterial degradation, sometimes resulting in the presence of algal scum and noxious odors. Hypoxic-anoxic events have been recorded in Mobile Bay since 1821 and are the cause of the Jubilee, where demersal fish and invertebrates are literally driven onto the shore to escape low oxygen bottom waters. Periodic low levels of DO are a part of the natural ecology in Alabama coastal waters. Therefore, while it is easy to show the conditions regarding DO concentrations, it is difficult to interpret whether the observed conditions are the result of natural processes or human intervention.

During the summer months of 1993, 59% of the bottom water area had DO concentrations greater than 2 mg/L. In 1994, similar conditions prevailed with 68% of the bottom water area

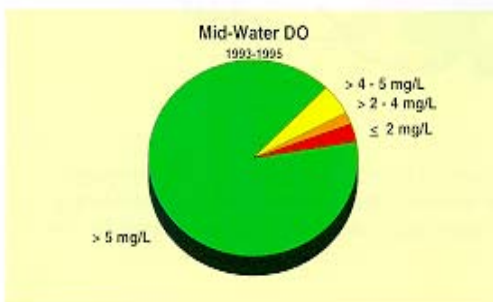
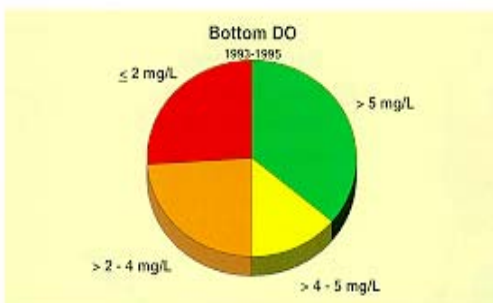
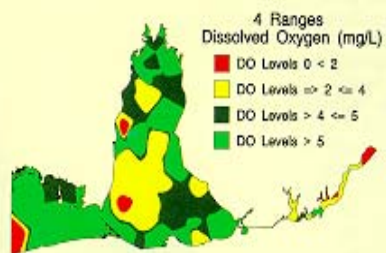
1993 Bottom Dissolved Oxygen



1994 Bottom Dissolved Oxygen



1995 Bottom Dissolved Oxygen



experiencing DO concentrations greater than 2 mg/L. In 1995, however, the proportion of bottom water area with low DO conditions was significantly reduced with only 6% with DO below 2 mg/L. If the mid-water DO criteria is used, Alabama waters would be rated as having good DO conditions with 88% of the area with mid-water DO greater than 4 in 1993, 99% in 1994, and 98% in 1995. Oxygen depletions primarily occurred in the mainstem portion of Mobile Bay in 1993 and 1994 and in Perdido Bay in all three years. Many of these areas may be continuously hypoxic during the summer months rather than experiencing a cyclic condition where low dissolved oxygen conditions occur only late at night.

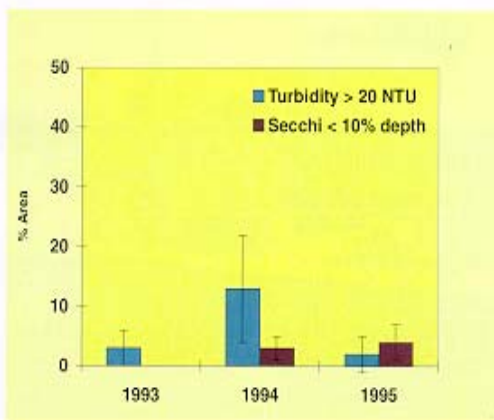
Water Quality (cont'd)

Dissolved oxygen conditions in Alabama waters are related to salinity patterns and especially to the degree of water column stratification evidenced by the difference in salinity from the surface to the bottom. The lowest DO conditions occur in areas with higher salinities and/or greater salinity stratification in all years. There is a significant association between increased levels of dissolved oxygen stress and the poor condition of bottom-dwelling organisms. While other environmental stresses also appear to affect bottom organisms, low levels of dissolved oxygen often co-occur with poor benthic conditions in Alabama waters.

Water Clarity

Clear waters are valued by society and contribute to the maintenance of healthy and productive ecosystems.

AL-EMAP estimates water clarity using two indicators: 1) turbidity which may be caused by suspended matter, such as clay, silt, soluble organic matter, plankton, and other microscopic organisms, and 2) secchi depth which represents an indirect measurement of sediment load and water clarity. For the purposes of this report, turbidity greater than 20 nephelometric turbidity units (NTU) and secchi depth less than 10 percent of the total water column depth are used to represent poor water clarity. Estuarine waters in Alabama occasionally show these conditions

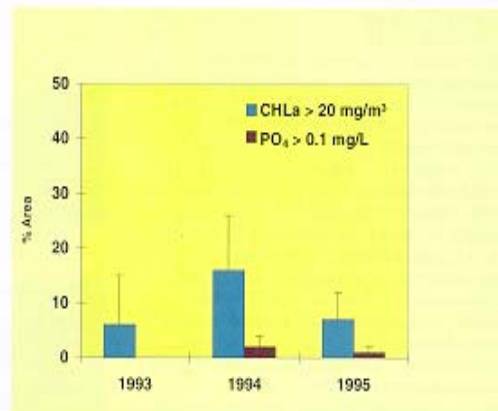
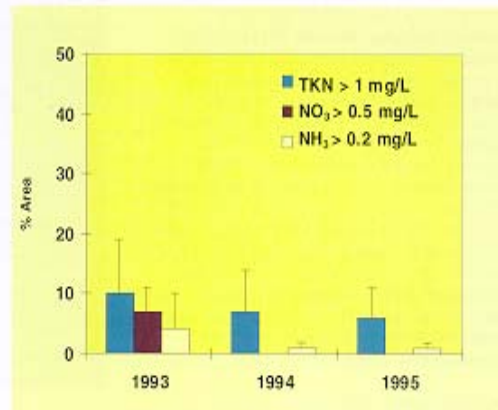


but, in general, Alabama coastal waters have good clarity. Less than 5 percent of the estuarine area showed secchi depths of less than 10 percent of bottom depth and/or turbidity greater than 20 NTU in 1993 and 1995. In 1994, good water clarity was indicated by secchi depth for 97% of the estuarine area and by turbidity for 87% of the area. Low water clarity primarily occurs in the upper reaches of Mobile Bay.

Nutrients

Eutrophication has been recognized as a priority problem in Gulf of Mexico estuaries. One of the most serious ecological effects of eutrophication is the depletion of dissolved oxygen associated with phytoplankton blooms. Because eutrophication refers to the conditions resulting from above-normal nutrient additions to a body of water and to the resulting increase in primary production by phytoplankton, ALAMAP-C measured the concentrations of nutrients and chlorophyll as indicators of nutrient enrichment. For the purposes of this report, nutrient enrichment is indicated if at least one of the following is true: 1) concentrations of

chlorophyll *a* exceed 20 mg/m³, 2) concentrations of ammonia (NH₃-N) are greater than 0.2 mg/L, 3) concentrations of nitrate (NO₃-N) exceed 0.5 mg/L, 4) total Kjeldahl nitrogen (TKN) exceeds 1 mg/L or 5) phosphate (PO₄) exceeds 0.1 mg/L. Alabama waters rarely showed excessive concentrations for either nitrate or ammonia. However, chlorophyll *a* was exceeded



in 16% of the estuarine area in 1994 and in 7% of the estuaries in 1995. TKN concentrations were exceeded in less than 10% of the estuaries in all three years.

Bacteria

Alabama has adopted standards for the levels of fecal coliform bacteria in its estuarine waters to protect shellfish harvesting, swimmability, and the health of fish and wildlife. Not all of the standards are applicable to all of the estuarine regions in Alabama. For the purposes of this report, a region showed poor quality for fecal coliform only if bacteria levels exceeded the standards that are applied to that region. Bacteria levels must be less than 14 colonies per 100 milliliters (cols) on average with a maximum of less than 43 cols in order to meet the criteria for shellfish harvest. A region was determined to be acceptable for swimming if bacteria levels were less than 100 cols. The criteria to be met for fish and wildlife is 100 cols. In general, 90% of all estuarine regions of Alabama met the applicable bacteria standards.

Applications of ALAMAP-C Estuaries Data

There is a growing need to know about the condition of estuarine resources that exceeds the boundaries of personal experience, conclusions in popular literature, or long-standing beliefs.

The ALAMAP-C program has compiled large amounts of information in a way that enables the experienced professional, as well as the relatively untrained observer, to examine the condition of estuarine resources. ALAMAP-C is designed to answer the following questions about the condition of Alabama estuaries: 1) What is the status of the ecological resources of estuaries in this region? 2) Are conditions improving or getting worse? and 3) What factors are most likely to influence the condition of Alabama estuaries? Users of this data must recognize that the data are intended to provide information pertaining to the region as a whole and not a specific site. These data have been used successfully to complete this regional characterization of Alabama estuaries and lend themselves to easily interpreted graphical representations such as the maps in this report.

The water quality and sediment quality indicators that have been monitored by ALAMAP-C do not stand alone, but rather, may be used to look at associations among indicators and to formulate hypotheses about their functional relationships in Alabama estuaries. For example, this data may be used to explore the following questions: 1) Are high concentrations of chlorophyll *a* driven by excess nutrients (i.e. nitrate or phosphate)? If so, does this indicate that eutrophication occurs in the estuaries of Alabama? 2) Is hypoxia a naturally occurring phenomenon in Mobile Bay (i.e. is it related to salinity stratification?) or is hypoxia due to a combination of natural and human-induced influences?, and 3) Is the benthic community structure affected more by natural factors such as salinity or by sediment contamination? Although ALAMAP-C was not designed to provide definitive answers to questions like these, the data generated from this program can be used to suggest which factors are more likely to affect the condition of Alabama estuaries.

There are interpretation issues related to the indicators that should not be overlooked. For example, consider the water clarity of estuaries. Many Americans would state a preference for clear, clean water rather than cloudy, unclear water, based on a desire for beachgoing and water contact sports. However, the American fishing population might prefer marginally clear (somewhat cloudy) waters because these waters attract fish. Such competing uses for the same resource make it very difficult to interpret these indicators. This does not mean that these types of indicators should be abandoned; but, potentially, these data may not be useful in evaluating the overall condition of estuarine resources, except within the context of a specific use.



Rating the Ecological Health of Alabama Estuaries

Among the national goals set by the Clean Water Act, restoring the ecological integrity of estuaries and ensuring their swimability and fishability is most applicable to the goals of ALAMAP-C. To rate how well we have achieved these goals, ALAMAP-C gauges conditions for ecological health and water contact in the estuaries of Alabama. The maps in the following section show the conditions associated with the indicators measured by ALAMAP-C in the estuaries of Alabama in 1993-95. The overall condition represents the weighted average of the individual indicators for the region. Those readers who would prefer to review the individual data may obtain a copy, for a nominal charge, by writing the Mobile Field Office, 2204 Perimeter Road, Mobile, AL., 36615.

WATER QUALITY. The quality of Alabama's coastal waters is an essential part of the overall coastal ecosystem health and, as such, is valued by society. The primary emphasis of ALAMAP-C is to describe and track the condition of estuarine resources, both the characteristics of estuarine health that are valued by society as well as those that are important to the ecology of estuaries. The four water quality indicators measured by ALAMAP-C can provide relevant information to both the ecological condition and human use of estuaries. Nutrient, dissolved oxygen, bacteria levels, and water clarity have been evaluated at most of the 355 sampling locations in the Alabama coastal region by ALAMAP-C.



Bacteria. The state of Alabama uses several criteria for determining the appropriate level of bacteria (measured as fecal coliform) allowable in different water bodies with different water use designations: 1) swimming (mean), 2) shellfish (mean and max), and 3) fish and wildlife (mean). Although all water bodies in Alabama are not subject to all criteria for bacteria levels, the percent area of each estuarine region that exceeded each of the fecal coliform criteria was estimated. Alabama waters, overall, were designated as having good water quality with respect to bacteria levels if <10% of the area failed any of the criteria. An individual region was designated as having good bacteria levels if <10% of the area failed any of the criteria. Additionally, regions were designated as fair if 10-25% of the area failed the criteria for bacteria levels and were considered in poor condition with respect to bacteria if >25% of the area failed the criteria.



Water Clarity. Water clarity is measured by the amount of ambient light that is able to reach to a certain depth in the water column. ALAMAP-C

measures two indicators of water clarity: 1) turbidity is a measurement of the amount of light refraction due to suspended particles in the water and 2) secchi depth represents the depth from the surface at which visible light ceases to penetrate. Good water clarity is indicated if <10% of the estuarine area in a region has either high turbidity (>20 NTU) or the secchi depth is less than 10% of the water column depth. If 10-25% of the estuarine area is affected by these conditions, the region is designated as fair with respect to water clarity and if >25% of the area has poor light penetration, the region is considered to have poor water clarity.



Dissolved Oxygen. In an estuary, a good rating for DO means that there is always enough oxygen in the water to support a healthy population of fish and other aquatic life. Alabama uses a threshold DO concentration of 4-5 mg/L at mid-water depth as a water quality standard. Low DO concentrations at the bottom, however, have direct effects on benthic fish and invertebrates. A concentration of less than 2 mg/L is considered extremely stressful to most estuarine organisms. A region is considered in good condition with respect to oxygen if <10% of the area has low bottom DO concentrations. An estuarine region is rated as poor with respect to oxygen if >25% of the area has bottom DO concentrations <2 mg/L, or if >50% of the area has bottom DO concentrations <4 mg/L.



Nutrients. High concentrations of nutrients may lead to excessive primary production and eutrophication in an estuary. ALAMAP-C rates nutrient quality as good if the concentrations of 1) chlorophyll *a* are below 20 mg/m³, or 2) ammonia are below 0.2 mg/L, 3) nitrate are below 0.5 mg/L, 4) total Kjeldahl nitrogen are below 1 mg/L, or 5) phosphate are below 0.1 mg/L. If <10% of the estuarine area exceeds these guidelines, the region is rated as having good water quality with respect to nutrients. A fair rating is given to a region if 10-25% of the area exceeds any of these guidelines. An estuarine region is designated as having poor nutrient quality if >25% of the area exceeds at least one of these guidelines.

SEDIMENT QUALITY. ALAMAP-C used a variety of physical, chemical, and biological indicators to determine whether the sediments of Alabama coastal waters are capable of supporting healthy benthic communities and to identify possible problems that should be studied more closely. Two key indicators are used to rate each estuarine region's overall sediment quality: bottom life and sediment contaminants.



Bottom Life. A good rating for bottom life means that samples taken from an estuary's sediments contain a wide variety of species, a low proportion of pollution-tolerant species, and a high proportion of pollution-sensitive species. These properties are embodied in the EPA-EMAP benthic index. A region is considered in good condition if <10% of the area has a low benthic index score. If >25% of the area of a region has a low benthic index value, then the region is rated as poor with respect to the quality of its bottom life.



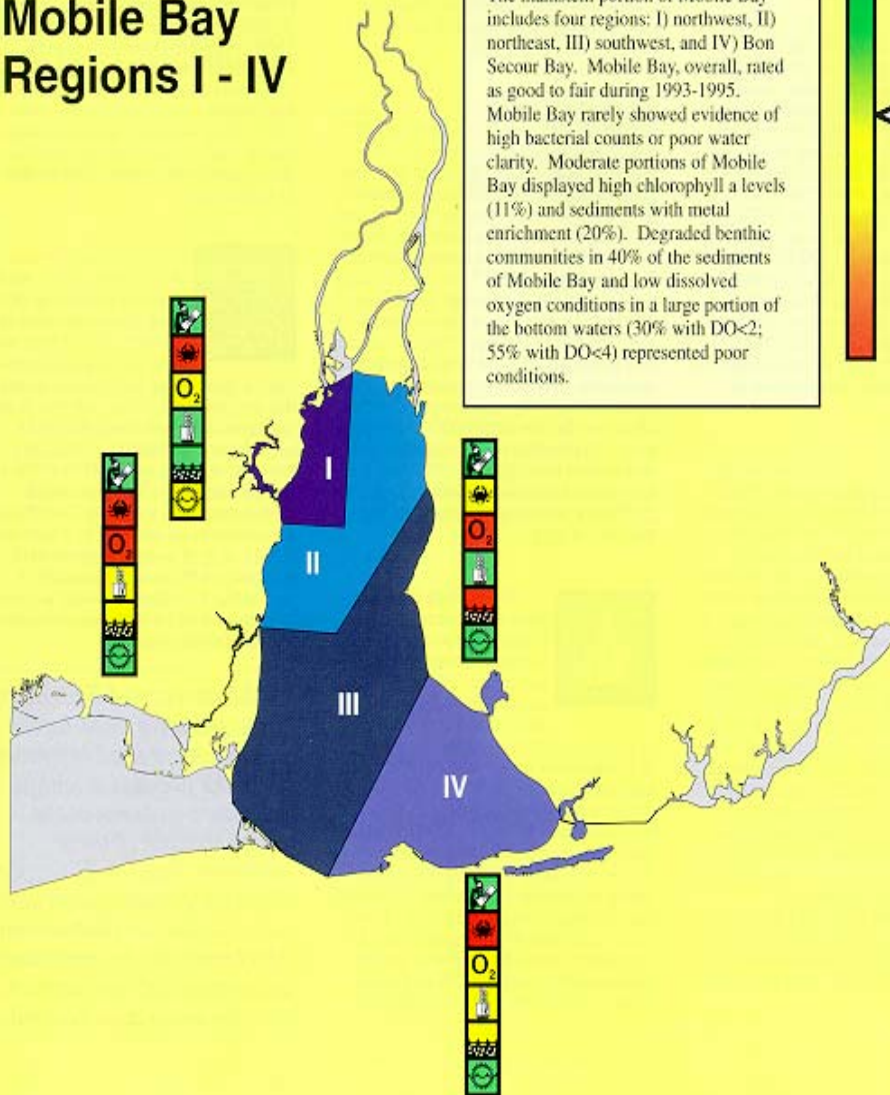
Sediment Contaminants. A sediment quality determination is based on the level of contamination in the sediments by both inorganic and organic chemicals. A good rating for sediment means that any potentially toxic materials in the sediments are below levels that could cause harm to bottom life. An estuary has good sediment quality if 1) <10% of the sediments have 3 or more metals greater than ER-L values, or 2) <10% of the sediments are enriched by 6 or more metals, or 3) if no detectable levels of pesticides or PCBs were measured. A poor rating for sediment quality is given to a region if >25% of the estuarine area exceeded these guidelines.

In the absence of Federal or State sediment criteria, the authors have used references from the popular scientific literature to assist in the interpretation of these sediment data for this report. Reference to any particular set of values or contaminant level must not be construed as acceptance of, nor support for, the value as a Federal or

Ecological Health at Sampling Locations

	Good	Fair	Poor		Good	Fair	Poor
Bacteria				Nutrients			
Benthos				Sediments			
Dissolved Oxygen				Water Clarity			

Mobile Bay Regions I - IV



Mobile Bay - Overall Condition

The mainstem portion of Mobile Bay includes four regions: I) northwest, II) northeast, III) southwest, and IV) Bon Secour Bay. Mobile Bay, overall, rated as good to fair during 1993-1995. Mobile Bay rarely showed evidence of high bacterial counts or poor water clarity. Moderate portions of Mobile Bay displayed high chlorophyll levels (11%) and sediments with metal enrichment (20%). Degraded benthic communities in 40% of the sediments of Mobile Bay and low dissolved oxygen conditions in a large portion of the bottom waters (30% with DO<2; 55% with DO<4) represented poor conditions.



Region I - NW Mobile Bay

The northwest region of Mobile Bay rated as good to fair during 1993-1995. Bacteria levels rarely exceeded the fish and wildlife standards in this region (7%). Northwest Mobile Bay showed good conditions for nutrients and sediment quality. Dissolved oxygen conditions (16% with $DO < 2$; 36% with $DO < 4$) and water clarity (14% with high turbidity) rated as fair. Only bottom life conditions were poor (33%).

OVERALL



Region II - NE Mobile Bay

The northeast region of Mobile Bay rated as fair during 1993-1995. Conditions were good for bacteria and water clarity. Moderate areas of this region showed high nutrient levels (15% with high chlorophyll; 12% with high nitrate) and sediments that were enriched with metals (13%). Bottom life (71%) and dissolved oxygen conditions (37% with $DO < 2$; 50% with $DO < 4$) were considered poor.

OVERALL



Region III - SW Mobile Bay

The southwest region of Mobile Bay rated as good to fair during 1993-1995. Bacteria levels never exceeded the lowest standards and conditions were good for nutrients and water clarity. Bottom life conditions were fair (22%). A large portion of this estuarine area had poor dissolved oxygen conditions (32% with $DO < 2$; 69% with $DO < 4$) and sediments enriched with metals (27%).

OVERALL



Region IV - Bon Secour Bay

Overall conditions in Bon Secour Bay were rated as good to fair during 1993-1995. Bacteria levels never exceeded the lowest standards and conditions were good for water clarity. Moderate portions of this estuarine area were affected by low dissolved oxygen conditions (25% with $DO < 2$; 45% with $DO < 4$), nutrients (15% with high chlorophyll *a* levels), and contaminated sediments (21% with metal enrichment). Only bottom life conditions were poor (43%).

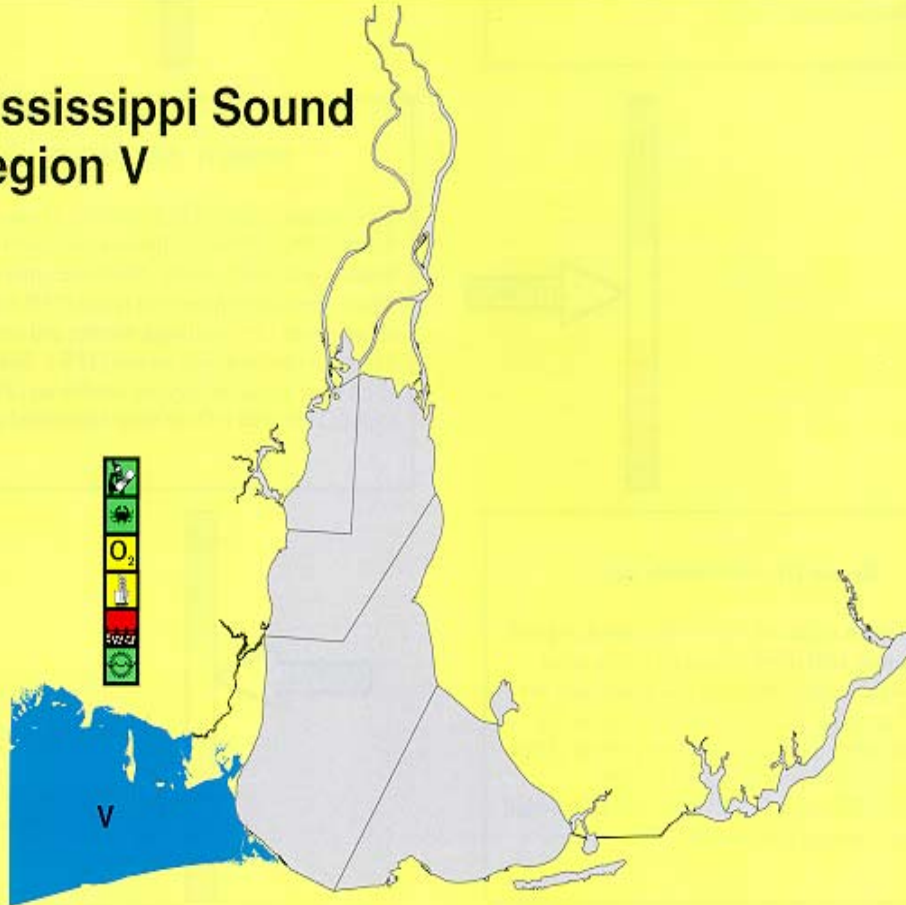
OVERALL



Ecological Health at Sampling Locations

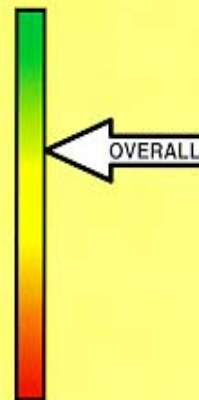
	Good	Fair	Poor		Good	Fair	Poor
Bacteria				Nutrients			
Benthos				Sediments			
Dissolved Oxygen				Water Clarity			

Mississippi Sound Region V



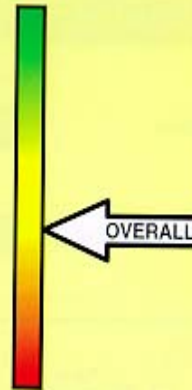
Region V - Mississippi Sound

Region V includes the Alabama portion of Mississippi Sound. This region was rated as good to fair during 1993-1995. Bacteria levels never exceeded the lowest standards and conditions for bottom life were always good. Conditions were rated as fair with respect to dissolved oxygen (14% with DO<2; 38% with DO<4) and nutrients (18% with high chlorophyll *a*). Only contaminated sediments were given a poor rating with 38% of the area showing sediments that were enriched with metals.

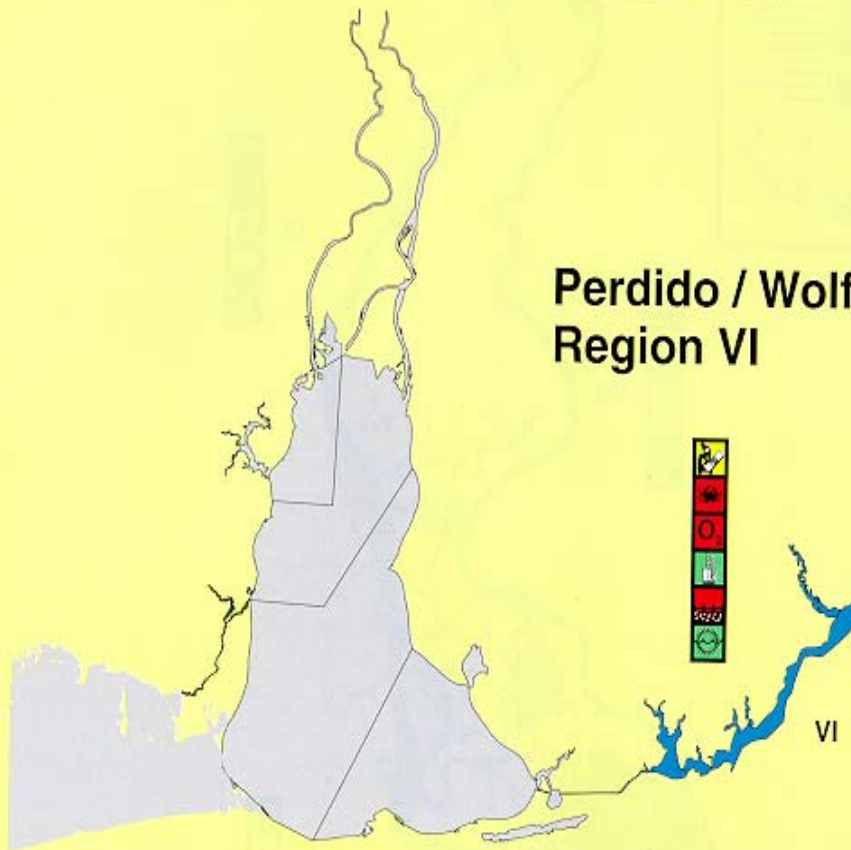


Region VI - Perdido/Wolf Bays

Region VI includes the Alabama portion of Perdido Bay as well as Wolf Bay and the intercoastal waterway between the two bays. Conditions in this area were rated as fair to poor during 1993-1995. Good ratings were given to this area for nutrients and water clarity. Region VI is the only area that did not receive a good rating for bacteria with 11% of the area exceeding the standard for shellfish. Half of the indicators suggested poor conditions, including bottom life (69% with low benthic index), dissolved oxygen (44% with DO<2; 71% with DO<4), and sediment contaminants (30% with metal enrichment).



Perdido / Wolf Bays Region VI

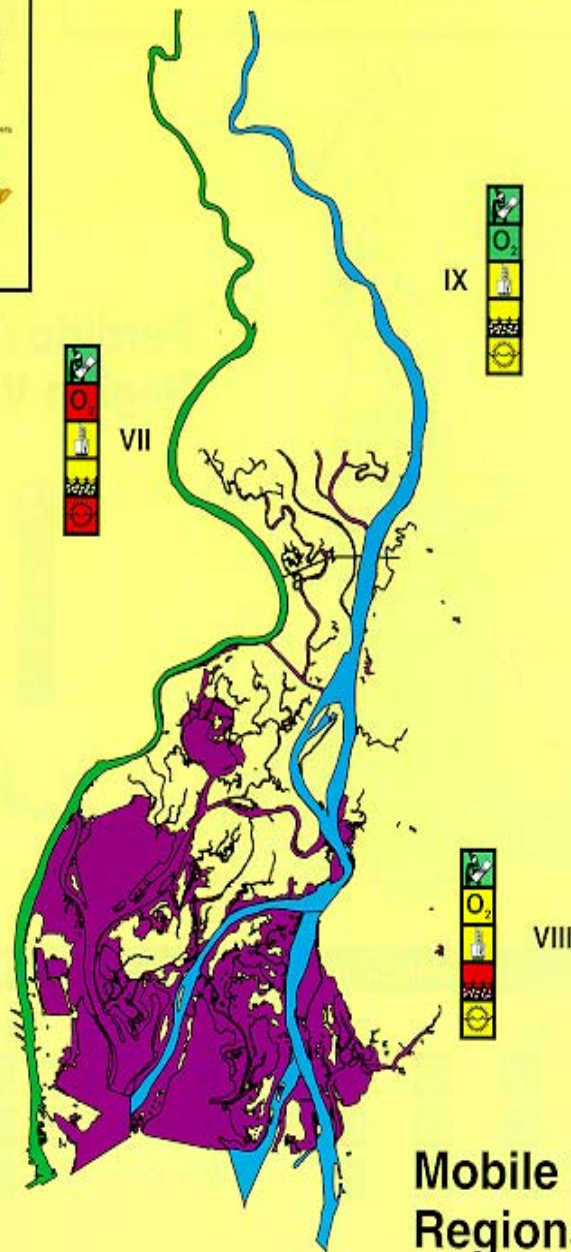


Ecological Health at Sampling Locations

	Good	Fair	Poor		Good	Fair	Poor
Bacteria				Nutrients			
Benthos				Sediments			
Dissolved Oxygen				Water Clarity			

Ecological Health at Sampling Locations

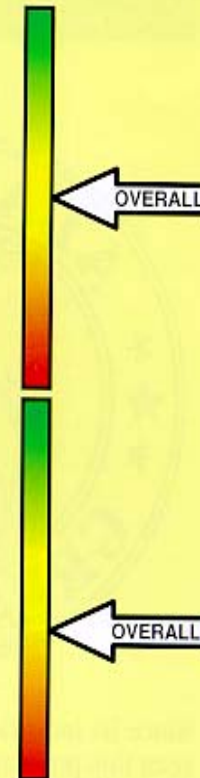
	Good	Fair	Poor		Good	Fair	Poor
Bacteria				Nutrients			
Dissolved Oxygen				Sediments			
				Water Clarity			



**Mobile River Delta
Regions VII - IX**

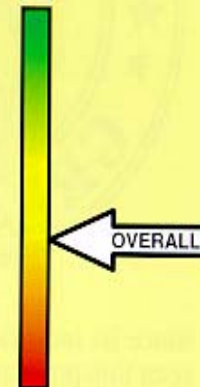
Mobile/Tensaw Rivers and Delta - Overall Condition

This area at the headwaters of Mobile Bay includes the tidal portions of the Mobile and Tensaw Rivers as well as the river delta region. Conditions in this area rated as fair during 1994-1995. This area was not sampled in 1993. Bacteria levels rarely exceeded either the fish and wildlife standards or the swimming criteria. Moderate portions of the area were affected by low dissolved oxygen conditions (15% with $DO < 2$; 26% with $DO < 4$), nutrients (17% with high chlorophyll *a* levels), and poor water clarity (23% with poor secchi depth readings). Sediments were rated as poor because 26% of the area showed detectable concentrations of sediment pesticides or PCBs.



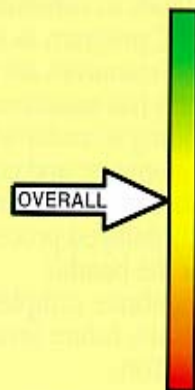
Region VII - Mobile River

The Mobile River was rated as fair to poor during 1994-1995. Bacteria levels never exceeded the fish and wildlife standard. Conditions for nutrients and contaminated sediments were fair (10% with high chlorophyll *a*; 13% with high ammonia levels; 10% with metal-enriched sediments). Dissolved oxygen conditions were poor in a large portion of the area (48% with $DO < 2$; 58% with $DO < 4$). Water clarity was also poor in 77% of the area.



Region VIII - Mobile/Tensaw River Delta

The delta region was rated as fair during 1994-1995. Bacteria levels never exceeded the fish and wildlife standard. Ratings of fair were given to this area for dissolved oxygen (18% with $DO < 2$; 35% with $DO < 4$), nutrients (21% with high chlorophyll *a*), and water clarity (18% with low secchi depths). Only contaminated sediments received a poor rating with 33% of the area showing detectable levels of pesticides or PCBs.



Region IX - Tensaw River

The Tensaw River was rated as good to fair during 1994-1995. Bacteria levels never exceeded the fish and wildlife standards and rarely exceeded the criteria for swimming. Dissolved oxygen levels never fell below 4 mg/L. Moderate portions of the area were affected by high nutrient levels (13%), contaminated sediments (20% with detectable levels of organics), and water clarity (15% with low secchi depths; 17% with high turbidity). This region did not receive a rating of poor for any of the indicators.



ALAMAP-C - The Future



Since its inception, you may have seen this program referenced as Alabama REMAP or ADEM's EMAP in various 305(b) reports or other technical publications. The success of this particular program led ADEM to revise its statewide ambient water quality monitoring program to incorporate similar sampling methodology on a watershed basis. ALAMAP - Coastal and ALAMAP - Upland are now portions of the Department's overall environmental monitoring strategy known as "ADEM's Strategy for Sampling Environmental Indicators of Surface water quality Status" (ASSESS).

ADEM is participating in local efforts within the coastal area to better coordinate the efforts of Federal, State and private entities involved in various monitoring activities. These efforts may result in some modification to how this program is implemented (i.e., location of sampling sites, frequency of sampling, etc.) in an effort to expand the scope of resources monitored. Additionally, the suite of analytical parameters may be modified as the years progress, deleting analyses for contaminants which are not being detected or which are no longer of concern, and adding ones which may impact upon or better define ecological health of Alabama's estuaries.

ADEM intends to continue the ALAMAP-C program as long as funding and resources are available. The program has unsuccessfully sought funding to assist with both initial development and continued implementation. The scarcity of funding has delayed processing and analysis of the benthic macroinvertebrate samples and jeopardizes the future level of analytical effort.

Technical data reports are prepared annually and statistical summaries, similar to this one, are planned following each four year cycle.

The appropriate citation for this document is:

Carlton, J., J. S. Brown, J. K. Summers, V. D. Engle, P. E. Bourgeois. 1997. *A Report on the Condition of the Estuaries of Alabama in 1993-1995: A Program in Progress*. Alabama Department of Environmental Management, Mobile, AL.

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Note: This report is not intended as a technical level document for the purposes of determining compliance with State or Federal environmental standards or criteria. Such technical reviews are provided in ADEM's biennial 305(b) Water Quality Report to Congress. It is intended to provide a general interpretation of the scientific data, in lay terms, and to generally characterize the condition of Alabama's estuaries. State or Federal standards are used within this report only as reference points although in some instances (i.e. bacteria) the ALAMAP-C sampling design is not in strict conformance with the requirements associated with the standard (i.e. sanitary survey). Where no recognized standard is available, professional judgment and the scientific literature is used to provide references points for the characterization of ecological conditions. Such references should not be construed as appropriate for formal recognition as a State or Federal standard or criteria.

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