Task 14

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MAN VERSUS MOLLUSC:

Studies of Water Quality Problems, How They Affect Shellfish and Shellfish Harvesting, and How the Commonwealth Should Address these Problems

A Report to the Shellfish Enhancement Task Force

By

Bruce Neilson, Nancy C. Wilson, and Carl Hershner

Virginia Institute of Marine Science
The College of William & Mary in Virginia
Gloucester Point, VA 23062

December 1991

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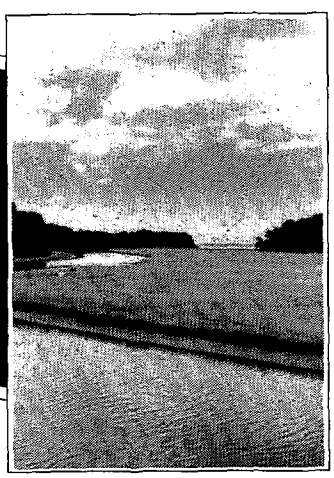
Council on the Environment Commonwealth of Virginia

VIRGINIA
COASTAL RESOURCES
MANAGEMENT PROGRAM



The Virginia Coastal Resources Management Program links state programs to manage coastal resources. The program's coastal boundary includes the 29 counties and 15 cities within Tidewater Virginia. The program is coordinated and monitored by the Virginia Council on the Environment.

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TABLE OF CONTENTS

Chapter No.	Title	Page No.
	Table of Contents	ii
	Executive Summary	iv
	Preface	ix
MAN VERSUS MOLLUSC Case Studies of Water Quality Problems and How They Affect Shellfish & Shellfish Harvesting		
1.0	Introduction	1
1.1	Current Virginia Shellfish Condemnation Areas	2
1.2	Elizabeth River: A Case Study of Bioaccumulation & Bioconcentration	5
1.3	Bonum Creek: A Case Study of Indicator Organisms & Nonpoint Source Pollution	10
1.4	Nansemond River: A Case Study of Impacts of Headwater Pollution Sources	14
1.5	Lynnhaven Bay System: A Case Study of Point Source Controls and the Consequences of Subrrban Runoff	18
1.6	Summary of Case Study Findings	25
WATER QUALITY PROBLEMS AND TRENDS IN OTHER COASTAL STATES AND THE CHESAPEAKE BAY SYSTEM		
2.0	Introduction	27
2.1	Conditions in Other Coastal States	27
2.2	Population and Development Trends	32

TABLE OF CONTENTS (Continued)

Chapter No.	Title	Page No.
RECOMMENDATIONS TO PROTECT VIRGINIA'S SHELLFISH GROWING AREAS AND PROMOTE THE SHELLFISH INDUSTRY		
3.0	Selection of Management Strategies for Virginia	33
3.1	Establish a Program to Designate "Shellfish Culture Areas" within the Commonwealth	34
3.2	Promote Alternative Methods of Shellfish Cleansing	37
3.3	Reduce All Pollutant Sources, Especially Sources of Fecal Pollution, and Restore Chesapeake Bay	44
4.0	References	50
	APPENDICES	
1.	SENTAF Members	56
2.	Closures in Lynnhaven Bay System	57
3.	Survey of Shellfish Sanitation Workers in Other States	65
4.	Workshop Attendees	79
5.	Agency Responsibilities for Shellfish and Water Quality	80
6.	Estimates of Oyster Resource in Closed Shellfish Growing Areas	85
7.	Estimated Annual Cost for a Long Range Program to Assist Low Income Families with Failing Septic Systems	88

EXECUTIVE SUMMARY

Shellfish pump water to obtain food, but in so doing they also accumulate pollutants. Thus, pristine water quality is needed for shellfish growing waters in order to protect the public health. The bacteriological standard for shellfish growing waters is much more stringent than that for recreational waters. Specifically, the mean number of fecal coliform organism per 100 milliliters of water must be less than 14 for shellfish growing waters, but can be as high as 200 for recreational waters in which people bathe and swim.

A small amount of sewage, such as from a failing septic system or a few farm animals, is sufficient to cause the growing area standard to be violated. Runoff from suburban and urban areas degrades water quality during wet weather periods and also results in violations of the growing area standard.

The Year 2020 Commission projects a continued increase in the population in the Chesapeake Bay watershed and an increase in the amount of land that is developed for each person. Thus impacts of nonpoint source pollution are expected to grow.

Special efforts are needed to ensure that there will always be growing waters of the necessary water quality. Other efforts are needed to allow shellfish from moderately polluted areas to be harvested and, after cleansing, sold. Specifically, it is recommended that the Commonwealth:

Establish a program to designate "Shellfish Culture Areas",

Promote alternative methods of shellfish cleansing, and

Reduce all pollutant sources, especially sources of fecal pollution, and restore Chesapeake Bay.

The more detailed recommendations, which are needed to implement these general recommendations, are listed on the following pages and in the main body of the report.

GENERAL RECOMMENDATION #1. THE COMMONWEALTH SHOULD ESTABLISH A PROGRAM TO DESIGNATE "SHELLFISH CULTURE AREAS"

Recommendation #1-a. The Council on the Environment should recommend to the General Assembly a program to nominate and designate Shellfish Culture Areas.

Recommendation #1-b. The Division of Shellfish Sanitation of the State Health Department should develop the water quality criteria appropriate for designated Shellfish Culture Areas.

Recommendation #1-c. The Division of Shellfish Sanitation, in conjunction with the Shellfish Enhancement Task Force, should conduct a preliminary inventory of state waters which meet these criteria.

Recommendation #1-d. The Marine Resources Commission should be the lead agency and be responsible for registering and monitoring Shellfish Culture Areas.

Recommendation #1-e. The Council on the Environment should establish the nomination procedures.

Recommendation #1-f. The official designation of Shellfish Culture Area should be an act of the General Assembly.

Recommendation #1-g. The Division of Shellfish Sanitation should be charged with overseeing the designated areas and ensuring that state and local government regulatory actions are consistent with the program.

Recommendation #1-h. The Council on the Environment should ensure that the Shellfish Culture Areas program conforms to Virginia's Coastal Resources Management Plan and use moneys, when possible, through the VCRMP to assist the other state agencies agencies in completing their assigned tasks.

GENERAL RECOMMENDATION #2. THE COMMONWEALTH SHOULD PROMOTE ALTERNATIVE METHODS OF SHELLFISH CLEANSING

A number of historically productive shellfish areas are closed and are projected to remain closed indefinitely. Even though the growing area standard is not met, water quality is good, usually good enough that shellfish will be cleansed if placed in clean waters for an established period of time.

Transferring, or "relaying", clams or oysters to clean waters provides the cleansing necessary to protect public health, but it is expensive. Relaying clams in trays held off the bottom has proven to be reliable and economically advantageous. At present many clams but few oysters are being cleansed using "caged relaying".

The cleansing of shellfish in a controlled environment is called depuration. Depuration plants have been used for decades in many states and in other countries, but none has been approved for operation in Virginia.

Recommendation #2-a. The Virginia Sea Grant Program should develop and disseminate a bulletin providing information on caged relaying operations.

Recommendation #2-b. The Division of Shellfish Sanitation should notify those individuals currently operating shellfish processing facilities, and other appropriate industry officials, of the Division's willingness to work to see that a depuration facility is established.

Recommendation #2-c. The Commonwealth should hire an engineering firm to design a "typical" depuration facility and estimate the costs to construct and equip this facility. These plans should be available to all interested parties.

Recommendation #2-d. Management agencies should assist the owners of the first depuration facility during the start-up tests. This assistance could include financial support or in-kind services.

Recommendation #2-e. The Commonwealth should coordinate its regulatory activities to facilitate permitting for depuration facilities.

Recommendation #2-f. The Marine Resources Commission should investigate how the state can provide financial incentives to depuration plant operators.

GENERAL RECOMMENDATION #3. ALL VIRGINIA AGENCIES SHOULD WORK TO IMPLEMENT THE CHESAPEAKE BAY PROGRAM ACTION AGENDA

The Chesapeake Bay Program includes many programs and efforts directed towards restoration of Chesapeake Bay. The recent Governors Agreement spells out an action agenda for the coming years. If this action agenda is followed, the shellfish and the shellfish industry should benefit. A few special efforts are needed to augment those already underway.

GENERAL RECOMMENDATION #4. THE AMOUNT OF SEWAGE REACHING STATE WATERS FROM MALFUNCTIONING SEPTIC SYSTEMS SHOULD BE REDUCED.

The water quality standards for shellfish growing waters are very stringent. Water quality is especially vulnerable to the discharge of raw sewage. Special efforts are needed to reduce sources of fecal pollution.

Recommendation #4-a. The state should re-instate the Chesapeake Bay Initiative that provided financial assistance to low income families who resided near shellfish growing waters and had failing septic systems; the level of support should be $250,000 per year.

Recommendation #4-b. The Shellfish Enhancement Task Force should regularly study and make recommendations on areas where the extension of sewer lines is expected to have a positive impact on shellfish growing water quality.

GENERAL RECOMMENDATION #5. THE STATE SHOULD TAKE STEPS TO REDUCE POLLUTION ARISING FROM BOATING ACTIVITIES.

Recommendation #5-a. State regulatory agencies should work to establish No Discharge Zones in shallow and congested areas.

Recommendation #5-b. The Health Department should set a time table (circa 3 to 5 years) for full compliance with the requirements for marinas to have pump-out facilities and should ensure that complete compliance was achieved at the end of that period.

Recommendation #5-c. The Division of Shellfish Sanitation should include, as part of the procedures for establishing condemnation zones around marinas, an explicit factor relating to the availability and use of pump-out facilities.

Recommendation #5-d. Facilities whose operations result in buffer zones or condemned areas should be made financially responsible for the maintenance of the signs indicating these closures.

Recommendation #5-e. The Health Department should continue and expand its "Don't Pass the Bucket" educational campaign.

Recommendation #5-f. The Health Department and the Water Control Board should work with funding agencies and private sources to conduct a demonstration project that brings sewerage to "live-on" boats.

PREFACE

In 1985 the Secretary of Commerce and Natural Resources requested that a task force be formed to coordinate the state's water pollution control efforts in shellfish growing areas. The Shellfish Enhancement Task Force or SENTAF, was established by the Marine Resources Commissioner and included representatives from many agencies (See Appendix 1 for SENTAF membership). Members ranked areas with regard to the resource in the area and the likelihood that water quality problems could be eliminated. In the targetted areas, failing septic systems were repaired through a special Chesapeake Bay Initiative funded by the legislature. Other pollution sources were eliminated or reduced, especially through cost sharing programs for agricultural runoff. These initial efforts were quite successful and over 6,000 acres of shellfish bottoms were re-opened as a consequence.

Subsequent efforts were not so successful. Although pollutant loads were reduced, the resulting water quality improvements were not sufficient to allow many additional shellfish areas to be opened. SENTAF members were of the opinion that the inter-agency cooperation and coordination were good and that the efforts had averted some new growing area closures. Members were discouraged that there appeared to be little chance that more areas would be re-opened, despite the collective efforts of the agencies. There was concern that at with "business as usual", most shellfish bedswould be closed, with the obvious negative impact that would have on the state and the shellfish industry. New management approaches seemed necessary to protect and enhance the industry.

A proposal was prepared and submitted to the Coastal Zone Management Program to study both the causes of the problems and possible solutions for the future. The project was funded and the Virginia Institute of Marine Science was contracted to do the studies. This report summarizes the project efforts and findings. First, the case study approach was used to define and describe the problem. Second, a survey of shellfish sanitation workers in other coastal states and a workshop were used to identify possible management actions, and these led to the study recommendations described below. The Task Force attempted to make these recommendations as specific as possible and for the costs to be moderate, and thus have a good chance of implementation.

This report fully describes the project. In addition, the study findings and recommendations will be summarized in a brief report which will be distributed widely. The Oyster Blue Ribbon Panel, the shellfish industry, legislators, management agency staffs and administrations, environmental advocacy groups, and other citizens are all target audiences.

MAN VERSUS MOLLUSC
Case Studies of Water Quality Problems and How They Affect Shellfish & Shellfish Harvesting

1.0 INTRODUCTION

An old joke features the newspaper headline "Man Bites Dog." Although we are not dealing with a joking matter, the headline for our story might read "Man Mugs Mollusc," for shellfish need clean waters and people produce pollution. Therein lies the source of a continuing problem. Shellfish harvesting restrictions in Hampton Roads date back to the turn of the century and those in many other areas have been in existence for decades (see Chapter 1.6 and Appendix 2, for examples).

Water pollution control efforts over the past twenty years have done much to reduce the impacts of pollution on the shellfish industry. Projections for population growth and development, however, suggest that additional efforts are needed. If we are not successful, soon there will be only a few places in Virginia where shellfish can be harvested for direct marketing.

The purpose of the study is to investigate the problem and make recommendations regarding the state's management of water quality and shellfish resources. The first step towards solving any problem is to define exactly what the problem is. In this section of the report, we begin by reviewing a number of situations or case studies that, we hope, will elucidate the ways that water quality degradation affects shellfish and the shellfish industry. This exercise is important because it helps us to understand the problem and devise strategies that will reduce impacts.

1.1 CURRENT VIRGINIA SHELLFISH CONDEMNATION AREAS

It is the responsibility of the Virginia Department of Health, through the Division of Shellfish Sanitation, to ensure that shellfish taken from Virginia waters are safe for human consumption. Because Virginia shellfish are transported to other states, federal regulations apply. The Food & Drug Administration's water quality standards are established by the National Shellfish Sanitation Program (NSSP).

In order for shellfish to be harvested for direct marketing, the waters must not only be of high quality, but there also must be limited potential for water quality pollution. For example, in harbors such as Hampton Roads, areas adjacent to anchorages are closed because vessels could anchor there and, while anchored, could discharge sewage overboard. Although the anchorage may be used infrequently, there is always the possibility that it will be used and that water quality will be impacted. While some may object that these precautions are not needed, it is typical of public health officials to be very cautious and to guard against all possible vectors for disease.

Degraded water quality can mean contamination with fecal matter or pollution of a chemical nature. Both can be the cause of a shellfish closure, but in practice, most condemnations and closures are due to fecal contamination. The mean fecal coliform count of approved growing waters must be no higher than 14 MPN per 100 milliliters of water; MPN (most probable number) is a statistical estimate of number of fecal coliform organisms in the water using the results of laboratory incubations. When the numbers are greater than 14, this 'red flag' indicates the possible presence of disease causing organisms.

Virginia shellfish waters are continually monitored by the Division of Shellfish Sanitation and are classified according to their state of 'harvestability' as follows:

1. Approved - direct harvesting to market allowed;

2. Conditionally approved - direct harvesting allowed under predictable conditions. Closing occurs when criteria are not met (i.e. following a rainfall);

3. Restricted - direct harvest to market not allowed. Shellfish must be relayed to approved areas for depuration or placed in purification tanks for specified periods of time;

4. Prohibited - no harvesting permitted.

Currently condemned areas (as of 30 January 1991) are shown in Figure 1. One can identify several types of condemned areas. First, much of Hampton Roads on the Bay side of Newport News Point is closed due to vessel traffic and anchorages for commercial freighters. Second, areas with heavy industrial activitiy and/or industrial discharges are closed. These include the Elizabeth River and the portion of the York River near West Point.

Third, parts of the James River, especially along the Newport News shoreline, are closed due to the discharges from large wastewater treatment plants, as is a portion of the lower York River. As with anchorages, the condemned areas around sewage treatment plant outfalls exist more because of the potential for problems than due to degraded water quality. Since 1972, wastewater treatment has improved markedly. EPA also has required safeguards such as interconnections between plants and auxiliary power supplies at each plant. Nonetheless, there remains the possibility that raw or only partially treated sewage will be discharged due to malfunctions, acts of God, or other causes. Consequently, the FDA requires and the Health Department establishes permanently condemned areas, where shellfishing is prohibited, around each outfall.

Most of the remaining closures are within smaller systems. Although some are closed in their entirety, many others have condemnation zones only in the upper reaches (e.g. the Nansemond, Poquoson, Back, Piankiatank, and Great Wicomico rivers). In general this is due to physical factors. Because a large portion of the drainage basin usually lies above the head of tide, the freeflowing river delivers most of the freshwater entering the estuary along with all the associated pollutants. When the river flow reaches the tidal portion of the river, there is a decrease in water velocity due to the tides and the broad channels. This combination, sluggish water movement and large pollutant loads in river flow, results in degraded water quality in many systems. Water quality often improves downriver where tidal currents are stronger and large volumes of water are available to dilute the pollutants. An exacerbating factor is the presence of towns and cities at the head of tide (for example, Fredericksburg, Richmond, Petersburg, Smithfield, and Suffolk). These population centers produce wastewaters and urban runoff, both of which can significantly degrade water quality at this vulnerable location.

In the case studies which follow, we will attempt to point out some specific water quality problems and the effects each has on shellfish.

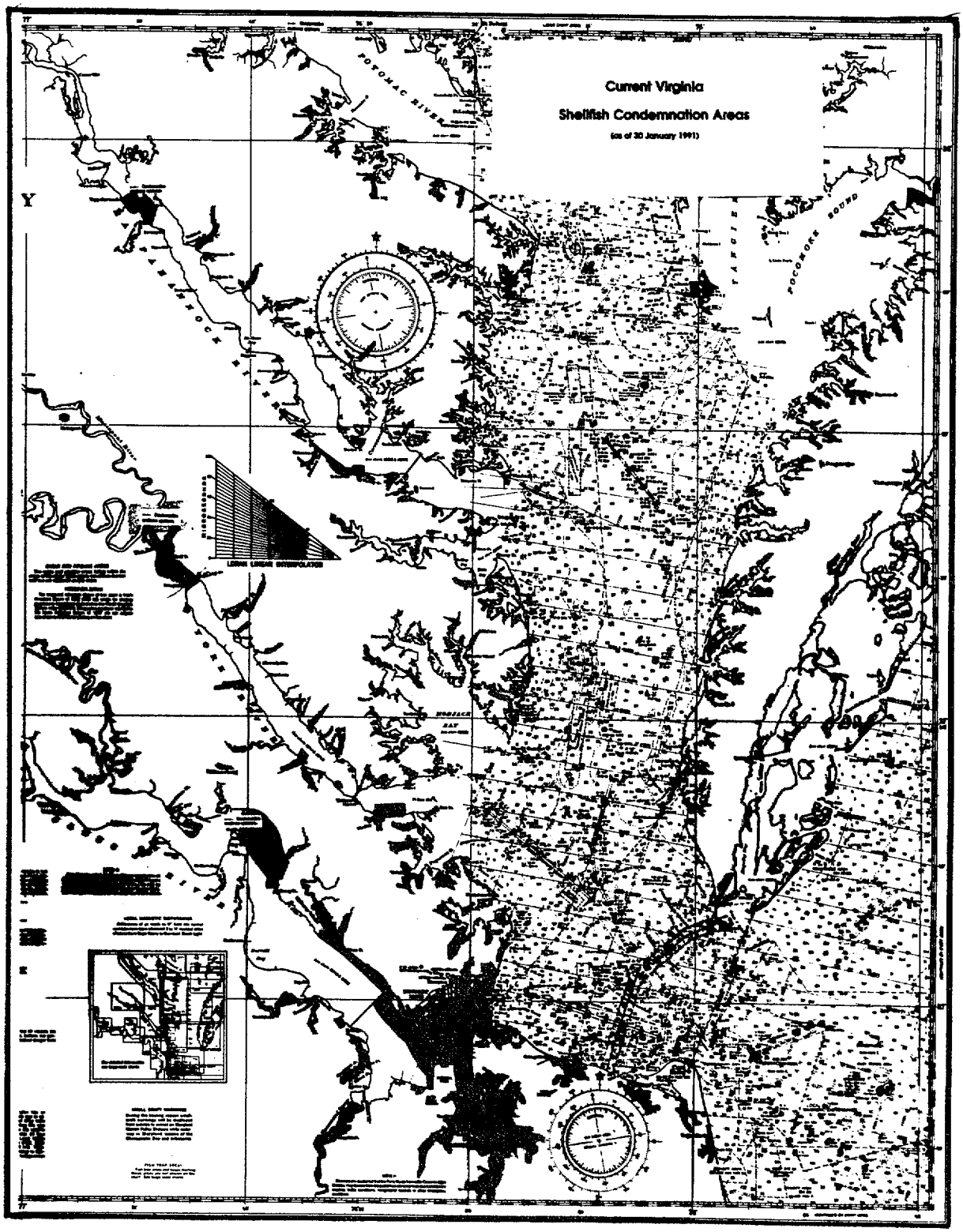


Figure 1. Virginia Shellfish Condemnation Areas, as of 30 January 1991.

1.2 The Elizabeth River: A Case Study of Bioaccumulation and Bioconcentration

Background

The Elizabeth River, a small tidal river on the southern side of Hampton Roads, drains a portion of the Great Dismal Swamp and flows through the cities of Chesapeake, Portsmouth, and Norfolk (see Figure 2). The drainage basin is small (at least in comparison to the James River watershed) and freshwater flows to the river during the summer are almost non-existent. Most freshwater enters via the several large sewage treatment plants located on the river. Conditions in Hampton Roads, rather than runoff, appear to control the circulation in the Elizabeth (Neilson, 1975). Some suggest that tidal exchange between Hampton Roads and the Elizabeth was greatly reduced when the Craney Island Disposal Area was constructed (Seufer, 1977).

Since before the American revolution, people have been living along the Elizabeth and it has been a site for ship building and related activities. The large numbers of people residing in Norfolk and Portsmouth caused water quality problems, and the Elizabeth River was closed for shellfish harvesting at the turn of the century, although most other areas in Hampton Roads still had acceptable water quality (Cummings, 1916). Many years later, the Hampton Roads "208 Study" found that water quality conditions were compromised by the large volume of wastewaters discharged, and that wastewaters tended to remain in the system for long periods of time. Also, "fecal coliform levels were far above shellfish growing water standards" (Neilson & Sturm, 1978).

Bioconcentration

Clams, oysters, and other filter-feeding bivalves pump water through their gills in order to secure food. In so doing they expose the gills to substances dissolved in the water and they take in any pollutants associated with the particulate matter suspended in the water, and in this manner they accumulate pollutants. This process is called bio-accumulation or bio-concentration. Unless there is a counterbalancing process to regulate or excrete the pollutants, the shellfish meats become highly contaminated. Filter feeders can accumulate pollutants to concentrations thousands of times greater than those in the water.

The concentration of pollutants in the shellfish tissue is a function of many variables, including ambient concentration and bioavailability of the pollutant, body

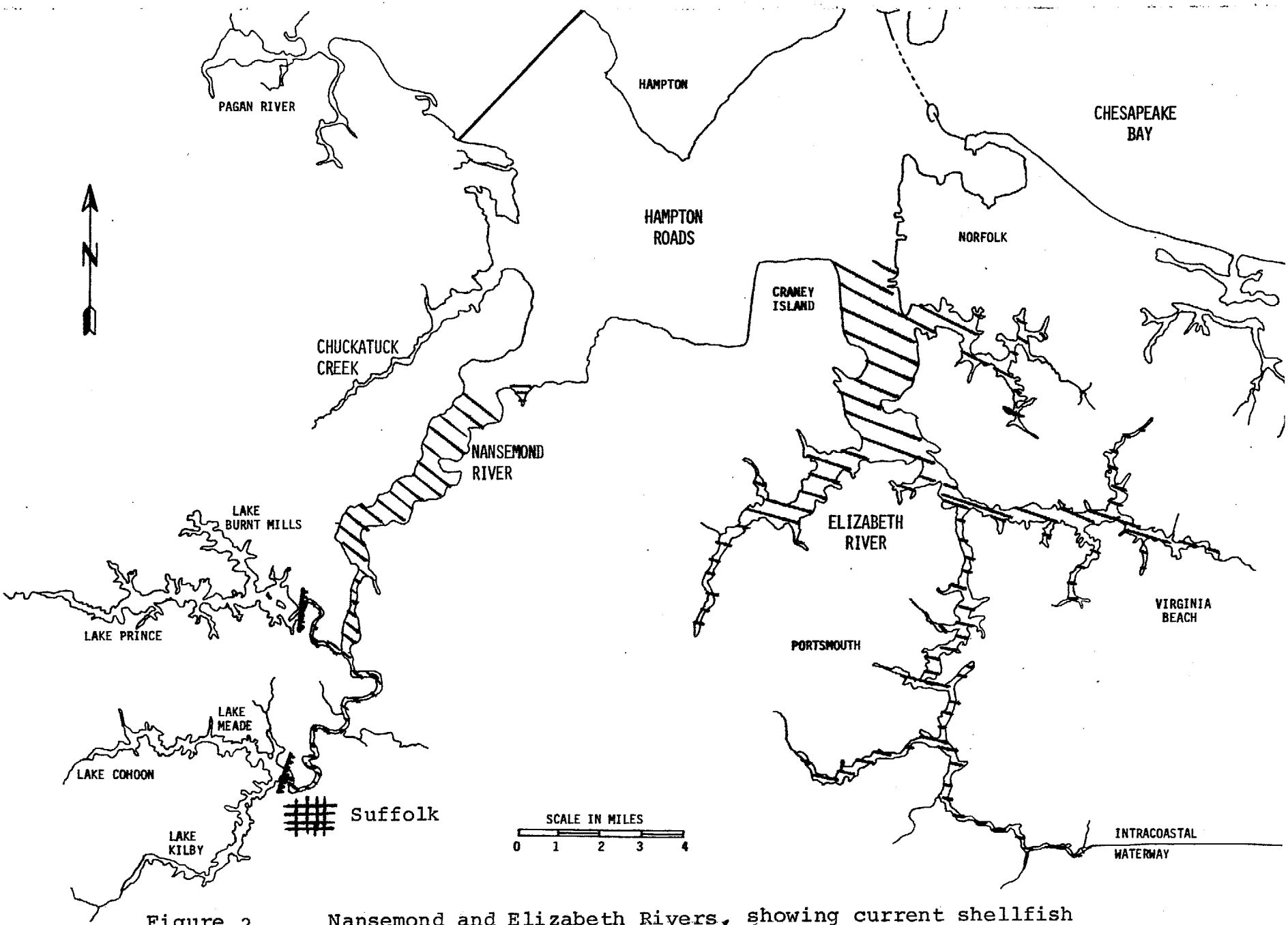


Figure 2. Nansemond and Elizabeth Rivers, showing current shellfish condemnation zones.

size, metabolic rate, and how these have varied over the life of the organism. The uptake of two compounds, zinc and PCB's, by oysters will be presented to illustrate the problem. The data are taken from a Virginia State Water Control Board report on "Metals & Pesticides in Shellfish and Fish Tissues in Virginia" (Gilinsky & Roland, 1983).

Oysters are "notoriously strong accumulators" of zinc (Rainbow et al, 1990). Concentrations of zinc in oyster tissue are of roughly comparable magnitudes in the three major estuaries, although one can see a clear relationship between human activities and zinc concentrations in oysters (see Table 1). Mean zinc concentrations in oysters are believed to be higher in the York than the Rappahannock because of mining activities in the upper portions of the York basin during colonial times. Concentrations in the James are higher still because of urban runoff, wastewater discharges (much of which comes from industries), and activities such as shipping and ship building. Concentrations vary from year to year in response to changes in river flow and pollutant discharges. Concentrations also vary within a river due to both the location of pollutant sources and changes in bioavailability associated with water chemistry (such as salinity and humic acids).

Table 1. Mean zinc concentrations in oysters from Virginia tributaries to Chesapeake Bay.

River	Mean Zn Conc. (mg/kg)
Rappahannock River	403
York River	575
James River	2,174

Zinc tissue concentrations for oysters collected from the Elizabeth River are very high (see Table 2), roughly three times those in Hampton Roads and ten times those observed in Lynnhaven Bay. The maximum zinc concentration observed in the Elizabeth is a thousand times greater than that observed in the tidal freshwater and transition regions of the James. The differences are believed due to varying water chemistry and the proximity of sources of zinc.

Tissue concentrations of PCB's also are quite high and show similar geographic variations, although the magnitude of the differences is somewhat reduced.

Table 2. Concentrations of Zinc and PCB's in the Tissue of Oysters taken from the James River, Elizabeth River, and Lynnhaven Bay.

River Segment	Zinc Concentrations in Oyster Tissue (mg/kg)		
	Mean	Min	Maximum
James - tidal freshwater	14	11	16
James - transition zone	16	12	19
James - estuary/upper	1,208	11	6,000
James - estuary/lower	993	72	6,546
Elizabeth River	3,563	484	19,990
Lynnhaven Bay	403	235	600

River segment	PCB Tissue Concentration (ppm)		
James - estuary/upper	0.38	0.05	1.00
James - estuary/lower	0.47	0.01	1.00
Elizabeth River	0.99	0.08	2.80
Lynnhaven Bay	0.14	0.10	0.20

Discussion

One must conclude that the activities occurring in and near the Elizabeth River have resulted in degraded water quality which in turn produces contaminated shellfish. The maximum concentrations are high by virtually any yardstick or standard and preclude the consumption of the oysters by humans.

Shellfish also can bioconcentrate bacteria and viruses. Standard water quality monitoring of shellfish growing waters emphasizes the bacteriological quality because contaminated shellfish pose a very real health threat to the humans who consume them, especially if eaten raw. Virginia water quality standards for shellfish waters require a mean fecal coliform count of less than 14 MPN (most probable number) per 100 ml (milliliters) of water. The corresponding water quality standard for recreational waters is 200 MPN/100 ml. It is because shellfish concentrate the pathogens (to levels hundreds or thousands of times higher than in the water) that the shellfish standard is more strict than the recreational standard.

In the remainder of this report, bacteriological aspects will be emphasized. The reader should remember, however, that the shellfish accumulate other pollutants as well. When metals and toxic organics are accumulated, the effect is long lasting. The bacteria and viruses, however, are mostly in the gut of the shellfish; if the organism is placed in clean waters, the bacteria and viruses will be eliminated naturally in a matter of days or weeks. This process is called depuration. At present there are no facilities for the controlled cleansing or depuration of shellfish in Virginia, although a number of East Coast states do have plants, especially for clams. When shellfish are transferred to naturally clean waters, they are said to have been "relayed". Relaying has been practiced for decades, but the costs sometimes mean that it is not practical. Not only must the shellfish be harvested twice (once from the restricted waters and then from the clean waters), there are the costs of transport, monitoring the relaying area, and of course something less than 100% of the original harvest can be recovered at the second harvest. Relaying that uses trays or cages appears to have great promise economically.

Metals and pesticides can be incorporated into the soft tissue and require lengthy periods (on the order of a year or longer) to be purged. Hence, the shellfish contaminated with metals or other chemicals cannot be harvested for human consumption. Monitoring of shellfish meats for chemical pollutants need not occur frequently, because the accumulation and depuration periods are long. In Virginia, this monitoring occurs semi-annually, whereas bacteriological monitoring of water quality occurs monthly.

An adult oyster may pump as much as 70 gallons of water during a day. A Maryland scientist has estimated that around 1870, the oyster populations in Chesapeake Bay pumped a volume of water equal to the volume of the bay in about three days. At present, the reduced populations take more than 300 days to pump the same volume (Newell, 1988). Shellfish thus appear to have the ability to change the environment in which they live, and the changes appear to be positive. Use of oysters and clams to cleanse the Bay may at first seem getting the cart before the horse, but perhaps this unusual way to restore Chesapeake Bay might be feasibile.

Conclusions

When natural conditions and/or human activities degrade water quality, shellfish tissue can become highly contaminated. Because pollution impacts are magnified, shellfish growing waters must be very, very clean. Shellfish are Chesapeake Bay's counterpart to the canary in the mine.

1.3 Bonum Creek: A Case Study of Indicator Organisms and Non-point Source Pollution

Background

Bonum Creek is a small, tidal creek, located on the south shore of the Potomac River in Westmoreland County, Virginia (see Figure 3). Salinities in the creek vary from 0-14 ppt. Bonum Creek is characterized as having sandy, well-drained soils with deep water tables at the headwaters, with bluffs up to 45 ft in height. The area around the mouth of the creek is flat and marshy, with poorly drained soils. It is primarily an agricultural area, and some residents own small numbers of domestic animals (hobby farming). There is a sparse population of single dwelling homes, most having on-site septic systems, but some with privies. The creek is considered free of known point sources of pollution.

A large oyster house is the only 'industry' on the creek. Dredging of the channel by the Army Corps of Engineers has been requested by local watermen and was scheduled to take place in October of 1991 (funds pending). About 22,000 cubic yards of spoil will be dredged and placed on nearby land. This same land was the site of the last spoils deposit when the channel was dredged in 1981. Previous dredgings occurred in 1971 and 1968.

Shellfish Closures

Notice #159 from the Bureau of Shellfish Sanitation, effective 27 April 1990, shows the entire Bonum Creek as being condemned for shellfishing.

A VIMS report on Bonum Creek by Howard Kator and Martha Rhodes (1988) sought to discover the sources of fecal coliform bacteria present in the creek and to identify those bacteria as being of human or animal origin. They noted the high level of bacteria at the headwaters of the creek, with concentrations decreasing toward the mouth (see section 1.1). The narrow mouth seemed to restrict tidal flushing; tidal height inside the creek was half that of outside the mouth. They suggested that because there was little flushing out of the creek, bacteria were retained within the system, resulting in elevated levels of fecal coliforms. The report also observed a "statistically significant correlation between rainfall, turbidity and fecal coliform densities." The high coliform counts occurred mostly at the headwaters and in feeder streams.

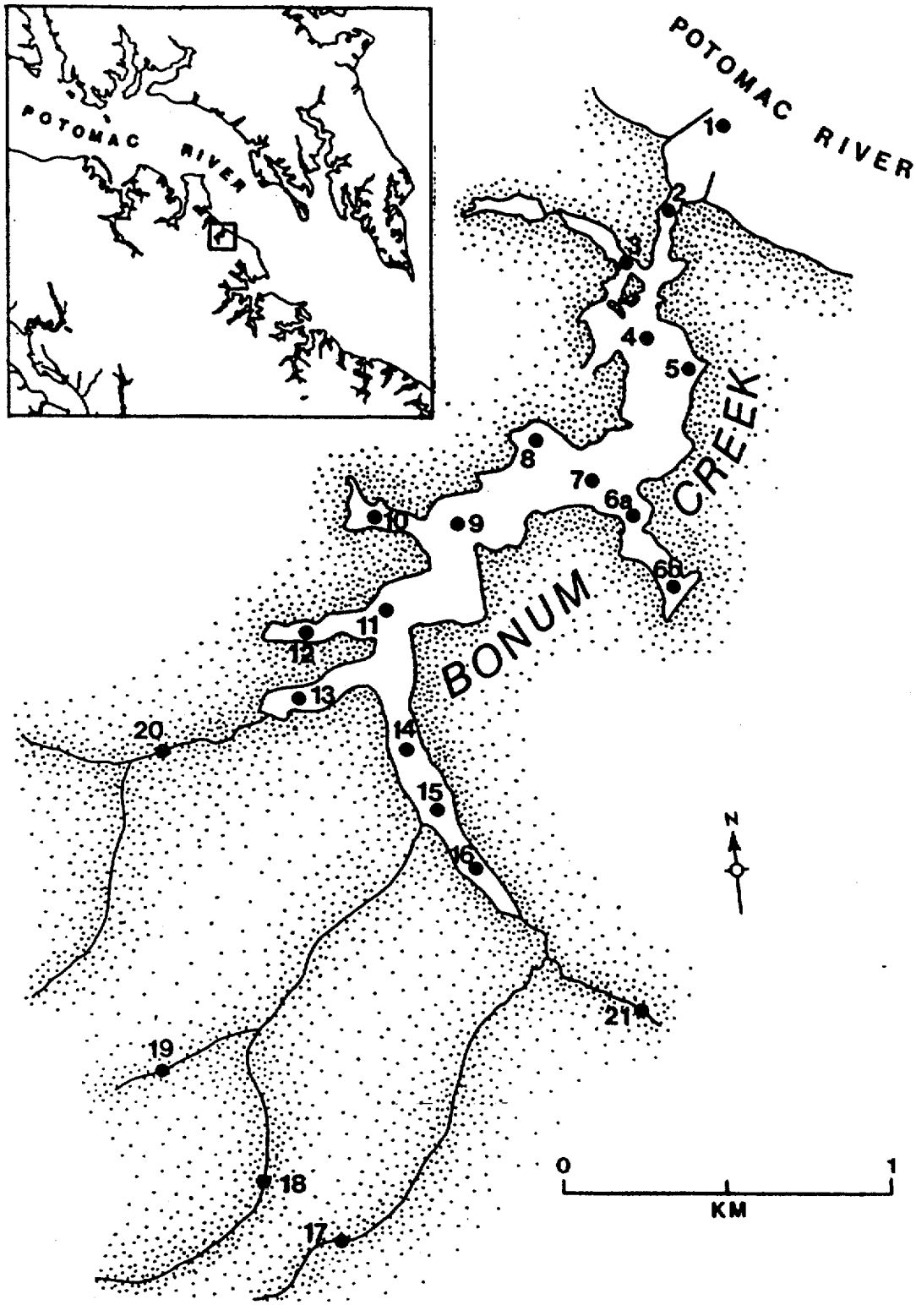


Figure 3. Bonum Creek, showing location of Kator & Rhodes (1988) sampling stations.

Sources of Pollution

A sanitary shoreline survey, conducted in 1988 by the Bureau of Shellfish Sanitation, detected a dozen sewage deficiencies that were contributing pollution to Bonum Creek, several sites of kitchen or laundry waste, and eight sites having no facilities.

On-site sanitation inspections by Westmoreland sanitation officials during the Kator & Rhodes study revealed malfunctioning septic systems and privies, compounded by poor soil characteristics, adequate reasons to explain fecal counts in Bonum Creek. The inspections also revealed areas of the hobby farming of animals that corresponded to the higher readings of two "animal" coliforms found in the feeder streams. These bacterial indicators were noted as "useful in assessing the 'freshness' of the pollution and their probable sources." High coliform counts occurred mostly in the headwaters and feeder streams. Deducing the theoretical population needed to produce the numbers of fecal bacteria observed in the creek corresponded well to the actual population living on Bonum Creek. The report concluded that nonpoint source runoff was adequate to explain coliform densities in the creek, and thus, the shellfish condemnations.

Discussion

In the best of all possible worlds, one would test shellfish waters for every potential water borne pathogen, but the tests for many organisms are complex and time consuming. In addition, many organisms (fortunately) occur in very low densities, meaning that large volumes of water would need to be filtered or processed to detect them. In practice these realities translate to very high costs. Consequently an indicator of fecal pollution is used to tell public health officials when waters have been contaminated by fecal matter. For many years the total coliform test was used, but for about twenty years, fecal coliforms have been the most commonly used indicator.

Some scientists and others have been critical of public health officials' use of these bacterial indicators of fecal pollution. It is likely that most public health workers would agree that neither fecal coliforms nor any other indicator is a perfect indicator of pollution problems and public health risks. The health department, however, has a mandate to protect the public and must use the tools available today. The paucity of incidences of illness related to consumption of shellfish indicates that current practice does indeed protect public health.

New bacteriological procedures and tests are being developed and these have the potential to greatly improve the information gained from monitoring. Indicators of animal pollution which were used in the Kator & Rhodes study appear to have the potential to discriminate between human and animal sources, and even perhaps various classes of animals. While these developments look promising, the sophisticated analyses required are likely to limit the usefulness of the procedures for routine monitoring purposes. Costs also are likely to limit use of these techniques.

. It also must be recognized that additional information will be needed to make these new tools effective. If, for example, it is possible to identify bacteria that are associated with cattle and no other animals, then the role of cattle as a vector for human pathogens must be known as well. Otherwise the source has been identified but the associated risks are unspecified. Development of this information is not likely to not occur quickly.

Conclusions

Fecal coliform counts in Bonum Creek at first glance appeared to be anomalously high. Closer study of the watershed revealed that sources did exist and that these few small sources were sufficient to raise the fecal coliform counts to the levels observed. For Bonum Creek, physical features of the setting tend to retain pollutants, making the impacts larger than would occur in a system that "flushed" better.

It is the authors' opinion that the fecal coliform indicator does work, even if imperfectly. New technology and techniques have great promise; it may be possible to identify the nature of the source precisely (e.g., animal or human, old or new) in the future. For the present, these tools seem most appropriate to research studies and to intensive studies of a watershed.

If the new tests are to be useful, the public health risks associated with each class of fecal pollution also must be known. The need for better indicators and for a good understanding of what each indicator tells us represent national needs, not just Virginia needs. We suggest that Virginia support indicator studies underway (Kilgen, 1988). In the meantime, current tools and practices are protecting the public health and should not be altered or discarded without careful consideration.

1.4 Nansemond River: A Case Study of the Impacts of Headwater Pollution Sources

Background

The Nansemond River, a tributary of the James River, enters southern Hampton Roads approximately 10 miles upstream from Chesapeake Bay (see Figure 2). The mouth is broad (4000 meters) but the river width decreases exponentially upstream to a narrow (100 meters) winding course, bordered by extensive marshland. Maintenance dredging by the Army Corps of Engineers keeps the channel depth at 12 feet and width at 100 feet. The narrowing geometry of the river results in a reflection of the tidal wave and an increase in the mean tide range from 2.8 feet at the mouth to 3.8 feet at the head with a phase lag of about one hour (Bosco & Neilson, 1983). Current velocities remain fairly uniform throughout the estuary.

The total drainage area of the Nansemond River is approximately 200 square miles and lies primarily in the city of Suffolk. The cities of Norfolk and Portsmouth, however, operate water supply reservoirs upstream of the old center of Suffolk. The drainage to these reservoirs accounts for nearly two-thirds of the entire drainage of the Nansemond watershed! Thus, little freshwater runoff directly enters the estuary, and spillover from the impoundments is regulated. Moderate currents (0.5 m/sec) can disperse pollutants but this will not occur quickly. Brackish waters often reach as far as Suffolk and there is little stratification in the water column.

Several water quality studies of the Nansemond River have occurred over the years. The Federal Water Pollution Control Administration collected samples in 1966 and 1967. The Virginia Institute of Marine Science (VIMS), funded by the 208 program of the Hampton Roads Water Quality Agency (HRWQA), conducted an intensive survey in August of 1976 (Kilch & Neilson, 1977). In 1981, the Nansemond River was chosen by the U.S. Department of Agriculture for participation in the Rural Clean Water Project. The purpose of this project was to study the effects of the implementation of Best Management Practices (BMPs), guidelines designed to control agricultural nonpoint runoff from farms located in the Nansemond watershed. A second VIMS study in 1982 and 1983 was funded by HRWQA to document water quality conditions prior to implementing the agricultural BMPs (Bosco & Neilson, 1983).

Shellfish Closures

The first closure of shellfish grounds in the Nansemond River occurred in 1933 and involved half of the upper estuary. More closures were put in effect in 1953, 1963, 1972 and 1975, proceeding downstream over time and encompassing about two-thirds of the river and several small areas near the mouth. As of May, 1990, the most recent notice of closure, shellfish harvesting was prohibited from just upstream of the Rt. 17 bridge, or three-fourths of the entire river!

Sources of Pollution

In the report on the 1982/1983 monitoring of the Nansemond River, VIMS scientists compared the new findings to those of the 1966 and 1976 studies. Point source discharges had decreased by an order of a magnitude over the intervening period as dischargers hooked up to Hampton Roads Sanitation District sewers. Conditions appeared more homogenous than the "marked longitudinal gradient" of the late sixties.

Several improvements in water quality were noted. Dissolved oxygen (DO) measurements below Lake Meade dam rose from 4.4 to 5.8 mg/l. DO standards require a daily average of 5.0 mg/l or greater and no readings below 4.0 mg/l at any time. The report states that "the frequency and severity of violations of the DO standards [have] been reduced significantly for the most upstream reach of the Nansemond estuary." Other improvements observed were a decrease in chlorophyll-a concentrations, a 50-80% reduction in total phosphorus concentrations, and a 70% decrease in orthophosphorus measurements. Remaining problems included inorganic phosphorus and nitrogen, and depressed areas of dissolved oxygen. The DO appeared sensitive to environmental factors such as runoff during warm weather combined with slack before flood.

At the time of the 1976 VIMS survey, only the lower third of the river was open to shellfishing; in other words, the fecal coliform count was below 14 MPN. In the upper half of the river, the fecal coliform counts exceeded the 200 MPN limit for primary contact, and the upper third of the river, nearest to Suffolk, had fecal coliform counts exceeding the 1,000 MPN limit for secondary contact which then existed. The 1982 study noted that fecal coliform counts increased during wet weather conditions and that water quality in general is unsatisfactory in the upper reaches of the tidal river.

Discussion

Surveys of the shoreline are made periodically by the Division of Shellfish Sanitation to see if there are any sanitation problems on the land which might impact water quality. Surveys of the Nansemond basin made in 1985, 1988, and 1990 all showed large numbers of malfunctioning septic systems, along with residences that had no sanitation facilities or that discharged kitchen and laundry waste onto the ground. Farm animals, boats, and industries also were noted; all of these have the potential to impact water quality.

Water quality conditions in the Nansemond appear to be controlled by two features: low freshwater inflow and pollutant sources near the head of tide. A large portion of the Nansemond watershed is impounded with runoff entering water supply reservoirs and being pumped to nearby cities. Consequently, little runoff flows directly into the tidal river. This means that any pollutants discharged to the river will tend to stay there. Although the tides will move the water upriver and downriver, the net movement downriver is caused by the riverflow, which in this case is very small.

Although water quality conditions improved markedly when major dischargers diverted the sewage to the HRSD treatment plants, it appears that a large number of small sources are still impacting the river. The fact that water quality decreases as one moves upriver suggests that many of these inputs are located near the head of tide. In other words, we have seen water quality improvements that resulted from the reduction in wastewater discharges. Water quality would improve even more if the remaining sources of pollution, which are believed to arise in Shingle Creek and other headwaters, also were eliminated.

Large sums of money (more than a million dollars) have been spent on the Nansemond-Chuckatuck Rural Clean Water Program. Farmers have improved animal waste management practices and this has resulted in decreased pollutant loadings. Some of the resulting water quality improvements will be lost if development trends replace farms and forests with shopping centers and subdivisions (Fisher, 1990).

Conclusion

Water quality in the Nansemond inproved markedly between the 1966 and 1982 surveys, demonstrating that removal of point sources does result in improved water quality.

The most recent data indicate that water quality continues to be poor in the upper reaches of the tidal river, apparently in response to a number of small sources, such as malfunctioning septic systems. This, coupled with a typical estuary geometry and a low freshwater inflow, result in degraded water quality in a significant portion of the river. This situation is not likely to change until the many small sources are eliminated, say by extending sewers to the affected areas. Stated somewhat differently, we will not enjoy all the benefits of water pollution control until we have addressed all of the major sources of pollution.

If water quality in the Nansemond River is to improve sufficiently for shellfish growing areas to be opened, the many small sources of pollution must be eliminated. If these gains in water quality are to continue into the future, careful planning is needed to ensure that increased runoff from residential and commercial development does not undo the gains made with better animal waste management and control of large wastewater discharges.

1.5 Lynnhaven Bay: A Case Study of Point Source Controls and the Consequences Suburban Runoff

Background

Lynnhaven Bay is a small coastal basin, located on the southern shore of the Chesapeake Bay in the city of Virginia Beach (see Figure 4). Lynnhaven Inlet, a narrow channel of some 900 feet, opens directly to the Chesapeake Bay. The system consists of several smaller water bodies - the Eastern and Western branches, the Bay itself, and Broad Bay and Linkhorn Bay extending to the east. The drainage area is small, only 156 square kilometers, exhibits little freshwater inflow, and lacks the continuous free flowing tributaries typical of larger estuaries. The system is shallow, less than 9 meters deep except at the Inlet, and its circulation is dominated by tidal flushing, resulting in mild, longitudinal salinity gradients. Soil characteristics range from well drained in the lower reaches to poorly drained at the headwaters.

The history of Lynnhaven's water quality reflects the change and growth of the surrounding area, moving from agricultural to suburban over the past few decades. The 11,500 acres of farmland in 1937 decreased to less than 5000 acres in 1971. Correspondingly, residential dwellings grew from about 250 in 1937 to almost 20,000 in 1971. The 1960's was a time of rapid growth. Population in the Lynnhaven watershed, not including Broad and Linkhorn Bays, escalated from 27,535 in 1960 to 76,691 in 1970, a 179% increase! These general trends continue today, although the rate of change has slowed down since less and less farmland is available for conversion to housing and commercial development.

Dwelling Units and Farm Acreage for Lynnhaven *		
Year	Dwellings	Farm Acreage
1937	263	11,527
1949	461	10,030
1958	2851	8,421
1971	19,465	3,899

* Lynnhaven in this study (Urbanization of Lynnhaven Bay, Oswalt,1975) did not include Broad or Linkhorn Bays

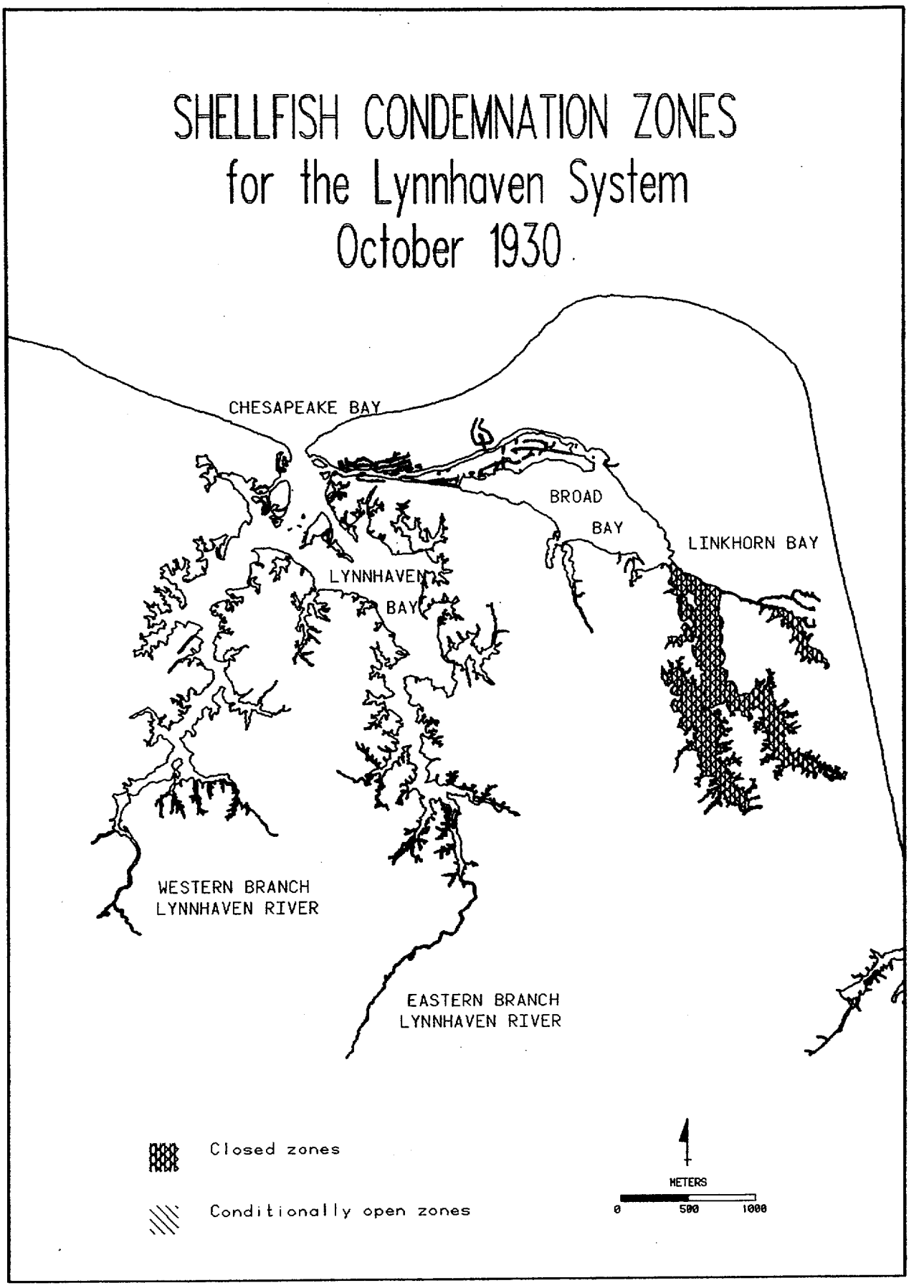


Figure 4. Lynnhaven Bay system showing the first shellfish condemnation area enacted on October 15, 1930.

Population in the Lynnhaven Borough	
1930	5,252
1940	7,070
1950	15,601
1960	22,957
1970	57,841
1980	72,459
1990	94,765

History of Shellfish Closures

The oyster has long provided a livelihood for watermen working the Lynnhaven, but it is a story of increasing closures of shellfish grounds and changing sources of pollution. It is very likely the year to year variations in the harvest of oysters is related, at least in part, to whether the shellfish beds are open or whether the oysters must be relayed before going to market.

The first closure of Lynnhaven Bay shellfish waters occurred in April of 1930 and involved all of Linkhorn Bay, a closure which has remained in effect to the present day (see Figure 4 and Appendix 2). Linkhorn Bay is the most eastward extension of the Lynnhaven system; in fact, one

VMRC Oyster Landings for Lynnhaven Bay		
Year	Bushels	Pounds
1976	391	2,581
1977	1,846	12,207
1978	2,856	18,886
1979	2,285	15,097
1980	454	3,008
1981	336	2,226
1982	572	3,779
1986	549	3,423

branch of its headwaters is in the old center of the city of Virginia Beach, referred to in census data as the Virginia Beach borough. The census results of 1910 through 1970 show that this small borough had the highest population density of all city boroughs. It is also interesting to note that the tidal range in Linkhorn Bay is only about half that of Lynnhaven Inlet, which suggests that water exchange between Linkhorn and the Chesapeake Bay is not great. The Lynnhaven borough, in which the rest of the Lynnhaven system is contained (with the exception of a portion of Eastern Branch) consistently displayed a higher total population when compared to other boroughs within the city.

Over the next few decades more closures followed, concentrated primarily in the Eastern and Western Branches. A 1937 condemnation closed the upper 25% of the Eastern Branch, succeeded by a 1941 condemnation of the upper 75% of Eastern Branch. This same 1941 closure shut several small creeks in the lower portion of Western Branch and its entire upper third, but was rescinded several weeks later. Half of Pleasure House Creek off Lynnhaven Bay was also closed. Two years later, in 1943, the upper 50% of Western branch was closed, with this closure in effect until 1946. From then until 1959, Western Branch was open to shellfishing. The 1959 closure closed the waters above Caraway Point, about 2/3 of the Branch.

Long Creek, which connects Lynnhaven Inlet to Broad Bay, was dredged by the Army Corps of Engineers in the 1960's to improve circulation between Chesapeake Bay and Broad and Linkhorn Bays. Long Creek had been condemned for shellfishing in 1964. Indeed, Broad Bay did show a stronger longitudinal salinity gradient than the Eastern and Western Branches in the 1975 intensive survey conducted by the Virginia Institute of Marine Science (VIMS). But the increased circulation did not result in any formerly closed shellfish grounds being reopened.

The pace of closures quickened in the 1970s and spread from the headwaters of the several branches to downstream areas. Western Branch was completely closed in June of 1971, a closure that was rescinded by December. Hurricane Ginger brought about the first complete closure of the entire Lynnhaven system in October, 1971, but this closure was rescinded the following February. Several small condemnations ensued over the next two years, involving Brock Cove on Lynnhaven Bay and Dey Cove and Mill Dam Creek on Broad Bay. In February of 1974, Eastern Branch was fully closed as well as the upper 2/3 of Western Branch. This remained in effect until March, 1975 when Lynnhaven was once again totally closed. From then until June, 1986 was a period of on again/off again condemnations. Portions of the

system would go from complete closure to conditionally opened and back again.

In the June of 1986 closure, all of Lynnhaven Bay proper, and the Eastern and Western Branches were closed and that closure remains in effect to present day. Linkhorn Bay, of course, has been closed since the first 1930 condemnation. Only Broad Bay was reopened to shellfishing in May of 1987. That closure was reinstated on July 19, 1991. Presently, all of the Lynnhaven Bay system is closed.

Sources of Pollution

The overlayering of several pollution sources combined with changing land use and continuing buildup of pollutants over long time periods may seem to limit the fingerpointing that can be done by regulatory agencies. But, with careful study, the complex issue can be broken into its components and a clearer picture can develop of the problem areas. In fact, what were once major sources of pollution may shift to minor roles as new issues develop. The key feature to note regarding Lynnhaven waters is the change of land use over the decades.

In common nomenclature, pollution sources are typically classified as point or nonpoint sources. Point sources refer to specific discharge sites, as from an industrial plant or sewage treatment facility, and are required by SWCB to have a discharge permit. Nonpoint sources are of more general, widespread origins, such as stormwater runoff. In reality, though, there are the shades of grey. While the few head of cattle from several hobby farmers might be considered a nonpoint site, a large animal facility could be considered a site-specific pollution source.

When one looks over the available data on the Lynnhaven area, the most obvious change is the rapid increase in the local population, beginning particularly in the 1950s with another sharp increase in the 1970s. In the 1990 National Shellfish Registry, Leonard & Slaughter contend that coastal development manifests itself in the following ways:

1. the largest increase of pollution runoff is attributed to urban runoff,
2. the second largest contributor is failing septics, which can indicate growth of tourism, vacation homes, and marinas in poorly drained areas,
3. increased number of STP buffer zones,
4. decreased agricultural runoff,
5. increased boating activity,
6. increased direct discharges.

With the beginning of residential development in Lynnhaven in the 1950s, the trend was toward small sewage treatment plant (STPs) and away from individual septic systems. These small STPs normally served only school or residential neighborhood. They were generally located in the upper reaches of Lynnhaven while septics served the downstream areas. There have been up to 13 of these small STPs. As of 1975, five STPs were still in operation.

The 1975 305b Report on Water Quality Inventory (VA State Water Conrol Board) states that the two major water quality problems were sedimentation and high bacteria count. Listed as the sources of sedimentation were (1) urban runoff/subdivision construction and (2) wetlands runoff. No solution was offered for the wetlands runoff problem, but the report suggested that legislation was needed for suitable control methods of urban and residential construction runoff. The source of the high bacteria count was listed as (1) heavy boating/marina activity and (2) inadequate or failing septic systems. Recommendations included the elimination of small STPs by connection to Hampton Roads Sanitation District (HRSD) or to have the remaining small STPs comply with National Permit Discharge Elimination System (NPDES) requirements. The report stated that hookups to the regional STP should eliminate leachate to groundwater.

Although an intensive survey conducted by the Virginia Institute of Marine Science in September of 1975 found good water quality in most respects, several foreshadowing observations were made. At the time of this survey, all small sewage treatment plants, including the Oceana STP, the largest point source contributor, had joined HRSD through the Chesapeake-Elizabeth plant. The only remaining independent STP was the Birchwood Gardens facility, but it was noted that though the use of holding ponds, its effluent tended to be steady and relatively good. The report maintained that nonpoint sources were the dominant factor in water quality assessment. Of the nonpoint sources, agricultural and wetlands runoff played a minor role, while the rapid development of the area, urbanization, unsuitable conditions of remaining septic systems and boating activities were the major influences.

Of the 4,686 harvest-limited acres in the Lynnhaven system, only 591 were classified as restricted due to an STP. The cause of the remaining closures were listed as urban/rural runoff and boating activities. It seems significant that the only remaining large open land in Lynnhaven area, Seashore State Park, borders Broad Bay, the only approved shellfish grounds.

Conclusions

The National Estuarine Inventory (Leonard, Broutman, & Harkness, 1989) summarizing Mid-Atlantic trends, stated that upgrades in classification of shellfish grounds were primarily due to improvements in sewage treatment. Downgrades were most often due to coastal development and increased boating activities. Improvement in sewage treatment did not lead to upgraded water quality in all cases. Ensuing development contributed its own pollution and nonpoint sources kept coliform levels high.

The Lynnhaven Bay system is, on the one hand, a success story. All of the point sources of pollution have been removed with concommittant improvements in water quality. The Lynnhaven, on the other hand, suggests a bleak future for the shellfish industry if many of the once productive small systems become developed and urbanized. At least for the Lynnhaven system, the runoff from the streets, parking lots, well manicured lawns, and driveways is sufficient to degrade water quality enough that harvesting is permitted only some of the time (mostly during droughts).

Implementation of the Chesapeake Bay Preservation Act is on-going and it is too early to tell whether this initiative will provide the protection to water quality that is needed. The story that the Lynnhaven tells is that protection is indeed needed, even when the development consists of very expensive homes.

The pollution in Lynnhaven Bay is moderate, making the waters suitable for shellfish culture if relaying or depuration follows harvesting. Both clams and oysters have been harvested from "the Narrows", Linkhorn Bay, Lynnhaven Bay near the confluence of the two branches, and the Western Branch. The shellfish have been relayed to Broad Bay or to other open areas for cleansing. Relaying of clams in cages or trays has proven beneficial, in that the second harvest is easily accomplished and losses of shellfish are greatly reduced. Comparably efficient methods for oysters and controlled depuration warrant consideration. If economic methods of cleansing were available, the Lynnhaven and other systems might again be "worked" by shellfish planters and harvesters.

1.6 Summary of Case Study Findings

The Mid-Atlantic region led the nation in oyster and clam landings until the early 1980s. Since then, due to overharvesting, disease, predation and environmental distress, watermen have been forced out of business or have switched to other seafood. Market demand has been met by increased imports and increased Gulf Coast production. In the current study, we are not addressing all of the problems facing the shellfish industry - only water quality impacts.

We believe that it is appropriate to seek ways to minimize the impacts of water quality degradation, although we recognize the seriousness of the other challenges. Whether those obstacles are overcome or not, clean waters will be needed.

What we have seen from the case studies is that shellfish accumulate pollutants from the waters in which they live. In most instances, they concentrate the pollutants to elevated concentrations. Consequently, shellfish growing waters must be very clean; current water quality standards and shellfish harvesting regulations reflect that fact.

Chemical contamination can be a problem, as was seen with oysters harvested from the Elizabeth River, a river system highly impacted by the surrounding cities and by the industries which use the river. Other similar situations exist, but typically they are limited to small areas. Much more common are the closures due to fecal contamination.

The recent experience in Lynnhaven Bay system and in the Nansemond River demonstrate that point source controls can produce measurable and significant improvements in water quality. Unfortunately, the numbers of bacteria and viruses in fecal matter are very, very large, meaning that a small source can impact a rather large volume of water.

The physical characteristics of Bonum Creek make it particularly vulnerable to water quality degradation. Despite the rural, undeveloped nature of the watershed, stream quality was impacted by a few small sources. Similarly, the Lynnhaven Bay system is impacted by the runoff from the driveways, parking lots, streets, and lawns of the surrounding area. The Nansemond River also is affected, presumably the result of privies and malfunctioning septic systems along Shingle Creek and other sources at its headwaters. Both the Nansemond River and the Lynnhaven Bay system are large, with good tidal exchange with the James River and Chesapeake Bay respectively. The fact that these systems are impacted by nonpoint source runoff and by a number of small sources indicates the difficulty of the

problem. Until we address these issues, the benefits of the point source control successes will be limited.

One might expect Lynnhaven Bay to be a harbinger of what future conditions will be. Although the water quality impacts of suburban runoff preclude direct harvesting much of the time, the waters definitely are not grossly polluted. Shellfish culture remains a viable activity, at least from the bilogical perspective if not economically. The relaying of clams in cages has been efficient and cost effective. Comparable techniques are needed for oysters. Controlled purification in depuration plants also warrants attention, in part because consumers appear willing to pay a premium for a product they know is of high quality.

There definitely are lessons to be learned from the case studies presented and from many other situations and events. If there is to be a brighter day for the shellfish industry, it behooves us to learn those lessons as best we can.

WATER QUALITY PROBLEMS AND TRENDS IN OTHER COASTAL STATES AND THE CHESAPEAKE BAY SYSTEM

2.0 INTRODUCTION

The situations described in the case studies are not unique to those water bodies or to Virginia. Similar conditions exist in other states, especially within the mid-Atlantic region. Since development trends and changes in land use appeared to be similar, it seemed logical to see whether any of the other coastal states had developed management strategies that would work in Virginia. A survey was prepared and distributed to gather information. Once responses to our survey were received and compiled, we convened a workshop to select the most promising strategies. Each of these steps is described below.

2.1 CONDITIONS IN OTHER COASTAL STATES

Shellfish sanitation workers in other states were contacted regarding the conditions of the shellfish industry and management strategies. Many reports, journal articles, and studies were sent to us and reviewed (see references for examples). Most of these addressed conditions in a single water body or state. Information on the classification of shellfish growing waters throughout the U.S. has been summarized in the "1990 National Shellfish Register" (Leonard, et. a., 1991). The Office of Oceanography and Marine Assessment (OMA) has entered the data into a geographical information system (GIS) similar to the one used to generate the maps of closures for Lynnhaven Bay (Appendix 2). OMA indicates that the data files will be provided to any state that requests them. Thus it will be possible for a state to create maps and note changes easily in the future.

A companion report, "The Quality of Shellfish Growing Waters on the East Coast of the United States" (Leonard, Broutman, and Harkness, 1989), provides insights into the causes of growing areas closures. Suburban and rural land and water uses are the primary cause of the closures in the mid-Atlantic region. These include: urban and suburban runoff, boating activities, marinas, wildlife, agricultural runoff, and septic systems.

As part of this study, a questionnaire was developed and sent out. The letter, questionnaire, list of respondents, and a summary of comments comprise Appendix 3.

The letter was sent to 65 attendees at the 1990 Interstate Shellfish Sanitation Conference (ISSC) and we received 31 responses. We feel fortunate to have gotten responses from all East Coast, Gulf Coast, and West Coast states (with the exception of Oregon), and Alaska and Hawaii. Several responses came from Canada and one from New Zealand. The survey results are summarized in the following paragraphs and figures.

The first portion of the survey concerned the physical makeup and setting of the state's oyster beds, the amount of exposure of the beds during low tide, and typical tide range and cycle. The questionnaire also asked for the average percent production from natural beds as opposed to hatchery production. Without exception, East and Gulf Coast states exceeded 80% production from natural beds, with most ranging from 95-100% total natural bed production. Hatchery production was higher for clams than oysters; often there was no hatchery production of oysters. West Coast responses showed just the opposite; hatchery production averaged 75-100%, with several respondents stating they had no natural production.

Key facts requested were the annual production of shellfish, excluding crabs, for the years 1980 and 1990. The East coast areas reporting an increase were Atlantic Canada, Connecticut, New York, and Georgia; Alabama and Louisiana reported increases for the Gulf Coast. All West Coast states and Pacific Canada reported an increase of the 1990 harvest over the 1980 harvest. No unit of measure was specified in the questionnaire. Production reports were given to us in tons, bushels, pounds, pounds of meat and number of dozens. Without a good way to standardize the production levels, we looked only at whether an increase or decrease was reported. Also, the general term 'shellfish' netted responses for shrimp, oysters, mussels and several species of clams.

The next section of the survey concerned the impact of point and non-point sources of pollution on the water quality of shellfish growing areas. Each participant was asked to rate the relative importance of pollutant sources. These ratings were calculated and plotted on a regional basis, according to categories used in NOAA's _"Quality of Shellfish Growing Waters." The Northeast (NE) region includes New York and states northward (we included one Atlantic Canada response); Mid-Atlantic (MA) includes New Jersey south through Virginia; Southeast (SE) includes North Carolina south through the Atlantic side of Florida, Gulf region includes Gulf side of Florida through Texas; and West Coast (WC) includes Pacific coastal states (we included one Pacific Canada response). The responses from

New Zealand and Hawaii were not included in the plots but are noted later.

There are several interesting features to note in these plots. The Northeast workers rate the importance of point source pollution higher than nonpoint sources (Figure 5). This is an exception to all other regions of the country where non-point source pollution is given a higher rating. The Northeast also rates large sewage treatment plants (STPs) as important contributors to pollution while other regions, particularly the Mid-Atlantic and the Gulf Coast, note the importance of suburban runoff (Figure 6). Perhaps this reflects the rapid suburban development taking place in these regions. Gulf Coast responses also indicate that failing septic systems are an important factor affecting shellfish growing water quality.

The final section of the questionnaire asked for comments on 1) the impact of coastal growth and development occurring in the state, 2) water quality problems in shellfish areas, and 3) threats to the shellfish industry. Comments from participants, identified by state and last name of the respondent, are included in Appendix 3. A list of management strategies was included and the respondents were asked to identify whether certain practices were planned or existing in their states.

Figure 5.

Perceived Importance of Point-Nonpoint Pollution Sources on Shellfish Closure

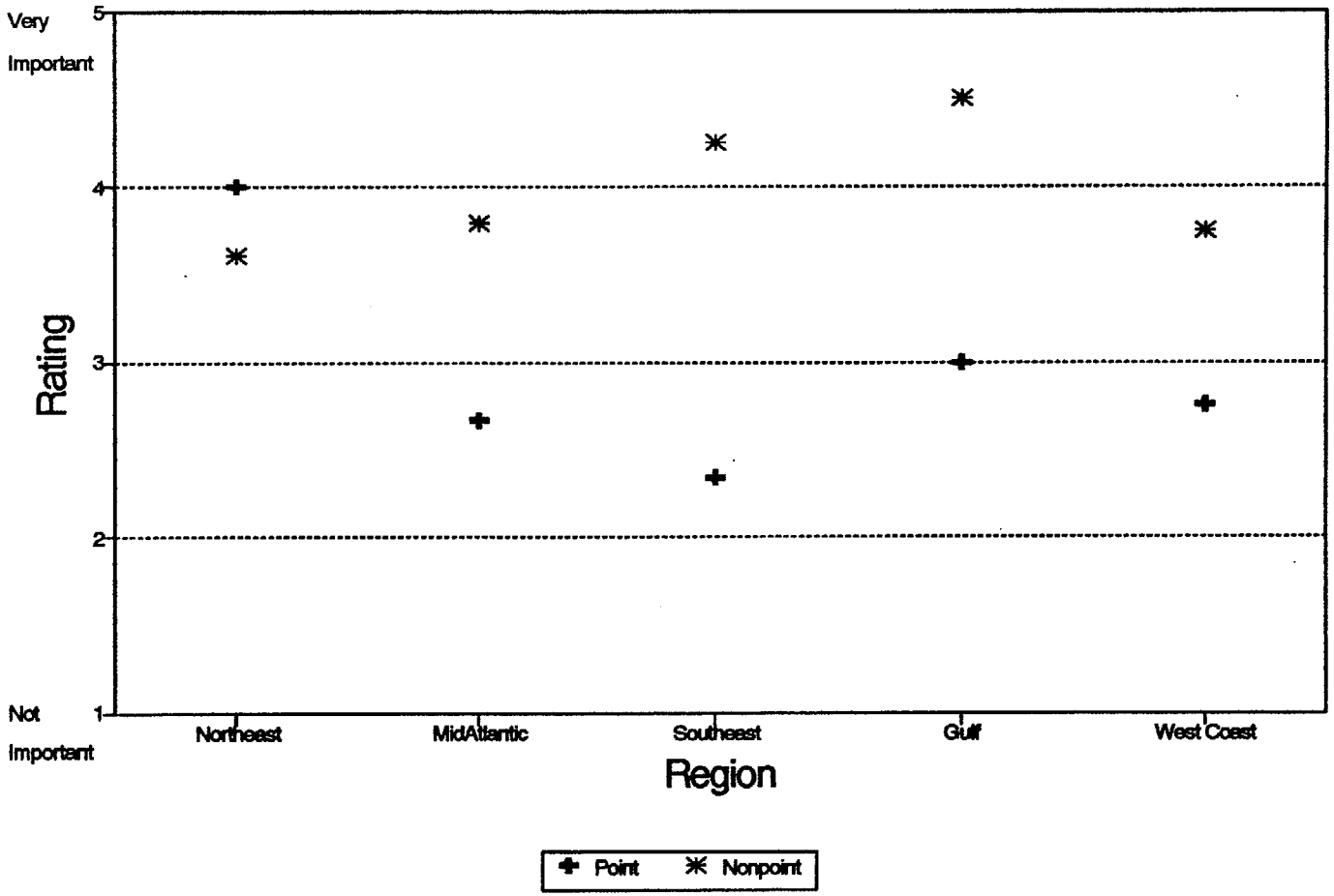
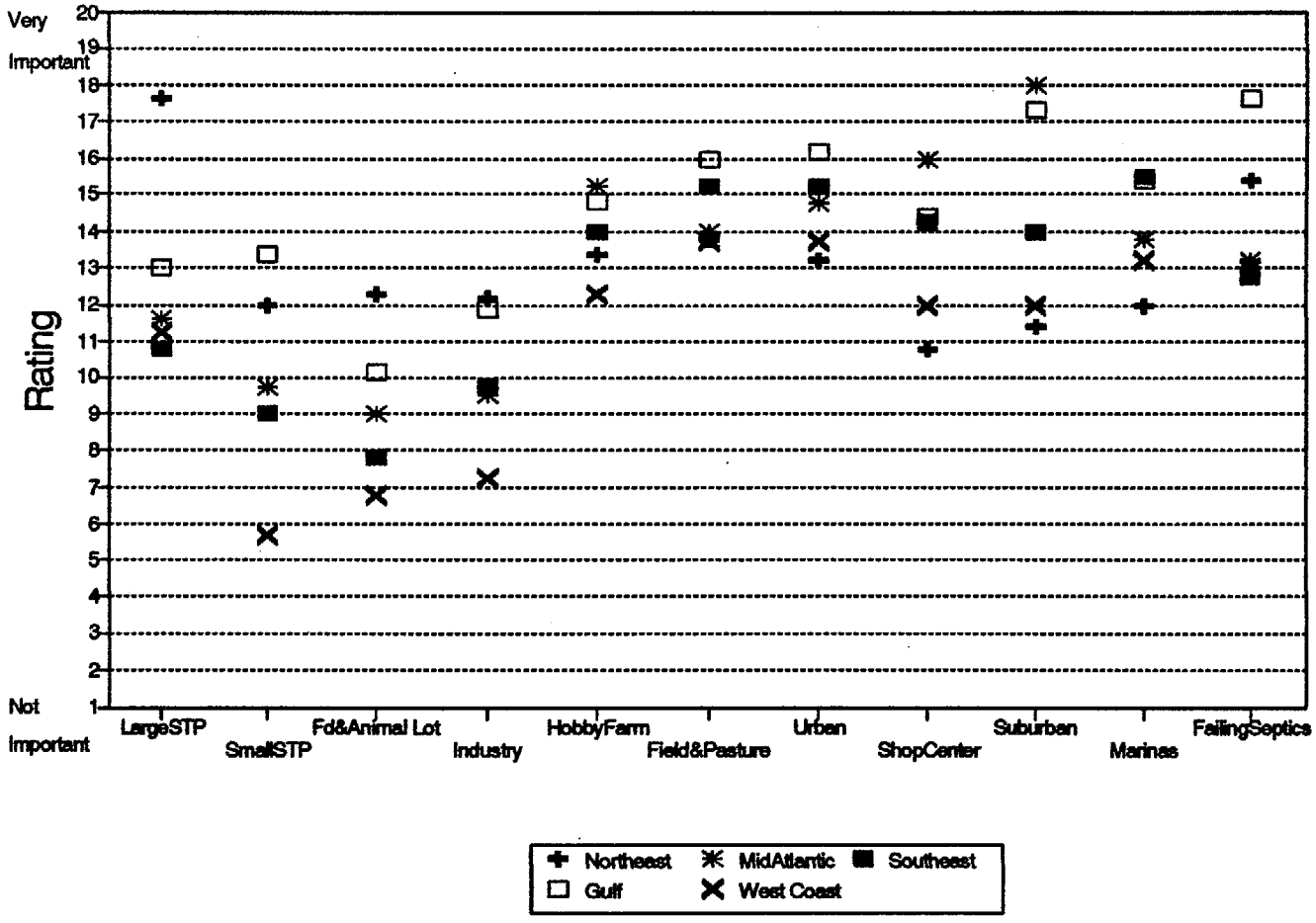


Figure 6.

Perceived Importance of Pollutant Sources on Shellfish Closures by Region



2.2 POPULATION AND DEVELOPMENT TRENDS

The portion of the U.S. population that resides on or near the coast has increased steadily, as the overall population has grown. This trend of relatively rapid population growth in the coastl zone is predicted to continue. In a recent study of the Chesapeake Bay region, a panel of experts projected a significant increase in population by the year 2020 (Year 2020 Panel, 1988). In addition they noted that more land is being developed for each new person. "As a result of its work, the Panel's major conclusion is that procedures currently being used throughout the Bay region for managing and providing for growth and development are inadequate, and must quickly be changed if current trends are to be reversed".

The panel described a number of "Visions of Success", along with the actions necessary to achieve these visions. Two of the visions seem particularly germane to the current study:

Vision II. Sensitive areas are protected, and

Vision IV. Stewardship of the Bay and the land is a universal ethic.

An action agenda was included for each of the states bordering Chesapeake Bay and for the federal government. The thrust of the action agenda was that the states must develop and implement new ways to manage growth and the activities on the water and the land, if we are to restore Chesapeake Bay.

These conclusions are very similar to those which one might reach after reading the case studies. The fact that SENTAF initiated this study indicates that they too agree with the need to find these new ways to manage growth. The final section of this report includes recommendations to address this situation, and also describes how these recommendations were developed.

RECOMMENDATIONS TO PROTECT VIRGINIA'S SHELLFISH GROWING AREAS AND PROMOTE THE SHELLFISH INDUSTRY

3.0 SELECTION OF MANAGEMENT STRATEGIES FOR VIRGINIA

A workshop was held on 16 July 1991 at Christopher Newport College in Newport News, VA to consider ways that the Commonwealth could better manage water quality and the shellfish resources of the state. The attendees came from various segments of the shellfish industry, state management agencies, citizen groups and the Oyster Blue Ribbon Panel (see Appendix 4 for a list of attendees). Possible courses of action, which were presented and discussed, ranged from doing nothing to improving existing programs to trying something new. Attendees were encouraged to express their opinions and to rate the effectiveness of suggested actions.

The focus of the discussions was on water quality problems, but diseases and other problems were mentioned as well. There was consensus that the state needed to do something more than it currently was doing. Three broad management strategies or programs met with general approval:

1. Give "extra" protection to some growing areas,

2. Promote shellfish cleansing, and

3. Continue efforts to restore Chesapeake Bay, and especially to reduce fecal pollution.

Following the workshop, the investigators developed the specific and detailed recommendations that are needed to implement each of these strategies. Draft recommendations then were discussed and modified at meetings of the Shellfish Enhancement Task Force. The final, detailed recommendations are described in the following sections.

3.1 ESTABLISH A PROGRAM TO DESIGNATE "SHELLFISH CULTURE AREAS" WITHIN THE COMMONWEALTH

The goal of water pollution control efforts (as stated in the 1972 amendments to the Clean Water Act: PL92-500) is for the nation's waters to be suitable for fishing and swimming. In the jargon of the trade, waters should be "fishable and swimmable." In Virginia, considerable progress has been made towards that goal, especially with regard to the waters that historically exhibited depletion or low concentrations of dissolved oxygen. Bacteria problems due primarily to agricultural runoff and municipal point sources, however, remain and were affecting an estimated 1,905 miles of streams statewide in 1988 (VSWCB, 305(b) report).

In the case studies, it was noted that shellfish filter particulates from large volumes of water each day and in so doing, concentrate pollutants in their bodies. Consequently, water quality standards for shellfish growing areas are very restrictive. Another way of saying this is that shellfish growing waters must be "pristine" - waters with extremely low concentrations of pollutants and low numbers of bacteria and viruses. Since the bacteriological water quality standard is 14 MPN/100 ml for shellfish growing waters and 200 MPN/100 ml for waters used for contact recreation (e.g., swimming, boating, wading), the shellfish standard clearly is much more restrictive than the recreational standard.

Contaminated shellfish will be cleansed if transferred to high quality waters. The federal Food and Drug Administration has set upper limits for the waters from which shellfish can be taken for cleansing in a controlled depuration plant. That upper limit is a mean fecal coliform count of 88 MPN/100 ml. In other words, the maximum allowable bacterial count for depuration is less than half the maximum allowed for waters that humans swim and play in. We repeat this information is to emphasize that:

(1) shellfish require very, very high quality water if they are to be harvested and sent directly to market, and

(2) very high quality water is needed if the shellfish are to be depurated prior to marketing.

Given these stringent water quality standards, the authors suggest that special efforts are needed to ensure that some growing areas maintain the pristine conditions necessary for shellfish culture. We further recommend that a program to designate shellfish culture areas is appropriate.

GENERAL RECOMMENDATION #1. THE COMMONWEALTH SHOULD ESTABLISH A PROGRAM TO DESIGNATE "SHELLFISH CULTURE AREAS"

Preserving the capacity to grow shellfish in the waters of the Chesapeake Bay will require effective management of the quality of those waters. Sediment and nutrient loading of the water column must be moderated in order to provide an opportunity for shellfish, particularly oysters, to grow quickly to marketable size. In addition, the waters must be free of toxic compounds and disease organisms if the shellfish are to be harvested for direct marketing. The presence of diseases affecting oysters in the Chesapeake Bay means that the most appropriate waters (in terms of salinity ranges) are typically found in the middle reaches of the major river tributaries to the Bay and in the many small creeks feeding these rivers and the Bay. These are the very areas most susceptible to pollution from the surrounding land mass.

While the Commonwealth of Virginia owns almost all of the subaqueous bottoms, the ability to achieve the necessary water quality conditions is problematic. In order to achieve or maintain the water quality necessary to grow marketable shellfish, it is necessary to manage both point and non-point sources of pollution. At present Virginia has a variety of regulatory programs which address individual components of the total pollutant loading to the Bay and its tributaries, but operating separately and with limited coordination, these programs have been unable to effectively prevent the degradation of water quality to levels below those acceptable for shellfish culture (See Appendix 5 for descriptions of agency responsibilities).

At present the Virginia Water Control Board has the authority to regulate the discharge of pollutants into state waters by so-called point sources, including the authority to limit the amounts of nutrients and toxics discharged. These limits could be expanded to include the discharge of disease causing organisms. It theoretically is possible, therefore, for the state to prevent the degradation of shellfish growing waters by point source discharges.

The principal water quality problems for shellfish growing areas in Virginia and other Mid-Atlantic states, however, come from non-point sources of pollution, which derive from the pattern and style of land use which occurs within the drainage basin. There are a number of state programs aimed at elements of this type of pollution, but land use control is basically a local government responsibility. Most non-point source pollution control programs (e.g., the sediment and erosion control program) involve some cooperative effort in which the state and local

governments both contribute resources and effort to implement the program. The Chesapekae Bay Preservation Act also addresses non-point source pollution. In this case the state established basic criteria and general objectives, and the final structure of the management program is determined and implemented by local governments.

Water quality sufficient to support culture of shellfish is frequently higher than the objectives of the existing management programs. Additionally, attainment of the specific requirements for nutrient, sediment, toxic, and disease conditions in shellfish growing waters would require close coordination of the various state and local management efforts. This type of unanimity of purpose is not typical in the implementation of the existing programs, although it is theoretically achievable. If the Commonwealth of Virginia is to be successful in retaining a viable shellfish industry, a means for preserving or restoring water quality appropriate to shellfish culture must be found. The current mix of state and local programs has the potential but not the history of such achievement.

The link between land use and water quality establishes some practical constraints, because managing land use is essential to protecting the quality of adjacent waters. Because land use control is a local government prerogative in Virginia, any effective program will have to include local governments. Unilateral action by local governments, however, would not suffice to guarantee culture activities would occur. Additionally, the state programs addressing pollutant control will need to be coordinated, sharing a common regulatory objective. Any effective program for management of shellfish culture areas, therefore, will have to include state government agencies.

The fact that water bodies frequently serve as boundaries for local jurisdictions within the state means that a mechanism for coordination between local governments should be available. Planning district commissions (PDCs) can provide a vehicle for some of this coordination, but PDCs have some of the same boundary constraints imposed on local governments. The occasional regional coordination can be managed at the state level by a designated agency or by simply making coordination a requirement for implementing any management program.

Management Model: The Virginia Scenic Rivers program provides a workable model for developing a program to manage shellfish culture waters. The essence of the Scenic Rivers program is that the Virginia General Assembly will designate a river reach if: (1) it meets the criteria for designation; and (2) the adjacent local governments support the designation. Once a river segment has been designated a local or state agency is identified to serve as an overseer, ensuring that subsequent state or local actions are consistent with the designation. The program does not establish any new regulatory authority, it merely serves to focus attention on the characteristics desired in the area and provides a basis for evaluating independent regulatory or management decisions.

Following the Scenic Rivers model, Virginia could develop a "Shellfish Culture Area" (SCA) designation. Some other name might be appropriate, and any of the particulars in the following discussion might be altered, but the objective would be to establish a program in which local governments might determine that preservation or enhancement of the shellfish culture capacity of a water body was desired, and then in cooperation with the state government work to achieve the necessary water quality for the area.

Elements of this program might include:

1. Establishment of water quality criteria for shellfish culture areas by an appropriate state agency, with guidance and assistance from other regulatory agencies. The purpose would be to identify the levels of water quality parameters which can be monitored or made part of permitting decisions.

2. Conduct a preliminary inventory of state waters which meet, or have the potential to meet, the SCA water quality criteria. The purpose would be to advise those localities which still have such areas of their existence and to encourage designation and preservation.

3. Identify a lead state agency for registration and monitoring of SCAs. Logically this might be the Virginia Marine Resources Commission.

4. Establish a nomination procedure by which local governments could identify areas they wish to manage as SCAs. This should include a step in which local land use planning tools (comprehensive plan and zoning ordinance) are evaluated against some general criteria to ensure consistency with maintenance of local water quality. This step could be an expansion of the current review undertaken as part of the Chesapeake Bay Preservation Act implementation (utilizing the resources of the Chesapeake Bay Local Assistance Department).

5. Have official designation of SCAs be an act of the General Assembly. This would ensure careful consideration of the interests of all parties and lend the weight of the Assembly to the designation. This latter element may be critical to enhancing coordination of all state programs which can potentially affect SCAs.

6. Like the Scenic Rivers program, each SCA should have a specific overseer, either a local or state entity, to provide the watchdog service of reviewing state and local government regulatory actions for consistency with the SCA designation.

Summary of Recommendations

Recommendation #1-a. The Council on the Environment should recommend to the General Assembly a program to nominate and designate Shellfish Culture Areas.

Recommendation #1-b. The Division of Shellfish Sanitation of the State Health Department should develop the water quality criteria appropriate for designated Shellfish Culture Areas.

Recommendation #1-c. The Division of Shellfish Sanitation, in conjunction with the Shellfish Enhancement Task Force, should conduct a preliminary inventory of state waters which meet these criteria.

Recommendation #1-d. The Marine Resources Commission should be the lead agency and be responsible for registering and monitoring Shellfish Culture Areas.

Recommendation #1-e. The Council on the Environment should establish the nomination procedures.

Recommendation #1-f. The official designation of Shellfish culture Area should be an act of the General Assembly.

Recommendation #1-g. The Division of Shellfish Sanitation should be charged with overseeing the designated areas and ensuring that state and local government regulatory actions are consistent with the program.

Recommendation #1-h. The Council on the Environment should ensure that the Shellfish Culture Areas program conforms to Virginia's Coastal Resources Management Plan and, when possible, use moneys available through the VCRMP to assist the other state agencies agencies to complete their assigned tasks.

3.3 PROMOTE ALTERNATIVE METHODS OF SHELLFISH CLEANSING

It appears that shellfish growing water standards are so restrictive that any significant amount of development in a watershed means that the shellfish standard cannot be met - even though water quality may be good in general and satisfy other water quality objectives. Development of the coastal zone seems very likely, suggesting a rather bleak future for Virginia's shellfisheries.

We also have seen that many small subestuaries and portions of a number of large estuaries are closed for the harvesting of shellfish (Figure 1). Preliminary examination of the data from the Division of Shellfish Sanitation's monitoring program, however, indicates that the mean fecal coliform counts for many of these areas are below 88 MPN per 100 ml of water. In other words, the waters are only moderately polluted and shellfish from these areas can be cleansed and then placed on the market. One means of reducing the impacts of pollution and the closure of shellfish growing waters is to promote methods of cleansing that will allow the resource to be harvested and, after cleansing, marketed.

GENERAL RECOMMENDATION #2. THE COMMONWEALTH SHOULD PROMOTE METHODS OF CLEANSING SHELLFISH.

Data compiled by the Marine Resources Commission staff suggest that more than 500,000 bushels of oysters are available (fall 1991) from presently closed shellfish waters (see Appendix 6 for the details). It should be noted that this volume is of the same magnitude as the harvest in recent years. Thus, there appears to be sufficient resource to warrant efforts by the state to encourage the harvesting and use of this resource.

RELAYING: Relaying, moving shellfish from closed areas to bottoms with good water quality and allowing the natural purification processes to occur, has been practiced for decades. When water temperatures are above 50 degrees F, the shellfish can be released after fifteen days in the clean waters. While satisfactory from a public health point of view, the process has economic drawbacks. First, the shellfish must be harvested twice. During both operations, shells will be broken and resource lost. The second harvest will never be one hundred percent successful, and some of the shellfish will be left behind. In addition, there can be losses during transfer, mortalities resulting from changes in temperature and salinity and from other causes.

CAGED RELAYING: A variation on the process is "caged relaying." Shellfish from the closed areas are put in containers which are then placed in the clean waters but off the bottom. There can be sizeable costs to begin such an operation, for the purchase of trays, fabricating and placing the structures to hold the trays, and special equipment needed for the operation. The efficiency of the operation is greatly improved, however, because all of the shellstock can be harvested at the end of the operation. Although there will always be some mortality, losses due to breakage are minimal. This method must have some economic advantages (at least for clams), because caged relaying of clams is now the preferred method of cleansing.

A few persons are using the cages to relay oysters, but these operations are few in number and small in size, relative to the clam operations. In order to promote this alternative cleansing method for oysters, we recommend that caged relaying operations be publicized.

Recommendation #2-a. The Virginia Sea Grant Program should develop and disseminate a bulletin providing information on caged relaying operations.

Information on caged relaying should be assembled and an information bulletin prepared and distributed. Because the Sea Grant Marine Advisory Program has prepared many bulletins of this nature in the past, this program is the logical entity to prepare a bulletin on caged relaying. The bulletin should emphasize that caged relaying of oysters is an acceptable cleansing method, that this method has been approved by the Virginia State Department of Health, and that the method is being used today. If data on operational costs are available, that information should be included. This should be done soon, preferably well before water temperatures reach 50 degrees F in the spring of 1992.

Relaying operations require special permits and have other requirements if they are to be successful. It is likely that many planters and most watermen do not want to become involved in these aspects of the process. They could, however, sell shellfish from closed areas to individuals or companies having a permitted relaying operation. The state should not promote any individual or company, but it could make available its list of approved relaying operations to those who request it. The availability of this list should be noted in the information bulletin.

DEPURATION: The state also should investigate and promote depuration, the cleansing of shellfish in a controlled environment. Depuration facilities have been used by other coastal states for decades, but most of these facilities have been used to cleanse clams. Only New Jersey and Florida are believed to have had approved depuration plants for oysters. Research conducted in Virginia, however, indicates that oysters will depurate reliably (Perkins **et al**, 1978; Neilson **et al**, 1978)

Although caged relaying appears to offer immediate benefits with little cost to the state, depuration has additional benefits. First, one of the many factors that can be controlled is water temperature. Thus, it would be possible to depurate shellfish even when ambient water temperatures are below 50 degrees F. This is relevant because the demand for oysters peaks at Thanksgiving and Christmas, times when relaying may not possible due to low water temperatures. Second, several major corporations have indicated that they do not serve raw shellfish in their restaurants, and will not serve raw shellfish unless and until they can offer their customers added protection (Arnold, 1991). Consequently, some have suggested that shellfish from approved growing areas be depurated as well, so that the quality of the shellfish would be enhanced.

Depuration could be a requirement in the distant future. Given the projected population growth and continued development in Virginia's coastal zone, the number of areas approved for relaying almost certainly will decrease. If there were no areas available for relaying, then depuration would be the only approved method for cleansing the shellfish. It is more likely that there will be fewer open areas, and these could be remote from the moderately polluted areas, thereby giving a local depuration facility an economic advantage.

Published information suggests that these facilities will be costly. A facility able to process one thousand bushels of oysters per week is likely to cost between one-half and one million dollars (Roberts, Supan, and Adams, 1991). Virginia businessmen have no experience with depuration plants, because none has ever been given a permit to operate in Virginia. Some are skeptical of the permitting process and are not convinced that the state will allow a facility to operate. If the private sector is to make this investment, then assurances from the state are needed.

Recommendation #2-b. The Division of Shellfish Sanitation should notify those individuals currently operating shellfish processing facilities, and other appropriate industry officials, of the Division's willingness to work to see that a depuration facility be established.

One means to demonstrate this would be for the state to bear some of the costs associated with the design and initial or start-up testing for the first depuration plant to be built in Virginia. All depuration plants must be designed to meet the standards and criteria established by the National Shellfish Sanitation Program (NSSP). Although these standards have been published, this does not tell a potential investor what a facility will cost to build, equip, and operate, nor does it guarantee that the facility will achieve the necessary cleansing.

Recommendation #2-c. The Commonwealth should hire an engineering firm to design a "typical" depuration facility and estimate the costs to construct and equip this facility. These plans would be available to all interested parties.

The standards and guidelines established by the NSSP are only the first step in designing a facility. Engineers must take those specifications and design or select tanks, pumps, a water distribution system and a building to house these items. Once the design has been determined, the costs can be estimated. Clearly some elements will be site specific, such as land costs and the foundations for the building. The engineers should prepare a list of such items, as well as a list of permits that would be needed for both the construction and the operation of the facility. Having the engineering designs and cost estimates available for a "typical" depuration facility should aid any entrepreneurs considering such construction.

The costs for the engineering design are estimated to be in the $10,000 to $25,000 range. The Oyster Repletion Program is one possible source of funding for such a study. Because a depuration facility would allow additional shellfish to be harvested, the taxes collected would increase. Thus, a successful depuration program would eventually pay back those moneys.

Recommendation #2-d. Management agencies should assist the owners of the first depuration facility during the start-up tests, including supporting the tests financially or with in-kind services.

Following construction, the facility must be tested and a plan of operation developed. This plan, the so-called Scheduled Controlled Purification Process (SCPP), dictates where shellfish may and may not be harvested, the conditions which must be maintained in the plant, the time that the shellfish must be held, and other aspects of the process. The objective is to develop standard operating procedures that will ensure a safe and clean product leaving the plant.

If problems are encountered during these initial studies, the tests must be repeated until successful. The state would encourage depuration if it agreed to cover some portion of the costs of these initial tests. This could mean a financial contribution, but it also could mean in-kind services. For example, bacteriological tests could be run at state laboratories. Subsequent plans would be developed by the entrepreneur. For example, the state could assist in the development of a plan to cleanse oysters. If the plant operator also wanted to depurate clams, or wanted to depurate oysters for different water temperatures, then other SCPP's would need to be established. These additional SCPP's should be developed at the operator's expense.

Recommendation #2-e. The Commonwealth should coordinate its regulatory activities to facilitate permitting for depuration facilities.

The Marine Resources Commission should be the lead agency in the development of Memoranda of Understanding (MOU's) among the agencies responsible for the various permits that would be needed for a depuration facility. Given that the state has limited experience with depuration facilities, some coordination is needed among the agencies to ensure that no permits are delayed due to misunderstandings. The sequence in which the permits are to be obtained, for example, should be determined in advance and made known to any applicant.

Recommendation #2-f. The Marine Resources Commission should investigate how the state can provide financial incentives to depuration plant operators.

The substantial costs required for the land, building, and equipment mean that few will be able to undertake such an endeavor. Financial incentives could increase the number of persons or groups who would be interested in operating a depuration facility. The Marine Resources Commission should investigate these options to determine what, if any, incentives the state can offer. In particular, low interest loans from the revolving fund or from an economic development agency might be appropriate.

3.3 REDUCE ALL POLLUTANT SOURCES, ESPECIALLY SOURCES OF FECAL POLLUTION, AND RESTORE CHESAPEAKE BAY

The Chesapeake Bay Program has grown from a primarily research study to a large and relatively comprehensive program that includes the efforts of federal, state, and local governments. It would not be feasible or appropriate to describe all of these efforts in this document, but it seems relevant to note the major points of the recent Governors' Agreement (Chesapeake Executive Council, 1991). These are:

1. Accelerate Nutrient Reduction,
2. Adopt Pollution Prevention,
3. Restore and Enhance Living Resources and Their Habitat, and
4. Broaden Participation in the Bay Restoration Program.

If these objectives are met, this should enhance the shellfish industry in Virginia. SENTAF supports these efforts and encourages all agencies to see that the action items in the Governors' Agreement are carried out.

GENERAL RECOMMENDATION #3. ALL VIRGINIA AGENCIES SHOULD WORK TO IMPLEMENT THE CHESAPEAKE BAY PROGRAM ACTION AGENDA

Reduction in sources of fecal pollution is particularly important for the shellfish industry. In previous sections the role of point sources of pollution and of runoff and other nonpoint sources of pollution have been described. The earlier recommendations address many aspects of this problem. Problems arising from malfunctioning septic systems and boating activities remain. SENTAF believes that special efforts are needed to control these sources of fecal pollution.

GENERAL RECOMMENDATION #4. THE AMOUNT OF SEWAGE REACHING THE STATE'S WATERS FROM MALFUNCTIONING SEPTIC SYSTEMS SHOULD BE REDUCED.

Recommendation #4-a. The state should re-instate the Chesapeake Bay Initiative that provided financial assistance to low income families who resided near shellfish growing waters and had failing septic systems, and the level of support should be $250,000 per year.

Shoreline surveys are conducted periodically, generally at five year intervals, to identify those discharges or operations that could or do pollute shellfish growing waters. Failing septic systems, in particular, are of great concern to public health officials. Some families do not have the financial

ability to correct the problems, meaning that shellfish closures must be enacted. For several biennia, there was a Chesapeake Bay Initiative to give financial assistance to these low-income families. This program should be reinstated.

The sanitarians in the various districts in the coastal zone were asked to estimate the amount of money needed for such a program. The number of problems found by a shoreline survey was adjusted to an annual basis. The number of eligible households was estimated using a percent of families in that area who fit the income guidelines, and the average cost for remedial work was estimated to be $3,000. The detailed information is included in Appendix 7. The total amount needed each year was estimated to be more than one million dollars.

The earlier Chesapeake Bay Initiative provided $150,000 per year. SENTAF recommends that the funding level be increased to $250,000 per year, with $50,000 to $100,000 allocated for the staff to administer the program. This could assist a county that does not have the staff to administer this program, or for a state agency to provide the necessary support.

Recommendation #4-b. The Shellfish Enhancement Task Force should regularly study and make recommendations on areas where the extension of sewer lines is expected to have a positive impact on shellfish growing water quality.

Information on growing area closures in GIS format should be available from the National Shellfish Register (NMFS) in the near future. Information on present and projected sewered areas is available from the Hampton Roads Sanitation District and from the localities which operate wastewater treatment facilities. These sets of information should be assembled, most likely by the Council on the Environments in GIS format, and compared.

The Shellfish Enhancement Task Force should review this information periodically, we recommend once every two years, and make recommendations to local governments regarding those areas where the availability of sewerage is expected to have positive and significant water quality benefits.

GENERAL RECOMMENDATION #5. THE STATE SHOULD TAKE STEPS TO REDUCE POLLUTION ARISING FROM BOATING ACTIVITIES.

The exact magnitude of boating pollution is unknown, but estimates in a recent brouchere developed by Virginia's Coastal Resources Management Program put the figure at over one million gallons each day. Although considered minor on a volume basis, boating wastewaters are still of serious concern. The dumping of raw sewage by a single boat may seem insignificant but the number of newly registered boats (Class 26-40 feet) in Virginia alone is greater then 5,000 for every year since 1980. Estimates of boats with installed toilets in all of Chesapeake Bay approach 50,000 and total number of boats is 300,000.

One aspect of the problem is that boats tend to gather in or frequent the smaller, quieter areas of Chesapeake Bay. These areas are often the places with reduced capabilites to circulate and flush out normal loadings of runoff, let alone the increases due to boating activity. Indeed, the three bodies of water chosen as case studies for this report all evidence problems related to flushing. Also, these more shallow, protected areas are often the site of oyster beds. In Figure 1.0-1, all condemned shellfish areas as of 1 January, 1991 are shown. The preponderance of these areas are the small creeks and coves of larger tributaries.

Recommendation #5-a. State regulatory agencies should work to establish No Discharge Zones in shallow and congested areas.

A long sought goal, that gained additional push with the 1987 Chesapeake Bay Agreement, is the designation of all of Chesapeake Bay as a 'No Discharge Zone'. This designation would require that all raw or treated sewage be held on board until the boat could reach a marina with pump-out or sewage connections. Currently, authority over design, installation and operation of Marine Sanitation Devices (MSDs) rests with the United States Coast Guard. In every day life, though, very few boaters ever are stopped for inspection of MSDs. In fact, the very design of MSDs makes it simple to switch from the closed-valve, normal MSD operation to an open-valve, straight-through and overboard discharge situation. While it is not our intent to indict innocent boaters, allowing sewage to bypass the MSD is a convenience hard to resist.

In the 1980's, the State Water Control Board (WCB) and the Department of Health (VDH) petitioned the Environmental Protection Agency (EPA) to establish a 'No Discharge Zone (NDZ)'. To meet NDZ requirements, the state must show, among other things, the locations, costs, schedules and numbers of pump-out facilities, that an adequate number of pump-out facilities is available to meet the needs of boaters, as well

as information of how sewage will be treated, vessel usage and population on the waters, and must be able to certify that the waters in question need the extra protection of an NDZ. The EPA did not grant Virginia's earlier request.

Although a Bay-wide no discharge zone may be the ultimate goal, water quality near shellfish beds would be enhanced by a no discharge zone, even if restricted to shallow waters and congested areas. The regulatory agencies should consider this option and pursue it, if they determine that federal approval is possible.

Recommendation #5-b. The Health Department should set a time table (circa 3 to 5 years) for full compliance with the requirements for marinas to have pump-out facilities and should ensure that complete compliance was achieved at the end of that period.

Any discharge of human waste will affect the marine environment. In the report, "Recreational Boat Pollution and the Chesapeake Bay," it is noted that intestinal organisms, increased nutients and biological oxygen demand, and toxic pollutants from chemical disinfection are introduced into the environment as by-products of MSD use. We do not want to discourage the use of MSDs aboard ship; their use is a great improvement over the dumping of raw sewage. Rather, we would like to encourage the development of effective MSDs, and <u>in particular</u> to encourage manufacturers and boaters alike to install <u>and use</u> existing facilities! Especially, pump out facilities.

The best solution is the use of holding tanks followed by pump-out to a land based system at a marina. As of January, 1991, there were 164 pump-out facilities available at marinas in Virginia that provided 11,087 seasonal slips and 544 transient slips. The 19 vessel sewage connection facilities provide for 134 seasonal and 8 transient slips.

The use of pump-out facilities is controversial. Boaters complain that the facilities are inaccessible, unavailable, costly, or not adaptable to their boats' fittings. The pump-out stations therefore often go unused. Marina owners, who foot the bill, complain about lack of use and the problem of dealing with holding tanks of raw sewage, especially those not connected to any regional sewerage system. These complaints continue despite the fact that the Department of Health requires adequate facilities at all marinas and that Virginia Marine Resources Commission (VMRC) cannot issue a permit to build a marina unless prior approval has been obtained from the Health Department for pump-out facilities that will meet the needs of the planned marina.

VDH has the authority to enforce compliance with pump-out regulations and conducts annual inspections of marinas to ensure compliance. The reasons for lack of compliance should be determined and a program developed to ensure compliance in the future. A three to five year time frame seems appropriate for achieving complete (or near complete) compliance.

In Maryland, a portion of the tax on boat purchases goes to a fund that assists in the construction of pump-out facilities. In addition, all state parks and public parks have these facilities available; there is also a mobile pump-out station. These options should be considered in VDH's management plan.

Recommendation #5-c. The Division of Shellfish Sanitation should include, as part of the procedures for establishing condemnation zone around marinas, an explicit factor relating to the availability and use of pump-out facilities.

Unless and until there are "costs" associated with non-use of pump out facilities, this issue will be ignored. Noting that use of pump out facilities logically is related to the amount of wastewaters discharged from boats to receiving waters, the DSS should incorporate a factor into the design of closure zones which penalizes those marinas with no pumpout facilities and rewards those marinas that not only provide, but see that boaters use, the pump out facilities. Appropriate record keeping must be instituted for this process to work.

Recommendation #5-d. Facilities whose operations result in buffer zones or condemned areas should be made financially responsibile for the maintenance of the signs indicating those closures.

The discharge of wastewaters, whether from boats or a treatment plant, will result in the establishment of buffer zones in the adjacent shellfish beds. Signs must be posted to let the public know that the harvesting of shellfish from these areas is prohibited, whether the harvesting is by commercial or recreational fishermen. Maintenance of these signs is expensive. Because the closures result from specific activities or discharges, it appears logical to expect that each operation to pay for the maintenance of the signs marking the limits of the condemned area around that facility.

Recommendation #5-e. The Health Department should continue and expand its "Don't Pass the Bucket" educational campaign.

The Department of Health, Division of Wastewater Engineering, has developed educational brochures for boaters that explain the three types of Marine Sanitation Devices currently available and encourage their use as a notable contribution to the health of the Bay. Also, a logo has been developed as a quick reminder to all users of Chespeake Bay.

The educational program developed by the Health Department is a good one. Unfortunately, successful programs require constant attention. New boaters must hear of the program, and those who have already heard the message must be reminded. Of course, the emphasis can and probably should change from year to year, and materials should be up-dated periodically.

Recommendation #5-f. The Health Department and the Water Control Board should work with funding agencies and private sources to conduct a demonstration project that brings sewerage to "live-on" boats.

It is easy to argue that "live-ons" should be a primary target for educational and regulatory efforts related to boating wastes, because the simple fact that persons are living on these boats dictates that "grey waters" (water from sinks and showers) and "black waters" (sewage) will be produced at least some of the time.

For most private residences, appropriate sanitary facilities are required before an occupancy permit is granted. Boats that are used as residences should be treated in a similar fashion, it can be argued, but from a practical perspective, the efforts will not be meaningful until reasonable and economically practical methods of handling wastewaters are demonstrated.

A public-private cooperative effort could demonstrate that sewerage for "live ons" is not only possible but is needed. Marina operators could be queried to determine which have significant number of "live-ons". Those facilities would then be solicited for participation in a demonstration. The facility could benefit from the positive publicity surrounding the demonstration facility. The state and the industry would benefit from the experience gained.

REFERENCES AND LITERATURE CITED

Literature Cited in the Report

Arnold, Robert E., 1991. "An Industry Perspective on Depuration," pp 3-5 in **Molluscan Shellfish Depuration**, CRC Press, Boca Raton, FL

Bosco, Cindy and Bruce Neilson, 1983. "Interpretation of Water Quality Data from the Nansemond and Chuckatuck Estuaries with Respect to Point and Nonpoint Sources of Pollution" A Report to HRWQA, VIMS, Gloucester Point, VA 71 pp.

Chesapeake Executive Council, 1991. "The Chesapeake Bay Program - An Action Agenda", Chesapeake Bay Progarm Office, Annapolis, MD 18 pp.

Cummings, Hugh S., 1916. "Investigation of the Pollution and Sanitary Conditions of the Potomac Watershed, with Special Reference to Self Purification and the Sanitary Condition of Shellfish in the Lower Potomac River" Treasury Dept., U.S. Public Health Service, Hygienic Laboratory - Bulletin No. 104. 239 pp.

Fisher, Paul E., 1989. "Cleaning Up Nansemond-Chuckatuck: A Threatened Success Story", in Critical Water Issues in Tidewater Virginia, VA Water Resources Research Center, Blacksburg, VA

Gillinsky, E. and J. V. Roland, 1983. "Summary and Analysis of Metal and Pesticide Concentrations in Shellfish and Fish Tissues from VA Estuarine Waters", SWCB, Richmond, VA 75 pp.

Haven, Dexter S., Frank O. Perkins, Reinaldo Morales-Alamo, and Martha W. Rhodes, 1978. "Bacterial Depuration by the American Oyster (Crassostrea Virginica) under Controlled Conditions: Volume I - Biological and Technical Studies" Special Scientific Report No. 88, VIMS, Gloucester Point, VA

Kator, Howard and Martha Rhodes, 1988. "Evaluation of alternate microbial indicators of fecal pollution in a non-point source impacted shellfish growing area" A report to the Council on the Environment, VIMS Gloucester Point, VA 40 pp.

Kilch, Linda R. and Bruce J. Neilson, 1977. "Field and Modelling Studies of Water Quality in the Nansemond River" A Report to the Hampton Roads Water Quality

Agency, VIMS Special Report No. 133, Gloucester Point, VA 60 pp.

Leonard, Dorothy L, Mariene A. Broutman, and Kristen E. Harkness, 1989. "National Estuarine Inventory: The Quality of Shellfish Growing Waters on the East Coast of the United States" US Dept. of Commerce, National Oceanic and Atmospheric Admin., Rockville, MD. 54 pp.

Leonard, Dorothy L, Eric A. Slaughter, et. al., 1990. "The 1990 National Shellfish Register", National Oceanic and Atmospheric Administration, National Ocean Service, Rockville, MD (Draft)

Neilson, Bruce J., 1975. "A Water Quality Study of the Elizabeth River: The Effects of the Army Base and Lambert Point STP Effluents", VIMS Special Report No. 75, Gloucester Point, VA 133 pp.

Neilson, Bruce J., 1976. "Water Quality in the Small Coastal Basins", A Report to the Hampton Roads Water Quality Agency, VIMS Special Report No. 129, Gloucester Point, VA. 139 pp.

Neilson, Bruce J., Dexter S. Haven, Frank O. Perkins, Reinaldo Morales-Alamo, and Martha W. Rhodes, 1978. "Bacterial Depuration by the American Oyster (Crassostrea virginica) under Controlled Conditions; Volume II - Practical Considerations and Plant Design" Special Scientific Report No. 88, VIMS, Gloucester Point, VA

Neilson, Bruce J. and Susan C. Sturm, 1978. "Elizabeth River Water Quality Report". A Report to the Hampton Roads Water Quality Agency, VIMS Special Report No. 134, Gloucester Point, VA 23062 45 pp.

Newell, Roger I. E., 1988. "Ecological Changes in Chesapeake Bay: Are They the Result of Overharvesting the American Oyster?", in Understanding the Estuary: Advances in Chesapeake Bay Research. Chesapeake Research Consortium, Publication No. 129.

Oswalt, Donald W., 1975. "Urbanization and Environmental Change in the Lynnhaven Estuary" Masters Thesis, Institute of Oceanography, Old Dominion University, Norfolk, VA

Rainbow, Phillip S., David J. H. Phillips, and Michael H. Depledge, 1990. "The Significance of Trace Metal Concentrations in Marine Invertebrates", Marine Pollution Bulletin 21:7, 321-324.

Roberts, Kenneth J., John E. Supan and Charles Adams, 1991. "Economic Considerations for Oyster Depuration," pp. 163-177 in **Molluscan Shellfish Depuration**, CRC Press, Boca Raton, FL

Seufer, Adm. Paul E., 1977. Personal Communication.

Smith, Russell S., 1950. "Water Quality Survey of Hampton Roads Shellfish Areas: 1949-1950," Virginia State Department of Health. 123 pp.

Virginia State Water Control Board, 1975. "Water Quality Inventory 305(b) Report, Virginia, 1975 Report to the EPA Administrator and Congress", Information Bulletin 509, Richmond, VA

Virginia State Water Control Board, 1980. "State Water Control Board's Role in Virginia's Shellfish Sanitation Control Program" Tidewater Regional Office, Information Bulletin 544.

Virginia State Water Control Board, 1982. "Water Quality Standards", Richmond VA.

Virginia State Water Control Board, 1988. "Virginia Water Quality Assessment: 305(b) Reprt to EPA and Congress" Information Bulletin 574. Richmond, VA

Year 2020 Panel, 1988. "Population Growth and Development in the Chesapeake Bay Watershed to the Year 2020", the Report of the Year 2020 Panel to the Chesapeake Executive Council.

References

Atlantic States Marine Fisheries Commission, 1951. "Marine Fisheries Pollution Studies" Mount Vernon, NY 84 pp.

Banoub, Samir, Norman J. Blake, and Gary E. Rodrick, 1984. "An Approach to a Cost-Analysis of Shellfish Depuration" Excerpt for Final Report to DOC/NOAA, award No. NA 83-GA-H-0007, 34 pp.

Barth, Carole Ann, 1989 "Fisheries Management and the Chesapeake Bay" Alliance for the Chesapeake Bay, 8 pp.

Center for Disease Control, 1991. "Gastroenteritis Associated with Consumption of Raw Shellish - Hawaii, 1991" **Morbidity & Mortality Weekly Report**, Vol. 40, No. 18, pp 303-305.

Cooke, Elsa, 1991. "Unfit Acreage for Shellfish Almost Doubled in One Year", Gloucester-Mathews **Gazette-Journal**, August 1, 1991.

Di Vincenzo, Mark, 1991. "Shellfish Continue to Lose Ground" **Daily Press**, Newport News, VA August 18, 1991.

Godfree, A., F. Jones, and D. Kay, 1990. "Recreational Water Quality: The Management of Environmental Health Risks Associated with Sewage Discharges" **Marine Pollution Bulletin**, Vol. 21, No. 9, pp 414-422.

Goldsborough, William J., 1991. "Oysters", **Daily Press**, Newport News, VA. July 21, 1991.

Hampton Roads Sanitation Commission, 1942. "Report on Sewage Disposal" , 63 pp.

Hauge, Paul, 1988. "Lost Harvest: Sewage, Shellfish, and Economic Losses in the New Bedford Area" Conservation Law Foundation of New England, Boston, Massachusetts 02108 27 pp.

Kassner, Jeffrey, 1990. "Suburbanization and the Decline of the Shellfish Industry in New York", in Long Island: The Suburban Experience, Heart of the Lakes Publishing, Interlaken, NY pp 91-102.

Kator, Howard I. and Martha Rhodes, 1989. "Occurrence of indiators of fecal pollution in water and sediment of a sub-estuary impacted by nonpoint pollution," A report to the VA Dept. of Cons. and Historic Resources, VIMS, Gloucester Point, 32 pp.

Kilgen, Marilyn B., 1988. "National Shellfish Pollution Indicator Study," Interstate Seafood Seminar, Cape May, NJ, October 25-27, 1988.

Land Use Roundtable, 1988. "Land Use Initiatives for Tidewater Virginia: the Next Step in Protecting the Bay", Senate Document No. 6, Commonwealth of VA.

Leffler, Merrill, 1991. "Maryland's Oyster Fishery: A New Era of Management?" in Marine Notes, Md Sea Grant College, College park, MD 20742.

Lowe, Carolyn, 1991. "Land Trusts can protect natural, cultural resources", in **Tidings**, Lower James River Association, Richmond, VA.

Magoon, Charles and Richard Vining, "Introduction to Shellfish Aquaculture in the Puget Sound Region", State of Washington, Department of Natural Resources, Olympia, Washington 98504 68 pp.

Maryland Department of Natural Resources & Virginia Marine Resources Commission, 1989. "Revised Second Draft - Chesapeake Bay Oyster Management Program"

McCarthy, Gerald P., 1991. "Needed: An Alternative Vision of Development for Va." Virginia Forum, Richmond, VA 23202

New Jersey, 1987. "Coastal Water Quality Management Project: A Proposed Element of the Statewide Water Quality Management Plan"

North Carolina Division of Health Services, Shellfish Sanitation Program, 1988. "An Overview of Shellfish Growing Areas since 1980" 35 pp.

Otwell, W. S., G. E. Rodrick, and R. E. Martin, Editors, 1991. **Molluscan Shellfish Depuration**, CRC Press, Boca Raton, Florida 384 pp.

Schneiders, Robert. "Shellfishing in Connecticut" (no citation, provided by Connecticut Dept. of Agriculture, Aquaculture Division) 5 pp.

Slade, David C. et al., 1990. "Putting the Public Trust Doctrine to Work: The Application of the Public Trust Doctrine to the Management of Lands, Waters and Living Resources of the Coastal States" Connecticut Coastal Resources Management Division. 361 pp.

South Carolina, 1990. "Statewide Water Quality Assessment:

FY 1988-89 (305(b) Report)" Office of Environmental Quality Control, Columbia, SC

Talley, Ken. "Depuration" in **Canadian Aquaculture**, pp 45-49 (no date shown).

Veazey, John E. and Stuart A. Stevens, 1990. "A Description of Biological and Physical Parameters Affecting the Sanitary Quality of Glynn and Camden County, Georgia Shellfish Resources: A Sanitary Survey" Georgia Department of Natural Resources, Coastal Resources Division. Contribution Series Number 48. 108 pp.

Virginia Council on the Environment, 1989. "Development Policies and Guidelines", Richmond VA

Virginia Dept. of Conservation and Historic Resources, 1988. "Nonpoint Source Pollution Management Plan", Division of Soil & Water Conservation, Richmond, VA

Virginia Dept. of Conservation and Recreation, 1991. "Nutrient Management Program" Division of Soil & Water Conservation, Richmond, VA

Virginia Marine Resources Commission, 1988. "Oyster Resources in Virginia - Oyster Fishery Management Plan" 11 pp.

Virginia Sea Grant College Program, 1990. "A Plan Addressing the Restoration of the American Oyster Industry: the Results of two Workshops" Sea Grant Publication VSG-90-02. 64 pp.

Virginia State Water Control Board, 1990. "The Study of Small Package Wastewater Treatment Plants", Senate Document No. 28, Commonwealth of VA 36 pp.

Willaims, D. C.,Jr., David J. Etzold, and Edward Nissan, 1980. "Oyster Depuration Facility: Economic Assessment" Mississippi-Alabama Sea Gran Program, MASG-79-011. 28 pp.

APPENDIX 1. SHELLFISH ENHANCEMENT TASK FORCE MEMBERS (SENTAF)

S. M. Rogers, Chairman

Chesapeake Bay Local Assistance Department
- Scott Crafton
- Darryl Glover

Council on the Environment
- Ann DeWitt Brooks
- Stephen Laughlin

Department of Conservation & Recreation
- Division of Soil & Water Conservation
  - Moira Croghan
  - Donald Wells

Health Department
- Eastern Regional Office
  - Paul Sandman
- Office of Water Programs
  - Eric Bartsch
- Division of Shellfish Sanitation
  - Robert Croonenberghs
  - Robert Wittman
  - Mary Wright
  - Cloyde W. Wiley*

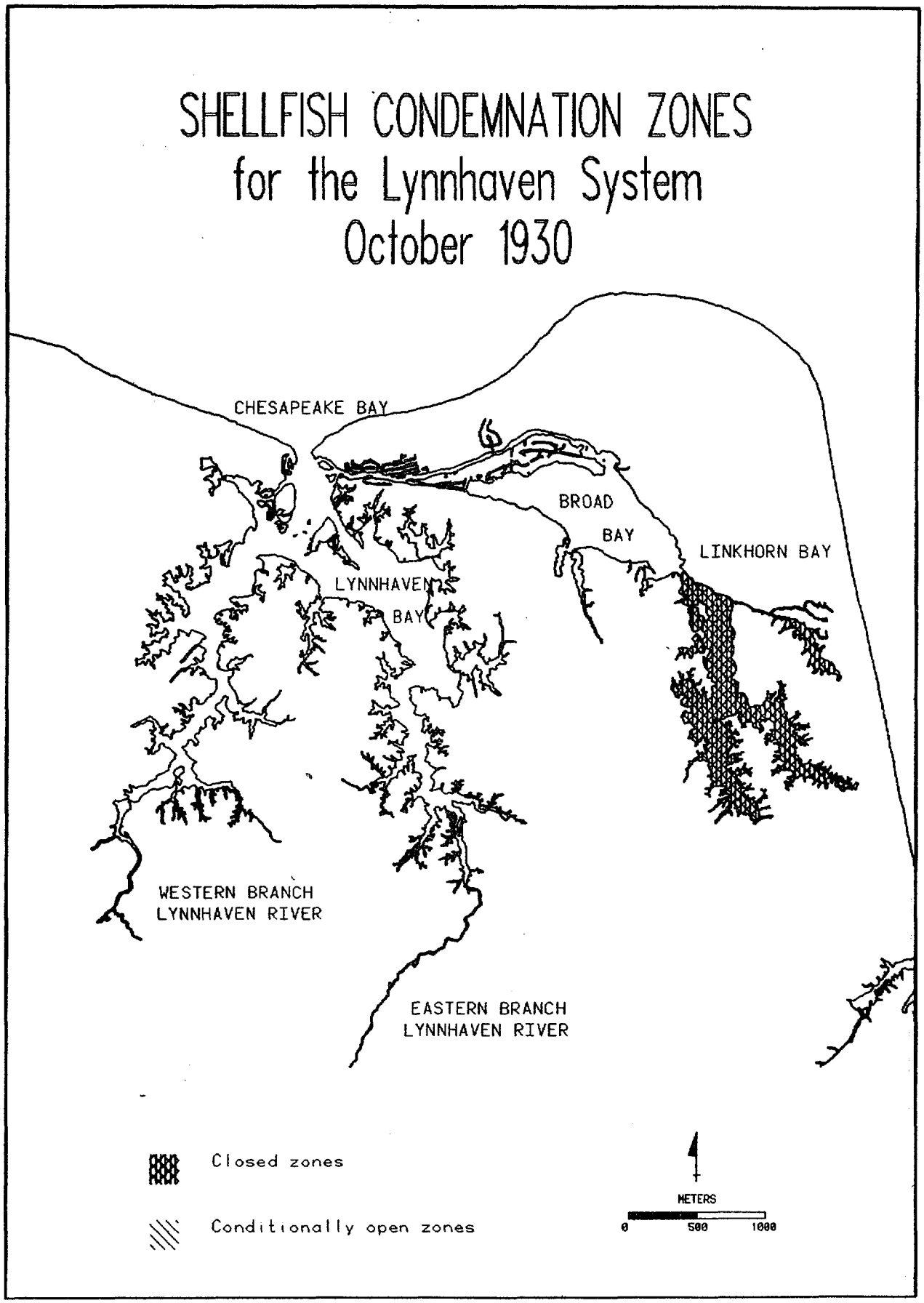
Dept. of Housing & Community Development
- John Baker
- Rebecca Millen

Marine Resources Commission
- R. C. Insley, Jr.
- S. M. Rogers
- Gerald Showalter

State Water Control Board
- Larry McBride
- Ernest R. Simmons

Virginia Institute of Marine Science
- Bruce Neilson
- Nancy C. Wilson

* Former member, now retired.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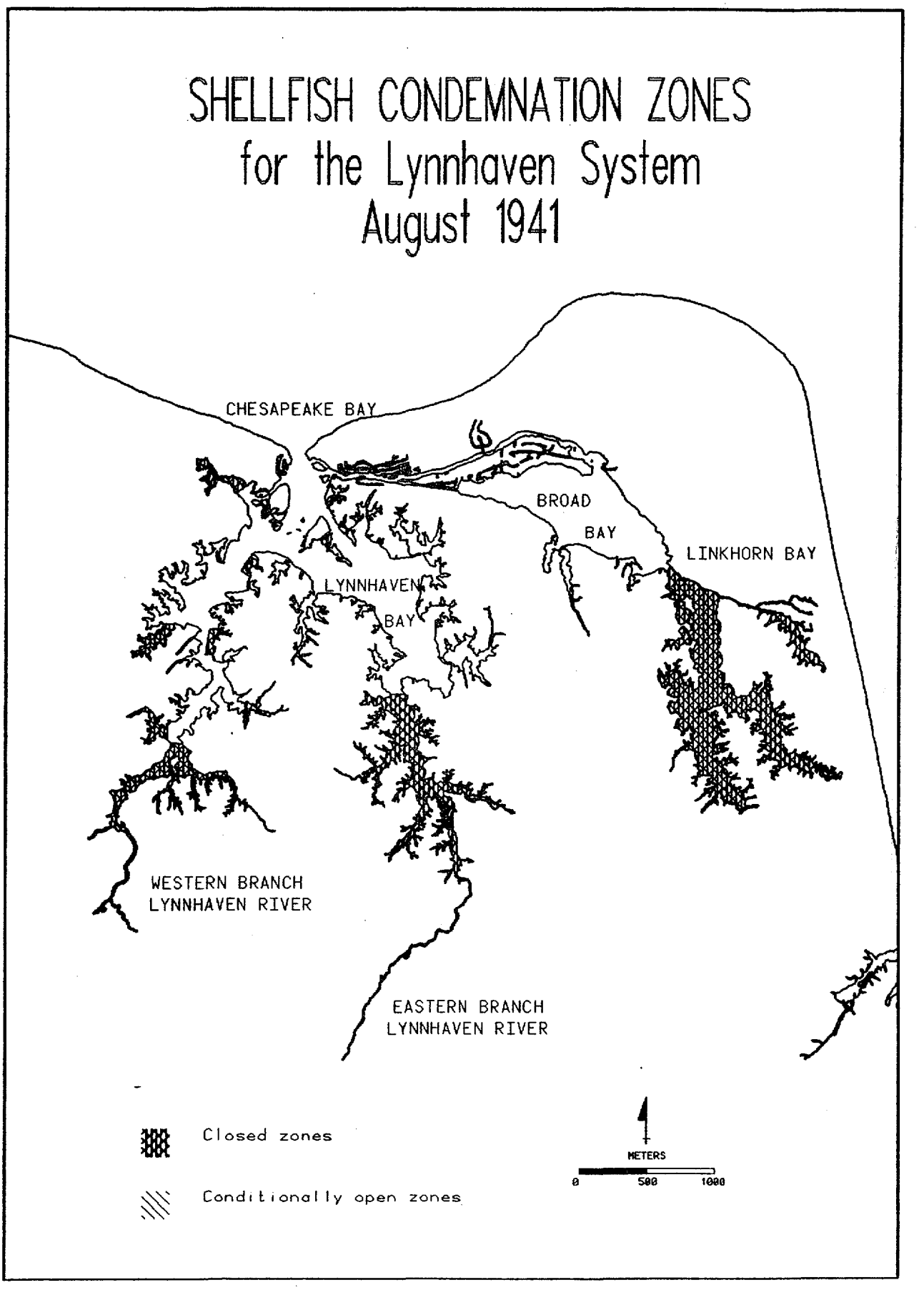
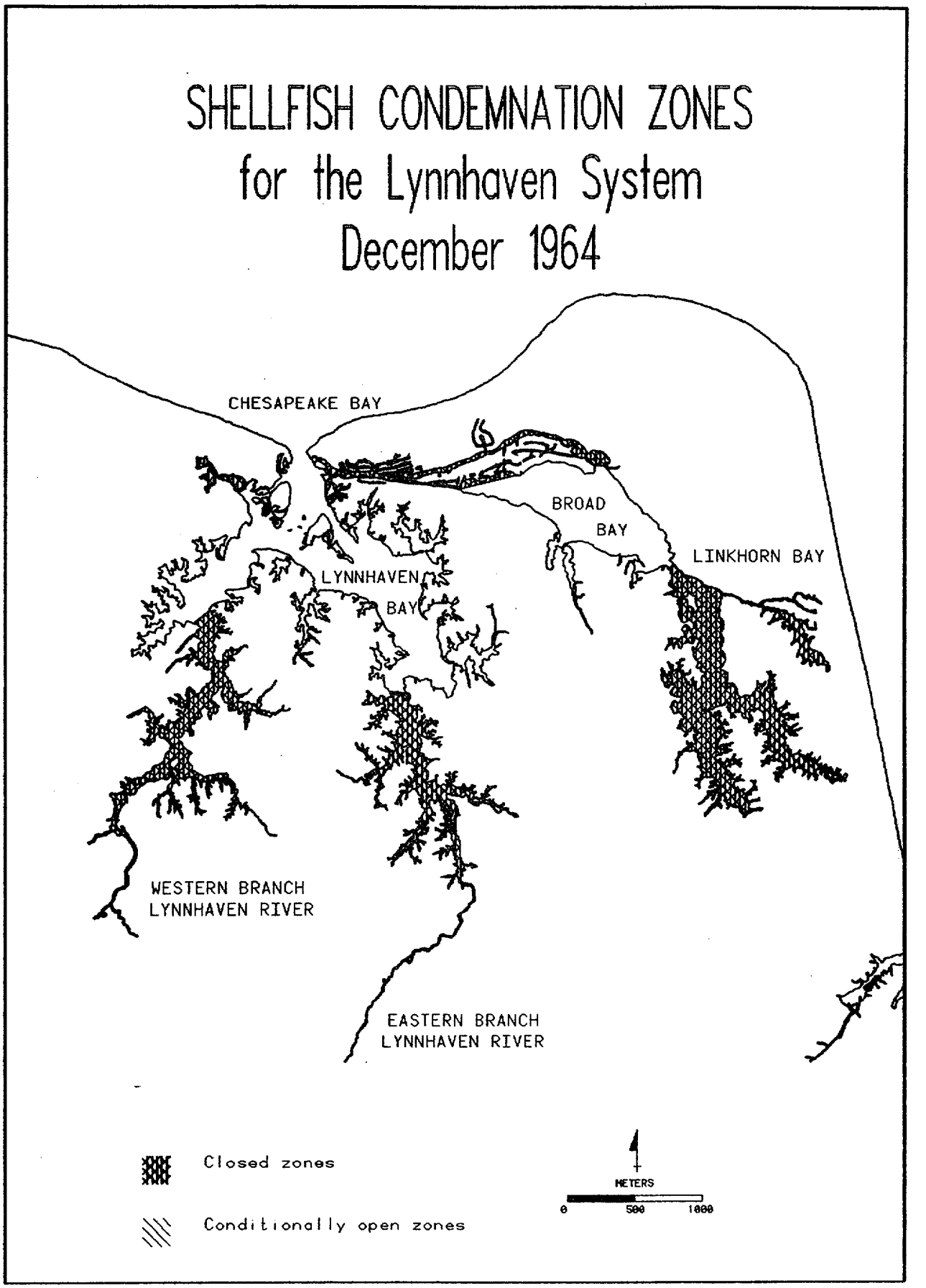
for the Lynnhaven System
October 1930
CHESAPEAKE BAY
BROAD
BAY
LINKHORN BAY
LYNNHAVEN
BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
1000


SHELLFISH CONDEMNATION ZONES
for the Lynnhaven System
August 1941
CHESAPEAKE BAY
BROAD
BAY
LINKHORN BAY
LYNNHAVEN
BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
1000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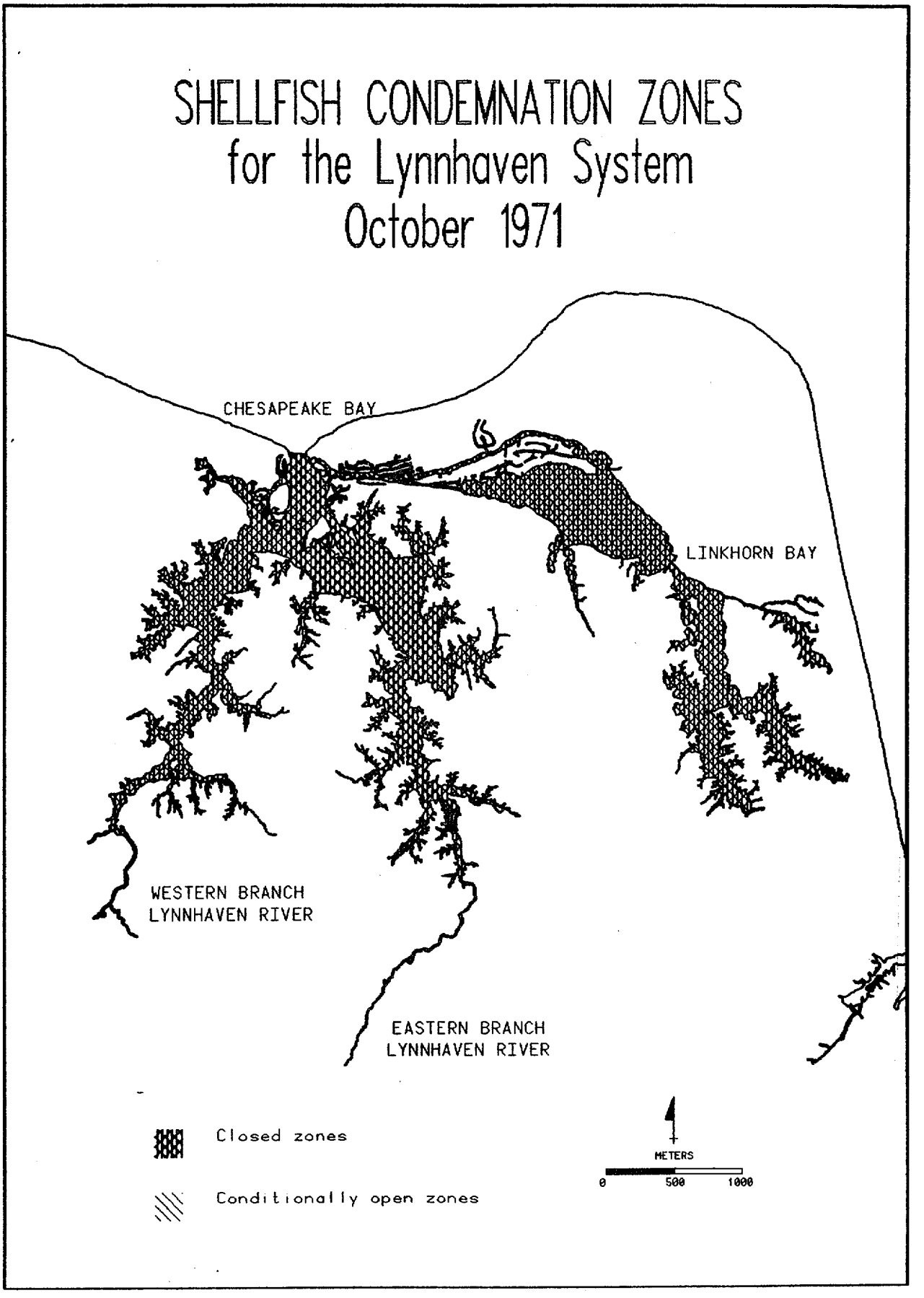
for the Lynnhaven System
December 1964
CHESAPEAKE BAY
BROAD
BAY
LINKHORN BAY
LYNNHAVEN
BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
1000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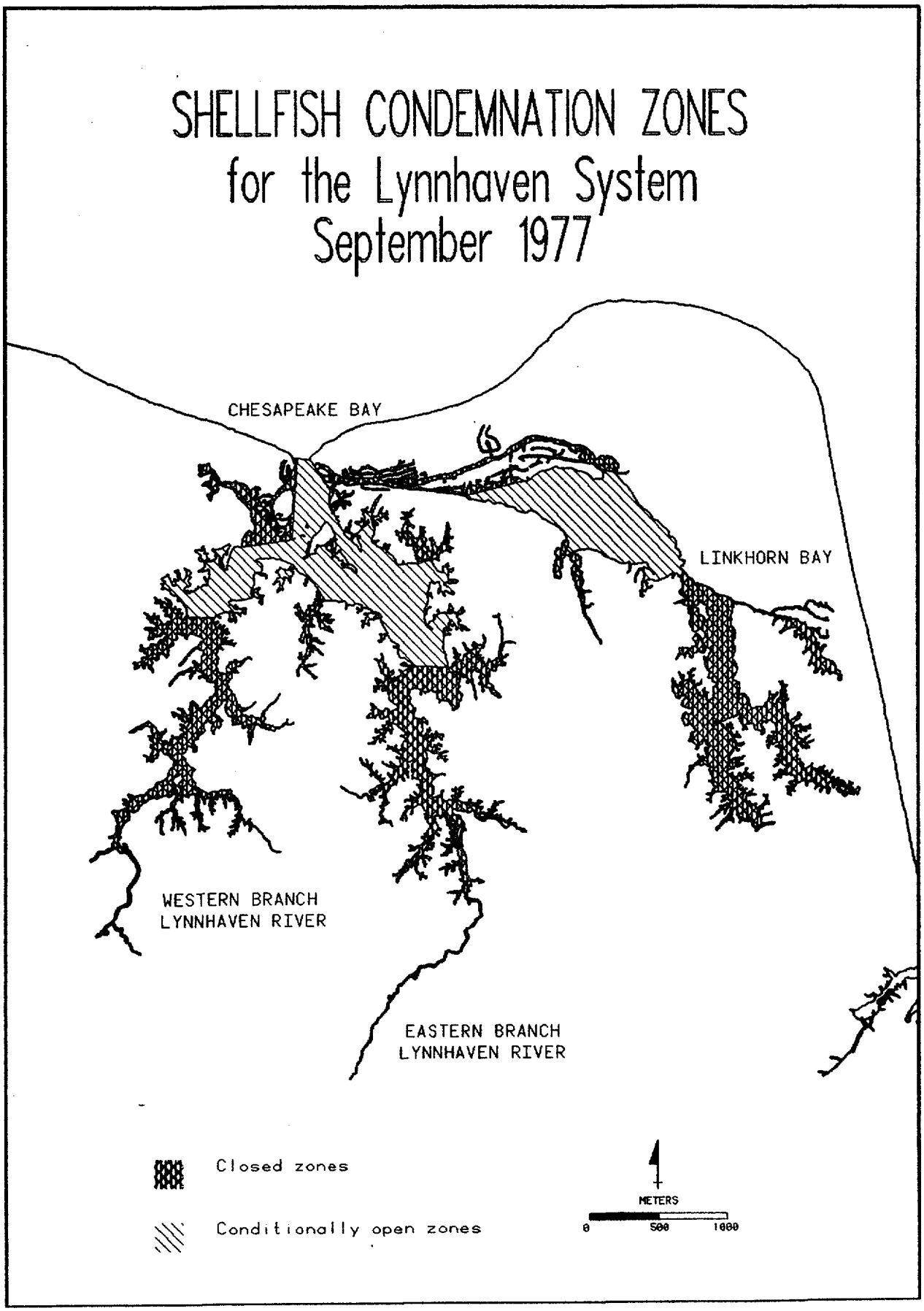
for the Lynnhaven System
October 1971
CHESAPEAKE BAY
LINKHORN BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
1000


SHELLFISH CONDEMNATION ZONES
for the Lynnhaven System
September 1977
CHESAPEAKE BAY
LINKHORN BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
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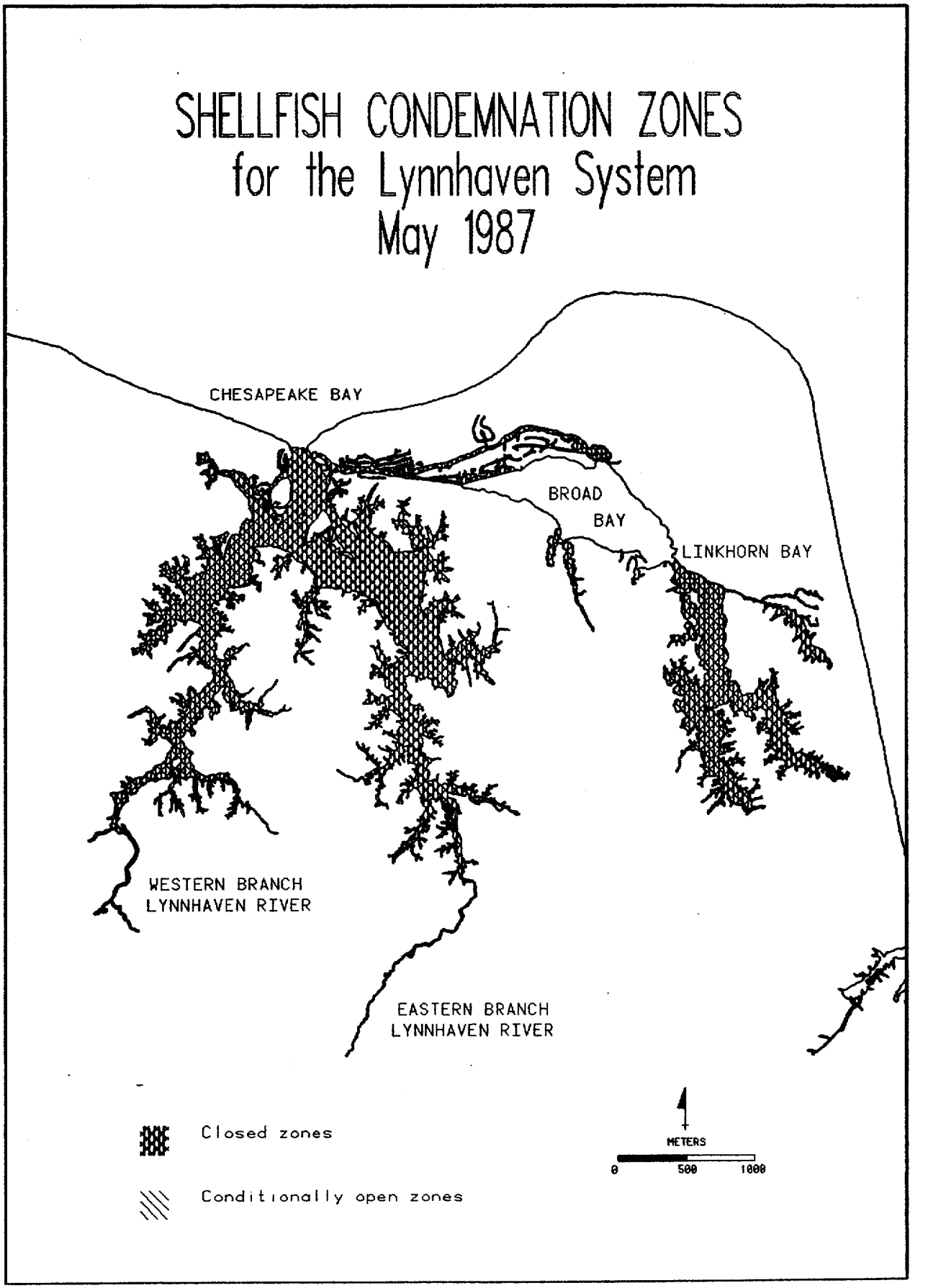
SHELLFISH CONDEMNATION ZONES
for the Lynnhaven System
May 1987
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BROAD
BAY
LINKHORN BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
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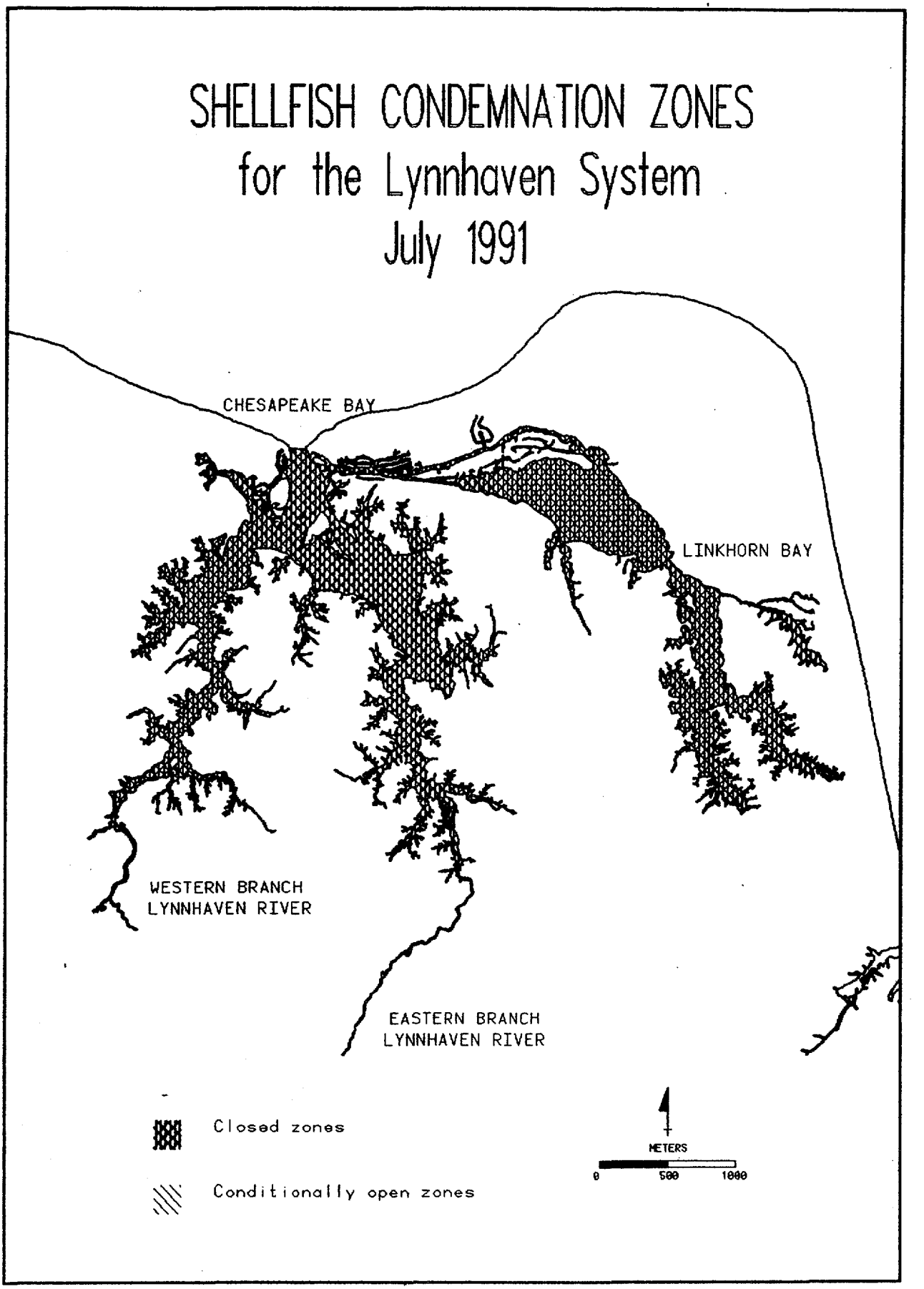
SHELLFISH CONDEMNATION ZONES
for the Lynnhaven System
July 1991
CHESAPEAKE BAY
LINKHORN BAY
WESTERN BRANCH
LYNNHAVEN RIVER
EASTERN BRANCH
LYNNHAVEN RIVER
Closed zones
Conditionally open zones
METERS
0
500
1000

SHELLFISH CONDEMNATION ZONES FOR THE LYNNHAVEN SYSTEM

DATE	OPEN	CONDITIONALLY OPEN	CLOSED
October 1930	81.1%		18.9%
August 1941	65.3%		34.7%
December 1964	51.4%		48.6%
October 1971			100%
September 1977		43.2%	56.8%
May 1987	15.9%		84.1%
July 1991			100%

Appendix 3. Survey of Shellfish Sanitation Workers in Other Coastal States

Letter
Respondents
Survey
Summary of Comments Received

The College Of
WILLIAM & MARY

Chartered 1693

Virginia Institute of Marine Science
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P. O. Box 1346
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804/642-7000, Fax 804/642-7097, Scats 842-7000

April 4, 1991

Dear ,

The Virginia Shellfish Enhancement Task Force (SENTAF) was formed several years ago to see if Virginia agencies could coordinate and combine efforts in a manner that resulted in water quality improvement and the opening of condemned shellfish growing waters. Initial efforts were successful, with several thousand acres of productive shellfish beds re-opened to direct harvesting.

Subsequently, the task force identified ways to either improve water quality or slow down water quality degradation, but in neither case was this sufficient to open presently closed areas. Additionally, signs suggest that present laws, regulations, and procedures are not able to safeguard the very high water quality required for shellfish against the seemingly inevitable decline in water quality which accompanies urbanization and development.

We in Virginia enjoy our shellfish and do not want to lose the clams and oysters that are associated with Chesapeake Bay. We would appreciate it if you would give us the benefit of your experience by completing the enclosed questionnaire. Any reports, legislation, or other materials that would illustrate how your agency or state is addressing shellfish and water quality problems also would be appreciated. We would be happy to send you our final report, if you indicate this on the questionnaire.

This survey is part of a federally funded project which must be completed by September 30th. We plan to compile the responses and then select for further study those approaches which seem most appropriate for Virginia. In order to meet our project deadline, we need your responses as soon as possible and preferably by May 1st. We have included many questions. If you do not know the answer to some of them, simply skip those questions and answer the rest. We need your input and would rather get a partial response now than a complete response next year (or never).

On behalf of the task force, we thank you for your assistance in this effort.

Nancy Wilson Bruce Neilson

50th year 1940 - 1990 VIMS

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Questionnaire on Shellfish and Water Quality
Virginia's Shellfish Enhancement Task Force

Please answer the following questions. If you do not know the information, don't worry. Please answer those questions that you can and return your response to us. We would prefer to have answers to some questions now, rather than answers to all of the questions next year (or never). Thanks.

THE SETTING IN YOUR STATE

Mean tide range = _____ feet. Spring tide range = _____ feet.

Tides are: ___ diurnal ____ semi-diurnal

Bottoms are: ___ sandy, ____ hard clay, ____ solid rock

___ shell reefs ____ mixture

Beds typically are: ____ exposed at most low tides

____ exposed only at extreme low tides

____ almost always submerged

The state's production is about _____% from natural beds and

____ % from hatchery seed.

The state's production of shellfish (excluding crabs) has

Increased / Decreased over the last decade.

Approx. annual production was: _____ in 1980

_____ in 1990.

How is water quality affecting shellfish growing areas?

% of shellfish beds closed in 1980 _____, in 1990 _____.

% of PRODUCTIVE beds closed in 1980 _____, in 1990 _____.

Comments:

WATER QUALITY IMPACTS ON SHELLFISH BEDS & INDUSTRY

Point Sources	A LOT				NOT AT ALL
Are many shellfish beds closed due to point source pollution?	1	2	3	4	5
The major sources are:					
Large municipal STP's (Sewage Treatment Plants)	1	2	3	4	5
Small (< 0.5 MGD) STP's	1	2	3	4	5
Feed lots & other major sources of animal wastes	1	2	3	4	5
Industries	1	2	3	4	5
Comments?					

Does your state issue permits for plants treating wastewaters from a few households? Yes No

from a single household? Yes No

Non-Point Sources	A LOT				NOT AT ALL
Are nonpoint sources of pollution affecting many shellfish beds?	1	2	3	4	5
Problems arise from:					
Hobby farms with a few animals.	1	2	3	4	5
Fields and pastures.	1	2	3	4	5
Urban areas.	1	2	3	4	5
Shopping centers	1	2	3	4	5
Suburban areas.	1	2	3	4	5
Marinas	1	2	3	4	5
Failing septics systems	1	2	3	4	5

Questionnaire on Shellfish and Water Quality
Virginia's Shellfish Enhancement Task Force

What would you say is the major threat to the shellfish industry in your state?

What water quality problems are of greatest concern to the shellfish industry in your state?

Is population growth and development of the coastal areas a problem in your state? Are there any particular problems associated with this?

Management Strategies: What management strategies are you using (or developing) to protect the shellfish industry and maintain water quality?

Land use ordinances	Planned	Existing
Special land use designations	Planned	Existing
Strict requirements for septic sytems	Planned	Existing
Stringent permits for discharges to shellfish growing waters	Planned	Existing
"Zoning" the water, as well as the land.	Planned	Existing
Designated Brood Stock areas.	Planned	Existing
Harvest "Sanctuaries".	Planned	Existing

What agencies are involved with protecting water quality, shellfish quality, and shellfish resources?

RESPONDENT

Name: Agency:

Title: Phone No:

Are there any limitations on the use of this information? If so, please tell us what restrictions apply.

Would you like a copy of our final report? Yes

What would you say is the major threat to the shellfish industry in your state?

Canada (Atl) / Menon - Degradation of marine environmental water quality from land based pollution sources.

Maine / Foster - municipal STPs and the single family working overboard treated system and/or failing subsurface system.

Connecticut / Volk - There are several limited upland areas available for dockage and process facilities. Reduction of state and federal monies for water pollution control and capital construction projects.

Rhode Island / Kovach - Rainfall causing combined sewage and stormwater overflows.

New York / Hastback - Nonpoint source pollution, stormwater drainage discharges.

New Jersey / Osborn - Over-utilization of land and water resources resulting in pollution and depletion of our natural resources.

Delaware / Howell - Development, conflicting use.

Maryland / DiStefano - Nonpoint source associated with development; diseases specific to shellfish (MSX, Dermo) which have and continue to decimate oyster populations.

Maryland / Outten - Shellfish disease, MSX and Dermo.

Virginia / Wright - MSX, Perkinsus marinus.

Virginia / Carpenter - MSX / Dermo and overharvesting.

North Carolina / Gilbert - Overfishing, oyster disease, development.

South Carolina / Burrell - Labor and markets for product (shellfish quality).

Georgia / Williams - Limited areas available for lease.

Florida / Heil - Bacterial loading resulting from septic systems associated with coastal development.

Alabama / Byrd, Waller - Weather-related problems.

Mississippi / Cirino - Nonpoint runoff that closes conditionally approved areas at low levels of rainfall (1"-2").

Louisiana / Perret - Habitat degradation brought about by land loss through subsidence, salt water intrusion from the Gulf of Mexico, and fecal coliform contamination from local

inadequate sewerage treatment facilities.

Louisiana / Lyles - Frequent closures caused by pollution.

Texas / Wiles - Excessive variability of the bacteriological criteria.

California / Hansgen - Increasing population/ urbanization.

Washington / Lilja - Increased watershed and waterfront development, nonpoint pollution.

Alaska / Ostasz - Unknown paralytic shellfish poison levels in areas unclassified or without any previous data on occurrence, distribution and/or seasonal presence. Also problems with getting permits with multiple state/federal and public input for utilizing marine waters.

Canada (Pac) / Kooi - Sewage from all sources - municipal outfalls, boats, single home discharges, faulty septic tanks.

Hawaii / Yung - Water quality and disease are the major threats to the natural beds. We have 3 aquaculture shellfish farms at present. Their biggest problem is the high-risk investment for business.

New Zealand / Busby - At the moment, there is no major threat (but bonamia has just struck an oyster growing area from which oysters have never been permitted to be exported from).

What water quality problems are of greatest concern to the shellfish industry in your state?

Canada (Atl) / Menon - Bacteriological and chemical contamination, point source and non-point source of pollution, agricultural runoff.

Maine / Foster - Domestic sewage.

Connecticut / Volk - Continued bacteria pollution in some productive shellfish habitats. Most problems with toxics or industrial pollution have been controlled or eliminated. Marine biotoxins PSP may be a concern.

Rhode Island / Kovach - Bacterial.

New York / Hastback - Nonpoint source pollution, stormwater drainage discharges and declining harvests of clams.

New Jersey / Osborn - Nonpoint source discharge directly and indirectly into shellfish growing areas.

Delaware / Howell - Bacteria.

Maryland / DiStefano - Nonpoint source pollution; elevated fecal coliform associated with urban/suburban runoff. Fecal coliform levels associated with plowed agricultural land runoff. Although this does not generally represent a public health risk it does result in closure of shellfish waters because of FDA's strict adherence to the shellfish water standard.

Virginia / Wright - Nonpoint runoff.

North Carolina / Gilbert - Stormwater runoff.

South Carolina / Burrell - Runoff.

Georgia / Williams - N/A

Florida / Heil - Bacterial loading from point sources: WWTPs and marinas. Vibrio bacteria.

Alabama / Byrd, Waller - High fecal coliforms.

Mississippi / Cirino - Nonpoint runoff, STP discharges in close proximity to shellfish beds, industrial and urban development.

Louisiana / Perret - Fecal coliform contamination and possible effects of oilfield wastes.

Louisiana / Lyles - Urbanization, human pollution.

Texas / Wiles - Nonpoint runoff from urban, rural and marshy areas.

California / Hansgen - Nonpoint source pollution, including on-site waste disposal (septic systems), livestock operations, wildlife (sea birds, seals), urban runoff.

Washington / Lilja - Nonpoint sources.

Alaska / Ostasz - Anadromous spawning areas attracting large mammal and bird populations and concentration of fecal coliforms, plus runoff from uninhabited uplands contributing fecals via shallow soils, muskeg soils, via wildlife populations.

Canada (Pac) / Kooi - Fecal coliforms, sewage / dioxins.

Hawaii / Yung - Pollution.

New Zealand / Busby - Runoff from animal farms.

Is population growth and development of the coastal areas a problem in your state? Are there any particular problems associated with this?

Canada (Atl) / Menon - Yes, increases pollution problems, creates potential conflict among the multi-use of the coastal waters for recreation, fishing, aquaculture and navigation.

Maine - Foster - Poor soil, high rainfall in spring and fall.

Connecticut / Volk - Yes. Competition by user groups in and out of the water for both space and resources.

Rhode Island / Kovach - Yes and individual sewage from homes.

New York / Hastback - Yes, nonpoint and stormwater discharges.

New Jersey / Osborn - Yes, see above responses.

Delaware / Howell - Yes.

Maryland / DiStefano - It is certainly a concern because of its input to area water quality due to increased impervious surface and its associated fecal coliform runoff and because of the loss of land and aquatic habitat. Waste disposal is a major concern associated with this growth.

Virginia / Wright - Yes, as coastal areas are developed, water quality deteriorates.

North Carolina / Gilbert - Yes, increased runoff, increase in pollution sources, destruction of nursery areas.

South Carolina / Burrell - Yes, retirement homes are located on water many times.

Georgia / Williams - No.

Florida / Heil - Yes, rapid growth in coastal areas.

Alabama / Byrd, Waller - Yes, sewage disposal.

Mississippi / Cirino - Yes, increased fecal coliform loading in the watershed.

Louisiana / Perret - No, nonpoint source and destruction of habitat.

Louisiana / Lyles - Yes.

Texas / Wiles - Any increase in coastal populations has increased fecal loadings.

California / Hansgen - Yes, increases nonpoint source pollution as well as places increased demands on wastewater treatment plants and needs for plant expansions.

Washington / Lilja - Yes, as areas are developed, adverse water quality impacts occur.

Alaska / Ostasz - No, majority if not all shellfish areas are remote from major population centers. upland ownership by the state, U.S. gov't and native corporations limit unchecked growth.

Canada (Pac) / Kooi - No.

Hawaii / Yung - Yes. With the population growth and development, the natural ground-covering is ever-decreasing. After large rainfalls, we are seeing more and more run-off and sediments flowing directly into the ocean.

New Zealand / Busby - It is a potential problem but NZ laws provide sufficient control.

Appendix 4.

Attendees at the SENTAF Workshop, "Options for the Future", 16 July

Virginia Marine Resources Commission

David Boyd
Jack Travelstead
Larry McBride
S. M. 'Mac' Rogers

Virginia Dept. of Health

Eric Bartsch
James White
Robert Whittman
Mary Wright

Virginia Div. of Soil & Water Conservation

Moira Croghan

Council on the Environment

Stephen Laughlin

Christopher Newport College

George Webb

Virginia Institute of Marine Science

Roger Mann
William Hargis

Hampton Roads Planning District Commission

John Carlock

Virginia Seafood Council

Francis Porter

Chesapeake Bay Foundation

Jolene Chinchilli

Seafood Extension Agent

Richard Daiger

Shellfish Planters/Processors/Dealers

Chad Ballard
George DeMarco
Wade Walker

Appendix 5

AGENCY RESPONSIBILITIES FOR THE MANAGEMENT OF SHELLFISH AND WATER QUALITY IN VIRGINIA

PREFACE

A fundamental problem is that the Commonwealth's waters are used for many conflicting purposes. Wastewater disposal and shipping, for example, typically result in the closing of some shellfish beds. With better management of the state's marine resources and water quality, it might be possible to reduce these use conflicts.

Before we can determine if we can manage our resources better, we must first examine how we do things now. The purpose of the present document is to describe the roles of the various state agencies in Virginia as they work to maintain clean waters and to protect the marine resources of the Commonwealth.

WATER QUALITY MANAGEMENT & WATER POLLUTION CONTROL

Virginia State Water Control Board

The State Water Control Board is the lead agency in Virginia for water quality management and water pollution control. Although it is an oversimplification, one could say that the Water Control Board regulates all "point sources" of pollution and is involved with reducing "non-point sources" of pollution as well. The former is achieved through:

(1) standards set by the SWCB, and
(2) permits to pollutant dischargers, issued through the Virginia Pollutant Discharge Elimination System (VPDES), a program delegated to the state by the U.S. Environmental Protection Agency (EPA).

Water quality standards are established by the SWCB, following the Administrative Proceses Act, thus ensuring public notice of changes or additions to existing standards. These include bacteriological standards for shellfish growing waters and maximum acceptable concentrations of metals, pesticides, and other pollutants.

Discharge permits are required for all individuals, corporations, or governing bodies that discharge wastewaters. Even operations which do not have any discharges to state waters during normal operations, but have the potential to cause water quality problems, must obtain a Virginia Pollution Abatement (VPA) permit, formerly called a "No Discharge" permit.

Discharge permits specify the quantity and quality of the flow, including the total mass of a pollutant that can be discharged during a specified period. Permits typically include requirements for the frequency of monitoring and how that monitoring should be achieved. The dischargers have the burden of not only conducting the monitoring but reporting the results to the state in a timely fashion. Violations of permit limits and state procedures result in the issuance of "Notices of Violations", and in extreme cases these result in fines. A number of other state and federal agencies are involved in the issuance and renewal of VPDES permits. The Health Dept (DSS), VIMS and VMRC are frequent participants.

Municipal facilities to treat wastewaters are subject to a design review by the State Water Control Board and the State Health Department prior to construction of a new facility or modification to an existing facility. The SWCB also inspects the facilities periodically to ensure proper procedures are being followed. STP's can have a significant effect on both shellfish and the ability to harvest shellfish. The direct impacts on shellfish relate to chlorination, while the harvest restrictions arise from the potential for water quality degradation.

Historically, great public health improvements have resulted from the chlorination of domestic sewage. Given the limited treatment most of these wastewaters received up until the mid 1970's, there was a bias towards over-chlorination in order to ensure that disinfection occurred reliably. One result of the more advanced treatment that is common today (and of increased environmental awareness) is the realization that at times chlorine discharges were sufficient to harm marine organisms, especially at critical life stages.

Considerable amounts of money have been allocated by the General Assembly to aid localities to either use an alternate disinfection technology or to dechlorinate the effluent. The goal of these efforts is to provide sufficient disinfection to protect public health while also protecting ecological health. Fears that reduced chlorination would result in increased levels of indicator organisms in the water column have not been found in practice. The amount of chlorine released to the marine environment has greatly decreased over the last decade.

The Water Control Board routinely monitors the quality of the states waters, and in cooperation with the U.S. Geological Survey also monitors stream and river flows. Water quality monitoring allows the SWCB to (1) identify situations where discharges are having a significant impact, possibly due to inappropriate releases or excess discharges, and (2) to assess the success of the pollution control programs.

The SWCB oversees groundwater resources and regulates some withdrawals. Withdrawals from streams and rivers also fall under the SWCB's purview. Although water withdrawal does not directly affect shellfish growing areas, secondary effects are possible. For example, withdrawals reduce the amount of freshwater reaching the estuary, and lower river flows could mean higher pollutant concentrations.

The relationships between the water quality programs and shellfish are summarized in "State Water Control Board's Role in Virginia's Shellfish Sanitation Control Program" (Info. Bulletin 544, August 1980).

Division of Soil and Water Conservation

The Department of Conservation and Recreation, Division of Soil and Water Conservation (DSWC) is the designated lead state agency for implementation of the **Virginia Nonpoint Source Pollution Management Program.** An element of this management program is the federally funded nonpoint source implementation program that is managed by the Division. It supports a base program as well as demonstration, monitoring, and educational projects. The Division coordinates the program implementation activities with the cooperation of individual agencies and organizations. The Nonpoint Source Advisory Committee provides a forum for information exchange among agencies participating in the implementation program. The management program contains a mix of voluntary and regulatory programs to address nonpoint source pollution.

The Department of Conservation and Recreation participates in the review process for application to dredge, fill, or otherwise alter the state's streams, rivers, and wetlands.

The Division operates an agricultural cost-share program to support the implementation of Best Management Practices on Virginia farms. A nutrient management program also has been initiated to work with farmers to ensure that the proper use and application of chemical and animal source fertilizers. Urban nonpoint source pollution is addressed through assistance to local erosion and sediment control programs and stormwater management programs. The Division's Shoreline Bureau assists shoreline landowners in erosion control, along with sponsoring cooperative research and assessment projects to further categorize shoreline erosion.

State Department of Health

On-site sewage disposal, often septic tanks and subsurface drainfields but sometimes privies, is regulated by the Health Department, via local sanitarians. When systems fail, the local health department also has responsibility to see that corrections are made or that use of the facilities is prohibited. In areas adjacent to shellfish waters, the Division of Shellfish Sanitation makes on-site inspections of all properties near the shoreline once every few years. The results of these surveys are reported to the local sanitarians, who then work to see that problems are corrected.

Chesapeake Bay Local Assistance Board

The Chesapeake Bay Local Assistance Board (CBLAB) oversees the implementation of the Chesapeake Bay Preservation Act. This relatively new legislation requires localities to consider the ways that land use impacts nearby waters. CBLAB has disseminated the general requirements for compliance with the Act, and local governments are developing approaches to zoning and land use planning to comply.

Virginia Institute of Marine Science (VIMS)

VIMS conducts some water quality monitoring for the Water Control Board, conducts research in water quality processes, and develops and applies mathematical models of estuarine circulation and water quality. VIMS advises the SWCB, VMRC, and other state agencies on matters relating to the coastal zone, including review of applications for wetlands permits.

SHELLFISH RESOURCE MANAGEMENT

Virginia Department of Health

The Virginia Department of Health has the mandate to protect the public health. The Division of Shellfish Sanitation achieves this by regulating the harvest of shellfish and by inspection of shellfish processing operations. Because shellfish concentrate pollutants to levels much higher than those observed in the water, water quality standards for shellfish waters are very high. Harvest of shellfish from grossly polluted areas is not permitted any time. Similarly, there is a permanently condemned area around each outfall from municipal and industrial wastewater treatment facilities. Shellfish from moderately polluted areas may be harvested if they are then cleansed, either by relaying to clean areas or by treatment in a controlled environment (this is called a depuration plant). The procedures defining these three types of waters (open, closed, and condemned) are formulated by the Interstate Shellfish Sanitation Conference, a group that includes both state and federal regulatory agencies. The procedures then are incorporated into the National Shellfish Sanitation Program, which is run by the U.S. Food & Drug Administration.

The facilities in which seafood is processed are inspected regularly. Interstate transport of seafood is not permitted unless the facility has been certified by the State Health Department.

Virginia Marine Resources Commission

The Virginia Marine Resources Commission is the lead agency for shellfish resources. It accomplishes its mission through (1) fisheries management, (2) habitat protection, and (3) law enforcement.

VMRC in most cases sets the time and size of the harvest for each major species and issues licenses. The nature of the harvest regulations varies from species to species, with elements of the regulations incorporated into the enabling legislation in some instances. For example, only certain types of gear are permitted for the harvest of oysters and clams.

Shellfish may be harvested from "public bottoms", most of which are included in the so-called Baylor Grounds. VMRC issues the leases which allow a citizen or corporation to engage in shellfish culture on a specified portion of river bottom. None of these leases may be granted within Baylor Grounds. Information on leases, shorelines, bottom sediments, and other factors is being entered into geographical information systems (GIS's), with the Council on the Environ-ment coordinating the efforts.

Modifications to state river bottoms require a permit; VMRC is the lead agency for the state. The modifications include dredging, filling in of wetlands, placement of piles for docks, and "hardening" of the shoreline. VMRC oversees the efforts of 32 local wetlands boards. The Health Dept (DSS), SWCB, and VIMS, also particpate in the process.

VMRC also is the lead agency for replenishment activities, such as placing shell to provide cultch for oysters. In recent years, aquatic biologists have begun to specify water quality criteria that should enhance the growth and survival of either the marine organisms or the plants they depend on. In particular, water quality needs for the propagation of submerged aquatic vegetation are receiving attention and will provide goals for the water quality managers.

VMRC Marine Patrol Officers monitor fishing activities to ensure compliance with regulations. In addition, they oversee the harvest of shellfish from closed areas. Shell stock from these areas may be moved, or relayed, to clean waters or may be transported to an approved depuration facility. Relayed shellfish must remain in the clean waters for a specifed period, with the duration longer during cool weather. At present there are no facilities in Virginia for the controlled cleansing, or depuration, of shellfish, although several other states have plants, especially for clams.

Virginia Sea Grant Program (VIMS and VPI&SU)

The federal government has established the Sea Grant program to foster the marine segment of our economy. The Virginia Sea Grant program has an active Marine Advisory Program that involves faculty and staff from Virginia Tech (VPI&SU) and the Virginia Institute of Marine Science, a branch of the College of William & Mary. Scientists from these institutions and other universities also conduct research on shellfish, some funded by Sea Grant but most funded by other agencies. VIMS monitors the extent and severity of disease infestation in oysters, the success of each year's spatfall, and has had a program in hatchery culture of bivalves for many years.

Virginia Institute of Marine Science (College of Wm & Mary)

VIMS scientists conduct research in many areas such as: physiology of oysters, life cycle of oyster diseases, nutritional needs, mechanisms and rates of pollutant accumulation. The institute has had a program in bivalve culture for many years. A large hatchery at Gloucester Point provides oyster "seed" to planters.

Appendix 6. **ESTIMATED BUSHELS OF OYSTERS IN POLLUTED WATERS**

October 8, 1991

POLLUTED AREA	BUSHELS
Assawoman Creek	4,000
Parker Creek	2,000
Gargathy Creek	5,000
Folly Creek	7,000
Partin Creek	15,000
Oyster Harbor	4,000
Magothy Bay	1,000
Jackson Creek	200
Bonum Creek	300
Yeocomico River	10
Dividing Creek	300
Indian Creek	450
Carter Creek	250
Chuckatuck Creek	10,000
Nansemond River and Tributaries	100,000
Pagan River	25,000
Ballard Marsh Creek	15,000
Lynnhaven	1,000
Lynnhaven (Clams - 1 Million)	
James River - Deep Shoals	10,000
Warwick River	200,000?
Back River, S.W. Branch	12,000
Back River, N.W. Branch	300
Harris Creek	50

POLLUTED AREA	BUSHELS
Mill Creek	100
Poquoson River	50
Chisman Creek	150
Cabin Creek	100
Bennett Creek	50
Back Creek	150
York River	5,000
Ware Creek	600
Skimino Creek	400
Queen Creek	500
Jones Creek	50
Poropotank Creek	150
Chincoteague Area & Chincoteague Bay Area	
Swan Gut Creek	3,000
Mosquito Creek	5,000
Assawoman, Hog, & Little Cat Creek	10,000
Wishart Point	6,000
Chincoteague Island - Adjacent	20,000
Cape Charles to Onancock Creek	
Plantation Creek	2,000
Kings Creek	500
Cherrystone Creek	2,000
Hungars Creek	5,000
Westerhouse Creek	500
Church Creek	500
Warehouse Creek	200
Nassawadox Creek	2,000

POLLUTED AREA	BUSHELS
Mattawoman Creek	1,000
Jacobus Creek	1,000
Occohannock Creek	1,000
Craddock Creek	500
Pungoteague Creek	5,000
Nandua Creek	4,000
Onancock Creek	5,000
The Gulf	2,000
Pocomoke Sound - Area 33 (Fishers Seafood Co. 35,000)	50,000
Messongo Creek - Area 167	1,000
Hunting Creek - Area 138	500
Deep Creek	500
Chesconessex Creek - Area 112	0

Total Bushels.....548,360

Compiled By G. W. Showalter

EASTERN REGION
VIRGINIA DEPARTMENT OF HEALTH
OFFICE OF COMMUNITY HEALTH SERVICES
ESTIMATED ANNUAL COST FOR A LONG RANGE
PROGRAM TO ASSIST LOW INCOME FAMILIES
WITH FAILING SEPTIC SYSTEMS

SURVEY AREA	LOCATION	HEALTH DISTRICT	ESTIMATED ANNUAL COST
1A	UPPER MACHODOC CREEK	KING GEO	.00
1	ROSIER CREEK	KING GEO	3600.00
DISTRICT TOTAL			3600.00
1	ROSIER CREEK	NO. NECK	11340.00
2	MONROE BAY: MONROE AND MATTOX CREEKS	NO. NECK	76050.00
3	POTOMAC RIVER: MATTOX CREEK TO CURRIOMAN BAY	NO. NECK	8010.00
4	NOMINI AND CURRIOMAN BAYS	NO. NECK	67095.00
5	LOWER MACHODOC CREEK	NO. NECK	26352.00
6	GARDNER, JACKSON AND BONUM CREEKS	NO. NECK	35910.00
7	YEOCOMICO RIVER	NO. NECK	49302.00
8	COAN RIVER, THE GLEBE AND KINGSCOTE CREEK	NO. NECK	27918.00
9	POTOMAC RIVER: COAN RIVER TO GINNY BEACH	NO. NECK	15948.00
10	LITTLE WICOMICO RIVER	NO. NECK	20304.00
11	GASKINS AND OWENS PONDS AND TASKMERS CREEK	NO. NECK	12276.00
12	COCKRELL CREEK	NO. NECK	6084.00
13	GREAT WICOMICO RIVER	NO. NECK	38286.00
14	CHESAPEAKE BAY: MILL CREEK TO DIVIDING CREEK	NO. NECK	2754.00
15	DIVIDING CREEK	NO. NECK	2529.00
16	INDIAN, DYMER AND TABBS CREEKS	NO. NECK	16776.00
17	LITTLE BAY AND ANTIPOISON CREEK	NO. NECK	5436.00
18	OYSTER, LITTLE OYSTER, WINDMILL POINT AND MOSQUITO CREEKS	NO. NECK	4158.00
19	RAPPAHANNOCK RIVER: MOSQUITO CREEK TO CARTER CREEK	NO. NECK	2241.00
20	CARTER CREEK	NO. NECK	10008.00
21	COROTOMAN RIVER	NO. NECK	85104.00
22	RAPPAHANNOCK RIVER: TOWLES POINT TO DEEP CREEK	NO. NECK	9108.00
23	LANCASTER, DEEP AND MULBERRY CREEKS	NO. NECK	18009.00
24	FARNHAM CREEK	NO. NECK	35568.00
25	TOTUSKEY AND RICHARDSON CREEKS	NO. NECK	52884.00
25A	RAPPAHANNOCK RIVER: TOTUSKEY CREEK TO TAPPAHANNOCK BRIDGE	NO. NECK	4878.00
25B	RAPPAHANNOCK RIVER: TAPPAHANNOCK BRIDGE TO CARTERS WHARF	NO. NECK	2979.00
DISTRICT TOTAL			647307.00
26B	RAPPAHANNOCK RIVER: MT. LANDING AND OCCUPACIA CREEKS	MID PEN	63000.00
26A	RAPPAHANNOCK RIVER: WARES WHARF TO TAPPAHANNOCK BRIDGE	MID PEN	24000.00
26	RAPPAHANNOCK RIVER: WARES WHARF TO MUD CREEK	MID PEN	24000.00
27	RAPPAHANNOCK RIVER: MUD AND PARROTTS CREEKS iv	MID PEN	.00

SURVEY AREA	LOCATION	HEALTH DISTRICT	ESTIMATED ANNUAL COST
28	LAGRANGE AND ROBINSON CREEKS	MID PEN	8400.00
29	URBANNA CREEK	MID PEN	600.00
30	WHITING AND MEACHIM CREEKS	MID PEN	.00
31	LOCKLIES AND MILL CREEKS	MID PEN	600.00
32	BUSH PARK AND STURGEON CREEKS	MID PEN	.00
33	JACKSON AND BROAD CREEKS	MID PEN	.00
34	PIANKATANK RIVER, LOWER	MID PEN	1800.00
35	PIANKATANK RIVER, UPPER	MID PEN	22800.00
36	GWYNN ISLAND	MID PEN	6000.00
37	STUTTS, QUEENS AND WHITES CREEKS	MID PEN	18000.00
38	WINTER HARBOR AND GARDEN CREEK	MID PEN	16200.00
39	HORN HARBOR AND DYER CREEK	MID PEN	44400.00
40	MOBJACK BAY: NEW POINT COMFORT TO EAST RIVER	MID PEN	5000.00
41	EAST RIVER	MID PEN	24000.00
42	NORTH RIVER	MID PEN	18000.00
43	WARE RIVER	MID PEN	14400.00
44	SEVERN RIVER	MID PEN	12600.00
45	BROWNS BAY AND MONDAY CREEK	MID PEN	19200.00
46	SARAH CREEK AND PERRIN RIVER	MID PEN	10000.00
47A	YORK RIVER: GLOUCESTER POINT TO CEDARBUSH CREEK	MID PEN	5400.00
47B	YORK RIVER: CARTER CREEK TO ALLMONDSVILLE	MID PEN	3600.00
48	YORK RIVER: POROPOTANK AND PURITAN BAYS	MID PEN	9000.00
49	YORK RIVER: WEST POINT VICINITY	MID PEN	5000.00
DISTRICT TOTAL			356000.00
50	YORK RIVER: CAMP PEARY TO TERRAPIN POINT	PENINSULA	6000.00
51	YORK RIVER: CAMP PEARY TO YORKTOWN	PENINSULA	4000.00
52	YORK RIVER: YORKTOWN TO GOODWIN ISLANDS	PENINSULA	4000.00
53	POQUOSON RIVER AND BACK CREEK	PENINSULA	6000.00
54	BACK RIVER	PENINSULA	4000.00
55	CHESAPEAKE BAY: BACK RIVER TO OLD POINT COMFORT	PENINSULA	.00
56	HAMPTON ROADS: OLD POINT COMFORT TO NEWPORT NEWS POINT	PENINSULA	.00
57	JAMES RIVER: NEWPORT NEWS POINT TO DEEP CREEK	PENINSULA	.00
58	WARWICK RIVER AND DEEP CREEK	PENINSULA	.00
59	JAMES RIVER: MULBERRY POINT TO JAMESTOWN ISLAND	PENINSULA	.00
DISTRICT TOTAL			24000.00
54	BACK RIVER	HAMPTON	.00
55	CHESAPEAKE BAY: BACK RIVER TO OLD POINT COMFORT	HAMPTON	.00
56	HAMPTON ROADS: OLD POINT COMFORT TO NEWPORT NEWS POINT	HAMPTON	.00
DISTRICT TOTAL			.00
60	COBHAM BAY AND LAWNES CREEK	SURRY	10000.00
60	COBHAM BAY AND LAWNES CREEK	WEST TIDE	1260.00
61	PAGAN RIVER	WEST TIDE	5400.00
62	CHUCKATUCK CREEK	WEST TIDE	3360.00

SURVEY AREA	LOCATION	HEALTH DISTRICT	ESTIMATED ANNUAL COST
63	NANSEMOND RIVER	WEST TIDE	7890.00
64	HAMPTON ROADS: NANSEMOND RIVER TO ELIZABETH RIVER	WEST TIDE	510.00
DISTRICT TOTAL			18420.00
65	ELIZABETH RIVER	PORTSMTH	.00
65	ELIZABETH RIVER	NORFOLK	.00
66	HAMPTON ROADS: TANNER POINT TO WILLOUGHBY SPIT	NORFOLK	.00
67	HAMPTON ROADS: OCEAN VIEW TO WILLOUGHBY	NORFOLK	.00
68	LITTLE CREEK	NORFOLK	.00
DISTRICT TOTAL			.00
68	LITTLE CREEK	VA BEACH	.00
69	CHESAPEAKE BAY: LITTLE CREEK TO LYNNHAVEN BAY	VA BEACH	.00
70	LYNNHAVEN BAY	VA BEACH	.00
71	BROAD AND LINKHORN BAYS	VA BEACH	.00
72	CAPE HENRY	VA BEACH	.00
73	VIRGINIA BEACH	VA BEACH	.00
DISTRICT TOTAL			.00
74	SMITH AND FOX ISLANDS	E. SHORE	.00
75	POCOMOKE SOUND	E. SHORE	6000.00
76	MESSONGO AND GUILFORD CREEKS	E. SHORE	5000.00
77	HUNTING AND DEEP CREEKS	E. SHORE	3000.00
78	TANGIER, GOOSE, AND WATTS ISLANDS	E. SHORE	1200.00
79	CHESCONESSEX CREEK	E. SHORE	1000.00
80	ONANCOCK AND MATCHOTANK CREEKS	E. SHORE	3500.00
81	PUNGOTEAGUE CREEK	E. SHORE	3000.00
82	NANDUA AND CURRATUCK CREEKS	E. SHORE	2500.00
83	CRADDOCK CREEK	E. SHORE	2000.00
84	OCCOHANNOCK CREEK	E. SHORE	5000.00
85	NASSAWADOX CREEK	E. SHORE	3500.00
86	HUNGARS AND MATTAWOMAN CREEKS	E. SHORE	2000.00
87	THE GULF	E. SHORE	1000.00
88	CHERRYSTONE INLET	E. SHORE	3000.00
89	CAPE CHARLES	E. SHORE	1000.00
90	OLD PLANTATION AND ELLIOTS CREEK	E. SHORE	2000.00
91	CHESAPEAKE BAY: ELLIOTS CREEK TO CAPE CHARLES POINT	E. SHORE	1200.00
92	FISHERMAN ISLAND	E. SHORE	.00
93	SEASIDE: CAPE CHARLES POINT TO SEAVIEW	E. SHORE	3000.00
94	SEASIDE: SEAVIEW TO EASTVILLE STATION	E. SHORE	3000.00
95	SEASIDE: EASTVILLE STATION TO NASSAWADOX	E. SHORE	3000.00
96	NACHIPONGO RIVER	E. SHORE	3500.00
97	SEASIDE: FINNEY AND FOLLY CREEKS	E. SHORE	3500.00
98	SEASIDE: METOMKIN, GARGATHY, AND KEGOTANK BAYS	E. SHORE	3500.00
99	SEASIDE: BOGUES AND SHELLY BAYS	E. SHORE	4000.00
100	CHINCOTEAGUE BAY	E. SHORE	3000.00

SURVEY AREA	LOCATION	HEALTH DISTRICT	ESTIMATED ANNUAL COST
101	CHINCOTEAGUE AND ASSATEAGUE ISLAND	E. SHORE	4000.00
DISTRICT TOTAL			76400.00
EAST REGION TOTAL			1122127.00
KING GEO & SURRY			13600.00
STATE TOTAL			1135727.00

NOTES:

Since the needs will not be uniform from year to year, it is important that we be able to carry the funds over from one year to the next.

Restrictions on use of funds must be avoided. Many of our toughest financial hardship cases are unable to meet restrictions like requiring indoor plumbing due to soil limitations. For example, sometimes only a vault privy is possible. Funding should not be limited to owner-occupied property -- some landlords are low-income individuals. Limits on cost for an individual correction should be avoided -- if soil conditions dictate, an elevated sand mound or other engineered system may be required and if the only suitable soil is on non-adjacent property, cost may exceed $15,000.00 for one correction.

Estimated Annual Cost for each shellfish survey area was determined as follows:

A. The average cost of correcting a septic system in the specific area was estimated. This cost is different for different districts and was determined from actual field experience by the local environmental health staff in each area.
B. The number of failing or inadequate septic systems in the specific area was determined from door-to-door shoreline surveys conducted approximately every five years by the Division of Shellfish Sanitation. This number was divided by 5 to get the annual number.
C. Trends in development and system failures in the specific area were applied to determine the projected number of failing or inadequate septic systems for that specific area.
D. The percentage of failing or inadequate sewage systems owned by low income families was determined by local census data and field experience of the local environmental health staff in obtaining corrections to the systems.
E. (Average repair cost) X (Number of failing or inadequate systems per 5-year survey cycle) X (% Low Income) / (5 Years) = Estimated Annual Cost

Prepared by:

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10/17/91