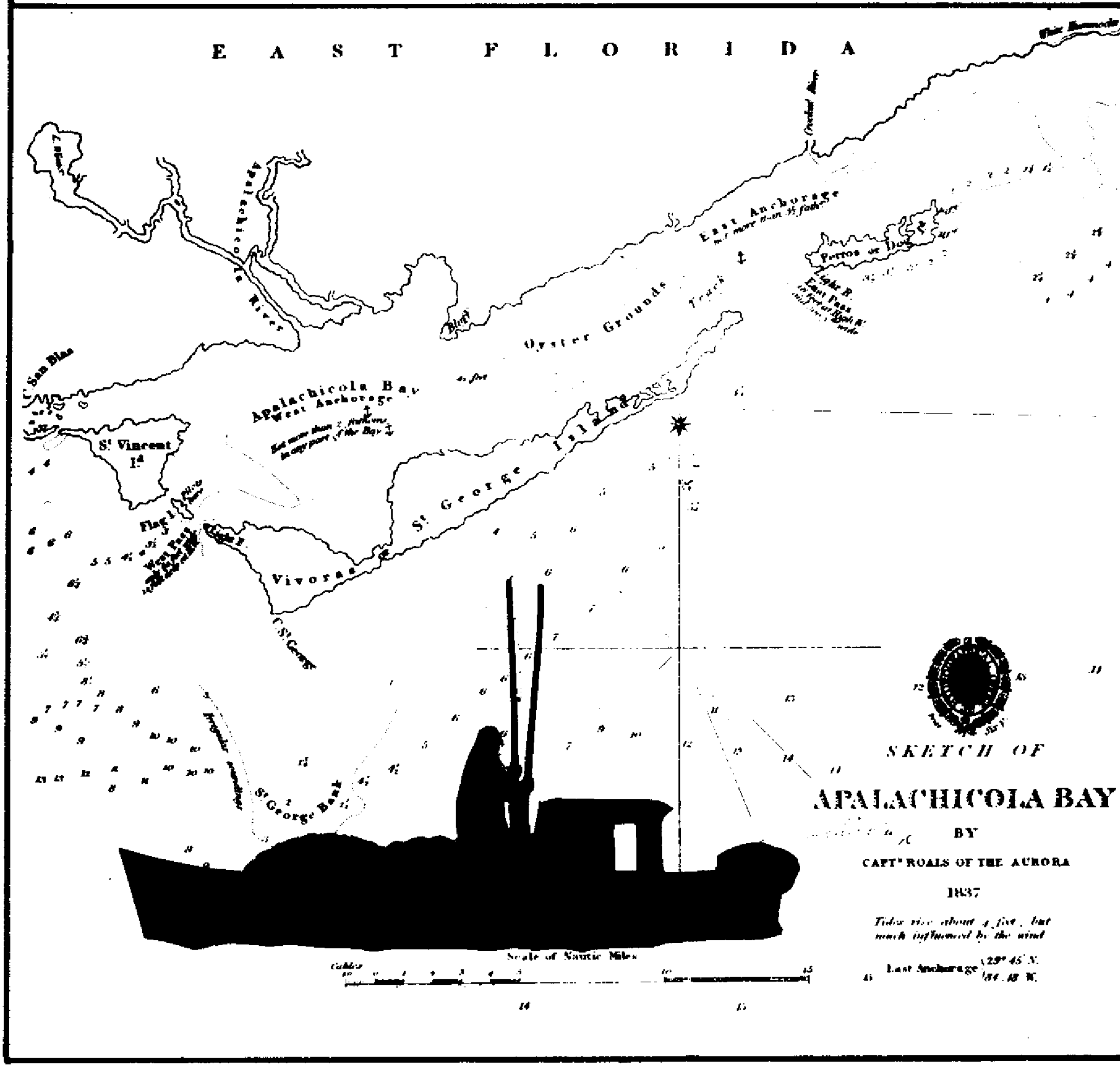
SGR-57

Apalachicola Oyster Industry: Conference Proceedings

Edited by Scott Andree



FLORIDA SEA GRANT COLLEGE

MARCH 1983

APALACHICOLA OYSTER INDUSTRY

Proceedings of a Conference
Held October 6-7, 1982
in Apalachicola, Florida

Jointly sponsored by:

Florida Sea Grant College/Marine Advisory Program
and
Florida State University

In cooperation with:

Apalachicola National River and Estuarine Sanctuary
Florida Department of Natural Resources
and
Florida Cooperative Extension Service

Edited by

Scott Andree

Sea Grant Project No. A/MAP-1
Grant No. NA80AA-D-00038

Report Number 57
Florida Sea Grant College
March 1983

Price: $2.50

TABLE OF CONTENTS

FOREWORD v

INTRODUCTION 1
James C. Cato

KEYNOTE ADDRESS 2
Elton J. Gissendanner

STATE OF THE FISHERY 5
Edwin A. Joyce, Jr.

SESSION I: James C. Cato, Moderator

Physical Aspects

Apalachicola Bay: Geology and Sedimentology 8
William F. Tanner

Hydrodynamics of the Apalachicola Bay System 10
B.A. Christensen

Biological Aspects

Correlation of Coliform Bacteria with Vibrios in Apalachicola Bay 17
Norman J. Blake and Gary E. Rodrick

Influence of Processing and Storage on the Microbiological Loads of Oyster Meats 20
Mary A. Hood, Fred Singleton, Gregory Ness, and Ron Baker

Genetics and Potentials of Oyster Production in Apalachicola Bay 22
R. Winston Menzel

SESSION II: Robert J. Livingston, Moderator

Biological Aspects

Limnology of a Small Coastal Stream: Impact of a Timbering Operation . 27
Daniel E. Canfield, Jr.

Riverine Transport of Nutrients and Detritus to Apalachicola Bay 28
John F. Elder and Harold C. Mattraw, Jr.

Research and Resource Planning the Apalachicola Drainage Systems 31
Robert J. Livingston

Fisheries Aspects

Aquaculture Possibilities 33
Robert M. Ingle

Oyster Reef Construction and Relaying Programs 34
Charles R. Futch

TABLE OF CONTENTS (continued)

Alternatives for the Seafood Industry 39
W. Steven Otwell

The Virginia Oyster Industry 43
Dexter S. Haven

SESSION III: Edwin A. Joyce, Jr., Moderator

Economics and Management

Apalachicola Bay Oyster Industry: Some Economic Considerations 47
Fred J. Prochaska and David Mulkey

Planning for an Environmental and Economical Future in the Coastal Community 53
James T. Floyd

The Apalachicola National Estuarine Sanctuary 55
Woody Miley

Regulation and Management

Florida's Shellfish Environmental Assessment Program 58
John W. Schneider

Management of Shellfish Resources: Problems in Law Enforcement 61
C.V. Holland

Department of Environmental Regulation Resource Protection Activities 62
Robert V. Kriegel

Industry Management Concerns 65
Willard Vinson

C.G. Lolley 67

CONFERENCE FLOOR DISCUSSIONS 68

SUMMARY OF RESEARCH AND INDUSTRY NEEDS 71
Scott Andree

APPENDIX A: Conference Participants 75

APPENDIX B: Conference Program 81

APPENDIX C: Sketch of Apalachicola Bay 85

FOREWORD

The vitality and economic stability of the coastal communities surrounding the Apalachicola Bay have always depended on its bountiful marine resources, particularly the oyster. Increased fishing pressure and environmental stresses from coastal development and pollution continue to threaten the oyster industry, not only in Apalachicola Bay, but throughout the state of Florida and the Southeast. Of particular concern to the Apalachicola Oyster Industry is the current sharp decline in oyster production since late 1981, leading many oystermen, processors, distributors, and local merchants to question whether their livelihood will survive.

The fears and frustrations generated by this situation was evidenced in a Franklin County Commission meeting in January, 1982. Realizing that immediate management decisions needed to be made, the board members were frustrated that the vast amount of research information was not available to them in a form that they could understand and use. Out of that concern, the Apalachicola Oyster Industry Conference was organized.

A previous conference on the Apalachicola Drainage System, held in 1976, was sponsored by the Florida Department of Natural Resources. To build on that effort, as well as focus on the specifics of the oyster industry, this conference was coordinated with the Marine Resource Division Director for that agency. In addition, a steering committee, comprised of representatives of Florida Sea Grant, Florida State University, Florida Cooperative Extension Service, Apalachicola River/Estuarine Sanctuary, and local industry, was formed to provide input as to the content and logistical support for the conference.

The objectives of the conference were to: (1) summarize the current research information on Apalachicola Bay, with its application to the oyster industry, (2) assess future management, research and industry needs to insure oyster productivity in Apalachicola Bay, and (3) provide a forum for discussion between researchers and representatives of state agencies and industry to address current and future oyster industry problems.

This report documents the presentations and discussions of the conference and hopefully will stimulate and catalyze further coordinated efforts by researchers, agencies, associations and persons interested and concerned with the oyster industry. Through the following presentation summaries, the reader should develop a better awareness of the diversity of research, agency involvement and industry needs relating to the oysters of Apalachicola Bay. Readers are urged to communicate directly with the program speakers for further details.

The editor gratefully acknowledges those individuals and organizations who helped make this conference possible. I especially appreciate the support of Florida Sea Grant, Florida Cooperative Extension Service Marine Advisory Program, Florida State University, Florida Department of Natural Resources, Apalachicola National River and Estuarine Sanctuary, and the Franklin County Oyster Dealers' and Seafood Workers' Associations. Of particular assistance were Dr. Roy Herndon, Dr. William Seaman, Mr. Jim Estes, Mr. Bob Ingle, Mr. Woody Miley, Mr. Grady Leavins, Dr. William Lindberg, and Mr. John Moerlins. Local support by the Florida National Guard, 710 Services Company, the Carrabelle Extension Homemakers' Club, and the banking institutions of Franklin County was greatly appreciated.

My thanks to Ms. Hunter Barnett and Ms. Mary Melton of the Florida Resources and Environmental Analysis Center and Mr. Tom Leahy and Ms. Billie Lowry for preparation of the final copy for publication. Finally, a special note of appreciation to Mrs. Rose Zongker for her vitality and support in planning, organizing, and conducting the conference.

Scott Andree
Editor

December, 1982

Scott Andree is the marine advisory agent for the Sea Grant Marine Advisory Program and the Florida Cooperative Extension Service serving the Big Bend counties of Florida.

INTRODUCTION

James C. Cato

The Apalachicola estuarine system is a vital resource of the state of Florida. Its fishery resources, particularly the oyster, support a wide variety of local interests from the boat builder to the grocery clerk. In its mandate to "promote the wise use of all marine resources through research, education and advisory services," the Florida Sea Grant College is proud to be a co-sponsor of the Apalachicola Oyster Industry Conference with its member institution, Florida State University and the Florida Cooperative Extension Service Marine Advisory Program. We have played a major role during the last decade in funding research in the Bay. This conference and the proceedings to follow represent a natural culmination of that research effort. Hopefully, through the presentations and discussions, the question: "What do we know about the Bay?" will be answered, and "What might we do in the future?" will be clearly defined.

Participants and attendants at the conference represent a wide variety of background and concerns in relation to the oyster industry. Basically, we have two broad audiences: (1) the research community, including the state agencies, which utilizes research information to set policy, and (2) the local industry and citizenry, which depend on the bay for a living.

For us to be successful, there must be communication. This conference provides the perfect environment for that to occur and Florida Sea Grant is enthusiastic about its end result.

Director, Florida Sea Grant College, Gainesville, Florida.

KEYNOTE ADDRESS:
INSURING FLORIDA'S OYSTER RESOURCE

Elton J. Gissendanner

Scattered along Florida's shores are great shell mounds--oysters harvested by the first Floridians, the Indians. The mounds attest to the abundanace of this shellfish and the important role it played in the life of the Indian as his food as well as in his culture. Much of the history of Florida Indian tribes can be read in the accumulated oyster shells of kitchen middens and ceremonial sites in the coastal areas of the state.

With the arrival of the Europeans and the ensuing population increase and urbanization, oyster-producing areas have been subjected to heavy fishing pressures, exposure to industrial pollution and human wastes, and alteration of substrate by dredging and silting of reefs. Many acres of once-productive oyster harvests are now closed due to bacterial contamination. Areas still available to shellfish harvest are subject to heavy fishing pressure and occasional contamination.

Florida became a state in 1845, and as early as 1881 the Legislature passed laws permitting individuals to obtain grants for the cultivation of oysters. At least 15 such grants were issued in Franklin County between 1895 and 1905. Approximately 30 percent of the total area of Apalachicola Bay, St. Vincent Sound and St. George Sound was under grant to private individuals. By 1913, most of these grants were abandoned and state laws were established prohibiting grants.

The Florida Shellfish Commission was organized in 1913 and shellfish laws were revised. Permits were required for oyster dredges, a statewide oyster lease program began, and an oyster severance tax was established to fund the management program.

Because of abuses and poor enforcement of the laws, dredges were finally banned on public reefs and in time they were discouraged on private leases in Franklin County by social pressures.

During the 1930s, many leases were issued in Franklin County and some are still productive. The 1913 severance tax was abolished in 1959. In 1963, Florida Statutes prohibited the leasing of future sites for cultivation in Franklin County.

The first state marine biologist, Mr. Robert M. Ingle, was hired in 1949. He established a management program to replace shell on overfished public reefs. As a result, more than four million bushels of shucked shell or aggregate limerock have been used to rehabilitate natural reefs or to construct new ones, covering nearly 1,000 acres of public bay bottoms in Franklin County.

Executive Director, Florida Department of Natural Resources, Tallahassee, Florida.

Oyster landing data for 1982 reflects a serious decline, according to recent National Marine Fisheries Service reports. We are also aware that a large percentage of the harvest this year is comprised of sub-legal sized oysters. The Florida Marine Patrol is stepping up enforcement of the three-inch minimum shell size. There were more than 82 arrests in September as a result of sub-legal sized harvest. There are 100 fishermen for every marine patrol officer, but we are intent on enforcing the laws. It is imperative that we maintain legal size limits to protect the resource. If reprimands and fines do not succeed, we will be compelled to confiscate boats to make the message clear.

Oysters, historically abundant and often abused, must be protected if the industry is to continue. This department will take any necessary steps to assure their survival, whether the pressure comes from overharvest, sub-legal size harvest, or any other human influences.

The Florida Department of Natural Resources, which in essence has evolved from that early shellfish commission, has an extensive program of oyster and shellfish protection and development.

Since 1977, certain designated areas in Franklin County have been opened for commercial summer harvest. This legislative action was designed to expand the economic base of the oyster industry throughout the year. The effectiveness of this economic assistance is being closely monitored.

The oyster industry in this county, which produces approximately 90 percent of the Florida oyster harvest, reflects a long history. There have been some unfortunate events resulting in poor conservation practices, and some positive, effective management efforts have enhanced production.

After more than 100 years, the Apalachicola oyster industry still faces several threats to its future production. One is the ever-present threat to the entire estuarine-bay system that has been the life blood of these fertile oyster grounds. There is great concern regarding the problems that automatically follow development, pollution and dredging which jeopardize shellfish survival.

The industry, the consumer and the department have great concern regarding the potential threat of heavy metal contamination in this unique estuarine system. About ten years ago, we collected water samples for analysis of heavy metals by the U.S. Food and Drug Administration (FDA). This summer, we again collected samples for FDA processing. At this time, the analyses are being completed and will be compared with the earlier background data so we may assess the situation.

The unusual outbreak of red tide in the northern Gulf in September demonstrated that natural phenomena are a threat to oyster resources, as well as man-induced problems. As filter feeders, oysters concentrate red tide toxins in their tissues, causing illness when humans consume them. Our department closely monitors Gulf waters when red tide threatens. Oyster beds are closed to harvest when red tide is imminent in nearshore waters. Our action is designed first to protect the health of the consumer, second to protect the health of the industry. We have been called too cautious on occasion. If the industry is to sustain a reputation of reliability, however, we must be certain that the product is the safest, most wholesome we can provide.

In the 1982 Legislature, funds were provided to relay oysters from areas that are always closed-to-harvest to areas that were to be opened September 1. More than 85,000 bushels were relayed this past summer: 41,000 in Franklin County and 44,000 in Wakulla County. The transfer of oysters was supervised by department personnel to areas agreed upon by local oyster harvesters. These counties have suffered several closings during the usual harvest season due to heavy rainfalls and the attendant pollutants. The relay program was primarily developed to enhance the local economy depressed by the frequent closings and, secondly, to make available marginal oysters that would otherwise be lost to the fishery.

With the cooperation of the industry, the processing plant sanitation program is upgrading the quality of Florida shellfish. The industry is recognizing that quality shellfish command the respect of the consumer. Step by step, with the sanitarians and industry working together, our image in the marketplace is improving.

At this time, there are 174 leases in Florida, eight of them remaining in Franklin County, totalling 2,158 acres throughout the state. The total annual lease rentals of $10,463.50 do not cover the administrative costs of the program, but the economic benefits to the industry outweigh this discrepancy. Currently, new leases in the state cannot exceed 25 acres and at least one-quarter of the leased area must be under cultivation by the second year.

The past 100 years have taught us many lessons. The future will depend on how well we have learned them and how well we protect this unique estuarine system. It will rely on how carefully we husband this living resource through wise conservation practices and harvesting techniques. It will require the cooperation of all parties to market safe and wholesome seafood. The future of the renowned Apalachicola oyster rests in our understanding of the problems, and especially in enlightened cooperation in resolving them.

The Apalachicola Conference on the Oyster Industry is a positive step. We appreciate your concern and your input. Survival of the industry and its future progress may well depend on the information discussed here. For that, the department thanks you.

STATE OF THE FISHERY: AN OVERVIEW

Edwin A. Joyce, Jr.

I want to take this opportunity to express my thanks to Sea Grant, the Marine Advisory Program, and Scott Andree in particular for arranging this much needed conference. When Scott first discussed his initial plans with me, he mentioned his desire to hold a conference which would serve as an update for the "Conference on the Apalachicola Drainage System," held in Gainesville, Florida in April of 1976. That conference brought together for the first time a diverse group of top professional researchers, each of whom had been working on the Apalachicola system and could speak with authority to its strengths, weaknesses and ultimate uniqueness. The proceedings of that conference were published in the scientific research series of the Department of Natural Resources Marine Research Laboratory, and was edited by Dr. Skip Livingston and me. At that time, there was severe pressure to greatly increase the number of dams on the Apalachicola system. That publication represented one of the first times that such a mass of information had been gathered and published prior to the destruction of an environmental system. Its availability was a significant factor in preventing those damages.

I have been requested to talk on the "State of the Fisheries", and to fully understand exactly what is happening today in Apalachicola, we must review past production. From 1971 through 1976, Apalachicola Bay produced an average annual commercial harvest of 2.5 million pounds of oyster meats. In 1977, that production rose substantially to 3.9 million pounds. In 1978, all previous production records were broken with 5.5 million pounds of oyster meats being harvested. Amazingly enough, 1979, 1980 and 1981 production each broke the previous record catches, with 5.8, 6.4 and 6.6 million pounds, respectively. I should also mention that during the highest production in twelve consecutive months (September, 1980 through August, 1981), the Bay yielded 7.5 million pounds of oyster meats. These are astounding increases in production, and although summer oystering first began in 1977, the production during those summer months do not account for the tremendous increases noted.

With that look at past production, what is the state of the fishery this year? Since a major characteristic of a marine species is widely fluctuating abundance from year to year, no one should be surprised to find that 1982 production has dropped in comparison to the record-breaking crop of 1981. Even so, over 2.7 million pounds of oyster meats were harvested in the first seven months of 1982. This is already higher than in 1971-1976 average annual production with five major producing months still to go. With proper management, 1982 could be as high as the record-breaking 1978 catch.

Director, Division of Marine Resources, Florida Department of Natural Resources, Tallahassee, Florida.

Production levels are not totally reflections of the abundance or availability of the species being harvested. Reduced market demand for the product may also be responsible for lower production, and this seems to be a factor in the Apalachicola landings thus far in 1982. National Marine Fisheries Service agents, who gather fishery landing statistics, have consistently noted weak market demands and that oyster harvesters were often limited to only two or three days work per week.

Why might market demand be reduced? One major factor is customer confusion and concern. The public is aware that there are pollution problems and, therefore, are especially sensitive to press headlines. We could all see the effects of this a few years back when routine safety closures of the Bay received severe press treatment and banner headlines. Fortunately, I feel the press and the public have begun to realize that such closings are not reasons for fear, but rather reasons to feel more secure about the safety of shellfish. As a result, such closings now are generally accepted as what they are--a good safety program in action.

However, we all--the agencies, the industry and individuals--must be especially careful not to raise bogus issues which create bad press and doubt in the mind of the consumer. The recent issues of cancer and heavy metal levels in the upper river are excellent examples. The issues caused significant press and great concern for the safety of the seafood produced in Apalachicola Bay. Yet, when all the facts were in, the heavy metal concentrations were found to be within the normal ranges and the cancer levels were equal to or less than the national average. Even though the explanation also received good press, which is not often the case, such bogus issues do irreparable harm.

The second, and in this case perhaps the most important, reason for a weak market demand is the quality of the product. This issue is of serious concern to our department at this time because of the very large number of under-sized oysters which are being landed and sold. Not only does this practice greatly lower the quality of the product the consumer is paying for, but it also removes oysters which will grow to legal size in two or three months and upon which the fishery will depend for the remainder of 1982 and 1983. Because of the many complaints of small oysters, our Marine Research Laboratory performed some scientific evaluations of the number and size of oysters in several areas of Apalachicola Bay. Those studies showed that in the heavily harvested areas, 5 to 25 percent of all measurable oysters were of legal size. Bags of oysters, ready for sale at the the fish houses, were also sampled, and 33 to 76 percent were of legal size. The laws requires that 85 percent should be of legal size. Such widespread harvest and sale of undersized oysters is doing severe damage to the productivity of Apalachicola Bay. It is lowering the quality of the product and therefore the consumers' desire for the product. It takes many more individual oysters to make a full bushel because of their small size, and finally, it is removing those oysters which will be needed to support a fishery during the last months of 1982 and the first of 1983.

Many complaints can be heard that the large number of small oysters is unusual this year. In reality, early research, by people such as Bob Ingle and Winston Menzel, has indicated that small oysters always predominate during this time of year. Basically, average oyster size in the Bay is cyclical, with the smallest occurring at about 55-60 mm (2 1/2 inches) in September, according to Ingle. The rapid growth described by Ingle continues to increase the average oyster size until it reaches a peak of about 80 mm (3 1/4 inches) in June, according to Menzel. The normal 50-70 percent mortality, which strikes only adult oysters and occurs annually in July and August, then reduces the average oyster size back to the readings of the previous month of September.

In summary, we have a very crucial problem. If the industry and the harvesters continue to take and sell undersized oysters, we could experience a virtual crash in production. The dealers will survive because they can buy and process oysters from other states. The harvesters, however, will have nothing left to harvest if they don't stop taking the small oysters now!

APALACHICOLA BAY: GEOLOGY AND SEDIMENTOLOGY

William F. Tanner

The bay is a combination estuary and lagoon, protected from the ocean, on the south, by a chain of moderate-energy barrier islands. The northern edge includes the estuary proper, which contains the delta of the Apalachicola River. The delta is of the confined type, like the Alabama River delta near Mobile, rather than any variant of an unconfined delta, such as the Mississippi River delta (bird's-foot type) or the Nile River Delta (delta-shaped). There are roughly 10 distributary channels, the most western of which is the river channel.

The bay is not as much as 10,000 years old. The earliest record of the present bay is an old shoreline at about 1.5 m elevation (5 feet); it dates from approximately 6,000 or 7,000 years ago, when rising sea level reached its highest stand in the most recent 100,000 years. By roughly 5,000 years ago, sea level had dropped to or a bit below its modern position, and the construction of the barrier island chain was under way. The general outline of the bay has been essentially stable since that time, except for the migration of the delta front southward into the estuary proper.

The migration rate of the delta front, over the past 5,000 years, appears to have been 1.5 to 2.0 m/year, toward the south. Whether or not this migration will continue at the same rate is highly problematical. Construction of a set of dams, farther upstream, has inaugurated a history which can be visualized in terms of four stages:

1. construction of dams
2. gradual reduction of sediment load
3. silting of the reservoirs
4. resumption of sediment delivery

These stages overlap in various ways. For example, for sand and fine gravel, No. 3 starts before No. 1 is completed. However, in a general sense, we can state that we are now into No. 2 and well past No. 1. Because the southernmost dam is some 200 km upstream, the early reduction of coarse sediment load depends almost entirely on the extent to which the chain of dams suppresses flood waves (thereby reducing maximum transport energy of the system). At a later date, as the downstream segment of the river is swept more or less clean of bed materials without a compensating supply across the spillway, the effects will be more pronounced.

The duration of the two parts of Stage No. 2 cannot be forecast with confidence. In certain arid areas, all of Stage No. 2 has been compressed into about two years; in the humid southeastern part of the U.S., this stage is more likely to last 50 or 100 years. The first part of Stage 2 (reduction in sand transport because of flood control effects) may be already visible if we look for it in the proper way.

Regents Professor, Department of Geology, Florida State University, Tallahassee, Florida.

The importance of the reduction in sediment load may be seen from various perspectives. For example, the southward growth of the delta front has depended on the delivery of new sediment at such a rate that deposition has more than compensated for compaction and dewatering of slightly older deposits. With the supply of new sediment curtailed, compaction may become the dominant process controlling the position of the delta front. This, in turn, would lead to northward (rather than a southward) migration of the front. A return to the longer-term conditions, with southward migration, cannot be expected until after we have gotten well into Stage No. 4.

If the delta were not confined, we would reason that an important reduction in the sand load of the river would lead fairly quickly to starvation of the beaches, and hence beach erosion. This, in turn, would probably result in landward migration of the barrier islands. However, the delta is confined, and therefore this chain of events is not to be expected. The barrier islands have been built from offshore sand, and at the moment this supply seems to be adequate. Therefore, we do not expect an early shift from stable beaches (more or less) along the seaward edge of St. George Island to serious erosion.

However, there is evidence of increasing erosion, and it seems that the worldwide beach erosion crisis, which has severely damaged St. Joseph's peninsula, is spreading eastward. It is likely that the beach stability which now protects the bay from the south is going to be restricted to the near future; and for the long view, we must expect increased erosion there. The presence of Sikes Cut does not now seem to have any important effect on the temporary stability of the barrier islands.

Most of the beaches along the shores of the bay are essentially stable although a few are eroding seriously. This erosion probably poses more of a threat to the adjacent land than to the bay itself. However, there is, at this time, no published energy budget for these beaches, and no data from which to construct one; therefore, future effects and even present processes cannot be specified except in the most general way.

HYDRODYNAMICS OF THE APALACHICOLA BAY SYSTEM

B.A. Christensen

Introduction

The rapid development of the world's coastal zones poses a serious threat to their freshwater resources and, at most locations, to the adjacent coastal waters. Such is the case in the Apalachicola Bay. Water transported pollutants generated in the upstream drainage basins enter the estuarine systems that serve as breeding grounds for numerous species of flora and fauna of vital, direct and indirect, importance to the human community and its economic welfare. Today, point source pollution, caused by residential, commercial and industrial developments, is being controlled to a wide extent by modern waste water treatment. However, in the industrialized countries, nonpoint source pollution, caused by such activities as agricultural, silvi-cultural, and certain mining operations, is one of the most serious pollution problems at the present time. For instance, clearcutting of forested areas may increase the rate of flow, reduce the time to peak and decrease the pH of the runoff, resulting in upset ecosystems in the receiving wetlands and coastal waters.

Numerous observations of water quality and biological cycles in the major estuarine systems of the United States clearly identify the problems of pollution and demonstrate the need for a solution. The problems in Apalachicola Bay, where forestry activities may be a major pollution source, are reported by Livingston et al. (1974) and Livingston (1975). A similar influence on water quality at other locations is discussed by Patric and Reinhart (1971) and Johnson et al. (1970).

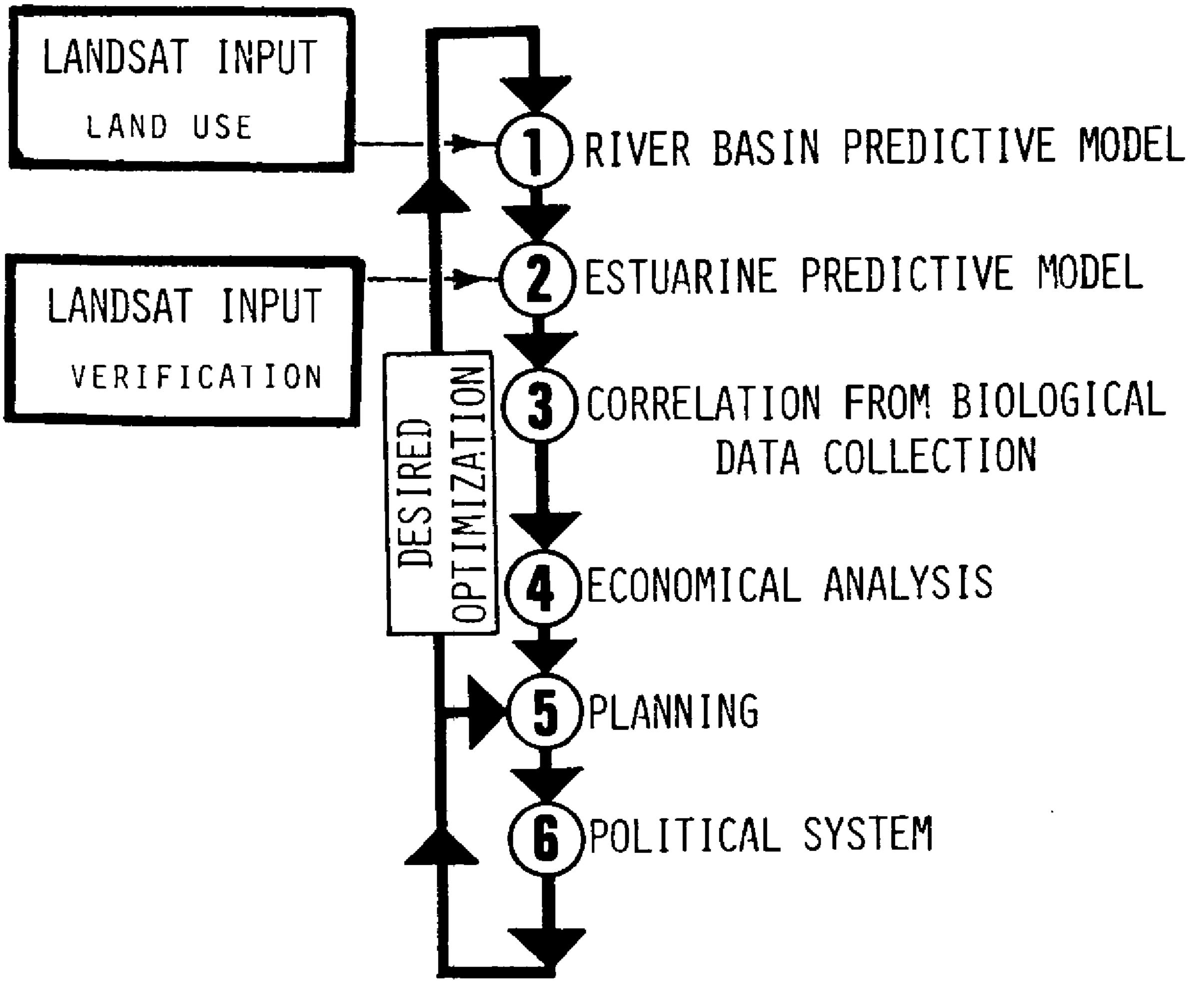
Numerical models of hydrological events in major drainage basins and of the hydrodynamics in estuarine systems have reached such a degree of reliability today that it seems natural to apply this methodology. A general layout of the logistics of such an approach is shown in Figure 1. Besides the interaction between drainage basin and estuary, the consequential influence of development on the biosystem and economy is considered. The method is periodical, in that the output from the economic analysis serve as input to the planning process and the legislative political system, which provides the input to the river basin model through land use.

The Apalachicola River basin, stretching south from Lake Seminole at Chattahoochee, Florida to the Gulf coast of Florida's panhandle, together with Apalachicola Bay estuary, were chosen for study because there existed: (1) relatively few and simple pollution sources, (2) a low degree of industrial and residential development, and (3) an extensive data base on the Apalachicola Bay estuary for water quality and biological activities since 1970. Satellite (LANDSAT) pictures were also available for the same period of time. These pictures provide input information for the basin model as well as contribute to the verification data for the water quality part of the estuarine model.

Professor, Hydraulic Laboratory, University of Florida, Gainesville, Florida.

FIGURE 1

LOGISTICS OF A COMPOSITE MODEL APPROACH



Selection of Basin and River Model

In order to establish the composite decision model outlined in Figure 1, models describing runoff from urban and nonurban basins, river flow and the hydrodynamics of a wind and tide-driven estuarine system must be selected.

The three most commonly used models representing nonurban basins are the Soil Conservation Service (SCS) procedure, as described by Mokus et al. (1969), the Hydrocomp Simulation Programming (HSP) (Anonymous, 1968) and the U.S. Army Corps of Engineers STORM (Storage, Treatment, Overflow Runoff Model) (Anonymous, 1976). Of these, the SCS method is a non-numerical approach which utilizes triangular unit hydrographs in the routing process and SCS soil unit properties. The HSP model is a special version of the Stanford Watershed Model (SWM) (Crawford and Linsley, 1966). It can simulate rate of flow, as well as quality of more than a dozen constituents from basins with areas ranging from the very small to continental size. Routine is done by the kinematic wave method.

For use in the composite modeling approach the HSP or SWM models are better suited than the STORM model or the SCS model upon which the latter is partially based. The HSP model is proprietary at the present time while several versions of the original SWM model are readily available with manuals, prepared by research groups at the University of Texas (Claborn and Moore, 1970), Ohio State University (Warns, 1971), and Georgia Institute of Technology (Lumb, 1972). The SWM model was chosen for this study.

Considering the Apalachicola basin and estuary system, it is realized that the volumetric input during one tidal cycle to the estuary from river flow is, by far, smaller than the exchange of water volume by tidal action and by the wind. Consequently, the quantitative role of the river flow is minor and a very high accuracy of the predicted river flow rate is not necessary. The same cannot be said when the water quality is considered. The river is probably the major contributor to the quality of the estuarine water. Therefore, special efforts are made to take this factor into consideration and relate the river's water quality to land use. Computer enhanced satellite images of the drainage basin assist in the identification of land use. They make it possible to identify clearcut areas, which may be the major sources of the low pH runoff, recently replanted lots, and areas ready for harvesting, without extensive field work.

Selection of Estuary Model and Application

The estuarine model is definitely the most critical part of the overall scheme. Several verified and proven models are available for vertically well-mixed conditions, while the availability of models capable of handling stratified conditions is somewhat limited. Fortunately, the Apalachicola Bay, like a majority of Florida estuaries, is shallow and wind-mixed so that the assumption of homogeneity in all verticals is valid, or at least an acceptable approximation.

Two basic types of numerical computation procedures, termed "finite-element" and "finite-difference", are in common use. Briefly, the finite difference method uses a rectangular geometric grid, while the finite element method, which is newer, can use a grid of arbitrarily sized and shaped elements. Most two-dimensional estuarine models, which are accepted, employ a finite difference scheme. However, the advantages of the recently developed finite element method models will, undoubtedly, make their adoption for application almost universal in the future. While more difficult to program, boundaries and other geometrical information fit better with finite elements, and the associated boundary conditions prescribed with enhanced facility. At present, the most promising model for the typical Florida conditions is the vertically averaged model, developed at MIT by Wang and Conner (1975). This finite element model was used in this project.

Summarizing, the HSP and MIT finite elements models were selected as the most promising for simulation of the upland basin and receiving estuary, respectively, for typical Florida conditions. Application for water management requires these models to be linked in a computationally compatible scheme, verified on a representative prototype and presented to users in an organized comprehensible format. Because HSP was considered too expensive to acquire for this project, a nonproprietary version of SWM was used with an improved quality package.

Examples of model results in the Apalachicola Bay are shown in Figures 2 and 3. Figure 2 shows the flow velocities averaged over one tidal cycle, clearly demonstrating how the tidal action is causing a net flow from east to west behind the barrier island. The relatively weak influence of the inflow of fresh water from the river and its surrounding marsh area is clearly seen, as is the influence of a man-made cut, Sikes Cut, in the barrier island.

The quality computations are based on a simple advective dispersion system. An example of the results of the quality modeling of a conservative pollutant is shown in Figure 3, where curves may be drawn through points having the same concentration. Results, like Figure 3, are used together with LANDSAT images and actual field observations for verification of the quality part of the estuarine model, which in turn is correlated with the biological observations. Field observations of spatial mean velocities and of elevations of the water surface at strategic locations in the bay, where several recording tide gages presently are installed, form the basis for verification of the model's hydrodynamic part. Boundary and initial conditions are obtained in the same way.

A 200-page atlas, describing flow velocities (and their orientation) and the distribution of pollutants in the bay during typical tidal cycles in each of the year's twelves months, has been prepared.

Conclusion

In conclusion, proper management of the Apalachicola Bay requires the ability to predict the effect of basin activities on quantity and quality of the runoff to the estuarine waters and the flow of water, pollutants, nutrients and chloride (or lack thereof) in the estuary proper.

Mathematical models now exist which have successfully simulated both basin and estuarine water quality and discharges. Selected available and proven models have been linked to simulate most of the hydrosystem of a relatively simple prototype locality for which a substantial data base is available. Verification of the composite model is, at the time of this paper, accomplished by direct observations and satellite (LANDSAT) imagery. The composite model, which is a part of a more complex scheme including biosystem and regional economy, shows promise for future application to more complicated and environmentally stressed systems.

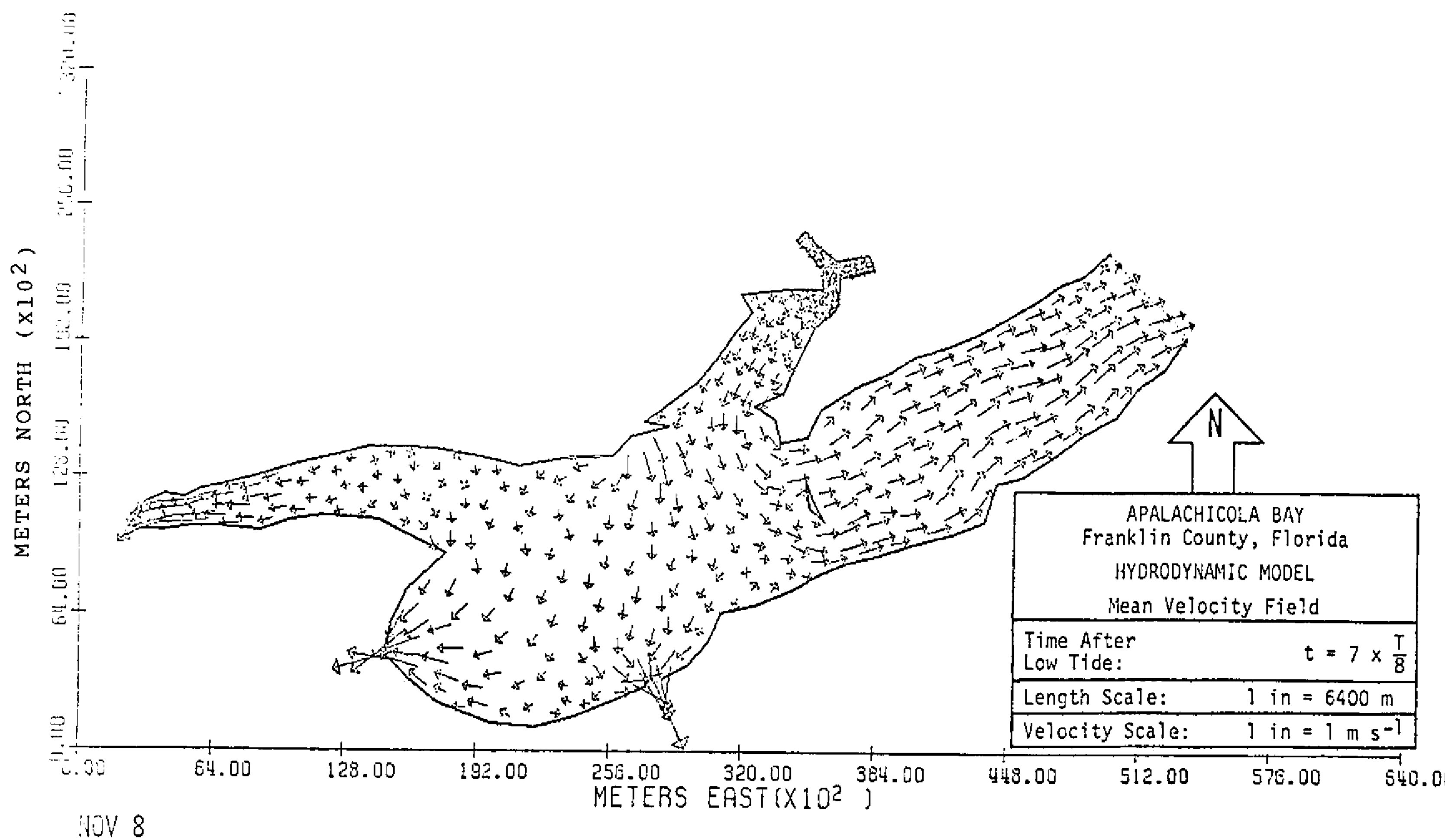


FIGURE 2

TYPICAL COMPUTER PREDICTED VELOCITY FIELD MEAN VELOCITIES

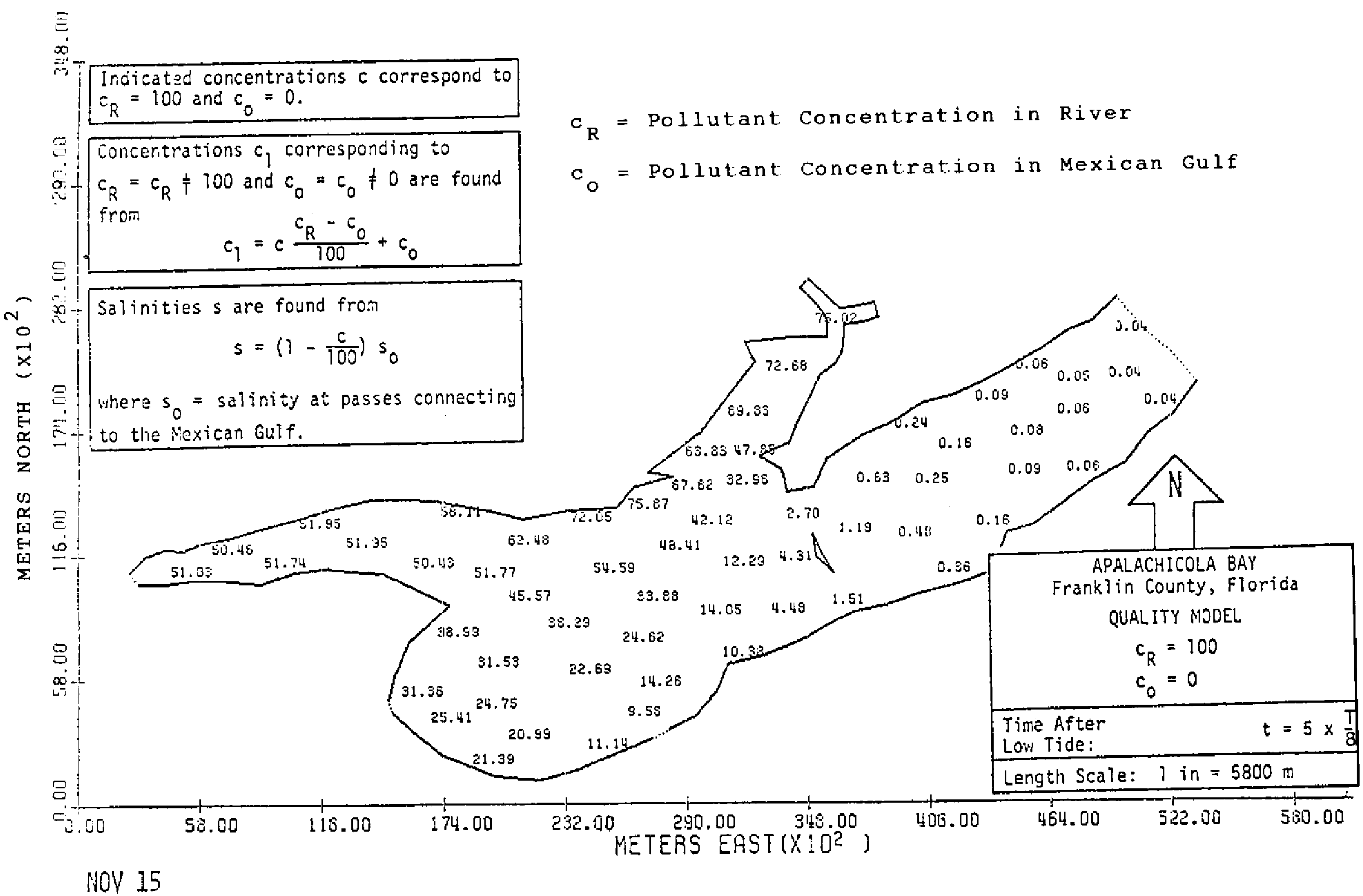


FIGURE 3

TYPICAL COMPUTER PREDICTED DISTRIBUTION OF POLLUTANT CONCENTRATIONS

Acknowledgements

This research was supported in part by funds from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, the Office of Sea Grant (Grant #04-158-44046) and the Engineering and Industrial Experiment Station, University of Florida. This support is gratefully acknowledged.

Literature Cited

Anonymous. (1968). Hydrocomp Simulation Programming Manual. Hydrocomp International, Inc. Palo Alto, California.

Anonymous. (1976). Storage, Treatment, Overflow Runoff Model "STORM" User's Manual. Hydrologic Engineering Center, U.S. Army Corps of Engineers Computer Program 73-88-L7520. Davis, California.

Claborn, B.J. and W. Moore. (1970). Numerical Simulation in Watershed Hydrology. Technical Report HYD-14 700 1. Hydraulic Engineering Laboratory, University of Texas, Austin, Texas.

Crawford, N.H. and R.K. Linsley. (1966). Digital Simulation in Hydrology: Stanford Watershed Model IV. Technical Report 39, Department of Civil Engineering, Stanford University, Stanford, California.

Johnson, N.M. (1970). A Working Model for the Variation in Streamwater Chemistry at the Hubbard Brook Experimental Forest. Water Resources Research 5: 1353-1363.

Livingston, R.J., R.L. Iverson, R.H. Estebrooks, V.E. Keys, and John Taylor, Jr. (1974). Major Features of the Apalachicola Bay System: Physiography, Biota and Resource Management. Florida Scientist 37 (4): 245-271.

Livingston, R.J. (1975). Impact of Kraft Pulp-Mill Effluents on Estuarine and Coastal Fishes in Apalachee Bay, Florida. U.S.A. Mar. Biol. 32: 19-48.

Lumb, A.M. (1972). Georgia Tech. Watershed Simulation - User's Manual. Manual 10/17-11:05:28. Georgia Institute of Technology, Atlanta, Georgia.

Mokus, Victor, H.O. Ogrosky, and C.J. Francis. (1969). National Engineering Handbook, Section 4, "Hydrology." U.S. Department of Agricutlure. National Technical Information Service, Springfield, Virginia.

Patric, J.H. and K.G. Reinhart. (1971). Hydrologic Effects of Deforesting Two Mountain Watersheds in West Virginia. Water Resources Research 7: 1182-1188.

Wang, J.D. and J.J. Connor. (1975). Mathematical Modeling of Near Coastal Circulation. MIT Parsons Laboratory, Technical Report No. 200. Cambridge, Massachusetts.

Warns, J.C. (1971). User's Manual for the Ohio State University Version of the Stanford Streamflow Simulation Model IV. M.S. Thesis, College of Engineering, Ohio State University.

CORRELATION OF COLIFORM BACTERIA WITH VIBRIOS IN APALACHICOLA BAY

Norman J. Blake[1]
and
Gary E. Rodrick[2]

The transmission of diseases, such as hepatitis, from the consumption of contaminated shellfish has been greatly reduced, largely through the cooperation of both state and federal governments in the implementation of the National Shellfish Sanitation Program. In the state of Florida, shellfish harvesting waters are approved if the fecal coliform bacteria most probable number (MPN) in the overlying water does not exceed 14 per 100 ml of water in more than 10 percent of the samples tested. The fecal coliform MPN in shellfish meats may not exceed 2.3 per gram of tissue and the 35C aerobic count may not exceed 500,000 per gram.

Currently in the state of Florida, over 2.2 million acres are available as potential shellfish harvesting areas. Only 22 percent of this is approved for harvesting, 5 percent is conditionally approved, 13 percent is prohibited, and 60 percent is unclassified. This represents a potential loss of almost 75 percent of our available area. Moreover, 88 percent of all Florida oysters are harvested in Franklin County.

Occasionally, fecal coliform counts rise dramatically in certain areas of Apalachicola Bay, largely as a result of heavy rainfall and/or decreased efficiency of sewage treatment facilities. When this occurs, the Florida Department of Natural Resources is forced to temporarily close an area to protect not only the public from possible disease, but also to protect the industry from possible notoriety.

Since 1979, over 13 cases of oyster-associated cholera have occurred in Florida. Adverse publicity concerning cholera has been detrimental to the oyster industry and has periodically affected sales.

In 1980, under the sponsorship of Florida Sea Grant and the Florida Department of Natural Resources, we began a project on the ecology of Vibrio cholerae designed to answer questions which would be of direct benefit to the oyster industry. First, we wanted to determine the correlation of Vibrio cholerae with fecal coliform levels in the water, oysters, and sediments, thereby shedding light on the importance of human contamination to the presence of Vibrio. We also wanted to determine the seasonality of Vibrio levels as they correlate with the seasonal changes in temperature and salinity.

---

[1]Associate Professor, Department of Marine Science, University of South Florida, St. Petersburg, Florida.

[2]Associate Professor, Department of Comprehensive Medicine, University of South Florida, Tampa, Florida.

Results and Discussion

Four species of *Vibrio* have been isolated from shellfish or estuaries (Table 1). All of these species may cause gastrointestinal or wound infection. The most well-known of these, *Vibrio cholerae*, has received widespread public attention since cholera in some countries occasionally has reached epidemic proportions. Such epidemics have been caused largely by a particular type of *Vibrio cholerae* referred to as 01. This type is not, as yet, common in our waters or shellfish.

Levels of fecal coliform bacteria varied widely between stations and between sampling times. In the water, the values ranged from near zero to 240 per 100 ml of seawater. Values in oyters reached as high as 2.4×10^6 per gram of meat. Although high fecal coliform values can roughly be associated with those stations which are influenced by river flow, there was no correlation of high fecal coliform counts in water with high MPN's in meats or sediments. There also was only a small correlation with temperature and only a slightly better correlation with salinity.

All four species of *Vibrio* were found at some time during the study at both approved and prohibited stations. *Vibrio cholerae* was present only in non-01 form. The numbers of non-01 *Vibrio cholerae* in the water ranged from zero to 4.6×10^5 per 100 ml seawater. This high number occurred just offshore from East Point. As with the fecal coliform bacteria, there was no correlation of high numbers of non-01 *Vibrio cholerae* in the water with the numbers present in oysters or sediments.

Higher numbers of non-01 *Vibrio cholerae* were observed in the eastern part of the bay than in the remainder of the bay. In the eastern part of the bay, these high numbers (greater than 100 per 100 ml of seawater or per gram of oyster) occurred mostly during the summer months when salinity was greater than 15 $^o/_{oo}$ and temperature was greater than 25°C.

The correlations of the number of fecal coliform bacteria with the numbers of any of the four Vibrios were very low. This indicates that the Vibrios present in the bay are part of the normal ecosystem and not of human fecal origin.

These results indicate that the bacteriological standards utilized for the classification of shellfish harvesting waters are not of great value for the prediction of Vibrios. Since all four groups of *Vibrio* can cause either intestinal or systemic infections, their presence and abundance in Apalachicola Bay should not be ignored; rather, their seasonal and spatial abundances may need to be considered when waters are classified for shellfish harvesting.

This does not in any way lessen the importance of present bacteriological standards for limiting the transmission of many pathogenic organisms by shellfish. However, the shellfish industry has been and will continue to be in jeopardy as long as "cholera scares" occur, and the relationship of human contamination to Vibrios is not put into proper perspective.

Table 1: Major Types of Vibrios and Their Associated Diseases.

Organism Type	Principal Diseases	Principal Environments
Vibrio cholerae (non-01)	Gastroenteritis	man, estuaries, and shellfish
Vibrio cholerae (01)		
classical biotype	Gastroenteritis	man, shellfish (?)
El Tor biotype	Gastroenteritis	man, shellfish
Vibrio parahaemolyticus	Gastroenteritis wound infection	estuaries and shellfish
Vibrio vulnificus	wound infection septicemia	estuaries and shellfish
Vibrio alginolyticus	wound infection	estuaries

INFLUENCE OF PROCESSING AND STORAGE ON THE MICROBIOLOGICAL LOADS OF OYSTER MEATS

Mary A. Hood[1]
Fred L. Singleton[2]
Gregory E. Ness[3]
Ron M. Baker[4]

The influence of processing and storage conditions on the microbial load of oyster meats was examined. Oysters were collected from approved, conditionally approved, and prohibited shellfish harvesting waters in Apalachicola and Tampa Bay over a year and a half period of time. The oysters were stored as shellstock, as shucked meats, and as fully processed meats at four temperatures (2, 8, 20 and 35°C) for as long as four weeks. At weekly intervals, the meats were examined for total bacteria, fungi, coliforms, fecal coliforms, fecal streptococci, _Aeromonas hydrophila_, _Clostridium_ spp., _Salmonella_ spp., _Vibrio cholerae_, _V. parahaemolyticus_, and Lac+ Vibrios. Samples were also collected from several oyster houses at different stages in the processing of oysters and analyzed for total bacteria, fecal coliforms and Vibrios.

Under storage as shellstock, mean levels of total bacteria increased with increased temperatures and time. Similar patterns were observed with levels of fungi, coliforms, _A. hydrophila_, and _Clostridium_ spp. Fecal coliforms, however, increased only at the higher temperatures (20 and 35°C), while fecal streptococci remained relatively constant under storage temperatures. Viable _Salmonella_ spp. could be recovered from shellstock oyster meats stored for up to 14 days at 8°C. _V. cholerae_ levels at 2°C increased after 7 days, but were recovered in low levels after that time. _V. parahaemolyticus_ increased after 7 days of storage at 20°C, and like _V. cholerae_, was rarely recovered after 7 days. The Lac+ Vibrios were observed to increase at 7 days at both 8°C and 20°C and likewise, were very low after 7 days of storage.

Comparisons of shellstock and shucked meats revealed the development of higher levels of total bacteria, fungi, coliforms, fecal streptococci, _A. hydrophila_, and _Clostridium_ spp. in shucked meats under storage, while fecal coliforms were the same under both treatments. In contrast, levels of Vibrios were higher in shellstock meats than in shucked meats. Comparisons of shucked and fully processed meats revealed that processed meats developed higher mean levels of total bacteria, fungi, fecal coliforms, fecal streptococci, and _Clostridium_ spp. under storage, while levels of Vibrios were substantially the same under both treatments.

---

[1]Associate Professor, Department of Biology, University of West Florida, Pensacola, Florida.

[2]Assistant Professor, Microbiology Department, Old Dominion University, Norfolk, Virginia.

[3]Graduate Student, University of West Florida, Pensacola, Florida.

[4]Visiting Instructor, Department of Biology, University of West Florida, Pensacola, Florida.

When the interactions of the physical and chemical parameters of harvesting waters and the microbial load of oysters under storage were examined, several interesting patterns were observed. Upon storage, levels of total bacteria, coliforms, fecal streptococci, A. hydrophila, Clostridium spp., and the Lac^+ Vibrios were higher when environmental water temperatures were higher. Salinity and the other parameters appeared to have less effect on the microbial load of stored oysters. As expected, fecal coliform levels were highest in stored oyster meats collected from prohibited shellfish harvesting waters, intermediate in conditionally approved waters, and lowest in approved waters. In fact, mean levels of all microbial groups examined (except fecal streptococci) in stored oysters were lowest in those oysters collected from approved shellfish harvesting waters.

Studies which were designed to determine the effect of processing on the microbial loads prove interesting. Samples were collected at several oyster processing houses in Apalachicola, Florida. At different stages in the processing, total bacteria, fecal coliforms, and Vibrio levels were determined. Mean concentrations of total bacteria and fecal coliforms decreased after the skimming procedure and levels further decreased after the blowing treatment. Because of the variability in samples, conclusive results on the Vibrios are unavailable at this time. However, with additional analyses, we hope to determine and subsequently report the effect of processing on the Vibrio loads.

In summary, it appears that oysters stored as shellstock may develop increased loads of Vibrios even at cold temperatures, although it should be pointed out that natural levels of Vibrios were never (in all samples examined) very high. Even though the overall microbial load in processed and stored oyster meats increased with time, it appears that processing as conducted by the skimming and blowing methods prevents the development of high Vibrio and coliform concentrations in the meats.

GENETICS AND THE POTENTIALS FOR OYSTER PRODUCTION IN APALACHICOLA BAY

R. Winston Menzel

Introduction

Our oyster, the American oyster (Crassostrea virginica) is the most important commercial species in the world, ranging from Canada on the east coast southward to Yucatan, Mexico. Next in importance is the Pacific or Japanese oyster, C. gigas, the largest living species which has been introduced to the west coast of North America, Southern Europe, Australia, and other areas. Other species of importance are the European flat oyster, Ostrea edulis, the Portuguese oyster, C. angulata in southern Europe, the Sydney Rock oyster, Saccostrea commercialis in Australia, a closely-related species, S. glomerata in New Zealand, several species in the Philippines, and the Bombay oyster, S. cucullata in India and other areas in the Indo-Pacific. The Caribbean or mangrove oyster, C. rhizophorae, occurs widely in the Caribbean and Gulf of Mexico coasts of Central and South America. There are three other oyster species in the region of Apalachicola, but all are small and of no commercial importance.

Genetical studies of oysters have generally been along three lines: (1) hybridization between populations of the same species, called intraspecific, or between different species, called interspecific; (2) selection studies to obtain strains that will have genetically controlled traits; and (3) basic studies involving chromosomal behavior and use of biochemicals to determine inheritance traits.

Oyster genetics is still in its infancy and nowhere near as advanced as the very rewarding genetical manipulations of terrestrial animals and plants. We are still trying to determine some of the basic mechanisms. The three aspects will be treated separately, although they are intimately related. Because of the time allowed, it will be possible to give only a limited discussion with some examples. No documentation is included, but selected references, mostly with extensive literature citations, are included in the manuscript.

Hybridization

One of the first recorded interspecific hybridization attempts was between the European flat oyster and the Portuguese oyster in the nineteenth century, after the Portuguese had been accidentally established on the Brittany coast of France. There was concern that the introduced species would hybridize with the endemic and more valuable flat oyster. The attempts were unsuccessful. At that time, the two species were placed in the same genus but are now recognized to be separate genera. Intergeneric crossing is usually more difficult than interspecific. However, despite being in different genera, a successful hybridization between the Pacific oyster and the native species in New Zealand was reported this year.

Professor, Department of Oceanography, Florida State University, Tallahassee, Florida.

There was concern that the Pacific oyster, a successful introduction on our west coast, if introduced on the east coast, would hybridize with our more valuable native oyster. Laboratory experiments in the 1930s showed that the two species would cross fertilize. At that time, techniques for larval culture had not been perfected and no attempts were made to rear the larvae; however, several Atlantic states enacted regulations prohibiting the introduction of the Pacific species. In 1950, it was found that, although fertilization was achieved, the hybrid larvae could not be reared. Later in the 1960s hybrids between these two species were reared through metamorphosis, but with difficulty after repeated attempts. Chromosome examinations in the hybrid eggs and early cleavage embryo indicated that the hybrids would likely be sterile. No attempts were made to rear hybrid larvae of the second generation. Hybrids had a faster growth rate than the American oyster parent, approaching that of the Pacific parent. However, the difficulty of obtaining hybrids would make impractical any commercial application.

The Caribbean oysters hybridize readily with our native species and it has been suggested that they are a subspecies of our oyster. Although of academic interest, such hybrids would have no commercial value here because of their intolerance to cold temperatures and also the growth rate was less than our native species, more like the smaller Caribbean parent. Although not applicable in this area, the Pacific and Portuguese oysters hybridize readily with normal chromosome behavior in the hybrids. It has been asserted that they are subspecies, and also that crossing and selection might be beneficial.

In 1961, two Japanese oyster biologists published twenty years of observations of crossing populations of the Pacific oyster. They found the hybrids to be more or less intermediate in different characteristics of shell color, shape and size between their parents but did find that some of the crosses had better adaptability to certain environmental conditions than did the parents. They inbred oysters for three generations and found reduced viability in the third generation.

Researchers in Connecticut found that the second generation of American oyster, when inbred, began to lose viability and concluded that there are barriers against inbreeding. This phenomenon would hinder the production of pure lines to establish a trait, or traits, of commercial importance. There are indications that inbreeding barriers do not occur or hold in other localities, but this has not been tested adequately.

The development of genetic resistance to a pathogen has been used successfully with both animals and plants. One of the first documented instances for which genetic resistance was a factor in the recovery of an oyster production was the Malpeque Bay mortality in Canada. After devastating mortalities, a small population was found that was resistant to the disease and from which the industry was reestablished. This was not produced by research, but was recognized and utilized.

The MSX disease, caused by a parasitic protozoan, Minchinia nelsoni, almost completely destroyed the oyster industry in New Jersey in the late 1950s, and one year later, the planted beds in the lower Chesapeake Bay. An extensive research program was begun by the several affected areas to understand the disease and decide how to combat it. One program was to hatchery breed oysters that were survivors on the supposition these were genetically less susceptible. By rigorous selection, New Jersey oysters were obtained that were almost completely resistant. In the meantime, natural selection, which was severe in Delaware Bay, resulted in the development of resistance in the natural population and the industry has recovered somewhat. I understand that in Virginia, where mortality selection was not as rigorous, considerable problems still exist.

Another disease that has caused extensive mortalities and is found in Apalachicola Bay is commonly called "Dermo", from the scientific name Dermocyctidium marinum, when it was thought that the causative organism was a fungus. It has now been put in the animal kingdom and has been renamed Perkinsus marinus. It was first described from Louisiana in 1950 and has been referred to as the warm water wasting disease because it causes mortalities only during the warmer months. Also, young oysters during the first summer after attachment are unaffected. Up to 50 percent of adult oysters have been reported to be killed annually. Although the disease occurs along the Atlantic coast, the mortalities are not as severe, probably because of shorter periods of warm summer weather. Attempts have been made to breed and select oysters that are resistant, with some success reported from New Jersey and Virginia. As far as is known, no natural immunity has developed, partly because the mortality selection is not rigorous enough and, in the Gulf area, young oysters in the first summer after attachment will spawn. Thus, natural selection cannot occur since susceptible individuals are not eliminated before reproducing.

Selection

It has been observed repeatedly that oysters, even from the same parents, will have different growth rates. Part of the difference is due to different environmental conditions, such as food availability, but part is due to genetical factors. As has been found with other organisms, it should be possible to establish the beneficial traits that are under genetic control by breeding and selecting.

Many oyster hatcheries practice selection, starting when the larvae are sieved with the changing of the water. By the use of selected size mesh sieves, only the larger larvae are retained. In addition, only the faster growing adults are used for breeders. It not known how effective this has been. Selection probably is not as rigorous as it should be and positive results will be a long time in coming.

A few limited carefully controlled experiments have demonstrated selection for faster growth is possible. These studies involve what is called additive genetic variation. If oyster breeders are to use selection in a systematic manner, they should know what factors have an adequate level of genetic variability so they can select for these. So far, these have been surmised but not really understood.

Basic Studies

Included in this section are chromosome and biochemical studies of allozymes. Surprisingly, even the chromosome number of oysters was not known until less than two decades ago. All oysters in the several genera that have been examined so far have a diploid number of 20. Since then, the chromosomes have been described in more detail, as well as their behavior at germ cell maturation and in fertilization between gametes, or reproductive cells. Behavior of chromosomes, especially at fertilization, has aided the researcher to determine the genetic relationships of oysters when they are hybridized.

The gametes (eggs and sperm) contain only half the 20 chromosomes and are called haploid, and at fertilization the 10 from the male and 10 from the female unite, resulting in the normal 20, called diploid. Recently, it has been found that a chemical called cytochalasin prevents the reduction, or halving, of the chromosome number in the maturation of the egg. These eggs which contain the diploid 20 chromosomes, when fertilized by the sperm with 10, result in triploid oysters. There are indications that these oysters, which have 30 chromosomes, have better growth rates when compared with normal diploids.

Another technique that has been applied to oysters and has proven useful is to irradiate the sperm. Although the sperm are not killed and can cause development of the eggs, the male complement of chromosomes does not unite in the developing embryo. Thus, there would be no inheritance from the male and such a procedure would allow the production of a pure line in fewer generations. One worker used the trait of oysters to change sex. He reported that he froze sperm when the oyster was male and later when the oyster changed sex used these to fertilize the eggs. Such a technique would establish a pure line in few generations also. I have never seen any additional work on this technique, so evidently it was not too successful.

Starch gel electrophoresis is widely used by geneticists to determine relationships between species and between populations of the same species. The so-called allozymes, which are loci that might be called genes, are usually polymorphic and correlated with inheritance. Studies have shown that oysters from more northern areas are very different from those in the Gulf of Mexico. Other studies had suggested this previously. Sophisticated experiments have demonstrated that the greater the allozymes heterozygosity, the better the growth rate.

Conclusions

No results from genetical findings have been used so far for improving oyster farming. This is partly because genetically improved oysters would have to be cultured in mariculture, and would require a hatchery, which is uneconomical except where natural recruitment is absent or very small. It is partly due to not knowing enough. The possibilities are great, however, when we consider the successes of animal and plant genetic manipulations. We have not had the concentrated efforts and extensive programs of the U.S.D.A., the states' programs, as well as university research, that has been going on for a long time. Although we are growing oysters, we are doing so with wild animals. It would do no good to plant genetically improved oysters in the Apalachicola Bay or in other natural populations in order to upgrade them, as is done with the use of a superior bull to upgrade a cattle herd. The countless wild oysters would "swamp" or mask the improved traits. The obtaining of more commercially desirable oysters through genetics will be a long and tedious process, but there is hope and anticipation when we see what has been done with other organisms.

I would like to interject another thought. The oyster industry of Apalachicola Bay is worth about $60 million as capital. This figure is derived from the annual harvest in the last several years of about $6 million by the oyster tonger. The harvest is interest at 10 percent. The capital, which is still there, is self renewable as long as it is managed wisely and there are no natural catastrophes. The oyster tonger has little expense (boats, tongs, fuel) when compared to the farmer with the expensive machinery, fertilizers and seed, as well as fuel. The labor is probably harder for the oyster tonger than the farmer, but he pays no taxes on the capital, only a modest permit fee. Immediate and future needs are wise management, including environmental protection of the capital so the "interest" can continue to be drawn.

Selected References

Ahmed, M. (1975). Speciation in Living Oysters. Adv. Mar. Biol. 13: 357-397.

Buroker, N.E., W.K. Herschberger and K.K. Chew. (1975). Genetic Variation in the Pacific Oyster, Crassostrea gigas. J. Fish. Rs. Bd. Canada. 32: 2471-2477.

Haskins, H. and S.E. Ford. (1979). Development of Resistance to Minchinia nelsoni (MSX) Mortality in Laboratory-reared and Native Oyster Stocks in Delaware Bay. Mar. Fish. Rev. 41: 54-63.

Hillman, R.E. (1968). Chromatographic Studies of Allopatric Populations of the Eastern Oyster, Crassostrea virginica. Chesapeake Sci. 6: 115-116.

Imai, T. and S. Sakai. (1961). Study of Breeding of the Japanese Oyster, Crassostrea gigas. Tohoku J. Agric. Rs. 12:125-165

Lanan, J.E. (1972). Estimating Heritability and Predicting Responses to Selection for the Pacific Oyster, Crassostrea gigas. Proc. Nat'l. Shellfish Assoc. 62: 62-66.

Longwell, A.C. (1976). Review of Genetic and Related Studies on Commercial Oysters and Other Pelecypod Mollusks. J. Fish Rs. Bd. Canada. 33: 1100-1107.

Longwell, A.C., S.S. Stiles and D.G. Smith. (1967). Chromosomes Complement of the American Oyster, Crassostrea virginica, as seen in the meiotic and cleaving eggs. Can. J. Genet. Cytol. 9: 845-856.

Menzel, R.W. (1968). Cytotaxonomy of Clams (Mercenaria) and Oysters (Crassostrea). Symp. Mollusca., Mar. Biol. Assoc. India. I: 75-84.

Menzel, R.W. (1971). Selective Breeding in Oysters. Conference on Artificial Propagation of Commercially Valuable Shellfish. University of Delaware. pp. 81-92.

Menzel, R.W. (1979). Genetic Manipulations of Bivalve Mollusks for Mariculture. I.C.E.S., Mariculture Comm., CM 1979F, 44: 21 p.

Newkirk, G.F., L.E. Haley, D.L. Waugh, and R. Doyle. (1977). Genetics of Larvae and Spat Growth in the Oyster, Crassostrea virginica. Mar. Biol. 41: 59-62.

Singh, S.M. and E. Zouras. (1978). Genetic Variation Associated with Growth Rate in the American Oyster (Crassostrea virginica). Evolution 32: 342-353.

LIMNOLOGY OF A SMALL COASTAL STREAM:
IMPACT OF A TIMBERING OPERATION
(Abstract)

Daniel F. Canfield, Jr.

In 1981, a limnological survey of Graham Creek (Franklin County, Florida) was conducted to determine the impact of intensive forest management on the limnology of a small coastal stream. In the headwater areas, pH average 4.2, oxygen concentrations average 4.5 and color concentrations averaged 230 Pt-Co units. Specific conductance averaged 47 μmhos/cm, phosphorus concentrations averaged 5.3 mg/m^3 and total suspendend sediment concentrations averaged 3.3 mg/l. All measured limnological parameters changed along a longitudinal gradient towards the mouth of the creek. At the junction of Graham Creek and the East River, pH averaged 6.1, oxygen concentrations averaged 6.5, color averaged 44 Pt-Co units, specific conductance averaged 92 μmhos/cm, phosphorus concentrations averaged 20 mg/m^3 and total suspended sediments averaged 15 mg/l. The observed longitudinal gradients results because the East River flows into Graham Creek when the tide is high in Apalachicola Bay. Water leaving intensively managed forest lands had an average pH of 3.9, an oxygen level of 6.9 mg/l, and a color of 370 Pt-Co units. Specific conductance averaged 59 μmhos/cm, phosphorus averaged 6.7 mg/m^3 and total suspended sediments averaged 7.7 mg/l. Although these values are different from those in the stream, the amount of water discharged from the forest lands was insufficient to impact the overall limnology of Graham Creek during 1981. Water quality in the East River during back flowage has a greater impact on overall stream limnology.

Assistant Professor, IFAS, Center for Aquatic Weeds, University of Florida, Gainesville, Florida.

RIVERINE TRANSPORT OF NUTRIENTS AND DETRITUS TO APALACHICOLA BAY

John F. Elder

The Apalachicola River in northwest Florida is formed by the confluence of the Chattahoochee and Flint rivers and has a 19,200 square mile drainage system encompassing parts of Alabama, Georgia, and Florida. With an average discharge of 24,700 $ft.^3/s$ at Chattahoochee, Florida the Apalachicola is the largest river in Florida and ranks 21st in magnitude of discharge in the contiguous United States. The river falls 40 feet in its 107-mile course from Lake Seminole, at the Florida-Georgia state line to Apalachicola Bay at the Gulf of Mexico. Each winter and spring, its rising waters flood the adjacent wetlands for 3 to 5 months. The floodplain, which broadens downstream from one mile wide just below Lake Seminole to over seven miles wide near the mouth, is thickly forested with cypress, tupelo, and mixed hardwood trees, which thrive on the periodic inundation. At the end of its course, the river empties into the Apalachicola Bay, which is one of the most productive shellfish regions in the United States.

Inputs of nutrients and organic particulate matter (detritus) to the estuary are critical to the highly productive food web in Apalachicola Bay (Livingston, et al., 1974; Livingston and Loucks, 1979). It has been assumed, but not previously demonstrated, that most of the riverine yield of nutrients and detritus originates in the leaf litter and other organic material produced by the dense bottom-land hardwood tree community of the Apalachicola floodplain. Periodic flooding is the assumed mechanism for transporting nutrient material to the river and bay.

The Apalachicola River Quality Assessment was a project of the U.S. Geological Survey, designed to develop methods for studying large river-wetland systems and to apply them to the Apalachicola basin (Mattraw and Elder, 1980). The major purpose of the study was to assess the role of the river-wetland system in the flow of nutrients and detritus into Apalachicola Bay. The basic approach of the study has been to examine a number of features of the system which are critical to nutrient production and transport in the river. These features include: (1) waterflow characteristics in the river and floodplain and effects of waterflow on distribution of tree species on the 175 square mile floodplain (Leitman et al., 1982); (2) production and decomposition of forest litter fall from floodplain vegetation (Elder and Cairns, 1982); and (3) transport of nutrients and detritus (organic particulate matter) in the river and tributary channels.

Hydrologist-Limnologist, Water Resource Division, U.S. Geological Survey, Tallahassee, Florida.

The relation between the river system and the bay contributes directly to the economic welfare of Franklin County. Substances which feed the biological productivity of Apalachicola Bay are transported by the river in two basic forms: dissolved and particulate. Although total flux of dissolved nutrients may far exceed that of suspended organic particulate matter (detritus), the latter plays an important role in sustaining estuarine productivity. In the Apalachicola Bay, detrivores occupy key positions in the food web (Livingston et al., 1974). The blue crab (Callinectes sapidus Rathbun), shrimp (Palaemonetes pugio and Penaeus setiferus), and the American oyster (Crassostrea virginica Gmelin) form the basis of an economically important shellfish industry. The pulses of freshwater from the river also discourage predation by oyster drills (Labyrinthomysa marina) (Menzel et al., 1966).

Hydrologic measurements coupled with water-quality analyses during 1979-80 provided data for assessment of the water budget and nutrient transport in the Apalachicola drainage system. Discharge in the Apalachicola River fluctuated by a factor of 10 from the low flow of 1979 to the 1980 spring flood. During the summer and autumn of 1979, the low-flow base level was approximately 14,000 $ft.^3/s$. Peak flow in the 1980 flood was 136,000 $ft.^3/s$. Flood events which inundate all or nearly all of the floodplain occur annually, except in very infrequent dry years. These floods provide considerable potential for transport of vegetative products from the floodplain to the river channels.

The organic carbon yield from the Apalachicola system during the one-year period of June 3, 1979 to June 2, 1980 was 240,000 tons (Table 1). Over half of this amount was transported during the 86-day spring flood period. The flood was especially important for particulate carbon transport, producing approximately 60 percent of the annual total. The measurements of phosphorus loads showed similar effects of the flood. Unlike carbon and nitrogen, however, phosphorus occurred primarily in particulate form.

Possible sources of nutrients and detritus in the Apalachicola system include: (1) inflow from Lake Seminole at the headwaters of the river, (2) groundwater and surface water inflow, (3) atmospheric input, (4) point source pollution, and (5) productivity of the floodplain forest. Data from the Apalachicola River Quality Assessment indicate that the first and fifth sources are the most important. The floodplain source is potentially very large: production of organic carbon in litter fall is nearly 4×10^5 tons per year, which, if totally flushed into the river channels, would increase total organic carbon concentration by 7 mg/L (Elder and Cairns, 1982). Actual nutrient yield from the floodplain is probably less than this maximum level because much of the production is recycled within the floodplain ecosystem.

In short, it appears that inputs of carbon, nitrogen, and phosphorus to the estuary from the river are highly dependent on annual flooding and the productivity of forest litter. The nutrient budget suggests that the floodplain can, at different times, act as either a source or a sink for dissolved nutrients, but on an annual basis, it is an important source of particulate material. Seasonally dependent detrital carbon is especially important to sustain the estuarine food web in Apalachicola Bay.

Table 1: Mass Transport of Dissolved and Particulate Nutrients During One Year (1979-80) and During the Flood Season of That Year*

	Organic Carbon		Nitrogen		Phosphorus	
	D**	P***	D	P	D	P
Transport in one year (June 3, 1979-June 2, 1980)	207	33	18.5	5.1	0.55	1.27
Transport during 86-day flood (March 9-June 2, 1980)	109	20	9.9	1.4	0.29	0.74
Percent annual load transported during flood	53	60	54	27	53	58

*All transport data from Sumatra sampling site (River Mile 21) are given in thousands of English tons.

**D - Dissolved.

***P - Particulate.

Literature Cited

Elder, J.F. and D.J. Cairns. (1982). Production and Decomposition of Forest Litter Fall on the Apalachicola River Floodplain, Florida. U.S. Geological Survey Open File Report 82-252, 73 pp.

Leitman, H.M., J.E. Sohm, and M.A. Franklin. (1982). Wetland Hydrology and Tree Distribution of the Apalachicola River Floodplain, Florida. U.S. Geological Survey Open File Report 82-251, 92 pp.

Livingston, R.J., R.L. Iverson, R.H. Estabrooks, V.E. Keys, and John Taylor, Jr. (1974). Major features of the Apalachicola Bay System: Physiography, Biota, and Resource Management. Florida Scientist 37 (4): 245-271.

Livingston, R.J. and O.L. Loucks. (1979). Productivity trophic interactions, and food-web relationships in wetlands and associated systems. In: Wetland Functions and Values: The State of Our Understanding. National Symposium on Wetlands, Lake Buena Vista, Florida, 1978, Proceedings, pp. 101-119.

Mattraw, H.C., Jr. and J.F. Elder. (1980). Nutrient Yield of the Apalachicola River Floodplain, Florida: River-Quality Assessment Plan. U.S. Geological Survey, Water Resources Investigation 80-51, 21 pp.

Menzel, R.W., N.C. Hulings, and R.R. Hathaway. (1966). Oyster Abundance in Apalachicola Bay, Florida in Relation to Biotic Associations Influenced by Salinity and Other Factors. Gulf Research Reports 2(2): 73-96.

RESEARCH AND RESOURCE PLANNING IN THE APALACHICOLA DRAINAGE SYSTEM

Robert J. Livingston

Introduction

For over a decade now, the Apalachicola estuary has been subjected to an intensive, long-term, multidisciplinary study by various state and federal agencies. Many of the results have been applied to various planning and management efforts throughout the Apalachicola basin. The natural benefits of this highly productive system remain uncontested. The problems concerning the application of scientific principles of broad-based management efforts remain considerable. However, it is possible that planning efforts that require multidisciplinary, long-term information cannot be directly applied to resource management questions because of the fragmented nature of current environmental management practices.

Science and Management: Applications

The lower Apalachicola drainage system represents one of the most thoroughly understood bodies of water in the world. Various researchers are currently involved in a wide range of studies. Our Florida State University (FSU) research group is just completing 12 years of continuous field studies in the lower river and estuary. The long-term scientific data have been applied to local problems such as pesticide use, aquatic weed control, shoreline development, and other forms of human activity around the bay. Initial studies provided information concerning the ecologically critical habitats within the drainage system. Certain macrohabitat and physiographic features were shown to be important for specific forms of estuarine productivity. The Apalachicola River, the upland wetlands (including the Tate's Hell Swamp), and the barrier islands all shaped the particular estuarine resource through activities that involved the hydrologic regime, nutrient structure, and physicochemical environment (salinity, water quality). Such habitat features, together with specific physical conditions--temperature, wind, tidal fluctations--provided the appropriate environment for the observed seasonal and annual progressions of key estuarine populations. Through contact with public officials, state and federal administrators, and leaders of private industry, the research base was channeled into the user domain in diverse ways so that local and regional environmental problems have usually been resolved in an objective manner.

Based on the scientific data, thousands of acres of wetlands and the barrier island system have been purchased by state and federal agencies as preservation areas. Such purchases include the lower river valley, most of the estuarine wetlands, and the bulk of the three barrier islands. A strong comprehensive land use plan has been developed by Franklin County, which concentrates to a considerable degree on the estuary. The county's plan was based on the long-term studies.

Professor, Department of Biological Science, Florida State University, Tallahassee, Florida.

In 1979, the Apalachicola River and Bay Estuarine Sanctuary was established, the largest such sanctuary in the United States (almost 200,000 acres). Thus, the lower Apalachicola valley was set aside, by law, as a natural field laboratory "for long-term scientific and educational purposes." The sanctuary has become the focal point of new management initiatives in the Apalachicola Bay system. A valley-wide planning effort is currently under way to develop a regional approach to the management of the Apalachicola resource. An educational program is being organized to disseminate established scientific facts to all levels of the local school systems. Thus, through a series of projects that coordinated and sustained the efforts of various local, state and federal agencies to develop a management program, the scientific data were used to determine the status and dimensions of the resource and to apply such findings to on-going resource problems in a relatively organized fashion. The results of this effort would substantiate the value of long-term, multidisciplinary field programs (i.e., the holistic approach) and the integration of such scientific efforts with the activities and needs of various user groups at all levels of society. When this approach is taken, little difference exists between "pure" and "applied" science since an understanding of impact (and, consequently, management application) is based on an objective base of scientific fact.

Future Problems

While much of the management program for the Apalachicola system has been positive, with active cooperation among various local, state and federal agencies, there are still serious problems that have eluded constructive action. Municipal use of fresh water in urban areas such as Atlanta, Georgia, could seriously reduce the overall river flow of the Chattahoochee and Apalachicola Rivers over the next 20-30 years. Already, toxic agents such as heavy metals have been released in various parts of the system. Battery plant operation and metal contamination in the Chipola river drainage area have highlighted what is now a growing problem in the tri-river area. Dredging and habitat destruction along the Apalachicola river continue unabated, with almost continuous addition of more structural changes to enhance barge operations. The use of pesticides for agriculture is also an, as yet, undetermined problem. As more people move into the valley, municipalization will become an increasing threat to the natural resources, especially in environmentally sensitive areas, such as the river flood plain and the barrier islands.

The above problems will continue to grow as population pressure increases in the south Georgia/north Florida region. Whether or not the natural resource base can be maintained in what is now a multiple-use system is problematical. New approaches to management will be needed as the area develops, and a progressive, holistic approach to resource protection is badly needed during this important period of transition.

AQUACULTURE POSSIBILITIES

Robert M. Ingle

Highly detailed studies of Apalachicola Bay and its fauna have been made intermittently since the latter part of the last century. Many of those, if not most, were in some way related to oysters. The latest full-scale investigation was carried out in the world's first pilot plant, eleven miles west of the city of Apalachicola, directed toward the problems and efficacy of artificially feeding and fattening oysters. Powdered cornmeal was used as food.

The project was highly successful in that substantial fattening and concomitant quality enhancement were shown to be obtainable within one to two weeks of artificial feeding. But in the economic context of the period (1979-81), the benefits of the process did not outweigh the cost. Therefore, at this time, this aspect of oyster cultivation is not a viable adjunct for the industry, even though it was shown that at very high summer water temperatures, typical loss of vigor can be reversed and growth accelerated.

Results of many other studies offer great promise, however. The basic biology of the American oyster in Florida waters offers many advantages to private cultivators. The impediments to leased bottoms and their private management do not lie with the animals but with the attitudes of the members of the industry. With few exceptions, the advantages of private cultivation have largely been ignored. The extensive knowledge developed in the past to aid private growers has not been utilized. Nor is the futility of past investigations restricted to oysters. Detailed studies of blue crabs and three species of shrimp have also been largely ignored in management and production of these species.

Obviously, the fishing industry and the governmental entities responsible for the best and wisest use of these resources have not taken advantage of available knowledge. The greatest need, therefore, is to bring seafood production and administration up to the state of the art, and the promotion of additional research in this area now seems to be open to question. Certainly more knowledge is always a plus, but at this time utilization of the expertise available should be the highest consideration, especially since funds are limited.

The obvious first step in bringing about needed advances is a strong and sustained public information program. Relevant fisheries educational material should be a prominent part of the curriculum of all levels of formal school instruction, and strong, perhaps innovative, methods should be used to bring progressive fishery production and management concepts to the adult population.

Founder, Adelanto Corporation, Apalachicola, Florida.

OYSTER REEF CONSTRUCTION AND RELAYING PROGRAMS

Charles R. Futch

Early research by R. M. Ingle unquestionably demonstrated that oyster reefs could be effectively constructed or rehabilitated by placing dead oyster shell in patterns and profiles resembling natural reefs in areas amenable to oyster growth. The Florida State Board of Conservation, this agency's predecessor, began a program of reef construction in Apalachicola Bay under Mr. Ingle's direction. This program has continued, benefitted by a statute providing that all shucked oyster shell is the property of the State for use as cultch. Although such reef construction has taken place in 10 counties statewide, most of the work has been in Apalachicola Bay. Since 1949, over 750 acres of reefs have been constructed in Apalachicola Bay. Whitfield and Beaumariage (1977:134) estimate that half of the Apalachicola Bay production comes from Department constructed reefs.

Procedurally, shells are loaded onto a barge, and "blown" off with a high pressure water hose. Because of rapid oyster growth on such reefs, harvesting around the edges may begin at 18 months (or earlier) and the reef may be in full production within two years (Ingle and Dawson, 1952, 53; Whitfield, 1973). Such reefs, when mature, may yield as many as 400 bushes per acre per year (Whitfield and Beaumariage, 1977).

Whitfield (1973) listed statewide oyster reef planting activities from 1949 through 1971. Table 1 describes subsequent reef planting activities.

Removal of oysters from polluted areas to areas of good water quality for purification is justifiable in terms of public health considerations and wise resource management. Likewise, removal of small intertidal oysters to areas more hospitable for growth and survival is a good management practice. In the last decade, five public oyster relaying projects have received legislative approval, and appropriations, for the Cedar Key--Horseshoe Beach Area in Dixie and Levy Counties near the mouth of the Suwanee River. Participants were paid a per-bushel wage to move oysters from polluted areas and/or tops of intertidal reefs to gaps of deeper water throughout the reefs. Hepburn et al. (1977), in a study of that year's planting, concluded that: "From a biological standpoint the planting has been highly successful, and there is no reason why the planting would not be commercially successful also." From these modestly-funded ($25,000 - 50,000) projects, came the 1982-83 appropriation of $300,000 for relaying oysters in Apalachicola Bay, and adjacent Wakulla County.

Assistant Director, Division of Marine Resources, Florida Department of Natural Resources, Tallahassee, Florida.

Table 1. Oyster reef planting activities of the Florida Department of Natural Resources, 1972-1981.

YEAR	LOCATIONS	BUSHELS	TOTAL BUSHELS
1972	Green Point, Apalachicola Bay, Franklin County.	38,808	
	Cabbage Top, Apalachicola Bay, Franklin County.	30,576	
	East end of Paradise Flats by St. Vincent Island in Apalachicola Bay, Franklin County.	137,592	
	6 Mile, St. Vincent Sound, Franklin County.	5,880	
			212,856
1973	East end of Paradise Flats by St. Vincent Island in Apalachicola Bay, Franklin County.	43,848	
	South of Gorrie Bridge, West of Eastpoint in Apalachicola Bay, Franklin County.	124,680	
			168,528
1974	Off Green Point in Apalachicola Bay, Franklin County.	127,176	127,176
1975	Off Green Point in Apalachicola Bay, Franklin County.	111,216	111,216
1976	Indian River, Pineda Causeway on North Side, Brevard County.	20,280	
	Bull Bayou, Bay County.	5,040	
	East Bay, approximately 700 yards N.W. of light #8 West of Allanton off Murray Point, Bay County.	14,616	
			39,936
1977	Cat Point, South of second fill on Gorrie Bridge, Franklin County.	60,528	
	Plover Point in Indian River about 1 mile North of Pineda Causeway, Brevard County.	17,200	
	Bull Bayou, approximately 6 miles East of previous plant site, Bay County.	6,648	
	East Bay off light #25 close to California Bayou, Bay County.	76,060	
			160,436

Table 1. (CONT.) Oyster reef planting activities of the Florida Department of Natural Resources, 1972-1981.

YEAR	LOCATIONS	BUSHELS	TOTAL BUSHELS
1978	Off Rock Point in Malabar Area where old U.S. 1 joins new U.S. 1, abut 200 yards off shore, Brevard County, using scallop shells.	16,800	
	Off Green Point in Apalachicola Bay, Franklin County.	223,052	
			239,852
1979	1/2 mile West of causeway, Bryant Patton Bridge in Apalachicola Bay, Franklin County.	137,880	
	Indian Lagoon, Gulf County.	31,680	
	Bull Bayou, Bay County.	19,488	
			189,048
1980	North-northwest of St. Vincent Point, South of 6-mile off Cabbage Lumps, Franklin County.	96,240	
	North of Green Point on extreme end of former plant site within piling markers, Franklin County.	29,352	
	East end Bull Bayou in East Bay, Bay County.	89,840	
	Salt Run, East Side, St. John's County.	2,568	
			218,000
1981	North-northwest off St. Vincent Point, South of 6-mile off Cabbage Lumps, Franklin County.	117,000	
	Rattlesnake Cove, Apalachicola Bay, St. George Sound, Franklin County.	66,528	
	North of Green Point on extreme end of former plant site within piling markers, Franklin County.	5,016	
			188,544
		TOTAL	1,655,592

The Department contracted with the Wakulla County Commercial Fisherman's Association and the Franklin County Seafood Workers' Association to assist in informing the local industry of the project, to assist in selecting harvest and relay areas, and be responsible for paying project participants. Participants were encouraged, but not required, to use "standard" fish boxes for measuring and transporting oysters. The "standard" fish box holds two "bushels" of shellstock. In Florida a "bushel" of oysters is not necessarily the 2,150.42 cubic inch Winchester bushel in common usage, but consists of approximately 60 pounds of shellstock. Loads of oysters were brought to the relaying site and number of bushels were counted by Department personnel. After oysters were spread on the bottom, participants were issued a receipt. The Associations each received a copy of individual receipts to develop a weekly billing statement, and the Department retained a copy for verification of billing statements. Each Association was paid $1.07 per bushel delivered; $1.00 per bushel was paid to project participants and the Associations retained $0.07 per bushel for their services.

In Wakulla County, oysters were removed from two Prohibited Areas, the mouth of Spring Creek and the Purify Creek vicinity. Transplanting sites included gaps in and around Carter Bar, and the north tip of Piney Island. Approximately 13,200 bushels were moved from the Spring Creek area and placed in gaps around Carter Bar; the remainder, about 31,300 bushels, were transplanted at the Piney Island site. This project was completed on 22 July 1982.

In Franklin County, about 41,000 bushels were moved from the Prohibited Area adjacent to Eastpoint and transplanted to an Approved area approximately one-half mile offshore. Enough money remains to transplant an additional 181,000 bushels in Franklin County. The project will not recommence until the late winter/early spring episodes of high river stage and resultant elevated fecal coliform abundances force temporary closure of the Apalachicola Bay harvesting areas. The relaying project will temper the economic effects of such temporary closures. The contract between the Franklin County Seafood Workers' Association has been subsequently amended to allow transplanting of intertidal oysters from Approved areas. Preliminary observations indicate abundant oyster resources near Rattlesnake Cove to the east and the 13-mile area to the west.

Literature Cited

Hepburn, M. J., R. C. Glassen, W. Menzel, and J. A. Paredes. (1977). The Cedar Key oyster relocation and demonstration project--1977. Final Report submitted to DNR. 103 p.

Ingle, R. M. and C. E. Dawson, Jr. (1952). Growth of the American oyster Crassostrea virginica (Gmelin) in Florida waters. Bull. Mar. Sci. Gulf Carrib. 2(2):393-404.

__________. (1953). A survey of Apalachicola Bay. Fla. State Bd. Conserv. Tech. Ser. No. 10. 39 p.

Whitfield, W. K., Jr. 1973. Construction and rehabilitation of commercial oyster reefs in Floirda from 1949 through 1971 with emphasis on economic impact in Franklin County. Fla. Dept. Nat. Resour. Mar. Res. Lab., Spec. Sci. Rep. No. 38. 42 p.

Whitfield, W.K., Jr. and D. S. Beaumariage. (1977). Shellfish management in Apalachicola Bay. Past--Present--Future. Pp. 130-140. In: Proceedings of the Conference on the Apalachicola Drainage System, R.J. Livingston and E.A. Joyce, Jr., eds. April 23-24, 1976, Gainesville, Florida. Fla. Mar. Res. Publ. No. 26. 177 p.

ALTERNATIVES FOR THE SEAFOOD INDUSTRY

W. Steven Otwell

The harvestable waters in Franklin County represent only 14 percent of the total approved and conditionally approved acreage for harvesting shellfish in Florida. This small area yields approximately 90 percent of the state's total annual oyster landings, which provided a 1981 dockside value of 6.5 million dollars from Franklin County alone. The importance of this resouce to the state is obvious and is essential to the local economic welfare of oystermen, processors and associated communities. Surrounded by national and private forests, and amidst the recently formed Estuarine Sanctuary, which restricts certain industrial development, Franklin County's economic alternatives are limited and remain primarily dependent on local fisheries.

Oystermen and processing firms about the Apalachicola Bay are becoming increasingly concerned about the economic welfare of their industry. Production data reveals the Bay has yielded record harvests every successive year since 1977, through 1981 (Figure 1). In 1977, the Bay was first opened to allow summer oyster harvest in June through August. Since the initial summer season, the summer oyster landings have increased from 6.6 percent to nearly 20 percent of the total annual Bay oyster production. Concerned opinions believe the summer season has lead to over fishing due to the increased harvest time and a larger fishing effort attracted by a continuous 12 month season. Counter opinions suggest the Bay productivity has increased and a summer season offers harvest of oysters which would otherwise be lost to natural mortalities. Regardless of the summer harvest, experienced opinions note a decreasing oyster size and increased fishing effort for less harvest. Increasing harvest pressure and decreasing producton suggest the Bay oyster resources are threatened. This concern is supported by preliminary statistics which indicate a substantially decreased harvest during the first half of 1982. Unfortunately, there is no data to substantiate claims of altered productivity and/or over fishing, but at best, under the prevailing conditions, the Bay appears to have reached or will soon reach a production limit.

Faced with limited production, the oyster industry must consider plans which offer continued growth in value and employment. Discussing alternatives relative only to the primary fishing industry, future plans must address three concerns -- assuring existing production, enhancing the value of current production, and initiating new production opportunities.

Assuring Existing Production

Initial efforts must minimize the threats to existing production. The major threats are pollution, overfishing, and certain natural factors most of which are uncontrollable. Pollution is controllable assuming there is local support and funds to finance the effort. A primary culprit is existing wastewater treatment facilities. On-going efforts to resolve these problems should remain a highest priority.

Extension Seafood Specialist, Florida Sea Grant College, IFAS, Department of Food Sciences and Human Nutrition, University of Florida, Gainesville, Florida.

The question of overfishing must be addressed with more current data. What is the current productivity of oysters in Apalachicola Bay? Measuring primary production indicators, i.e. spat formation, and monitoring fishing effort and yields (oyster size) is recommended. The consequence could be more regulatory enforcement and legislation. Enforcement and self-regulation of size limits at the processing level is in the best interest of the entire industry. Future considerations to control fishing effort may be closed seasons, bag limits, specified harvest time, limited permits, etc. Closed seasons and specified harvest time seem fair for all concerned, easier to enforce and offer additional quality benefits if used to avoid thermal abuse of the harvest. No further regulations are recommended without data to substantiate need and record benefits.

The detrimental influence of certain natural factors (weather, diseases, predators, pollutants) seem best suited for academic interest which can be integrated with the purpose of the Estuarine Sanctuary and structured to assist the regulatory scheme of responsible agencies. Resolution of these natural problems should have a lower priority to pollution and overfishing.

While addressing threats to production, plans should include programs to stabilize or increase oyster production in the Bay. An improved oyster planting program is paramount. Proper financing and efficiency must be encouraged by the respective industry associations. Which method of shell planting is most successful in Apalachicola Bay? Is data available to map existing substrata and currents to help select planting sites? Would private contracts to perform actual shell collection and planting be more efficient and successful, and elevate the pressure of limited state labor?

Private involvement should be further encouraged by revitalizing the oyster leasing procedures. Experienced lease programs in other states have provided boosts to oyster production. A review of existing progams and potential options and methods of administration in Florida should be prepared by an independent group for comment by the industry and respective regulatory agencies. Detrimental aspects of leases, both legal and biological must be included in the review.

Finally, the potential benefits of relaying, depuration (land based) and aquaculture should remain considerable, but ranked with lower priority. These latter alternatives can increase production, but the economic and long term benefits are questionable. Also, these alternatives conclude pollution is inevitable and should be circumvented rather than prevented.

Enhancing Value of Production

Assuming a certain production limit, efforts should be directed to enhance value. All major food producing industries attempt to enhance the value of their product through new and more efficient processing concepts. For the oyster industry new processing concepts means new product forms or packaging. For example, an oyster breading operation could be started in Franklin County to enhance the value of the smaller oysters. Benefits could be increased product value, additional revenue from out-of-state sales, and more employment. New jobs would be important as alternatives for other depressed fishing activities. Steam shucking represents a more efficient processing concept. Studies at the University of Florida's Department of Food Science and Human Nutrition have shown that steam tunnels to aid hand shucking operations can increase daily production by 30 to 40 percent without replacing labor and providing additional income for the processor and individual laborer. Other concepts like automated sorting of shucked oysters, controlled and attractive packaging, etc. should be investigated by the industry in company with academic and private programs.

The economic reality of these new processing options could be realized through the revitalized 'Fisheries Obligation Guarantee Program.' This financial program offered through the U.S. Department of Commerce (NMFS) is now being formulated to authorize Federal guaranteed financing on the dept portion of the cost for construction, reconstruction, reconditioning or (under limited circumstances) purchase of fisheries shoreside facilities. Specific conditions for this financing are now undergoing comment. Competition for these limited funds will be extremely keen, but this option should be explored by the oyster industry on the foundation of new processing concepts rather than perpetuating existing conditions.

New processing efforts must, in turn, be linked with improved marketing efforts. Assistance from established marketing programs has been essential and effective, but new efforts must go beyond posters and demonstrations. The industry must initiate a common bond to help themselves rather than depend on government assistance to market their products. What has the local industry associations in Franklin County done to promote the image and sales of Apalachicola Bay oysters? If they do not know what to do, then now is the time to ask and participate financially and in person. Remember oyster quality, especially size, water content and bacterial grade are a reflection on the reputation and marketability of the Apalachicola Bay oyster.

New Production Opportunities

Use of non-traditional resources offers potential for increasing total seafood production and value, as well as offering new and alternate employment. Local latent resources include nearshore options, i.e. soft crabs, clams, etc. and offshore species, i.e. deep sea crabs, bulldozer lobsters, etc. No doubt these ventures are questionable, but with the increasing demand for seafood, and the eminent production limit for traditional species, all resources should be explored.

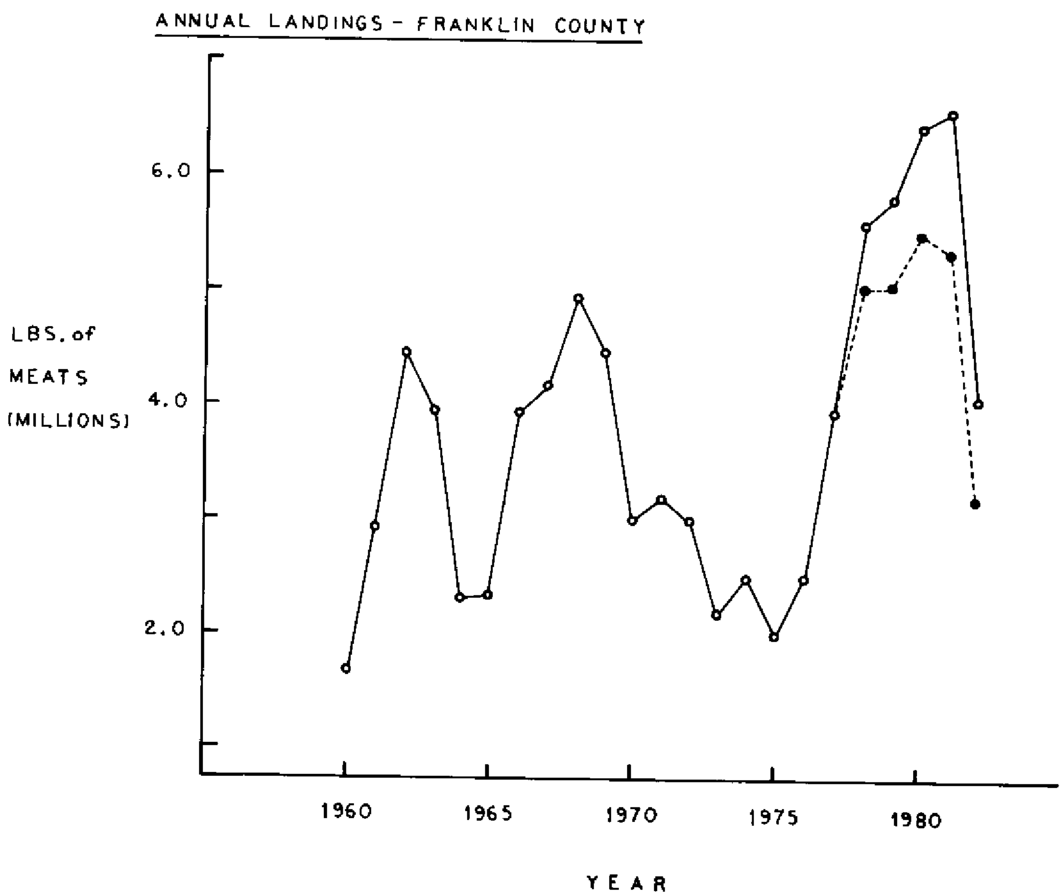
Currently, soft crab production seems the most feasible. Despite annual fluctuations, Franklin County has produced over 1,500 pounds of hard blue crabs per year. If only 2 percent of this production could be directed to soft crab production it could provide an additional 150 thousand dollars for the annual county dockside landings. Investments to initiate a soft crab fishery are small relative to other fisheries, but require experience in harvest and production. In contrast, a potential deep sea crab fishery would require more expensive gear and extended fishing time in deep water. Success of these ventures remains in question but deserves industry support for investigations. Although the opportunities are not immediate, they represent an integral part of planning for the future, especially when realizing the future seems sure for limited production of existing fisheries.

Conclusion

It is easy to point to the existing problems and construct a list of recommendations. The difficult challenge is instigating and following a plan of action. Hopefully this paper will provide some direction for a plan. The industry must remember the success of any plan will depend on their support and cooperation with the respective regulatory agencies, developing fishery management efforts, the Estuarine Sanctuary, and academic programs. The industry must represent themselves by challenging these groups to insure the stability and assist the development of their fisheries. Ask the regulatory agencies if they are performing in the best interest of the consumers and industry, or under the best conditions relative to existing funds and political pressures. Ask the Estuarine Sanctuary if they can carry out their primary purpose, "education and research . . . to encourage multiple uses as long as its compatible", while recognizing and assisting the traditional fisheries within their jurisdiction. Also ask the academic studies to realize more application of their work to the existence of the Bay fisheries. Finally, ask yourself, are your values and commitments sufficient to help yourselves and the economic welfare of the dependent communities in Franklin County?

FIGURE 1

ANNUAL OYSTER LANDINGS IN FRANKLIN COUNTY, FLORIDA
(Note: dashed line represents landings without the summer season)



THE VIRGINIA OYSTER INDUSTRY

Dexter S. Haven

Introduction

Virginia, once the leading oyster producer in the United States, has, since 1961, experienced a major decline in production. To fully understand the nature of the decline we must first recognize the dual nature of Virginia's industry.

The Public and Private Sectors

The natural oyster bottoms in Virginia were set aside by legislative action in 1894. Additions have been made since, but any reduction must be accomplished by legislative action. Today, there are about 243,000 acres of public bottom administered by the State. They contain most of the areas which are naturally productive. They also contain large areas which are not naturally productive, but which potentially are excellent growing areas.

Bottoms located outside the designated public bottoms may be leased from the Virginia Marine Resources Commission (VMRC) by individuals or companies for renewable periods of 20 years. The annual leasing fee in the Bay is $0.75 per year and in the estuaries $1.50. Today about 110,000 acres are leased. Typically, leased bottoms are not naturally productive, as are many public bottoms, and must be planted with seed oysters to make them productive. For the last 100 years from 70 to 80 percent of this seed has been tonged from the public bottoms in the James River. The result is a dependence of the private sector for seed oysters on the public areas.

The Decline in Oyster Production

A major decline in oyster production began in the lower Chesapeake Bay in 1960 when the oyster pathogen MSX (*Haplosporidium nelsoni*) entered the Lower Bay and other East Coast estuaries. MSX virtually eliminated oyster culture in areas where fall salinities exceed at 15 ^{o}/oo (Andrews, 1967). MSX is still a problem and will continue to cause mortalities in genetically susceptible seed stocks such as those from the James River.

Coincident with the onset of MSX there has been a decline in the intensity of the set of oysters in many areas. This has been especially severe in the state's most important seed areas (the James River). The cause or causes of this decline have not been determined.

Professor, Virginia Institute of Marine Science of the College of William and Mary, Gloucester Point, Virginia.

The statewide decline in oyster production since 1961 has been catastrophic. In the decade prior to 1960, annual production of oysters in Virginia averaged about 3.2 million Virginia bushels. Of this total, about 0.55 million came from the 243,000 acres of public bottom. In sharp contrast, 2.65 million bushels came from about 130,000 acres of leased bottoms. The leased bottoms produced nearly 5 times as many oysters as did the public bottoms and on fewer acres. This level of production occurred despite the fact that the public bottoms contain most of the natural seed stocks and naturally productive growing areas. During 1979-80, leased bottoms in Virginia yielded only 0.43 million Virginia bushels. In sharp contrast, the public grounds produced 0.61 million bushels. There was an initial decline on Baylor Grounds after 1960 but today production is slightly above the pre1960 level. (Haven, Hargis and Kendall, 1981).

Restoring Statewide Levels of Harvest

The present level of production can be increased, and the goal should be to restore it to the pre-1960 level. It may be done, with the least cost to the state, by encouraging or enhancing production by the private sector.

Some Socio-Economic Problems Causing a Decline in Production

The nationwide demand for oysters at the consumer level seems to have reached a plateau around the mid 1960s. This has been associated with many complex and interrelated factors including: 1) High costs of oysters to consumers, 2) poor quality of the final product, 3) poor marketing practices by chain stores and other retail outlets, and 4) change in food preference (Haven, Hargis and Kendall, 1981).

Private growers have been faced with major escalations in cost of labor, transportation, insurance, plant and marine equipment maintenance, vessel supplies and money in a period of nearly stable dockside prices. These factors have all reduced their margin of profit. As a consequence, many growers went out of the business and landings declined. The surviving growers are using only their best growing areas where yields (and profits) are maximal.

The public sector has experienced some of the same problems, and there has also been a decrease in repletion activities due to decreased state and federal funding.

Possible Solutions

Some of the more important remedial solutions, or needed reforms, follow. It is emphasized, however, that remedying any one aspect would not be enough; many changes are needed.

1. More cost-effective methods of oyster production are needed. Many corporations or individuals, as well as those managing the public sector, utilize techniques of growing and planting oysters which were in use 100 years ago. Many cost-effective techniques are now available for use but have not been widely adopted. Often their use is prohibited by regulations or by public opinion. Their use should be encouraged by modifying existing regulations when the new practice is compatible with sound conservation and management practices. For example, dredges could be used in some areas instead of

tongs. Mechanical oyster harvesters have been developed which need only minor modification prior to their use by industry. Gear has been developed for planting shell or seed more efficiently than the traditional method of shoveling it over the side or by washing it off the deck.

Machines for opening oysters have been developed but they need additional development. If such gear was perfected, then the savings in production could be large. Studies are needed to determine where improvements may be made.

2. A major problem constantly faced by industry is to maintain and improve, in some instances, high bacterial standards of the water in growing areas and in the final product.

3. Water content of the final pack has been the subject of much discussion in Virginia during the past few years. The need for a nationwide uniform standard has been recognized and one should be implemented.

4. Seed oysters are a major cost in Virginia in growing oysters. Any way that their cost could be reduced would benefit both the public and private sector.

5. There is a need to investigate the possible use of Viriginia's buried shell resource to increase production. Moreover, shell should always be planted on bottoms capable of growing oysters.

6. The possibility of increasing consumer demand by advertising, improved processing or packaging, and otherwise encouraging use by food vendors, restaurants, institutions, government agencies and housewives should be seriously considered.

7. Private growers in Virginia would greatly benefit if some of the presently unproductive or unused public bottoms were made available for leasing.

Changing Regulations or Laws to Enhance Production

The preceeding recommendations are considered reasonable, but often it is impossible to put them into action due to inadequate existing regulations or laws. Frequently, regulations are poorly written, or they apply to the industry as it existed 50 to 100 years ago; often they act to inhibit production. Such regulations or laws **MUST** be modified or changed if production is to be increased. For example, present regulations in Virginia need to be repealed or modified to clearly permit harvest of seed or market oysters using modern cost-efficient gear such as dredges or mechanical harvesters. Legislation needs to be enacted to enable the private sector to use some public bottoms. Attempts to do this have met with strong opposition.

Flexibility must be built into new regulations so that they are not carried forward into times when they are no longer wanted or needed by management.

In conclusion, one of the most needed remedial measures for Virginia and perhaps other states is the need for long range plans to enhance culture of oysters on leased and public bottoms.

Literature Cited

Andrews, J. D., and J. L. Wood. (1967). Oyster Mortality Studies in Virginia. VI. History and Distribution of Minchinia nelsoni, a pathogen of oysters in Virginia. Ches. Sci. 8(1):1-13.

Haven, D. S., W. J. Hargis, Jr. and P. Kendall. (1981). The Oyster Industry of Virginia: Its States, Problems, and Promises. The Virginia Inst. of Mar. Sci. Gloucester Pt., Va. VIMS Spec. Papers in Mar. Sci. No. 4.

THE APALACHICOLA BAY OYSTER INDUSTRY: SOME ECONOMIC CONSIDERATIONS

Fred J. Prochaska[1]
and
David Mulkey[2]

Introduction

The purposes of this paper are to provide an economic overview of the oyster industry and to assess the economic importance of the industry to the area and state. Statistics are limited for the most part to Franklin County since the county accounts for over 90 percent of Florida oyster production. The first section is a review of total marine landings. In section two, oyster production is considered over time and with respect to effort devoted to the fishery. The final sections are devoted to estimates of the total economic impact of the oyster industry on the area economy.

Commercial Marine Landings

Total value of commercial marine landings in Franklin County increased gradually from $1.5 million in 1960 to $2.7 million in the early 1970's (Table 1). After that time, value of landings increased rapidly to $12.0 million annually by 1980. Franklin County total landings accounted for 7 percent of both total quantity and value of Florida landings in the 1960-64 period. Franklin County's share was also 7 percent of total quantity in the 1976-80 time period but increased to 10 percent of total value of marine landings in Florida.

Shellfish are the primary type of marine products landed in Franklin County. In 1960 shellfish accounted for 70 percent of the value of Franklin County landings. By 1980 their relative contribution was 95 percent of total value. Shellfish landings have been responsible for nearly all of the trend in total value of landings. Shrimp and oysters are the most important species landed. During the 1960-64 period oyster production averaged 3.0 million pounds annually and accounted for 22 percent of the total quantity landed and 43 percent of commercial fisheries value in Franklin County. Average oyster landings increased to 4.8 million pounds valued at $3.9 million during the 1976-80 period. Oysters, as a percent of total county volume landed, increased to 41 percent, but the relative share of total value declined to 36 percent. The decrease in relative importance in value of county landings was due to an increase of 63 percent in county shrimp landings and considerable increases in shrimp prices. Value of shrimp landings averaged 53 percent of total value of marine landings in Franklin County during 1976-80 (up from 33 percent during 1960-64).

---

[1]Professor, IFAS, Department of Food and Resource Economics, University of Florida, Gainesville, Florida.

[2]Associate Professor, IFAS, Department of Food and Resource Economics, University of Florida, Gainesville, Florida.

Table 1. Commercial Marine Landings and Number of Oystermen, Franklin County, 1960-1981.

Year	Total Fish		Total Shellfish		Total		Oysters		Fishermen
	lbs.	dols.	lbs.	dols.	lbs.	dols.	lbs.	dols.	No.
1960	11.7	.5	6.6	1.1	18.3	1.5	1.7	.4	317
1961	7.6	.4	7.2	1.6	14.8	2.0	2.9	.9	390
1962	4.3	.4	6.7	1.9	11.0	2.3	4.4	1.2	595
1963	4.7	.4	7.0	1.8	11.8	2.2	3.8	1.1	562
1964	5.1	.5	6.5	1.6	11.6	2.1	2.3	.6	550
1965	5.2	.5	6.3	1.7	11.5	2.1	2.3	.8	510
1966	10.3	.5	6.1	1.7	16.5	2.2	3.8	1.2	539
1967	2.5	.3	6.8	1.8	9.3	2.1	4.2	1.3	576
1968	10.6	.4	8.4	2.7	19.1	3.1	4.8	1.5	570
1969	5.0	.3	6.7	2.4	11.8	2.8	4.4	1.6	536
1970	2.4	.3	6.8	2.4	9.1	2.7	3.0	1.2	471
1971	2.2	.3	6.1	2.5	8.2	2.7	3.2	1.4	477
1972	2.1	.3	7.4	3.1	9.4	3.4	3.0	1.4	406
1973	2.2	.3	6.9	4.0	9.2	4.3	2.2	1.3	389
1974	1.4	.3	7.9	4.2	9.3	4.6	2.5	1.4	369
1975	1.7	.4	9.0	6.1	10.7	6.5	2.0	1.1	296
1976	1.5	.4	9.7	7.8	11.2	8.3	2.5	1.6	347
1977	.9	.3	9.8	9.2	10.7	9.5	3.9	2.9	519
1978	1.1	.3	11.9	12.5	12.9	12.8	5.6	4.3	605
1979	1.3	.6	9.9	10.5	11.2	11.1	5.8	4.9	694
1980	1.6	1.0	11.2	11.1	12.8	12.0	6.4	5.7	734
1981							6.6	6.5	733

SOURCE: Florida Landings, National Marine Fisheries Service, U.S. Dept. of Commerce, Annual Issues and Personal Communications, E. Snell, NMFS, Miami, Florida.

Other species of importance in the county are blue crab, grouper, black mullet and red snapper. These species plus oysters and shrimp accounted for 94 percent of total landings in recent years. There has been, however, a considerable decline in quantity of black mullet, grouper and red snapper landed while total value of each has increased due to increased prices.

Franklin County Oyster Production

Oyster production generally increased from 1960 through 1968 with the exception of low production years in 1964 and 1965 (Table 1). In 1960, 1.7 million pounds were landed. By 1968 annual production was reported at 4.8 million pounds. After 1868, landings trended downward reaching a low of 2.0 million pounds in 1975. After 1975, the trend has been upward. Landings in 1981 were a record of 6.6 million pounds.

Variations in value of oyster landings were less erratic on an annual basis because of offsetting price changes and an overall upward trend in prices. Prices increased from 25 cents per pound in 1960 to 55 cents in 1975. During this period, value of landings increased from approximately $.5 million to $1.25 million. Prices then increased rapidly to 98 cents per pound, and total value of oyster landings increased to $6.5 million in 1981. Value of oyster landings exceeded the value of shrimp landings prior to 1971 and again in 1980 and 1981 in Franklin County.

The number of oystermen in Franklin County varied widely during the past 22 years. After reaching a high of 595 in 1962 the number of oystermen declined to a low of 296 individuals by 1975. The number of oystermen again began to increase in 1976 and reached a high of 734 in 1980.

Oyster production in terms of pounds per man increased at an annual rate of 114 pounds over the past 21 years in Franklin County. Average value per man increased at an increasing rate because both pounds per man and prices have increased. In 1967, the average value increased by $138 per man per year. In 1975, the increase was $506 per man, and in 1981, average value per man increased by $782 per year.

There is a strong positive relationship between effort and oyster landings in Franklin County. An effort-yield model was estimated for the 1960-81 time period. Pounds of oysters landed in each year were statistically related to the number of oystermen in each year and the cumulative bushels of oyster shells planted in Franklin County. Oyster shell plantings were lagged two years to allow time for establishment of commercial production. That is, landings in one year were related to the shell plantings two years before the year in which landings were recorded. Oyster shell plantings reached a total of 554,858 bushels by 1960. Between 1960 and 1981 an additional 3,847,829 bushels had been planted. Abnormal production in 1964 and 1965 was accounted for with a dummy variable. The regression model explained 95 percent of the variation in annual oyster landings in Franklin County. The model showed that an increase (decrease) of one oysterman would increase (decrease) total county landings by 10,239 pounds (Students-t-statistic equaled 16.90). The shell-plantings effect indicated a 100 bushel increase in plantings would result in increased production of 13 pounds of oyster meats two years later and each year thereafter (t-statistic equaled 2.20).

This analysis suggests a relatively healthy oyster industry within the range of historical effort. Wide variations in landings are accounted for by variation in the number of oystermen. In addition, the plantings of oyster shells has been shown to have a significant impact on landings. The analysis does not, however, suggest oyster landings can be increased indefinitely simply by increasing the number of oystermen and/or shell plantings. Additional analyses are necessary to determine the maximum sustained yield. The model does suggest that annual variations can be large for environmental reasons independent of the number of oystermen or shell plantings. The model showed a decline in oyster landings of 1.6 million pounds annually for 1964 and 1965. The literature mentioned a hurricane in 1964 and silting of oyster beds in 1965.

Fisheries: An Export Industry

As we note from previous discussion, fisheries in general and oysters in particular represent a major source of economic activity in Franklin County. In 1980, Franklin County alone produced over 6.4 million pounds of oysters with a dockside value of $5,739,207. The economic impact of this catch, however, extends far beyond this value.

Fishing is an "export" industry for Franklin County and the larger Apalachicola Bay region, in that, practically all industry sales are outside the region. These external sales (direct impacts) bring money into the region, and respending of these dollars for labor and other production inputs generates sales for a variety of local businesses (indirect impacts). In addition, the direct and indirect purchases generate local income (wages, salaries, rents, profits, etc.), a part of which is spent locally generating additional economic activity (induced impacts).

Export sales then trigger a chain reaction throughout the local economy termed the "multiplier" effect. Estimated multipliers for gross sales for four different local regions are presented in column 1, Table 2. The sales multipliers measure the total sales impact in the local economy per dollar of external sales. For example, the Franklin County multiplier of 1.41 means that a $1.00 external sale (direct impact) generates an additional $0.41 in local sales (indirect and induced).

The multipliers allow some preliminary estimates of the economic impact of the Franklin County fishery in the four areas listed in Table 2. Assuming that all the product is sold outside the region, the multipliers may be used with the Franklin County value of landings for 1980 to estimate the total sales impacts (columns 2 and 3, Table 2). Total impacts range from $16.9 million in Franklin County to $23.1 million in the six-county area. In each case oysters account for approximtely one-half the total impact.

Some Additional Considerations

Data presented above provide only preliminary estimates of multipliers and impacts for fisheries in Franklin County and the Apalachicola Bay region. For this reason, the numbers should be viewed with some caution. Three points, in particular, should be made.

Table 2: Gross Sales Multipliers and Impacts of Franklin County Oysters, Fish and Shellfish in Selected Areas Around Apalachicola Bay, 1980.

Area	Sales Multipliers	Oysters	All Fish and Shellfish
Franklin County	1.41(1)	$ 8,092,282(3)	$ 16,964,237(4)
Franklin and Gulf Counties	1.57(1)	9,010,555	18,889,257
Apalachicola Region (six counties)	1.92(1)	11,019,277	23,100,238(5)
BEA Economic Area 38[2]	1.63(2)	9,354,907	19,611,140

[1]Based on preliminary input-output model estimated for 1976.

[2]United States Department of Commerce, Industry-Specific Gross Output Multipliers for BEA Economic Areas, U.S. Government Printing Office, Washington, D.C., Janury 1977.

[3]Multipliers from column 1 times value of landings, Franklin County, 1980 ($4,739,207).

[4]Multipliers from column 1 times value of landings, Franklin County, 1980 ($12,031,374).

[5]Impacts for the larger areas include the impacts estimated for the smaller area. Figures cannot be added for two regions.

First, the impact estimation procedure in Table 2 relies solely on the dockside value of fish and shellfish landed in Franklin County which misses any value added associated with any type of processing activity (i.e.; breading). If, in fact, some processing activity takes place, the multiplier should be estimated at the processing level rather than the production level. A detailed study of product markets and product movements out of the area would allow more precise estimates of seafood industry impacts.

Second, a related caution has to do with the nature of the multiplier. Multipliers in Table 2 were estimated at the fishery production level based on adjusted national input-output coefficients (a similar procedure was used for the BEA area multiplier). To go beyond this more study of the local industry is needed. Detailed studies of input usage and purchases in the local area would allow more accurate estimates of indirect and induced impacts.

A third and final consideration concerns the way in which the problems discussed above will reflect in the final impact estimates. The basic idea of the multiplier is to capture all transactions that occur and some transactions are probably missing. Thus, the values in Table 2 must be interpreted as preliminary and conservative estimates of economic impact.

PLANNING FOR AN ENVIRONMENTAL AND ECONOMICAL FUTURE IN A COASTAL COMMUNITY

James T. Floyd

Nowhere in the world will one find the economics of a community more directly related to the natural environment than a coastal community where the daily and annual cash flow is based on the daily and annual harvest of seafood resources. There is no question; a healthy environment will pay dividends in healthy production and a healthy economy. Leave this environment to chance and you also leave the economy to chance.

Of course, no one really wants to leave their daily bread to chance. However, there can be no absolute assurance of a healthy environment or a stable economy without careful and progressive planning for each. Protecting the seafood resources by combating environmental brush fires may save the bay for another day, but it will not win the war.

The initial step in planning is to establish a goal, and if indeed this goal is one of a healthy natural environment that will result in a healthy economy, then it becomes imperative to determine a measure of such quality. Indeed, there is always the philosophy of different strokes for different folks, and establishing an acceptable measure that will please all folks may be very difficult. The only possible solution is to try and achieve an acceptable common ground.

Once a goal has been established, assuming this goal is as simple or as complex as a healthy natural environment, a long range plan is necessary to sustain a yield of seafood resources that will provide a stable economy and assure a measure of health and happiness for the citizens of the coastal community.

So far everything has been straight forward. Now we encounter the first major hurdle of the overall long range plan. The programs or activities that become necessary to achieve the goal and objectives of the plan frequently become personal issues. It is here that the going gets sticky, toes get stepped on, tempers boil and names are called. Unfortunately, in the heat of this battle for development versus environment the overall goal may be forgotten and dilution of the programs may actually endanger the long range objectives.

The adoption and ultimate enforcement of a long range comprehensive land use or resource use plan requires three basic elements: (1) The expertise to measure existing resources and determine future potential and long range needs, (2) an administration with enough foresight to see the needs and adequate intestinal fortitude to enact viable programs to protect the existing resources and meet the future demands, and (3) citizen support, which is probably the most vital and important element of all.

County Planner, Franklin County Department of Planning and Zoning, Apalachicola, Florida.

Because this third element is frequently the key to the ultimate adoption or rejection of a coastal resource use plan, I will elaborate on this subject. For some reason there seems to be a great void between citizen concern as expressed at the coffee shop and that exhibited at the public meeting place. There is also the recognized fact that those who are most vociferous at meetings are usually the minority expressing dissatisfaction with the proposal. It has also been observed that the reason for this dissatisfaction is based on either a general misunder standing of the program or for some personal self-serving motivation. Perhaps there is no real solution to the self-serving interest other than to recognize it for what it is, but there is a solution to the area of misunderstanding.

About a quarter of a century ago, I was introduced to the expression "Bio-Politics" which probably has a foundation in the statement of Ding Darling, who responded to the cry for separation of resource conservation and politics by saying, 'Separation, hell, let the conservation interest get involved in politics!' Essentially there was a break down in communications between the resource biologist, the resource user and the politician who served as the resource administrator. A similar situation exists today between the resource planner and the resource user, and until this communication gap has been bridged, there can be no real hope for general citizen understanding and support of land or resource use plans no matter how progressive, how lofty, or how basically sound such plans may be.

Thus far, I have identified a major stumbling block in the path of progressive land and resource planning for the coastal community, that being citizen comprehension and citizen support. I have also identified the reason for this condition, simply, failure to communicate.

Another situation that compounds the problems of coastal planning is the fact that you can't develop a land use plan for a coastal area that does not also involve coastal aquatic resources. Consequently, when you involve coastal resources you also involve the bank account of the citizens residing in the coastal community which depend on those resources for a living.

The first step in the coastal planning effort is identification of the problems. Once the problems have been identified, they can be isolated and addressed. Once addressed, the problems may well turn out to be opportunities. If the communication gap does exist, and I am of the opinion that it is very real, then there is a need to bridge this gap and create an opportunity for greater citizen understanding and support of planning programs. Perhaps when all the fat has been cooked away and we get down to the bare bones of planning, the problems of planning for coastal communities is not so different from those of any other area. Without public support few planning concepts will ever be enacted.

In summary, let's return to the three basic elements. (1) We have the scientific expertise on which to base a coastal resource use plan. (2) We have an administration with foresight and fortitude to face current and future challenges. (3) Alas! We do not have the vital third element of an informed citizenry. Perhaps the greatest need of coastal community planning and resource use management is generating a program for citizen understanding which will lead to citizen support.

THE APALACHICOLA NATIONAL ESTUARINE SANCTUARY

Woody Miley

The Sanctuary, administered by the Bureau of Environmental Land Management of the Florida Department of Natural Resources, was established in November, 1980, as a cooperative effort between local, state and federal governments under the Federal Coastal Zone Management Act (section (315)). The Apalachicola Sanctuary Management Committee is composed of six persons who are primarily responsible for determining the policies for management of the sanctuary.

The Apalachicola Sanctuary is the largest of 15 existing national estuarine sanctuaries and represents the Louisianian Biographic Region. When completed, the national program will consist of 30 estuarine sanctuaries and 17 marine sanctuaries. Two (2) from each category will be in Florida.

The Apalachicola Sanctuary encompasses 180,159 acres, including the bay, floodplain and portions of the barrier islands. Over three quarters, 135,680 acres, are submerged lands. Proposed acquisitions, if successful, will increase the sanctuary to over 241,000 acres.

Apalachicola Bay, which is one of the most productive bays in the Northern Hemisphere, is characterized by a series of rivers, bays, bayous, tidal creeks, marshes, and barrier islands, each essential to the integrity of the system. The bay supports major fisheries for oysters, shrimp, crabs, and fin fish. Between 60 and 85 percent of the local people make a living directly from fishing, and the industry brings approximately $10 million annually into the local economy.

In 1900, the bay supported over 12,000 acres of oysters beds; today, only 6,000. Most of this decline is due to habitat loss. The construction of Sikes Cut changed the salinity gradient, thus allowing greater densities of parasites and disease. Changes in hydrographic period, due in part to the construction of Jim Woodruff Dam, have also had an adverse impact on oyster populations. Without exception, all principal pests, parasites, and predators of oysters in Florida require higher salinites. However, extended periods of low salinities have adverse effects on oyster growth and can destroy bars. Hence, the pulsing of the river discharge is essential to oyster production.

In 1897, 32 oyster boats worked the area that is now the sanctuary. Today the number of boats is estimated to be 750. An oysterman can, with a lot of work, tonge 20-25 bags of oysters per day. Dockside value for his prize is 6 to 7 dollars per bag. The reasons for such high sustained yields are the nutrient rich waters from the alluvial plain, temporal flooding, and the physical aspects of the bay. These parameters result in a situation that produces the fastest growing oysters in

---

Sanctuary Manager, Apalachicola National River and Estuarine Sanctuary, Florida Department of Natural Resources, Apalachicola, Florida.

the entire range of the American oyster and thus supports incredible harvest pressure. Within the sanctuary the Department of Natural Resources conducts an oyster planting and bed-building program. During the 1969-1971 period, approximately 190 acres of oysters were planted. Estimated returns were $150,000 and $600,000 per year for dockside and resale value, respectively. Cost to benefit ratio for just one year's harvest was one-to-one dockside and 3 or 4 to 1 resale value.

Shrimp represent the largest and most valuable fisheries in the sanctuary. Dockside landings for 1978 were $5.5 million. The importance of the sanctuary to this industry is probably underestimated, since many shrimp spend their juvenile stages in the bay but are harvested elsewhere. In 1979, an estimated 150 in-county and 200 out-of-county shrimp boats worked in the sanctuary. Many of the latter landed their harvest elsewhere and are not reflected in the landing figures. Statewide landings have decreased to approximately half of what they were in the early 1950's, yet landings within the sanctuary have increased throughout this period.

Blue crabs and finfish are an important harvest from the sanctuary but are dwarfed by the oyster and shrimp industries. However, the importance of the sanctuary to these species cannot be overstated. Dog Island, one of the system's barrier islands, is a major spawning ground for blue crabs. Individuals migrate as much as 300 miles to spawn in the vicinity of Dog Island. Many spend their larval and juvenile stages in the bay, and then add substantially to the Gulfwide harvest. In 1976, in excess of 12 million pounds, worth $2.5 million, of blue crabs were harvested from the Florida Gulf coast. Mullet is the major finfish harvest from the sanctuary and contributes over $100,000 per year to the harvest value.

Bee culture is also important within the sanctuary. During 1979 area apiaries produced 750,000 pounds of honey worth $387,000. Approximately half this production was light (tupelo) honey. The lower Apalachicola basin has the largest natural stand of tupelo in the world.

The Apalachicola River basin within the sanctuary supports a myriad of plants, mollusks, fish, amphibians, reptiles, birds and mammals. One hundred and sixteen species of plants, 21 of which are rare, threatened, or endangered are found in the sanctuary, such as the Harper's Beauty, that beautiful small lily of flooded pinelands and the national Ogeechee Tupelo on St. Vincent's Island. Twenty-three (23) species of rare, threatened, endangered, or endemic mollusks are also found in the basin. There are 116 species of fish, and the area is a tremendous spawning/nursery ground for important commercial and recreational species. Endangered, or potentially endangered, species include the atlantic sturgeon, blue-stripe shinner, shoal and suwannee bass. The highest density of amphibians and reptiles in North America, with the possible exception of Mexico, is found in the basin, including 10 species considered rare, threatened, endangered or of special concern. The sanctuary is one of the most important bird habitats in the Southeastern United States with a species list in excess of 250 species, including 25 rare, threatened, endangered or special concern species. The count of perigrine falcons on the barrier islands this year was 60. Rare, threatened, or endangered mammals include the panther, black bear, Florida and Southeastern weasel, Florida and Southern mink, and several species of bats, including the Indiana and gray bat.

The role of the sanctuary is to encourage the quest for knowledge and understanding and to serve as a guardian for those parameters deemed essential to the survival of the system. The establishment of the sanctuary is not intended to block commercial development, but rather to assist in guiding compatible development to maintain the very aspects that have made the area attractive to growth and development.

If this multi-use system is going to survive; if we are going to preserve a way of life for a coastally dependent people; if we are going to maintain commercially harvestable quantities of marine life important to the entire state and nation, then it is imperative that the Apalachicola National Sanctuary succeed!

FLORIDA'S SHELLFISH ENVIRONMENTAL ASSESSMENT PROGRAM

John W. Schneider

The Shellfish Environmental Assessment Section (SEAS) of the Florida Department of Natural Resources was created in November 1980 under the Division of Marine Resources' Bureau of Marine Science and Technology. Currently, SEAS maintains four field offices each manned by two environmental specialists. Offices are located in Apalachicola, St. Petersburg, Punta Gorda and Titusville. The Apalachicola office monitors shellfish harvesting areas from Pensacola through Levy County, the Punta Gorda office handles Citrus County through Ten Thousand Islands and the environmental specialists in Titusville cover the east coast. The St. Petersburg field office serves as a newly formed shellfish harvesting area survey team responsible for the classification of potentially productive shellfish harvesting areas. The laboratory support facility is located in Apalachicola.

SEAS performs four primary tasks: (1) conducting shoreline surveys to locate and evaluate all actual and potential sources of pollution, (2) establishing and monitoring water quality sampling stations, (3) red tide monitoring, and (4) managing shellfish harvesting areas for the purpose of protecting public health.

Shoreline surveys are probably the most important function of SEAS. Pollution sources are evaluated to determine the possible effect on the bacteriological quality of adjacent shellfish waters. Information is obtained from the Department of Environmental Regulation and local health departments, and a site inspection is conducted. In the case of sewage treatment plants, drogue and dye studies are often necessary to determine the travel time and dilution rate of the sewage and to ascertain whether a discharge will impact shellfish waters. Several drogue and dye studies have been accomplished with the assistance of the U.S. Food and Drug Administration in the Apalachicola Bay system.

It is not only sewage treatment plants which are responsible for the contamination of our estuaries. Septic tanks can also cause problems. Generally, Florida soil is porous and provides inefficient filtration. Additionally, the water table is very high. With heavy rainfall, poorly treated sewage from septic tank drainfields leaches through the soil into adjacent estuarine waters.

Routine monitoring of most open shellfish harvesting areas is conducted monthly. In the case of Apalachicola Bay and Wakulla County waters, samples are collected weekly. Sampling stations are located in such a manner as to monitor pollution sources and major freshwater discharges. Additionally, sampling stations are located near major harvesting areas. Water samples are collected and iced immediately. Several environmental variables are measured at each station; these include, salinity, temperature, dissolved oxygen and turbidity. We also have the capability of measuring incident light intensity and light penetration into the water column.

Administrator, Shellfish Environmental Assessment Section, Florida Department of Natural Resources, St. Petersburg, Florida.

Samples collected from counties other than Bay, Gulf, Franklin and Wakulla are transported to the lab via Purolator Courier. Samples from those counties mentioned above are returned to the lab by the Apalachicola field team. The U.S. Food and Drug Administration requires that samples are delivered to the lab and set up within 30 hours from the time of collection. Once in the lab, the modified A-1 method, developed by the U.S. Food and Drug Administration, is used to determine the most probable number (MPN) of fecal coliform per 100 ml of water. Once samples are set up it takes 24 hours to obtain numerical results. Ultimately, each set of samples and subsequent laboratory analyses yield an overall bacteriological picture of the Bay.

It is important to note that fecal coliform bacteria are called indicator bacteria, indicating the possible presence of pathogenic bacteria and viruses normally associated with sewage contamination. Such pathogens include salmonella, shigella, typhoid and hepatitis.

The red tide organism (Ptychodiscus brevis) is a microscopic, toxic dinoflagellate which, under certain environmental conditions, multiplies at an extremely rapid rate. A bloom recently occurred off St. George Island and Panama City which was responsible for the temporary closure of several shellfish harvesting areas. Water samples are collected, often with the assistance of the Florida Marine Patrol, and the red tide organisms are enumerated. Florida's Department of Natural Resources will close shellfish harvesting areas when the concentration equals or exceeds 5,000 cells/liter in nearshore waters. This recently was the case at Indian Pass in the western portion of the Apalachicola Bay system. Water samples yielded a concentration of 8,000 cells/liter. FDNR closed Indian Lagoon and St. Vincent Sound west of 11-mile. The bloom moved back offshore. Figuring that the bloom had affected inshore waters for a short period of time and the concentration was relatively low, we collected oyster samples from Indian Lagoon and the 11-mile area. The red tide toxin is chemically extracted and injected into three laboratory mice. The mice are then observed for six hours. Two of the mice injected with the extract from the Indian Lagoon sample died. Oysters had become toxic in a very short period of time. Oysters were sampled a week later and found to be non-toxic.

Getting back to bacteria, based upon the shoreline survey and the bacteriological results, shellfish harvesting areas are classified using U. S. Food and Drug Administration recommended standards. The standards for an open shellfish harvesting area call for a median of less than 14 MPN and less than 10 percent of the values should exceed 43 MPN.

Shellfish harvesting areas fall into one of four categories: (1) Approved-areas normally open to shellfishing, (2) Conditionally Approved-areas normally open to shellfishing which are occasionally closed either after finding high fecal coliform densities or by following an established management plan, (3) Prohibited-areas which are never open to shellfishing due to high pollution levels, and (4) Unclassified-areas in which shellfishing is not permitted pending surveys by the Shellfish Environmental Assessment Section. It generally takes from six months to one year to determine the suitability of an area for shellfish harvesting.

Considering the amount of rainfall we receive in Florida and the number of necessary closures of Approved areas, most Approved shellfish harvesting areas should be reclassified as Conditionally Approved. This will require extensive data analysis to determine what criterion should be used to manage individual bay systems.

The Shellfish Environmental Assessment Section is dedicated to assuring the sanitary quality of oysters and clams harvested from Florida waters. At the same time, consumer confidence in Florida's shellfish products is maintained, thereby maintaining a healthy shellfish industry.

MANAGEMENT OF SHELLFISH RESOURCES: PROBLEMS IN LAW ENFORCEMENT

C. V. Holland

The taking of undersized oysters from Apalachicola Bay is a major concern of law enforcement, and unfortuantely, is impossible to stop totally. Possible reasons for this are as follows.

The laws governing oyster harvest do not receive the needed voluntary compliance. Why? I can only guess. Maybe it is profitable to take undersize oysters because there is a market for them. If they can be sold in the houses, there must be a buyer willing to buy them. Therefore, undersized oysters will continue to be taken from the bay. To stop or control this is a near impossible task.

A second reason involves the magnitude of the fishery. On a given day there are perhaps 300 boats on the bay to check. If each boat has 20 bags with an average of 300 oysters in each bag, that's 6000 oysters per boat times 300 boats. That makes 1,800,000 oysters a day coming from the bay. Most of the time we have four officers per shift (2 shifts) to do the checking and that would be optimum conditions. This means that only 40 boats, on the average, would be checked per day. What happens to the other 260 boats? They go to land and sell their oysters. As a result, a large number of small oysters are being placed on the market.

In the recent past, Marine Patrol efforts were beefed up in Apalachicola resulting in many citations being written. Courts have clamped down and all concerned have become more aware of the problem. This has helped, but will not totally stop small oysters from being harvested.

There are no easy answers. It will take a cooperative effort from all facets of the industry to accomplish this.

From a law enforcement standpoint the amount of work involved in checking oysters for size is too time consuming and complex. Not enough oysters get checked to make a difference. Maybe there are other ways to manage the product. Alternative methods should be examined. For example, at the present time, law enforcement cannot check oysters for size after certification in the house, thus tying the hands of officers in oyster houses, trucks, and other places.

Oysters are now being harvested year round. It seems that law enforcement is being asked to do the impossible. Maybe education is the answer. However, even with modern equipment, well trained officers, better judicial system, education and cooperation, 1.5 to 2 million oysters still cannot be checked for size each day, but at least there is hope for improvement. There must be a better way.

Captain, Florida Marine Patrol, District II, Florida Department of Natural Resources, Carrabelle, Florida.

DEPARTMENT OF ENVIRONMENTAL REGULATION RESOURCE PROTECTION ACTIVITIES

Robert V. Kriegel

My role today is to provide some insight as to the role of the Department of Environmental Regulation in protecting the Apalachicola seafood industry from environmental stresses and pollution.

I would like to start off by noting that here in Florida, and especially here in Apalachicola, we consider our environmental and natural resources to be very important. Our natural resources directly support much of our economy. We have no State income tax in Florida, partly because of the State's reliance on the sales tax, which is supplemented so much by tourist dollars. Much of the local economy in the coastal counties surrounding Apalachicola Bay is directly dependent on the resources and condition of the bay.

I will briefly review the regulatory and planning functions of the Department and touch on some of the problems that we have in discharging these functions. First of all, it is important to recognize that there are many agencies and levels of government that have a mandate to protect the environment. Local government is directly responsible for land-use planning and control. The County Health Departments and the State Department of Health and Rehabilitative Services are generally responsible for issues relating to the public health. The Water Management Districts are responsible for issues relating to the consumptive use of water supplies, as well as the management and storage of surface waters. The State Department of Natural Resources is responsible for the management of State-owned and sovereign lands, and, of course, the fisheries industries. Lastly, the Department of Environmental Regulation is responsible for regulating activities impacting environmental quality.

The Department's most general regulatory function simply includes the regulation of most stationary sources that discharge pollutants into the air and waters of the State. In the broadest sense, this includes all point source dischargers to groundwaters, surface waters, and the atmosphere, and encompasses domestic and industrial wastewater sources, sanitary landfills, stormwater dischargers, hazardous waste sites, and air sources.

Very simply, the way our regulatory process works in these areas is through permitting and source compliance activities. We require potential sources of pollution to obtain permits from us prior to construction. In evaluating these construction permit applications, we apply the tougher of two criteria. The first criterion is whether the proposed source utilizes appropriate technology for removing the pollutants from the discharge. If the design has done this, we then evaluate the discharge in terms of its impact on the environment. If the proposed

---

Northwest Florida District Manager, Florida Department of Environmental Regulation, Pensacola, Florida.

source meets appropriate technology and does not degrade applicable environmental criteria, we issue a construction permit. The construction permit allows the source to be built and to operate briefly while monitoring its discharges to confirm that the design and operation meet the design requirements. Subsequently, we require that the source obtain an operation permit. We impose self-monitoring and reporting, and we conduct source inspections periodically to insure that the sources are operated as required.

The second regulatory function is our Dredge and Fill Program. Simply stated, most activities in most wetland areas of the State require a dredge and fill permit from the Department. Prior to issuing a dredge and fill permit we examine the application to insure that whatever construction is proposed will not cause environmental problems or violate applicate environmental standards.

Our last general area of responsibility is that of regulating public drinking water supply systems.

And, needless to say, we have a lot of sources to account for. In the sixteen counties of the Department's Northwest District we have almost 1500 permitted sources, and this does not include either dredge and fill or stormwater facilities. Additionally, we conduct a limited air and water quality ambient monitoring program, with some 44 biological, chemical and air stations. You combine our permitting, compliance monitoring, enforcement, and administrative functions and parcel these out to the sixty-odd employees in the District, and you see that we're stretched pretty thin.

Florida is growing at an astounding rate. A recent Sports Illustrated article entitled, "There's Trouble in Paradise," has this statement about Florida's environment: "The sad fact is Florida is going down the tube--indeed in no state is the environment being wrecked faster and on a larger scale." -- Without vouching for the accuracy of this quote, I do feel that many of our environmental problems are the result of our rapid population growth. Increased population brings more urban pollution, including sewage discharges, landfills, urban stormwater, as well as more associated industrial discharges. The Department is one of the smallest agencies in the State and, as I have said, simply does not have the personnel or financial resources to police the State. As a result, it is vitally important that all levels of government work very closely together. A good example of this lack of coordination occurred recently with two battery recycling plants that discharge into tributaries of the Chipola River. In both cases, the Department was neither aware nor involved with the facilities until they had been built, with local building permits, and in operation for some time. In both cases, discharges from the facilities posed environmental problems which will be much more difficult to address after-the-fact than before-the-fact; and, I believe, in both cases these problems could have been eliminated had local government and State government coordinated their activities more effectively at the outset. However, as many of you are aware, there has been a tremendous amount of press coverage and emotionalism associated with these two battery recycling plants. The simple facts are, the facilities did opeate without State permits. We feel discharges from one, Sapp Battery, resulted in biological damage in the tributaries leading to the Chipola, and there is no information substantiating water quality impacts in either the Chipola or Apalachicola Rivers. In fact, comparative water quality data indicate the Chipola/Apalachicola systems have substantially less lead than other river systems. In example, the mean of 79 water quality analyses in the

Chipola/Apalachicola for lead was 26 micrograms/liter; the mean in the Peace, Suwannee, and St. Johns for 129 samples was 44. In comparing the Apalachicola/Chipola with the Susquehanna River which feeds into Chesapeake Bay, a major shellfish and finfish resource for the Central Atlantic, we see recurring concentrations of lead in the Susquehanna water column in the hundreds of micrograms, as high as five to six hundred. This compares with our 26 micrograms/liter.

The Department is involved in more than just regulating sources of pollution. We are very much involved in instituting and requiring planning for the Apalachicola Basin, corollary to our regulatory functions. These efforts include the Federal 201 grant programs for obtaining Federal funding to upgrade municipal sewage treatment facilities. Both the Apalachicola and Eastpoint sewage treatment systems have received various Federal grants through the 201 process.

In reviewing the U.S. Army Corps of Engineers' maintenance dredging permit requests, we have consistently required long-range planning, environmental impact assessment, and interstate coordination. We are very concerned with the long-term changes to river hydraulics, and the concomitant environmental impacts as well as the short-term physical alterations from dredging and filling and the Corps' activities. We have obtained roughly $160,000 in coastal zone grants for long-range spoil disposal planning. We also put a great deal of effort in coordinating the establishment of the Apalachicola National Estuarine Sanctuary.

We are trying to obtain funding for an inter-state multidisciplinary study of the Apalachicola/Chattahoochee/Flint River System to specifically look at upstream out-of-state impacts associated with water use and pollution. To this end, we testified before the Congressional House Committee of Public Works and Transportation to impress upon them the importance and significance of interstate impacts on the Apalachicola River System.

The Department has a major role in coordinating the purchase of lands needed to protect our water resources under the Save Our Rivers Legislation. The Northwest Florida Water Management District's long-range plan for purchasing these lands in the Apalachicola basin includes the acquisition of some 36,000 acres with some 7.5 million dollars. Thus far, documentary stamp taxes have resulted in some 1.7 million dollars for this purpose.

So, in summary, I hope I have given you a better perspective concerning the regulatory and planning functions of the Department as they relate to the seafood industry in this area. I hope I have highlighted the very real need that all levels of government work more closely together to protect this resource, and I hope that in the future we will be more effective in doing that.

INDUSTRY MANAGEMENT CONCERNS -- OYSTER DEALERS

Willard Vinson

The following is a summary outline of priority concerns and recommendations of the Franklin County Oyster Dealers' Association relating to the current situation of the Apalachicola Bay oyster fishery.

1. There is a major need for increased shell planting in the bay.

   * Sample plantings in different areas of the bay would be helpful to test for the best planting locations on a larger scale.

   * Also, re-shelling the submerged lump bars at the western end of the bay would increase their productivity.

   * More equipment and personnel are needed to accomplish these tasks. Due to the shortage of state manpower and equipment breakdown, industry people may be able to help in oyster shell planting process.

2. Better law enforcement concerning undersized oysters is needed.

   * Stiffer fines would help, with the violator required to return the entire catch back to the water. Currently, the $56.70 fine for harvesting over 15 percent undersized oysters has no effect on the violator who tongs 40 bags of small oysters and is still allowed to sell his catch even after being being fined. Returning a violator's catch to the bay is purely common sense and should be a common practice.

   * Oystering on leases should have stricter controls. Currently, an oysterman who works for a lease holder harvests oysters from public bottoms that are undersized or from prohibited areas and merely passes through the leased area in order to claim, if caught, that the oysters were harvested from leased bottoms. This practice should not be tolerated.

3. Transporting of oysters out of Franklin County is a problem and a major concern of the entire industry.

   * Since Florida law allows unrefrigerated transport of oyster shell stock up to 70 miles from the source, a large amount of oysters are being taken to neighboring counties on the back of pick-ups, which are usually quite dirty and allow the oysters to be exposed to the sun and rain. This is a potentially dangerous situation not only to the consumer, if a "bad" oyster is eaten, but also to the industry due to the notoriety of that event.

President, Franklin County Oyster Dealers' Association, Eastpoint, Florida.

4. Improvement is needed in the water sampling procedures.

* Since only two men monitor water from Cedar Key to Pensacola and only 28 stations are monitored in Apalachicola Bay, adequate coverage is not available during problem periods of high water to keep the bay open whenever possible.

* Also, even the 24-hour fecal coliform test is not adequate to catch local run-off pollutants during short, but heavy, rainfalls at certain times of the year. Current water sampling methods need to be reexamined to improve its overall efficiency.

INDUSTRY MANAGEMENT CONCERNS -- SEAFOOD WORKERS

C. G. Lolley

The following is a brief summary of the priority concerns and recommendations of the Franklin County Seafood Workers Association relating to the current situation of the Apalachicola Bay oyster fishery.

1. A massive summer "coon" oyster planting program should be undertaken to continue the work started in the summer of 1982, providing jobs during the summer, while improving the oyster production in the fall.

2. The State should intensify its program of shell planting to improve the quality of existing oyster bars and add new bars.

3. There should be better enforcement of the size limit for oysters. A change in the law may be necessary here.

4. The seafood workers would like to create a panel to work with FDNR on specific issues or problems. For example, the mouth of the East River needs to be opened to allow more freshwater to reach the bay.

5. The oyster relaying program has been successful and relayed oysters are surviving. This program should be expanded to at least 10 sites to study where oysters will grow best.

President, Franklin County Seafood Workers' Association, Eastpoint, Florida.

CONFERENCE FLOOR DISCUSSIONS

(Editor's Note: Provision was made during the conference for open discussion to promote speaker-audience dialogue and encourage interaction and exchange of ideas. These discussions occurred at designated periods throughout the conference and are organized as to the session they occurred in.)

Session I:

Q. S. Otwell: Can the geological and hydrodynamic information be useful in directing planting programs or leasing programs for oysters?

A. W.F. Tanner: Presently, there is no data on sediments and erosion effects on oyster production in the Bay.

A. B.A. Christensen: The model I discussed can be modified and may be useful in certain situations, such as for bacterial predictions.

A. E. Joyce: Oyster production will vary throughout the Bay, depending on the variable conditions. Oyster bars placed in areas of decent, or consistant conditions will be productive.

Q. S. Otwell: Is there a need for substrate mapping in oyster reef construction and leasing?

A. E. Joyce: Yes, we need this type of data wherever we can get it.

Q. D. Haven: Is there any data on current scour versus actual sedimentation for Apalachicola Bay?

A. W.F. Tanner: Only in spot samples, but the information is limited.

Q. W. Miley: Dr. Christensen, will your model help predict the best way to dispose of spoil from river dredging?

A. B.A. Christensen: Yes, but it is a difficult process. The model gives velocities which leads to deposition and scour information in general areas. Placement of spoil in positive areas may still have secondary impact.

Q. W. Menzel: The quality of oyster meats are better later in the season; therefore, what would be the problem with keeping the bay closed to oystering until November?

A. E. Joyce: Presently, we do have a summer season in Franklin County on bars most suceptible to closure in the winter. This also allows oystermen to work, harvesting oysters that would normally die off due to the summer wasting disease. As for leaving the winter bars closed until November, I see nothing wrong with that. It would allow the oyster biomass that much longer to regenerate from the previous season.

Q. P. McVety: Do the records of lower production and small size, when partitioned out, reflect increased pressure?

A. E. Joyce: We did not look at this, but Fred Prochaska may speak on this tomorrow.

Q. Anonymous: Is the west end of the bay growing saltier?

A. B. Christensen: The model predicts that the general glow of freshwater from the river is from east to west; therefore, salinity in the west is less than in the east side of the bay.

Q. Anonymous: Conchs (oyster drills) prey on small oysters and seem to be concentrated in specific areas. What would cause this?

A. E. Joyce: Conchs are higher salinity animals and avoid excessive freshwater areas. The pulses of freshwater drive the conchs out.

Q. Anonymous: What environmental level of vibrios is of medical concern?

A. N. Blake: Counts of 10^3-10^4 of Vibrio cholerae is the recognized level where human health can be affected. However, this is a general figure, since the effects are quite variable depending on the person's susceptibility. An individual's susceptibility is based on several factors, including natural resistence, acidic vs. basic stomach fluid, general health, etc.

Q. W. Miley: Does the vibrios data suggest that the fecal coliform standards, presently used, are inappropriate to detect vibrios?

A. N. Blake: Fecal coliform is a good indicator of some human pathogens associated with human intestines, but others, like Vibrio, are more controlled by ecological conditions than by human influence.

Q. W. Miley: What about lower pH effects?

A. N. Blake: pH values are low in other areas and have little effect.

Q. W. Seaman: What is the maximum oyster productivity in the bay?

A. W. Menzel: Unfortunately that is unknown.

Session II

Q. Anonymous: What is better management, small (forestry) cuts or one large clear cut?

A. D. Canfield: Clear cuts affect the pH of the runoff water, leading to changes in the nutrient load. Therefore, small cuts are better for the bay productivity. Generally, small cuts are the typical activity of timbering now, but possibly could increase. Typical forest cutting areas are roughly 200 hectares.

Comment: D. Canfield: Since forest outfalls occur at the point of land, not at the bay headwaters where rapid dilution occurs, maybe the forestry industry ought to consider cutting on longer rain cycles to maximize dilution.

Q. <u>Anonymous</u>: Is there no net flow of nutrients through the floodplain?

A. <u>J. Elder</u>: That's right, only an increase in detrital carbon.

Q. <u>J. Elder</u>: Isn't there some conflict with having flexible management plans, yet maintaining rigid standards for bacteria?

A. <u>C. Futch</u>: Not necessarily, since basic management merely encompasses the present state of knowledge.

Q. <u>Anonymous</u>: Are private leases in Virginia not thoroughly cultivated because of the decreased spat fall?

A. <u>D. Haven</u>: That's only part of the problem. Also, the socio-economic demand for seed oysters is down and these limits equal the absence of profit.

Q. <u>W. Menzel</u>: Would the use of mechanical dredges turn the fishery around in Virginia?

A. <u>D. Haven</u>: There would need to be a set plan first in order to avoid pilage of the resource.

Session III

Due to the shortness of time, discussion periods during this session were eliminated. Please see summary papers for primary content of this session.

SUMMARY OF RESEARCH AND INDUSTRY NEEDS

Scott Andree

Research information and agency involvement, directly or indirectly related to oyster biology and management, is quite diverse. During this one and one-half day conference, we have briefly summarized, at a single place and point in time, essential information concerning Apalachicola Bay and its relationship to the oyster industry so that all can benefit from an exchange of knowledge and ideas. In this regard, the conference has far exceeded my original expectations. The moderators, participants and attendants are to be commended for the quality of their presentations and their interest and enthusiasm for conserving the oyster resource and related industries.

I have chosen to conclude the proceedings by summarizing the industry and research needs suggested during the conference. Since the summary papers document well "what is known," it is now time to address "where do we go from here." It should not be our intention to merely perpetuate more research, but rather to fine tune a coordinated research and education effort, addressing those gaps in our knowledge identified in the presentations and discussions.

The areas of research and industry concern addressed during the conference can be summarized under three broad categories:

*Environmental effects on oyster productivity
*Management and regulation of fishery resources
*Maintaining a quality product for the consumer.

Many of the recommendations actually overlap these categories; however, to summarize, comments have been generalized and listed under these headings.

Environmental Effects on Productivity of Oysters

1) Actual oyster production in Apalachicola Bay is unknown, only oyster harvest is recorded. The **biological productivity of oysters** needs to be correlated with rainfall, salinity, density of predators, and other environmental parameters.

2) Our knowledge of the substrate (bottom) types and location is extremely limited. **Mapping of substrates** in Apalachicola Bay is needed to improve the Florida Department of Natural Resources efforts to plant oyster cultch in suitable locations.

Sea Grant Marine Advisory Agent, Florida Cooperative Extension Service, University of Florida, Perry, Florida.

3) In addition to substrate mapping, **sedimentation and current scour** needs to be examined in relation to oyster spat survival. Information concerning the location of these events would also improve the oyster reef construction program by placing oyster reefs in areas where spat survival would be greatest.

Management and Regulation of Fishery Resources

1) It was highly recommended that the Florida Department of Natural Resources continue its **oyster reef construction** program. However, greater effort should be made in site selection, construction methods and reef monitoring following placement to improve results.

2) **Leasing submerged bottoms** should be re-examined, particularly those bottoms which are currently unproductive and are not likely to be developed by the state's oyster reef construction program. Further consideration may also involve allowing oystermen and dealers an opportunity to enhance existing public reefs. Consideration must include the other competing bottom-dependent fisheries, e.g., shrimp.

3) A need exists for better **economic guidance** for not only the oyster dealer, but also the oystermen. At this time the direct economic impact of this fishery is only conjecture without further analysis.

4) Current **laws** governing the harvest of undersized oysters, transportation of oysters and harvest of oysters during the summer need to be re-examined to make **law enforcement** more efficient with limited personnel.

5) A functional **long-range resource use plan** is needed for oysters, as well as other marine resources in Apalachicola Bay. This has become particularly apparent under increasing fishing pressures on finite resources.

6) There must be **improved communication** between state agencies, researchers and the industry concerning problems and possible solutions. A forum composed of representatives of these groups should be formed to meet annually, possibly under the leadership of the Apalachicola National River and Estuarine Sanctuary.

Maintenance of a Quality Product for the Market

1) Of major concern at this meeting is the harvest of **undersized oysters.** A conscientious cooperative effort on the part of not only law enforcement and management agencies, but also the oystermen and dealers is needed. A concensus of the participants agreed that continued harvest of undersized oysters would not only harm future production, but also cause consumers to look elsewhere for better oysters.

2) Good **water quality** will continue to be a problem as development increases. Most oyster processing houses have improved their sanitation methods. However, quality control procedures could be established in the houses to monitor their final product, especially during summer and winter months when high temperatures or high rainfall can lead to higher bacteria counts in oyster meats.

3) Currently, there is no adequate indicator bacterial **tests for vibrios** in oyster meats. An easy test needs to be developed to monitor the presence of these potential problem pathogens and avoid costly consumer "scares".

It was the overall opinion of those participating that the conference and subsequent proceedings is only a beginning. Problems facing many nearshore fisheries, in this case the oyster industry, will continue to increase unless wise management and use of coastal resources is mandated. Out of this concern, the effort initiated at this conference should be continued through the combined, coordinated efforts of researchers, managers and the industry. Future meetings will be planned to evaluate our progress and continue the communication process. Hopefully, a viable oyster industry will be maintained.

APPENDIX A

CONFERENCE PARTICIPANTS

Doug Alderson
Florida Public Interest Research Group
215 University Union
Florida State University
Tallahassee, FL 32306

Cindy Alspaugh
Apalachicola Times
P.O. Box 820
Apalachicola, FL 32320

Karen Amison
162 Avenue E
Apalachicola, FL 32320

Scott Andree
Florida Marine Advisory Program
Taylor County Extension Service
P.O. Box 820
Perry, FL 32347

Gene Andrews
Rt. 1, Box 216
Alligator Point, FL 32327

Jimmy Andrews
108 Pace Drive
Perry, FL 32347

Nancy Andrews
Rt. 1, Box 216
Alligator Point, FL 32327

David W. Arnold
3535 Roberts Avenue
Lot #109
Tallahassee, FL 32304

Ron M. Baker
Biology Department
University of West Florida
Pensacola, FL 32504

Clinton Bankister
Florida State University
Tallahassee, FL 32306

R.P. Barbaree
P.O. Box 209
Carrabelle, FL 32322

Alfred Bea
Tallahassee Democrat
2106 Haines St.
Tallahassee, FL 32301

Norman J. Blake
Department of Marine Science
University of South Florida
at St. Petersburg
140 South Avenue S.
St. Petersburg, FL 33701

Duane Bradford
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32303

Kathy Bradley
Florida Department of Environmental Regulation
2600 Blair Stone Rd.
Tallahassee, FL 32301

Julian Branch
Florida Department of Natural Resources
Shellfish Lab
Apalachicola, FL 32320

Millard Brayman
P.O. Box 253
Eastpoint, FL 32328

Terry Burch
Northwest Florida Water Management District
Rt. 1, Box 3100
Havana, FL 32333

Cliff Butler
Gulf State Bank
73 Avenue E
Apalachicola, FL 32320

Daniel E. Canfield, Jr.
Center for Aquatic Weeds
University of Florida
7922 N.W. 71st St.
Gainesville, FL 32606

James C. Cato
Director, Florida Sea Grant
Building 803
University of Florida
Gainesville, FL 32611

Elizabeth Chesnut
Box 6, St. George Island
Eastpoint, FL 32328

B.A. Christensen
Hydrolics Lab
Department of Civil Engineering
University of Florida
Gainesville, FL 32611

Bill Collins
91 Tenth St.
Apalachicola, FL 32320

Quinton Crenner
Apalachicola, FL 32320

Kevin X. Crowley
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32303

Ronald Crum, Sr.
P.O. Box 153
East Point, FL 32328

Diane Curlee
P.O. Box 551
Panacea, FL 32346

Robert J. Daria
Franklin County Schools
245 Prado
Apalachicola, FL 32320

Richard S. Dawdy
Northwest Florida Water Management District
Rt. 1, Box 3100
Havana, FL 32333

Angelo DePaola
Food and Drug Administration
Gulf Coast Technical Service Unit
P.O. Box 158
Dauphin Island, AL 36528

Shaun Donahoe
P.O. Box 666
Apalachicola, FL 32320

Joseph F. Donoghue
1556 Mount Eagle Place
Alexandria, VA 22302

Gary Doyens
Channel 13 News
P.O. Box 1340
Panama City, FL 32401

Lawrence Eaton
Department of Oceanography
Florida State University
Tallahassee, FL 32306

Neal F. Eichholz
Game and Freshwater Fish Commission
Office of Environmental Services
620 South Meridian St.
Tallahassee, FL 32304

John F. Elder
U.S. Geological Survey
325 John Knox Rd., Suite L103
Tallahassee, FL 32303

Adrienne Elliott
Franklin County Extension Service
Apalachicola, FL 32320

Gloria Estes
1007 Bluff Road
Apalachicola, FL 32320

James B. Estes
Franklin County Extension Service
Apalachicola, FL 32320

Joyce Estes
Bayside Gallery and Flowers
Apalachicola, FL 32320

Robert Estes
1007 Bluff Road
Apalachicola, FL 32320

Harry Falk
P.O. Box 43
Apalachicola, FL 32320

Glen L. Faulkner
U.S. Geological Survey
325 John Knox Road
Suite L103
Tallahassee, FL 32303

Craig F. Feeny
1535 Paul Russell Road
Tallahassee, FL 32301

Annie Mae Flowers
Flowers and Son Seafood
P.O. Box 416
Eastpoint, FL 32328

James T. Floyd
Franklin County Planning and
Zoning Department
County Courthouse
Apalachicola, FL 32320

Charles R. Futch
Marine Resource Division
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32308

Elton J. Gissendanner
Executive Director
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32303

Charles S. Hardy
P.O. Box 153
Apalachicola, FL 32320

Lamar Hardy
P.O. Box 153
Apalachicola, FL 32320

Anna Marie Hartman
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32303

Dexter S. Haven
Virginia Institute of Marine Science
William and Mary College
Glouchester, VA 23062

John Hendrix
Little St. George Island Wildlife Refuge
57 Market Street
Apalachicola, FL 32320

Roy C. Herndon
Florida Resources and Environmental
Analysis Center
Florida State University
Tallahassee, FL 32306

Thomas Herrington
U.S. Food and Drug Administration
179 W. Putnam Ferry Road
Waycross, GA

William F. Herrnkind
Biology Unit I
Florida State University
Tallahassee, FL 32306

David Hinton
P.O. Box 305
Carrabelle, FL 32322

Vance C. Holland
Florida Marine Patrol
District II Office
Carrabelle, FL 32322

Doris Holton
Carrabelle, FL 32322

Mary A. Hood
Mary Ingrahm Bunting Institute
Radcliffe College
10 Garden St.
Cambridge, MA 02138

Robert L. Howell, Clerk
Franklin County Courthouse
P.O. Box 340
Apalachicola, FL 32320

R. A. Hudson
Star Route Box 228
Carrabelle, FL 32322

Linda Hutton
P.O. Box 273
Panacea, FL 32346

Robert M. Ingle
173 Avenue B
Apalachicola, FL 32320

Edwin A. Joyce, Jr.
Marine Resource Division
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32308

Daryll E. Joyner
150 Blidd Dr., Apt. 16
Tallahassee, FL 32301

Steve Keller
Florida Public Interest Research Group
215 University Union
Florida State University
Tallahassee, FL 32306

Ralph Kendrick
P.O. Box 314
Carrabelle, FL 32322

Margaret Key
P.O. Box 263
Apalachicola, FL 32320

Bobby Kirvin
P.O. Box 759
Apalachicola, FL 32320

George Kirvin
Quality Seafood
P.O. Box 759
Apalachicola, FL 32320

Robert V. Kriegel
Florida Department of Natural Resources
160 Governmental Center/Suite 202
Pensacola, FL 32501

Kitty Kritzler
Carrabelle, FL 32322

Chris Leadon
Suwannee River Water Management District
Rt. 3, Box 64
Live Oak, FL 32060

Grady Leavins
P.O. Box 596
Apalachicola, FL 32320

Ed Leuchs, Executive Director
Apalachee Regional Planning Council
P.O. Box 428
Blountstown, FL 32424

William Lindberg
MAP Coordinator
117 Newins-Ziegler Hall
University of Florida
Gainesville, FL 32611

Robert J. Livingston
Biology Department
Florida State University
Tallahassee, FL 32306

C.G. Lolley
P.O. Box 417
East Point, FL 32328

B. G. Lunsford
214 Avenue C.
Apalachicola, FL 32320

Dan MacDonald, R.S.
Franklin County Health Department
Box 490
Apalachicola, FL 32320

Jan Mandrup-Paulsen
Department of Oceanography
Florida State University
Tallahassee, FL 32306

Dwight Marshall
Citizen's Federal Savings and Loan
Apalachicola, FL 32320

Janice L. Martina
124 16th Street
Apalachicola, FL 32320

Evelyn Mayes
Carrabelle, FL 32322

Hugh A. McClelllan
U.S. Army Corps of Engineers
P.O. Box 2688
Mobile, AL 36628

James T. McNeill
Indian Pass Beach
Port St. Joe, FL 32456

Merrill McPhearson
U.S. Food and Drug Administration
P.O. Box 158
Dauphin Island, AL 36528

Pamela McVety
Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32301

R. Winston Menzel
Department of Oceanography
Florida State University
Tallahassee, FL 32306

Andy Middlebrooks
Middlebrooks Funeral Home
Apalachicola, FL 32320

Woody Miley
57 Market St.
Apalachicola, FL 32320

Minnie Millender
P.O. Box 414
Eastpoint, FL 32320

James Miller
Southern Can Distributors
P.O. Box 625
Eastpoint, FL 32328

Jeannette Miller
Southern Can Distributors
P.O. Box 625
Eastpoint, FL 32328

John Moerlins
Florida Resources and Environmental
Analysis Center
Florida State University
Tallahassee, FL 32306

Doug Morris
Florida Department of Natural Resources
3900 Commonwealth Blvd.
Tallahassee, FL 32308

Jim Mosconis
Apalach Marine
Apalachicola, FL 32320

David Mulkey
Food and Resource Economics (IFAS)
University of Florida
Gainesville, FL 32611

John F. Musselmann
Department of Health and Human Services
Food and Drug Administration
Northeast Technical Services Unit
Bldg. S-26, Construction Battalion Center
North Kingstown, RI 02852

Clay Olson
Taylor County Extension Director
P.O. Box 820
Perry, FL 32347

W. Steven Otwell
Extension Seafood Tech. MAP
207 Food Science Building
University of Florida
Gainesville, FL 32611

George Patrinos
Southeastern Fisheries Association
124 W. Jefferson St.
Tallahassee, FL 32301

G.W. Pridgeon
Big Bend Production Credit
P.O. Box 519
Apalachicola, FL 32320

Fred Prochaska
1170 McCarty Hall
University of Florida
Gainesville, FL 32611

Hans Riekerk
Forest Resources and Conservation (IFAS)
118 Newin-Ziegler Hall
University of Florida
Gainesville, FL 32611

Jack Salmon
Department of Biology
University of West Florida
Pensacola, FL 32504

Lawrence Sangaree
Florida Department of Natural Resources
Shellfish Lab
Apalachicola, FL 32320

John Schneider
Florida Department of Natural Resources
Shellfish Environmental Assessment
100 Eighth Avenue, S.E.
St. Petersburg, FL 33701

Darrell L. Scovell
Florida Game and Freshwater Fish Commission
620 S. Meridian
Tallahassee, FL 32300

William Seaman, Jr.
Building 803
University of Florida
Gainesville, FL 32611

Wayne P. Smith
Agriculture Research Station
Rt. 3, Box 638
Quincy, FL 32351

Art Suber
Panama City News-Herald
P.O. Box 1940
Panama City, FL 32401

Henry Sullivan
P.O. Box 291
Apalachicola, FL 32320

William F. Tanner
Geology Department
Florida State University
Tallahassee, FL 32306

Faye Tarantino
Citizen Federal Savings and Loan
P.O. Box 699
Apalachicola, FL 32320

John Taylor, Jr.
P.O. Box 530
Eastpoint, FL 32328

Mitchell Teminix
Eastpoint, FL 32328

Blake Thomason
Big Bend Seafood
Apalachicola, FL 32320

Virginia A. Vail
Florida Department of Natural Resources
Bureau of Land Management
3900 Commonwealth Boulevard
Tallahassee, FL 32303

Bud Vause
Panama City, FL 32401

Annette Vinson
Bay Seafood
Eastpoint, FL 32328

Willard Vinson
Bay Seafood
Eastpoint, FL 32328

Richard C. Watkins
Apalachicola State Bank
P.O. Box 370
Apalachicola, FL 32320

Jerry Williams
167 Avenue C
Apalachicola, FL 32320

Leslee A. Williams
Rt. 3 Box 22 E
Monticello, FL 32344

Leslie Williams
Florida Department of Environmental Regulations
Tallahassee, FL 32301

Scott Willis
Florida Department of Natural Resources
Marine Research Lab
100 8th St. S.E.
St. Petersburg, FL 33701

Donnie W. Wilson
D.W. Wilson Seafood
Apalachicola, FL 32320

Donald Wood
St. Joe Paper Company
Woodlands Division, St. James Unit
STAR Route, Box 98
Carrabelle, FL 32322

Rose Zongker
Florida Resources and Environmental Analysis Center
Florida State University
Tallahassee, FL 32306

APPENDIX B

APALACHICOLA CONFERENCE ON THE OYSTER INDUSTRY

October 6-7, 1982

National Guard Armory
Apalachicola, Florida

PROGRAM

Wednesday, October 6, 1982

1:00-1:30 Registration

Opening Remarks - Scott Andree, Conference Director

Afternoon Session - James C. Cato, Moderator

1:30-1:45 Welcome
James C. Cato, Director, Florida Sea Grant

1:45-2:00 "State of the Fishery: An Overview"
Edwin A. Joyce, Jr., Florida Department of Natural Resources

Physical Aspects

2:00-2:15 "Apalachicola Bay: Geology and Sedimentology"
William F. Tanner, Florida State University

2:15-2:30 "Hydrodynamics of the Apalachicola Bay System"
B.A. Christensen, University of Florida

2:30-3:00 Discussion

3:00-3:15 BREAK

Biological Aspects

3:15-3:30 "Correlation of Coliform Bacteria With Vibrios in Apalachicola Bay"
Norman J. Blake and Gary E. Rodrick, University of South Florida

3:30-3:45 "Influence of Processing and Storage on Coliform and Vibrio Populations in Shellfish"
Mary A. Hood, Fred Singleton, Gregory Ness, and Ron Baker
University of West Florida

3:45-4:00 "Genetics and Oyster Production"
Winston Menzel, Florida State University

4:00-4:30 Discussion

4:30-4:45 Critique

4:45	Adjourn
5:00-6:00	Social Hour

Thursday, October 7, 1982

Morning Session - Robert J. Livingston, Moderator

Biological Aspects

9:00-9:15	"Limnology of a Small Coastal Stream: Impact of a Timbering Operation" Daniel E. Canfield, Jr., University of Florida
9:15-9:30	"Riverine Transport of Nutrients and Detritus to Apalachicola Bay" John F. Elder, U.S.Geological Survey
9:30-9:45	"Apalachicola River-Bay Interactive and Productivity Cycles" Robert J. Livingston, Florida State University
9:45-10:15	Discussion
10:15-10:30	BREAK

Fisheries Aspects

10:30-10:45	"Aquaculture Possibilities" Robert M. Ingle, Adelanto Corporation
10:45-11:00	"Oyster Reef Construction and Relaying Programs" Charles R. Futch, Florida Department of Natural Resources
11:00-11:15	"Alternatives for the Seafood Industry" W. Steven Otwell, University of Florida
11:15-11:30	"Oyster Production in the Lower Chesapeake Bay" Dexter S. Haven, Virginia Institute of Marine Science
11:30-12:00	Discussion
12:00-1:30	LUNCH Keynote Speaker: Elton J. Gissendanner, Executive Director, Florida Department of Natural Resources

Thursday, October 7, 1982

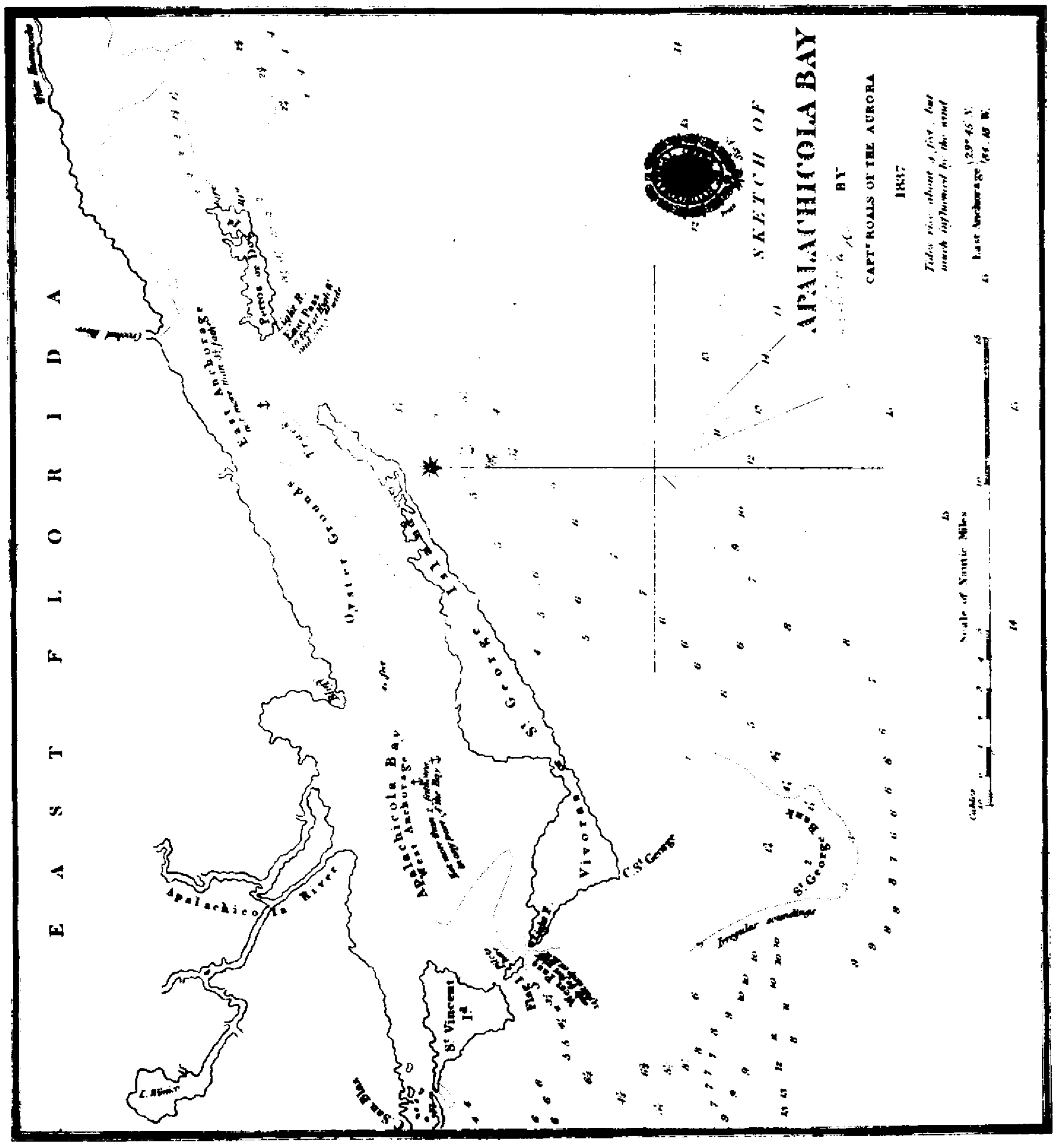
Afternoon Session - Edwin A. Joyce, Jr., Moderator

Economics and Management

1:30-1:45	"Apalachicola Bay Oyster Industry: Some Economic Considerations" Fred J. Prochaska and David Mulkey University of Florida
1:45-2:00	"Planning for an Environmental and Economical Future in the Coastal Community" James T. Floyd, Franklin County Planner
2:00-2:15	"The Apalachicola National Estuarine Sanctuary" Woody Miley, Sanctuary Manager
2:15-2:45	Discussion
2:45-3:00	BREAK

Regulation and Management

3:00-3:15	"Florida's Shellfish Environmental Assessment Program" John Schneider, Florida Department of Natural Resources
3:15-3:30	"Management of Shellfish Resources: Problems in Law Enforcement" Vance Holland, Captain, Marine Patrol, District 2
3:30-3:45	"Department of Environmental Regulation Resource Protection Activities" Robert V. Kriegel, Florida Department of Environmental Regulation
3:45-4:00	"Industry Needs" Willard Vinson, Franklin County Oyster Dealers' Association C.G. Lolley, Franklin County Seafood Workers' Association
4:00-4:30	Discussion
4:30-4:45	Summary of Research and Industry Needs Scott Andree, Florida Marine Advisory Program
4:45	Adjourn


SKETCH OF
APALACHICOLA BAY
BY
CAPT. ROALS OF THE AURORA
1837
E A S T F L O R I D A
Apalachicola River
Apalachicola Bay
Oyster Grounds
St. George Island
Vivoran
C. St. George
St. George Bank
Irregular soundings
St. Vincent Id.
Scale of Nautic Miles