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Proceedings of the Delmarva Coastal Bays Conference III:

Tri-State Approaches to Preserving Aquatic Resources

November 12-13, 1999

Ocean City, Maryland

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PROCEEDINGS

DELMARVA COASTAL BAYS CONFERENCE III:
Tri-State Approaches to Preserving Aquatic Resources

Edited by

Frederick W. Kutz *, Phyllis Koenings **, Laurie Adelhardt ***

* U.S. Environmental Protection Agency
Fort Meade, Maryland 21401

** Assateague Coastal Trust
Berlin, Maryland 21811

*** Owl Creek Consulting
Berlin, Maryland 21811

November 12-13, 1999
Ocean City, Maryland

United States Environmental Protection Agency
National Health and Environmental Effects
Research Laboratory
Atlantic Ecology Division
27 Tarzwell Drive
Narragansett RI 02882

ABSTRACT

On November 12 - 13, 1999, approximately 300 people attended the Delmarva Coastal Bays Conference III: Tri-State Approaches to Preserving Aquatic Resources (CBCIII). The conference was organized by the Assateague Coastal Trust with planning and financial assistance from twenty-one local, state and federal agencies and organizations - plus support from the local business community.

Much has been accomplished since the preceding Delmarva Coastal Bays Conference II held in 1996, including formation of the Maryland Coastal Bays Program, accomplishments by the Delaware Center for the Inland Bays, and the generally increased awareness along Delmarva's seaside of the importance of protecting the aquatic resources that underpin the local economy and quality of life.

To date, relatively more attention has been given to land use and development issues that affect water quality. CBCIII has narrowed the focus to the direct impacts on the bays' "critters" from such aquatic stresses as habitat destruction, increasing harvest pressures, invasive species and diseases, and the relevant resource management strategies.

More particular objectives of CBCIII included:

- increasing the awareness of ecological differences between the coastal bays and the Chesapeake or Delaware Bays and consequent best management practices;
- facilitating regional partnerships and cooperative tri-state approaches to resolving common issues;
- presenting successful resource-sustaining initiatives, both from within the region and from other coastal areas around the country;
- and, of great interest to local recreational and commercial fishermen and the recreationally and commercially dependent business communities, sharing viewpoints to both protect the commercially and recreationally significant fisheries and minimize user conflicts.

Among the most contentious subjects covered, hydraulic clam dredging continued to invite sharp criticism from scientists, as well as the sports fishing community. The principle concern here has been the impact of dredging on submerged aquatic vegetation (SAV) - one of the bays' richest nurseries - notwithstanding efforts to delineate and prohibit dredging where the aquatic grasses currently exist. Or, as Vice President of the American Fishing Association noted in his presentation, a clear priority in stewardship of the coastal bays should follow the caveat: "It's the habitat, stupid!"

Another concern was the recent decline in crab and horseshoe crab populations - and the lack of data to support a clear direction of how to correct the problem. Is there too much commercial pressure on the blue crab populations? Increasing mortality of crabs in mid-summer from *Hematodinium* sp.? Disturbance of sook migrations and their wintering beds? No answers, but certainly a mandate to devote more time, money and effort toward a solution.

The flounder received similar attention as the most sought-after finfish -- and a matter of conflict between commercial netters and recreational fishermen. The issue here was simpler, if unresolved: how should the flounder "catch" be fairly divided between the resource-users, not just locally but also along the entire Atlantic coast?

Looking at successful management strategies, presentations by Dr. Scott Nixon and Mr. Billy Causey suggested the beneficial efforts of establishing aquatic sanctuaries that protect the resource while sustaining - and even enhancing - species populations outside the sanctuary areas. No doubt the time has come for water-use planning, just as it did for land-use planning and zoning a half century ago.

Strategies to mitigate the pressures from increasing tourist visits and year-around residential population growth were also highlighted in presentations, exhibits and poster sessions devoted to aquaculture and ecotourism, among other topics. In fact, the numerous exhibits (35) provided a substantial addition to the presented data and covered secondary aquatic species and stressor issues that were beyond the limit of the conference.

In the wrap-up panel discussion, resource managers, legislators and the business community noted the short-falls in Best Management Practices outlined during the conference, and pledged their support to the development of a cooperative Aquatic Resources Management Plan, which has been lacking in focus until now.

Tom Patton, President
Assateague Coastal Trust

PREFACE

The views expressed in these Proceedings are those of the individual authors and do not necessarily reflect the views and policies of the U.S. Environmental Protection Agency (EPA). Scientists in EPA's Office of Research and Development have prepared the EPA sections, and those sections have been reviewed in accordance with EPA's peer and administrative review policies and approved for presentation and publication. Mention of trade names or commercial products does not constitute an endorsement or recommendation for use.

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Planning Committee

Jim Alderman, Delaware Center for Inland Bays
David Blazer, Maryland Coastal Bays Program
Nancy Butowski, Maryland Department of Natural Resources
Mary Conley, Maryland Department of Natural Resources / Coastal Zone Management
Sarah Cooksey, Delaware Coastal Management Program
Tom Jones, Salisbury State University
Phyllis Koenings, Assateague Coastal Trust
Frederick Kutz, U.S. Environmental Protection Agency
Jim McGowan, Accomack-Northampton P.D.C.
Laura McKay, Virginia Coastal Program, Department of Environmental Quality
Francis O'Beirn, Virginia Institute of Marine Science
Tom Patton, Assateague Coastal Trust
Kent Price, University of Delaware
Bruce Richards, Delaware Center for Inland Bays
Gwynne Schultz, Maryland Department of Natural Resources / Coastal Zone Management
Eric Walbeck, U.S. Environmental Protection Agency
Cathy Wazniak, Maryland Department of Natural Resources / Coastal Bays Program
Dave Wilson, Maryland Coastal Bays Program

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University of Maryland Eastern Shore Cooperative Extension Service

University of Delaware Sea Grant Program

University of Maryland Sea Grant Program

Virginia Institute of Marine Science

Worcester County, Maryland

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Ms. Gretchen Messick, Center for Coastal Environmental Health & Biomolecular Research, Oxford Lab

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Mr. Bill Baker, Owner, Bill's Sport Shop, Rehoboth Beach, DE
Mr. Harley Speir, Chief of Biological Monitoring & Analysis Program, MD DNR
Dr. Bob Orth, Virginia Institute of Marine Science
Mr. Sam Martin, Owner, Martin Fish Company, Ocean City, MD
Mr. Richard Welton, Executive Director, Coastal Conservation Assoc./ VA
Mr. Steve Dawson, MD Department of Environment, "Outdoor Report" WBOC-TV

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Mr. Norville Prosser, Vice President, American Sportfishing Association
Mr. Jack Travelstead, Chief, Fisheries Mgt. Division, VA Marine Resources Commission
Mayor Jim Mathias, Mayor, Ocean City, Maryland
Mr. Marc Koenings, Superintendent, Assateague Island National Seashore

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Mr. Steve Parker, Virginia Coast Reserve, The Nature Conservancy

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Mrs. Jeanne Lynch, President, Board of Commissioners, Worcester County, Maryland
Mr. Charles "Buddy" R. Jenkins, Sr., President, Bay Shore Development Corporation
Ms. Margo E. Jackson, Deputy Director, Office of Ocean and Coastal Resource Management, NOAA
Mr. Henry Koellein, Maryland Saltwater Sportsfishermen's Association
Honorable Shirley Price, Delaware State Representative
Mr. Eric Schwaab, Director, MD Fisheries, MD Department of Natural Resources
Ms. Suzanne Schwartz, Director, Ocean and Coastal Protection Division, U.S. EPA

3:15 pm - 3:30 pm — Questions and Answers

3:30 pm - 3:45 pm — Wrap Up and Adjourn
Dr. Bruce Richards, Executive Director, Delaware Center for the Inland Bays
Mr. David Blazer, Executive Director, Maryland Coastal Bays Program

WELCOME

TOM PATTON, PRESIDENT
ASSATEAGUE COASTAL TRUST

Wayne Cannon and Mayor Mathias are a tough act to follow, but I have to add to their comments that this is a great time to be on Delmarva. This is a fantastic weekend and I think many of you out here, if you were not in this room today, you would be with me, out fishing on the coastal bays, not very far from here. The rockfish are running.

I want to welcome the speakers participating in our program, especially those that came in late last night or had to travel from afar this morning. I'd like to also welcome the resource management agency representatives at federal, state, and local levels. And I'd particularly like to thank all of those private citizens who've come here this morning, who represent the many interests that go into sustaining and protecting and using the aquatic resources in these bays--be they sport fishermen, recreators, or commercial fishing interests. We all have a place to use the resources and many of us have been waiting for this event for a long time to focus on the coastal bays.

I think those of us who live along the seashore have been hearing for many years what's taking place in the Chesapeake Bay, and that it's a wonderful estuary. But sometimes down here we say, "Well, why doesn't the media give us some of the attention?" We also hear about all that's taking place in trying to conserve the big resources on the continental shelf--the tuna, the swordfish, and so forth. And sometimes we feel like a little sliver of meat between these two thick pieces of bread that are overshadowing what we have to offer here.

This meeting is our time to give our input on what we want to see over the next 20 years. Much of what you're going to hear over the next couple of days is positive. Many good things are taking place on Delmarva. But there are stresses, and now is the time to look at these stresses, because we are in an area that is the fastest growing area of both Delaware and Maryland. Even on the Eastern Shore of Virginia, we are seeing the stirrings of economic development and demographic changes. Now is the time to be looking at what we can do to sustain the resource, to enhance the resource, to manage it, and to share it equitably among all of the users.

Before I turn the program over to our moderator, I would particularly like to recognize Phyllis Koenings, the Executive Director of the Assateague Coastal Trust, who's worked so hard over the last four months in helping make this conference possible. Thank you very much.

NUTRIENT ENRICHMENT OF SHALLOW MARINE ECOSYSTEMS

SCOTT NIXON, PH.D.
GRADUATE SCHOOL OF OCEANOGRAPHY, RHODE ISLAND SEA GRANT PROGRAM

Note: The following document is a transcription of the presentation by Dr. Nixon. It has been reviewed and approved by the author for publication.

Some of my first and finest experiences being out on the water were crabbing in Rehoboth Bay. I think that as a result of those experiences, I have had a life-long interest in these shallow water ecosystems that you call "inland bays". We call them "salt ponds" in New England, and most of the rest of the world calls them "coastal lagoons". But, by whatever name we call them, they are very special kinds of ecological systems. It is unfortunate that most of my colleagues in marine ecology and oceanography have pretty much ignored this special environment until the last 10 years or so. I don't know if it is because you can't come into these waters in sophisticated oceanographic research ships, but they were studied much less than the phytoplankton-dominated, open coastal waters of larger bays and estuaries. So, I appreciate very much the invitation of Kent Price of the University of Delaware and the Assateague Coastal Trust to participate with all of you in talking about these very shallow systems. An oceanographer has to call them "very shallow systems" because when oceanographers talk about shallow they mean less 100 meters deep, and these systems are usually less than 2 or 3 meters deep. Some of my colleagues who study blue water oceanography say that your I.Q. is directly proportional to the depth of the water you work in. I don't subscribe to that point of view.

One of the things that people in marine ecology struggle with all the time is envy for limnologists, those who study lakes, because the lake people have so many lakes to manipulate and study, and experiments can de done with them. We can't do that in the marine environment very easily, so one of the things we have done at Rhode Island has been to build little plankton-based bays inside tanks. This has been done at the Marine Ecosystems Research Laboratory (MERL). These tanks are giant aquaria, or living models, of Narragansett Bay. Narragansett Bay is a relatively deep embayment. It is almost ten meters deep on average, and it doesn't have any plants living on the bottom. The bottom is "heterotrophic", which means that it doesn't produce any organic matter. All the production, the total energy base of that estuary, comes from the phytoplankton in the water column. This is the kind of system we know the most about and has been studied most intensively and simulated using various computer models during recent decades.

I want to discuss the results of some experiments done in these tanks, to show you how well-behaved that kind of an ecosystem is, and then contrast it with the kind of environment we are talking about here in the coming days. We did experiments in these tanks where we added inorganic nitrogen, phosphorus, and silica to the water every day, in different amounts, over a two-year period, and we studied the response of several factors to that experimental addition. This was a very simple experiment and one that is very relevant to all of us because we know that a major human impact on the coastal environment is the fertilization of coastal waters by nutrient runoff and discharge. That is a ubiquitous anthropogenic perturbation that has been going on for decades, and it is going to continue and probably get a lot worse.

The annual average chlorophyll in the water column and the productivity of that phytoplankton-based system over the year as a function of the amount of nitrogen being put into the system was compared. The more nitrogen we add, production rises, and the standing crop of chlorophyll rises. It is very well-behaved. The results in the different tanks tightly fit the observations. That is the kind of result we would like. It makes you believe you have predictive power and you can relate the response of the ecosystem to the amount of nutrients coming into it. It is a wonderful management tool that gives you a great deal of power.

But, the kinds of systems we are talking about here today share one really important characteristic. All of these coastal systems have a very shallow water column. It is important because it dominates everything about these systems. It means that wind, for example, can be very effective in mixing them vertically, so that we tend to have fewer problems with dissolved oxygen in these shallow systems than we do in deeper bays and estuaries. But it also means the wind can suspend the sediment on the bottom easily and make the water very turbid, and that creates some problems. It also means that light reaches all the way to the bottom, and once that happens, it changes the whole ecology a great deal because instead of just having phytoplankton, single-celled plants to run the ecosystem on, suddenly we have multi-celled plants that grow all over the bottom sediments. We get mats of diatoms and filamentous algae that grow right on the sediment-water surface. Then we get macro-algae, or what people call seaweeds, that grow in the shallow systems -sometimes in great abundance. It means that we can have sea grasses, like eelgrass, or *Zostera*, growing in the sediments. These are angiosperms, seed-bearing plants, that grow here and not in the deeper water. And on those plants grow other plants, the epiphytes that grow on the leaves of the sea grasses. And then, of course, we have the phytoplankton in the shallow water itself. So the whole energy base of these shallow systems is much, much more complicated and diverse than it is in the continental shelf or deeper embayments, like Delaware Bay. That has very important consequences for the way they respond to nutrient enrichment, and to the way they produce finfish and shellfish.

Another characteristic of these shallow systems is that many of them are connected to the ocean by very shallow channels. Often these have been stabilized by engineers and made permanent, but in the past they were more ephemeral and they used to open and close. Because we have these narrow inlets, we often say that these shallow bays are frequently poorly flushed. I use that word with a great deal of reservation because I think the concept of "flushed" for an ecosystem is unfortunate, because most of us, if you will excuse me being blunt, are experienced with the word "flushed" as to do with a toilet. The hydrodynamics and the physics of flushing in an estuary are very different from the flushing in a toilet, because in a toilet when you flush, you get rid of everything. When we talk about the flushing rate of a bay or estuary, bear in mind that this is not that kind of a process. You don't get rid of all the water in the bay or estuary and replace it with new water. What happens is that things get slowly exchanged between the estuary and the offshore water.

If, for example, the flushing rate is 20 days for an embayment, it generally means that if you had put a conservative dye in that bay, (that didn't react with the water), after 20 days you would have a third of it still remaining in the lagoon, left and two-thirds would have been lost offshore. This is what we call an exponential process. In absolute terms, concentration of the dye drops quickly at first, but because you lose the same percentage every day, after 20 days of flushing time, you still have a third of the dye left; and 20 days later, there will be a third of that third left. So I think when people talk about pollutants in coastal bays and flushing rates, the term flushing is a bit of a misnomer. You have to remember you are talking about a very different process.

The other thing that is important is that when people are talking about chemicals like nitrogen, they are not conservative. They are taken up very dramatically by the biology in that lagoon. So the flushing time for water, or for a conservative dye, in a place like Rehoboth Bay, is very different than the residence time for a highly bio-reactive chemical like nitrogen. It may stay in there much longer than a passive tracer, like a dye, would. So we have to not confuse those two things.

But the shallowness of these systems, and their biological complexity, raises interesting questions for how they behave. It is unfortunate that we have started studying, with some intensity, these much more complex systems, so recently. As a result, our knowledge base for managing them, and making predictions about them, is not as good as it is for the deeper, more offshore, oceanic systems. We have to realize that we don't have the same levels of understanding and certainty.

I have gone through the literature and looked at the primary production for shallow bays like the ones you have here – the Delmarva Coastal Bays and a number of others all around the world. Places like the Lagoon of Venice even, which is a similar system in many ways to yours here. I looked at their rate of primary production compared to the rate at which nitrogen is added to those systems per unit area, and I have corrected it for flushing rate. The point I want to make is that they are very poorly behaved. There is no nice regularity in the response of these very shallow, biologically complex systems to nitrogen loading like there is in the phytoplankton-based systems.

The other point is that they are high. You get much more response for each atom of nitrogen in these shallow environments, than you do in the deeper ones. The same information can be expressed per unit volume of the coastal lagoons, because it is argued that if you start comparing these very shallow systems with much deeper systems you can't compare them per unit of fertilizer you put in per unit area, you have to compare per unit volume because they are so much shallower. The same data per unit volume are still poorly behaved. Even when we

correct them for flushing rate, they are still poorly behaved. So we don't have the kind of predictive capacity in these systems that we do in the phytoplankton-based ones.

Here is another important difference. In the MERL tanks that I discussed earlier, we have asked whether there is a relationship between how much nitrogen we dump into these systems every day and the concentration of nitrogen we measure in the water, if we had a monitoring program out there measuring dissolved inorganic nitrogen in the water. Does it relate very well to how much is going in? It is a simple sounding question and you think the answer should be "yes". In fact, in the MERL tanks you do get a pretty good relationship. It behaves nicely, although it doesn't behave like a conservative tracer. Not all the nitrogen shows up in the water, but enough of it does that we see a good relationship between how much is in the tank as we measure it in a monitoring program and how much is going in.

In very shallow systems, filled with sea grasses and seaweeds and algal mats on the bottom, we don't find any relationship between the amount of nitrogen we are putting in and how much we see in the water column. The water is essentially stripped of dissolved inorganic nitrogen all summer long. Even though huge amounts are being put in, it vanishes. That is because it is all tied up in the biology. In the shallow systems, you get biological organisms that are larger than phytoplankton, they turn over slowly, and their metabolism is lower. But these organisms act as a big storage for the nitrogen, so a lot of it is tied up in the biology and we don't see it in the water any more. That is another big difference between the two kinds of environments.

One of the questions that is often asked about very shallow systems is, when we begin to add more and more nutrients to them, which plant group wins? As outlined previously, we have the algae on the mud surface, sea grasses, seaweeds (macro-algae) and phytoplankton. Which one of those groups does best when you begin to fertilize the tanks? In the scientific literature, some authors contend that phytoplankton always win out, while others find that the seaweeds dominate. This is simply the result of surveying a lot of literature and finding out which group of plants is found in that shallow water system and how much nitrogen is estimated to be going into that system. Each of the numbers is 10 times the one before. So we have a 1000-fold range in how much nitrogen is going into these different coastal bays around the world. Some systems dots are dominated by phytoplankton as the major primary producers, others are dominated by seaweeds (macro-algae), while others are dominated buy sea grasses as conspicuous, dominant primary producers. This is done based on nitrogen per unit area and nitrogen per unit volume of the shallow water system.

The important thing to notice is that one can have almost any combination. You can have systems dominated by phytoplankton that are very oligotrophic, not heavily fertilized, or some that are extremely heavily fertilized--1000 times heavier. Seaweeds extend across a very wide range. There is no clear separation in the data as to whether phytoplankton or seaweeds are going to be dominant in highly fertilized systems. One thing that is clear, is that we don't get sea grasses in systems that are heavily enriched with nitrogen, they disappear.

If we can study phytoplankton-based systems using tanks like the MERL tanks, can we do the same thing with these shallow water systems? Can we make living models of those? We built shallow, coastal bay models that are a little over one meter deep and 4 square meters each. We used these because we think they are much more reliable than working with single species. One of the traditional approaches in science is to take a single species out of nature, culture it, have it there by itself, and then do experiments with it. But does that mean anything when you go back into nature and all the different parts of the system are together and interacting with each other? Often we find that it doesn't. So we are trying to do experiments not with the whole piece of nature, because we don't have all of the complexity of the real world in these tanks, but with a whole lot more than you get in a culture with a single species because we are able to capture a lot of interaction that is happening. We wanted to see if there were some interesting interactions between temperature and nutrient enrichment, because the environment is getting warmer. Every summer for the last 8 or 10 years has been warmer than the one before, and we wondered if there were some interesting interactions between higher temperatures and fertilization, since both of these things are happening together.

We ran some experiments last summer where we took long-term temperature records in the salt ponds on the Rhode Island coast. We maintained some tanks at the 10-year mean temperature, we ran some at 3-4 degrees warmer, and some 3-4 degrees cooler all summer long. We made them all the same to begin and then we fertilized some with nitrogen and phosphorus and didn't fertilize others. Then we looked for any interaction between the temperature and the nutrient enrichment.

In addition to the phytoplankton and zooplankton and bacteria in the water, we put eelgrass, red seaweed (*Agardhiella*), a green seaweed (*Enteromorpha*), and fish, oysters, and scallops, etc. into the tanks. So we had a rich biological community in there.

First of all, in the plot of the resulting phytoplankton in the water column and the biomass, or standing crop, of seaweeds in the tanks, we see right away, without putting any nutrients in, there is a temperature effect. We get more seaweed growing in the warmer tanks and we get phytoplankton blooms in the warmer tanks which are not evident in the mean temperature tanks or the cooler tanks. This has nothing to do with nutrient enrichment, just warm summers, and these are not unrealistically warm. These are summers that we have already encountered during the last 10 years in the temperature record.

When we add nutrients we get very large phytoplankton blooms in the early spring. The phytoplankton blooms last longer in the cold tanks than in the warm tanks, which means in the colder weather you could assume that this would be worse for the eelgrass because the phytoplankton is shading the eelgrass longer in the early spring when the grass is trying to grow and come up from the sediments, and the bloom lasts longer there. You might make that prediction, but you would be wrong as I will demonstrate later.

We also grew a lot more seaweed in the warm fertilized tanks than in the cold fertilized tanks. There is a big explosion in the seaweed biomass in the fertilized tanks, almost 6000 grams of seaweed. The interesting thing is that these are not the seaweeds we put in the tanks to start with, these are invasive seaweeds that came into the tanks from spores. We flushed the tanks at 10% a day with Narragansett Bay water, so these seaweeds entered as invaders into our mesocosm tanks, and they bloomed enormously. The species we put in the tank died off and didn't compete with these invasive species which took over. There is an interaction between the temperature and the nutrients that yields more seaweeds.

We also looked at what happened to eelgrass. Eelgrass had very little height growth over time in the warm tanks, either the unenriched or enriched. The ones that grew the best and got tallest were in the cold tanks with nutrient enrichment.

The lowest level of epiphyte cover on the eelgrass came in the warm tanks and the warm tanks with nutrients. These are not significantly different statistically, but on average there was a little less biomass of the epiphytes on the warm and nutrient treatment, probably because they were shaded by the seaweeds floating on the top. The invasive algae that grew there shaded out the epiphytes. They also shaded out the sea grasses, and there is a very dramatic difference in the survival of the eelgrass in the tanks with warm temperature and nutrients.

The grass did very well in the cold temperature, much better than it did in the warm temperature. The warmest summers we get are not good for eelgrass. At least with our northern strains of *Zostera*, really warm summers are too warm for our plants because they are very sensitive. So a few hot summers may go a long way to explaining why we are seeing a loss of our eelgrass in New England.

When you combine the higher temperatures with nutrient loading, the eelgrass does not do well at all. We lost virtually all of the eelgrass in that combined interactive effect between the nutrients and the high temperature. In treatments with nutrients and low temperature, the grass persisted. It did not do as well as in the controls, but it did fine. So there is a real potential for a problem there.

Looking at the higher trophic levels, the growth rate of the winter flounder juveniles, which were put into the tanks was much better in the cold tanks, and even in the cold nutrient enriched tanks, than in the warm tanks. None of the other fish showed any significant difference in their growth rates.

This is another difference between these shallow water ecosystems and the phytoplankton-based ones. In ten years of doing experiments, we have never seen any significant improvement in fish growth with fertilization of any of our shallow water mesocosms. Data from lots of experiments of different kinds on the growth of some of the major small bait fish that live in eelgrass meadows in these shallow coastal bays as a function of the rate at which we fertilize them over time, shows no fish growth response. That contrasts with phytoplankton-based systems in bays and shelf areas where, with higher primary production, we see an increase in landings data for the fish. Phytoplankton-based systems may be production-limited, and there really is a response of higher trophic levels to the primary production. In shallow areas, the productivity is so high anyway, it doesn't respond in a clear way to nutrient loading, so it doesn't seem that we get a payoff in increased fish production measured as growth, let alone reproduction and egg survival.

Questions

You were talking about seaweed and eelgrass, and here we talk about submerged aquatic vegetation, could you define how you use these terms?

Submerged vegetation, the botanical term is called submersed, and that is just a fancy botanical name for growing underwater, growing submerged. I think here in the Chesapeake Bay region, people usually refer to SAV or submersed aquatic vegetation, meaning the grasses or the rooted vegetation, and not including the seaweeds. But if you took the term submerged literally, it would include algae, including seaweeds, but people don't use it that way. They refer to the rooted plants. Seaweeds have no roots,

they get all their nutrition directly from the water, whereas there is a whole variety of seed-bearing and flowering plants that grow under water. Eelgrass has flowers and it has seeds. They are inconspicuous flowers, but they are flowering plants, unlike the seaweeds.

In your experiments on plant growth, how do you factor in the effect of natural wind conditions on growing plants in your lab?

That is probably a thing that we don't capture very well. Mesocosms are not a perfect tool and they don't reproduce everything we would like. We do have a current in them. We mix them with a clear acrylic paddle wheel. Each one has a paddle wheel that goes across it, that rotates in one direction for three or four hours, then reverses and rotates in the other direction. So it sets up an advective current in the tanks, but it doesn't mimic the episodic nature of wind very well.

Are you going to publish this data?

I hope so. We are going to try anyway. We have to write it up and it goes to the journals and the reviewers and it takes time. But we certainly are heading in that direction.

How do you factor in the dissolved gases in the different temperature gradients?

We measure continuously the dissolved oxygen in each of the tanks with electrodes and record all that and we also have direct measurements of the air-sea gas exchange of dissolved oxygen so we can correct for diffusion, and we can calculate the total production and the total consumption of organic matter in each tank. There is an effect of temperature on the saturation level of the oxygen. Because we keep these tanks well mixed, oxygen never gets low. We have never done a low dissolved oxygen experiment. It would be an interesting thing to do.

The oxygen was constant during the experiment?

No, it varies, there is a large diel cycle in it. Of course, during the day photosynthesis raises the oxygen up to super-saturation, and at night it goes down, but it doesn't vary as far from saturation as it would if we didn't mix it. If we shut the mixers off, within four or five hours these tanks go anaerobic, as your bays would too. There is so much metabolism occurring that if they stratify, or you put a lid on them, the oxygen goes right down.

What were your rooted vascular plants planted in?

We collected natural mud-sandy substrate from a coastal lagoon with a corer and put it in big trays. Then we brought it back in and put it down in the bottom of our tanks. So we plant the grasses in a natural sediment.

CURRENT STATUS OF IMPORTANT FINFISH STOCKS IN MARYLAND'S COASTAL BAYS

JAMES F. CASEY
MARYLAND DEPARTMENT OF NATURAL RESOURCES, FISHERIES SERVICE
COASTAL BAYS FISHERIES INVESTIGATION PROJECT

The Mid-Atlantic region, including the coastal bays have been the site of fishing opportunities for many centuries. Prior to the coming of the first Europeans, Native Americans harvested fish and shellfish by a variety of means. By the early seventeenth century, European colonists recognized that fish were in greater abundance than in their home waters. Early fishing efforts targeted sturgeon, whales and shad but ultimately settled on shad, herring, sheepshead and a variety of other species (Pearson, 1944). Both Native Americans and colonists fished for subsistence and for sport but by the mid - eighteenth century, shore side plantations began fishing commercially to supplement their income.

In the coastal bays area, large plantations often used haul seines and salted their catch for food and export. Later, small companies, using even longer haul seines set off ocean beaches, supplied growing east coast markets with a wide variety of fish products. Saltwater sportfishing accelerated during the nineteenth century as more and better equipment was manufactured. After formation of a stable inlet at Ocean City in 1933, both commercial and sportfishing interests benefitted by the easy ocean access.

Since then, landings by both user groups have accelerated here and coastwide, resulting in intense fishing pressure on many species. In the mid-Atlantic region today, nearly half of species for which a management plan has been prepared are considered overfished (NRDC, 1997). In response to declining stocks and public concern, a formal management process was initiated and regional councils were formed to manage stocks outside three miles. The Atlantic States Marine Fisheries Commission (ASMFC) is an interstate compact among east coast states which cooperatively manages shared stocks in state and marine waters. By 1998, 19 species were subject to federally mandated Fishery Management Plans (FMP) while other species are managed by state plans (ASMFC, 1998).

In Maryland's coastal bays and Atlantic Ocean, over 40 species of finfish are harvested commercially while over 20 species are sought by sportfishers. In 1995, the Atlantic coast accounted for 52% of total U.S. marine recreational finfish catch by number and for 62% of the fishing trips (NMFS, 1996). In 1996, estimates of the economic impact of sportfishing statewide to the state of Maryland totaled over $896 million (ASA, 1997). In 1995, the estimated number of sportfishing trips in Maryland's coastal area and Atlantic Ocean approached 1.0 million, generating in excess of $111 million in related expenditures. In 1995, commercial landings in Maryland were valued at over $60.5 million with an economic impact of $151 million (NMFS,1996). Both industries comprise a significant part of Maryland's economy and have an impact far beyond its borders.

The Maryland DNR Fisheries Service has maintained a fish population monitoring project in its coastal bays since 1972. The Coastal Bays Finfish Investigation Project characterizes stocks and estimates the annual relative abundance of juvenile and adult marine species in the coastal bays and near-shore Atlantic Ocean. This process involves monthly sampling from April through October of 20 sites with a fine mesh trawl and the bi-annual sampling of 19 additional sites by seine net. Both methods sample primarily juveniles. Monthly sampling trips aboard commercial ocean trawlers yield data on the age, size and sex composition of adult species. Areas of high value as spawning and nursery areas are delineated and data on juveniles and adults are evaluated to assess the local status of six important species - summer flounder,

weakfish, spot, Atlantic croaker, bluefish and black sea bass. Limited stock data is also furnished for eight additional species. To date, over 130 species of finfish have been identified from the coastal bays.

Summer flounder, weakfish, croaker, spot, bluefish and black sea bass are important finfish of Maryland's coastal region and are the subject of fishery management plans. In 1995, these species represented 64% of the total number of fish caught by marine recreational anglers in the mid-Atlantic region with the majority being caught in bays and inland marine waters or within three miles of the coast (NMFS, 1996). In 1995, mid-Atlantic region commercial landings for these same species exceeded 600,000 pounds.

Summer Flounder

Summer flounder is found in the coastal bays in both juvenile and adult stages. Spawning takes place offshore in the fall and winter with the larvae moving inshore to the shallow, forage-rich waters of coastal embayments. It is one of the fastest growing of the North Atlantic flatfish, reaching 6 to 12 inches (16 - 30 cm) during its first year of life and is fully recruited into both sport and commercial fisheries by age 2, when it averages 16 inches (40 cm) in length. This species is sought by both the commercial and sport fisheries with commercial catches from the near-shore Atlantic Ocean while sport catches are primarily landed in the coastal bays.

Summer flounder have been the subject of a very active effort to manage its harvest through a joint Mid-Atlantic Fisheries Management Council (MAFMC) - ASMFC Fishery Management Plan (FMP), first approved in 1982. Following a severe decline in the late 1980's, strict harvest controls were set. Subsequent amendments to the FMP regulated coastwide and statewide harvest by use of size limits, creel and landing limits, seasons, daily quotas and net mesh size limitations. A fixed coastwide harvest quota of 18,522,000 pounds (8.4 mt), of which 40% is a recreational quota, has been in place since 1996. Maryland's quota, based on traditional commercial and sport harvest levels, was set at 2.04% of the quota, or 226,600 pounds for commercial and 151,000 pounds for recreational interests. According to Amendment 12 of the Summer Flounder FMP, the stock is still considered to be overfished even though it is currently undergoing a slow recovery (ASMFC, 1998).

Annual catch of juvenile flounder by the Coastal Bays Fisheries project mirrors the resource recovery (*Figure 1*). The abundance of juvenile flounder less than 8 inches (203 mm) peaks in June and July then begins to drop off as the larger juveniles leave the bays. In 1998, the trawl index for juvenile flounder ranked as the 7th highest over the past 27 years. About 93% of flounder collected were Age 0, suggesting good reproductive success.

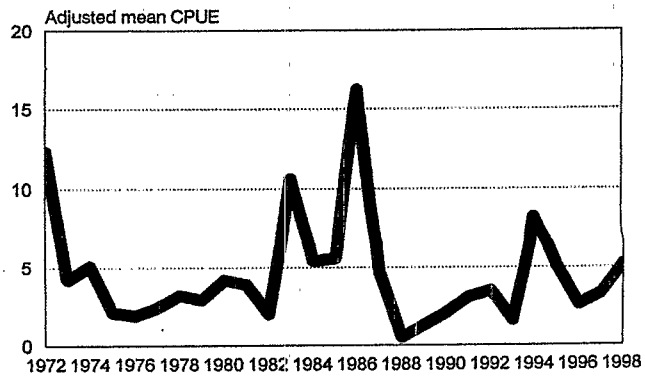

Figure 1. Catch per Unit Effort (CPUE) of Summer Flounder, Maryland Coastal Bays trawl, 1972-1998. (n-9767)

Offshore, the mean size of commercially caught flounder increased for the third straight year following an increase in the minimum legal size in 1997 from 13 inches (330mm) to 14 inches (356mm). In 1998, the plan also required commercial trawl nets used to catch flounder to use at least a 5.5 inches (140mm) mesh. The recreational size limit increased to 14.5 inches (368mm) in 1997, then to 15 inches (381mm) in 1998. The current recreational size limit on Maryland's coastal area is 15.5 inches (394mm) while the Chesapeake remains at 15 inches. A study of Maryland Saltwater Sportfishing Association member logbooks detailing their catch in Ocean City, indicated the ratio of legal to sublegal flounder has changed from 1 : 1.9 in 1996 to 1 : 3.7 in 1998, suggesting an improvement in juvenile production.

Weakfish

Weakfish, also called sea trout, has seen considerable variations in its abundance. Found along the Atlantic coast from Massachusetts to Florida, adults of this species migrate into bays and estuaries during the spring to spawn. The majority of adults then return to ocean waters, migrating south and offshore in the fall. The inshore areas then become important nursery grounds for the juveniles. Growth is rapid during the first year with juveniles reaching an average length of 6.7 inches (170mm). These juveniles usually leave the bays by December.

From 1980 to 1989, recreational landings decreased coastwide by 95% while the commercial harvest dropped 60%. Traditionally 80% of the weakfish harvest has been attributable to the commercial fisheries. Implementation

of ASMFC sponsored FMP measures, principally size and possession limits for sport fishers and size, season and net mesh size limits for the commercial fishery, have led to a steady increase in stocks. Commercial landings increased slightly between 1995 and 1997, while recreational landings increased 46% during the same period. Other restrictions such as the North Carolina closure to flynets south of Cape Hatteras and requiring shrimp trawl nets to include a bycatch reduction device to reduce retention of juveniles, are assisting in the recovery of this species.

The Coastal Bays Fisheries project contributes management information to the FMP. The catch of juveniles in Maryland's coastal bays indicate a steady increase in juveniles (*Figure 2*). The 1998 trawl index of juvenile weakfish was ranked 8th highest out of the past 27 years. The population of juvenile coastal bay weakfish peaks during the months of June and July and by September, begins a slow offshore migration. Offshore populations are being sampled for age, size and sex analysis and also suggest a slow but steady recovery.

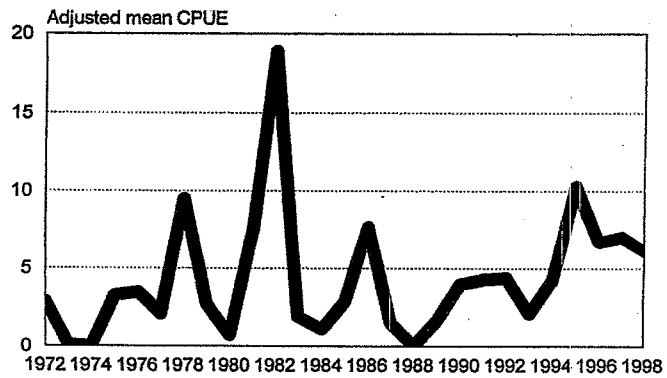

Figure 2. CPUE of Weakfish, Maryland Coastal Bays trawl, 1972-1998. (n=16200)

The mean size of weakfish caught offshore by commercial trawlers from Ocean City was 15.4 inches (391 mm), the largest since sampling of the commercial catch began in 1993. Imposition of a minimum size, season, and net mesh size requirements have been instrumental in improving mean size and year class abundance. In 1994, there were no fish sampled over four years old. Currently however, the average age of fish sampled is 4.15 years old with ages ranging from 1 to 8 years of age.

Atlantic Croaker

The croaker or hardhead has been a staple of commercial and sport fishing in Maryland waters for decades but annual recruitment is highly variable and dependent on natural environmental conditions. It is known that cold winters can have an impact on its abundance by reducing survival of young fish (Norcross and Austin, 1981), (Norcross, 1983). Fishing pressure can also have an influence.

This species can be found along the Atlantic coast from Massachusetts to Mexico with its greatest abundance extending from Chesapeake Bay to Florida.. It spawns from August through December in offshore waters of the Atlantic Ocean with the post-larvae migrating into coastal estuaries by late summer. Growth is rapid with most males reaching maturity by Age 2 and a size of 7.1 inches (180mm) and most females by Age 3 and a size of 8.2 inches (209mm).

Coastwide, recreational catches have varied from 3.6 million fish to 23 million fish while commercial catches have varied from 1 million to 64 million pounds (ASMFC, 1998). In 1987, a FMP was adopted for croaker in the states of Maryland to Florida, the area of greatest croaker abundance. There are no regulatory compliance requirements in the 1987 ASMFC Atlantic Croaker FMP. Only Maryland, Delaware and the Potomac River Fisheries Commission have size limits. There are few meaningful season limits. Gear restrictions and North Carolina's requirement for fish excluder devices in all trawl nets to reduce juvenile bycatch in the South Atlantic shrimp trawl fishery, may be, in part, responsible for croaker stocks now showing consistent improvement.

Increases in juvenile abundance in the coastal bays also suggest a steady improvement (*Figure 3*). Juvenile croakers peak in abundance during the late summer. In 1998, the Atlantic croaker trawl index was the 3rd highest of the past 27 years. During August, larger juveniles 8 to 9 inches (203-229mm) undergo migration, contributing to peak offshore commercial landings in September and October. The mean size in the offshore commercial trawl fishery in 1998 was 10.8 inches (274 mm), similar to the mean size in both 1996 and 1997.

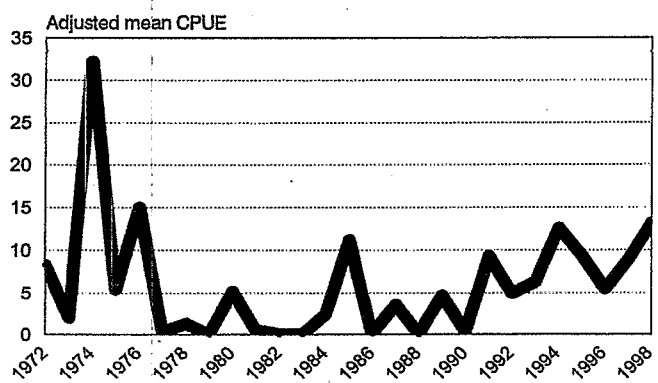

Figure 3. CPUE of Atlantic Croaker, Maryland Coastal Bays trawl survey, 1972-1998. (n=17099)

Spot

The spot is one of the most widely utilized species in the mid-Atlantic area. Found from Maine to Mexico, its greatest abundance occurs between the Chesapeake Bay and South Carolina Bottom feeders, the large spot population is considered one of the major regulators of benthic invertebrate communities in shallow embayments. During the fall, adult spot move offshore to spawn in a spawning season that extends from late fall to early spring. Larvae move into estuarine areas as early as December. Young-of-year then reside in tidal shallows during the summer, moving into deeper waters as temperatures decrease. Spot become mature late in Age 2 or early Age 3, when they are 7.3 inches (186mm) to 8.4 inches (214mm) long.

Commercially, small spot are caught for animal food and bait while those greater than 8 inches are sent to market. From 1987 to 1997, Atlantic coast recreational harvests varied from 2.0 to 4.4 million pounds while commercial harvests fluctuated between 5.6 and 8.0 million pounds. The spot is also an important food source for other valuable species. Their predators include striped bass, bluefish, weakfish, flounder and shark (Mercer, 1987b).

Juvenile abundance in the coastal bays in the 1970's fluctuated widely without trend. Since 1980, their numbers have declined substantially (*Figure 4*). The decline in the coastal bay spot trawl index is the greatest in magnitude of all species monitored over the past 27 years. The reason for the decline is unknown though a variety of factors are known to contribute to population variations including benthic forage availability, cold winters, fishing effort and habitat degradation (Mercer, 1987b). Although the ASMFC spot FMP was begun in 1987, there are no compliance requirements and the FMP review board judged that its recommendations were too vague.

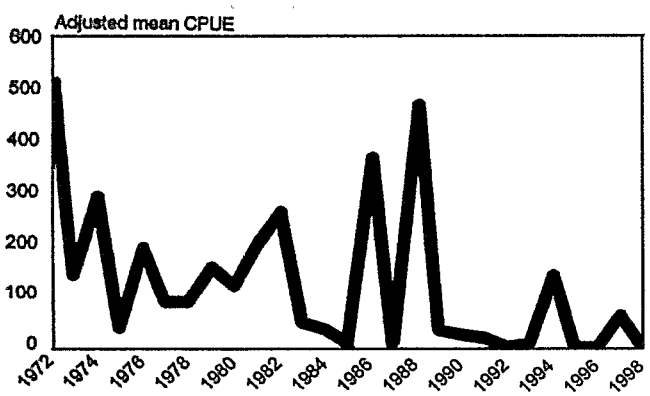

Figure 4. CPUE of Spot, Maryland Coastal Bays trawl, 1972-1998. (n=17526)

Currently, Maryland has no restrictions on the harvest of spot. Although recruitment data is being collected in several states for creation of a juvenile index, no formal stock assessment of spot has been conducted. Currently, the only management measure recommended is the use of bycatch reduction devices in trawl nets and delaying the harvest of spot until Age 1 or older.

Bluefish

The bluefish has a world-wide distribution with catch reports coming from the Black Sea, Indian Ocean and the Mediterranean. Along the east coast, it is found from Nova Scotia to Texas. They migrate extensively, traveling in like-size groups, following warmer waters and making local movements into coastal estuaries. In the mid-Atlantic area, spawning takes place from June through August in the offshore waters. Larval distribution is initially controlled by wind and currents until they begin to swim, at which time they move to deeper inshore waters. In the fall, these fast growing juveniles leave estuaries for the ocean. At this time, they are 2 to 4 inches long (50-100mm).

As late as 1989, bluefish was considered one of the top three recreational fish on the Atlantic coast. However bluefish have undergone a substantial decline in abundance. Stock biomass has declined from a high of 216 million pounds in 1979 to just 36 million pounds in 1994, a decrease of 83% (ASMFC, 1998). In the mid-Atlantic region, it is more actively sought by sport than commercial interests.

Historically, the estimated recreational catch of bluefish coastwide has been much larger than the recorded commercial landings (CBP,1990). In 1980, recreational landings of bluefish in Maryland tidal waters were estimated at 9.6 million pounds while commercial landings for the same year totaled only 437,000 pounds (Williams, et al, 1982, 1983). Even as late as 1985, bluefish were the preferred species on the Chesapeake (Fedler & Jacobsen, 1988).

The ASMFC bluefish FMP requires a commercial quota and recreational possession limit to reduce fishing mortality. These quotas and possession limits are adjusted annually. Currently the coastwide commercial quota is 9.583 million pounds while the recreational fishery requires a 10 fish creel limit.

In 1995, anglers in the northeastern U.S. spent an estimated $300 million to fish for them (NRDC, 1997). Found along the entire east coast, this species is judged to consist of only a single stock for spawning and management purposes. Environmentally induced physical

differences are discernable and in the past, two stocks were thought to exist.

This perceived decline in stocks may not be as bad as initial assessments indicated. Large bluefish may have moved farther offshore in the Atlantic than in prior years, perhaps in response to forage availability and other environmental factors. Until 1994, the majority of Maryland citation bluefish were caught in the Chesapeake but since then, the majority of these citations are from the Atlantic (*Figure 5*). Stock biomass is currently on the increase.

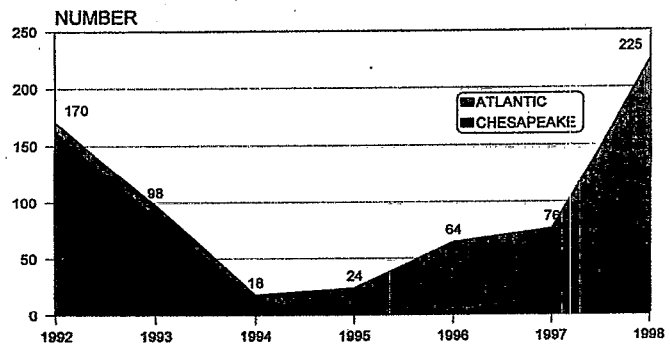

Figure 5. Number of bluefish citations awarded in Maryland, 1992-1998.

The coastal bays juvenile index has traditionally been low (*Figure 6*) and is most likely due to the pressure wave caused by the small mesh sampling gear and the ability of the fast swimming juveniles to sense and avoid it and the gear. It does however, indicate the continued presence of juvenile bluefish in the coastal bays.

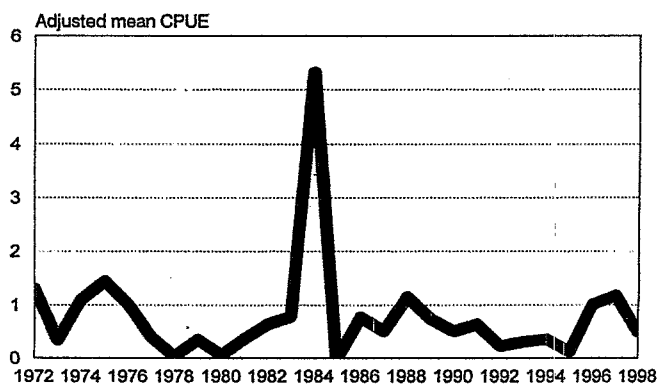

Figure 6. CPUE of Bluefish, Maryland Coastal Bays trawl, 1972-1998.

Black Sea Bass

Black sea bass are found from Maine to the Gulf of Mexico. This species north of Hatteras are seasonally migratory while those to the south are not. However, those of the mid-Atlantic region are year-round inhabitants of the offshore waters. Most black sea bass are hermaphroditic, functioning first as females then later in life as males. In the mid-Atlantic region, spawning takes place in the Atlantic Ocean between June and October.

Larval development takes place in the ocean. When about one-half inch in length (13mm), these juveniles move inshore to estuaries where they find habitat and forage in eelgrass beds and around structures like bridge pilings and wharves. Sea bass grow slower than many other coastal species but reach maturity at Age 2, when 7.5 inches(190mm) in length. At this stage, they leave the estuaries for the ocean.

In 1995, fish pots contributed 79% of the commercial landings while headboats and structure fishermen make up the bulk of the Maryland sport fishery. Virtually all the commercial and sportfish landings of sea bass are taken from the Atlantic Ocean. Though juveniles use the coastal bays, few adults are caught except by sportfishermen in the fall when the new adults are leaving for the ocean. The most recent assessment on black sea bass stocks, completed in June, 1999, indicates that this fish is over-exploited and at a low biomass level.

The joint MAFMC - ASMFC black sea bass FMP strategy calls for a reduction in fishing mortality over an eight year period beginning in 1996. Beginning in 1998, a commercial coastwide quota of 3.025 million pounds and recreational coastwide quota of 3.148 million pounds was instituted. States were given the additional option of a recreational seasonal closure of August 1 - 15 or a 20 fish creel limit.

Federal survey results indicate poor year classes in 1993, 1994, 1996 and 1997 with a moderate year class in 1995 and 1998 and a 1999 year class that was three times the average of the past 30 years. Increases in fishable stocks are expected in 2000.

The catch of juvenile black sea bass in the coastal bays is low and is probably due to the inability to sample its preferred structure habitat with trawls and seines (*Figure 7*). A fish pot, tailored to the coastal bays is currently being tested as a more appropriate gear.

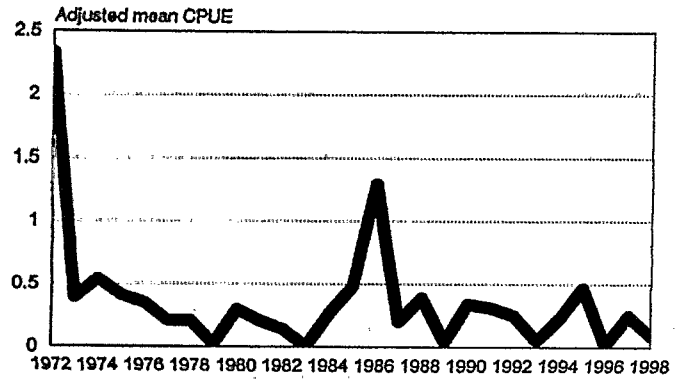

Figure 7. CPUE of Black Sea Bass, Maryland Coastal Bays trawl, 1972-1998.

Index of Forage Species

A coastal bays trawl index of forage species has been developed by Maryland Fisheries Service to give a general idea of the status of the availability of forage species to gamefish. Juvenile Atlantic menhaden, spot, bay anchovy and Atlantic silverside are a large component of the diet of many gamefish (CBP, 1990; CBP, 1991; Wilk, 1978,). Spot are caught by commercial and sport interests but menhaden are strictly a commercial species. Other than their use as a recreational bait, there is no fishery for bay anchovy and silversides.

Population levels of forage as determined by this index suggest that these species have undergone a very gradual decline over the past 26 years (*Figure 8*).

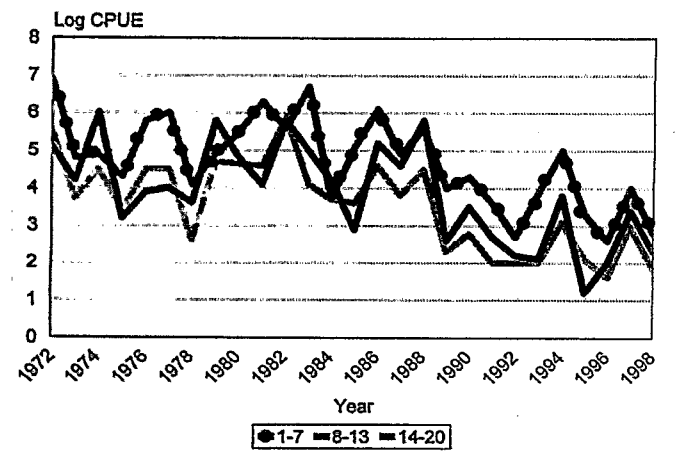

Figure 8. Forage Index for the Maryland Coastal Bays by sites. (Spot, Atlantic menhaden, Atlantic silverside, Bay anchovy)

Individually, each exhibit these downward trends (*Figures 9* and *10*). A variety of factors could be contributing to this decline, including increased predation, habitat alterations, water quality, natural environmental changes and others.

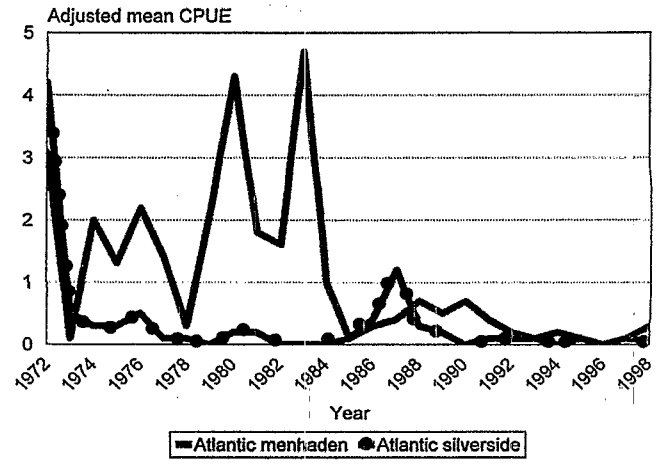

Figure 9. Atlantic menhaden and Atlantic silverside abundance, Maryland Coastal Bays, 1972-1998.

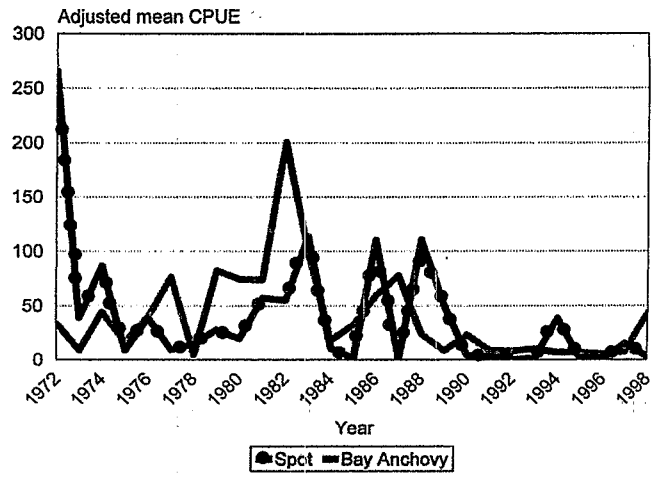

Figure 10. Spot and Bay anchovy abundance, Maryland Coastal Bays, 1972-1998.

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FINFISH RESOURCES OF DELAWARE'S INLAND BAYS

STEWART MICHELS
DELAWARE DEPARTMENT NATURAL RESOURCES & ENVIRONMENTAL CONTROL

Abstract

Finfish populations in Delaware's Inland Bays (Indian River and Rehoboth Bays) support substantial recreational and commercial fisheries. Between 1988 and 1998, recreational fishermen averaged 145,451 fishing trips and landed over 145,866 pounds of finfish annually from the Inland Bays. Annual commercial landings averaged approximately 35,269 pounds between 1985 - 98. In addition to providing recreational and commercial fishing opportunities, these small coastal bays support a diverse assemblage of juvenile finfish that utilize the area as important nursery and feeding habitat. The Delaware Division of Fish and Wildlife has monitored finfish relative abundance in the Inland Bays as part of its 16-foot bottom trawl survey (1986-98). Annual catches were typically comprised of over 41 finfish species, dominated by bay anchovy.

The survey has demonstrated the extensive use of the bays by young-of-the-year (YOY) weakfish, Atlantic croaker and spot. These species undergo large annual fluctuations in year-class strength. Although Inland Bays YOY summer flounder and winter flounder catch rates were relatively low, they typically exceeded catch rates encountered in the Delaware Estuary. Young-of-the-year relative abundance estimates for weakfish, spot and Atlantic croaker are correlated ($P \leq 0.05$) with YOY indices generated for the Delaware Estuary. This suggests that for these species, non-estuary specific factors are responsible for annual fluctuations in year-class strength. Continued monitoring of the Inland Bays finfish populations is essential to ensure their ecological, recreational and commercial value is maintained.

Table 1. Finfish species collected with a 16-foot bottom trawl from Delaware's Inland Bays (1986-98).

Bay anchovy	Striped bass	Smallmouth flounder
Spot	Crevalle jack	White perch
Weakfish	Blueback herring	Conger eel
Atlantic croaker	Blackcheek tonguefish	Northern stargazer
Silver perch	White mullet	Alewife
Atlantic herring	Pinfish	Fringed flounder
Atlantic silverside	Lined seahorse	Little skate
Atlantic menhaden	Spanish mackerel	Silver hake
Striped anchovy	Striped searobin	American sand lance
Hog choker	Pigfish	Spotfin butterflyfish
Summer flounder	Atlantic moonfish	Cownose ray
Northern pipefish	Gizzard shad	Spiny butterfly ray
Winter flounder	Northern searobin	Yellow stingray
Butterfish	Yellow perch	Cunner
Mummichog	Black drum	Atlantic spadefish
Northern kingfish	Lookdown	Banded rudderfish
Bluefish	Green goby	Red hake
Black seabass	Etropus spp.	Striped killifish
Naked goby	Harvestfish	Sandbar shark
Scup	Clearnose skate	Smooth puffer
Oyster toadfish	Threespine stickleback	King mackerel
Northern puffer	Bluegill	Grey snapper
Inshore lizardfish	Rainwater killifish	Cobia
Smoth dogfish	Planehead filefish	Striped bass hybrid
Spotted hake	Pollock	Bluntnose stingray
American eel	Rough wilverside	Brown bullhead
Windowpane	American shad	White catfish
Striped cusk-eel	Feather blenny	Striped burrfish
Fourspine stickleback	Striped blenny	Striped mullet
Tautog	Orange filefish	Grubby

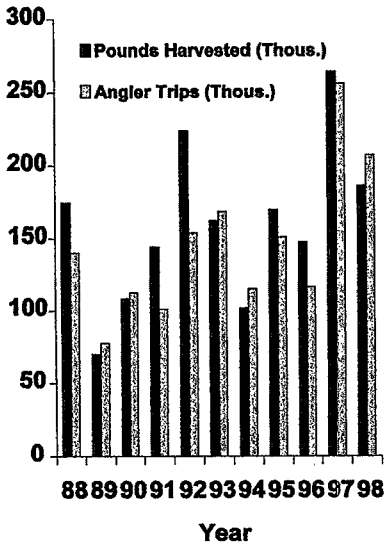
Summary

- Delaware's Inland Bays, though small, support substantial commercial and recreational finfisheries.
- Recreational fishing effort in the Inland Bays exceeds that of the Delaware Estuary by area.
- Trawl sampling shows that the Inland Bays are used extensively as nursery habitat for a variety of species.
- Long-term monitoring is necessary to identify changes in these important estuaries. This is especially true when one considers the large fluctuations in year-class species strength exhibited by many.

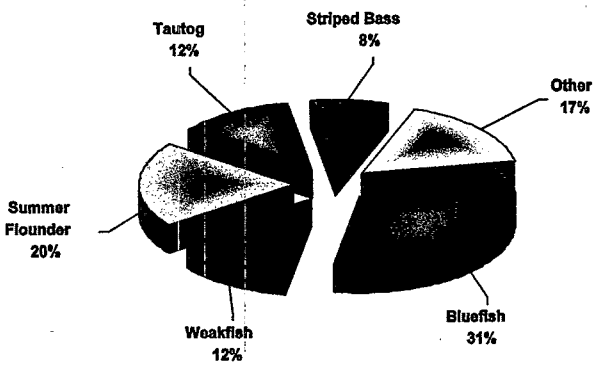
Suggested Reading

Assessment of the Ecological Condition of the Delaware and Maryland Coastal Bays, U.S. EPA, 1996.

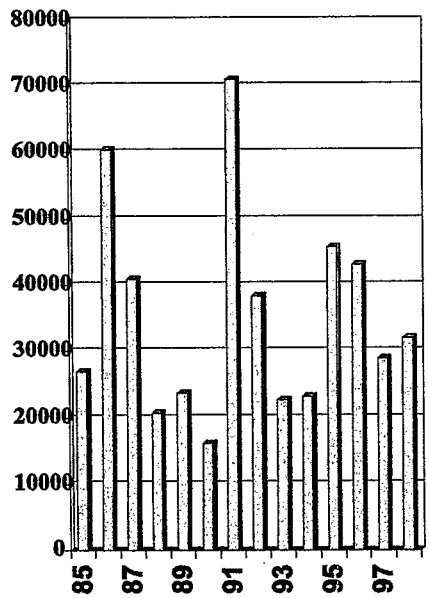
Delaware's Inland Bays Recreational Harvest and Effort



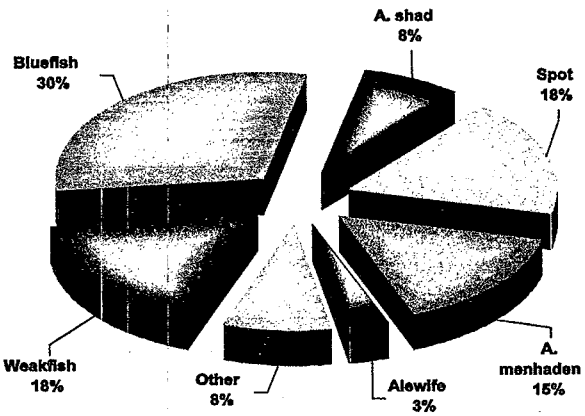
Recreational Catch Composition 1988-98

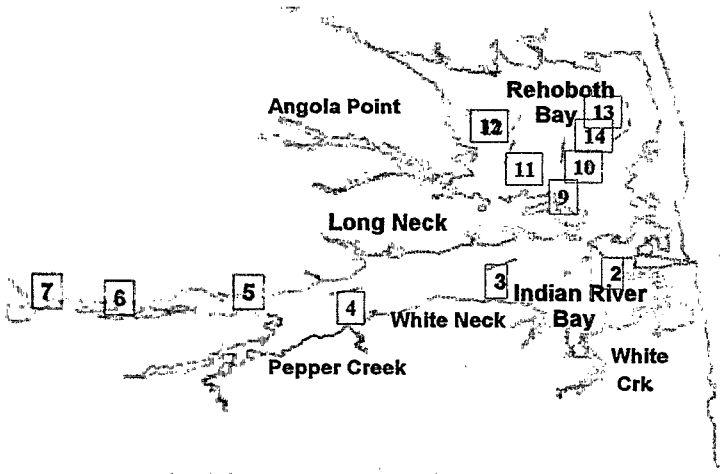


Inland Bays Commercial Landings



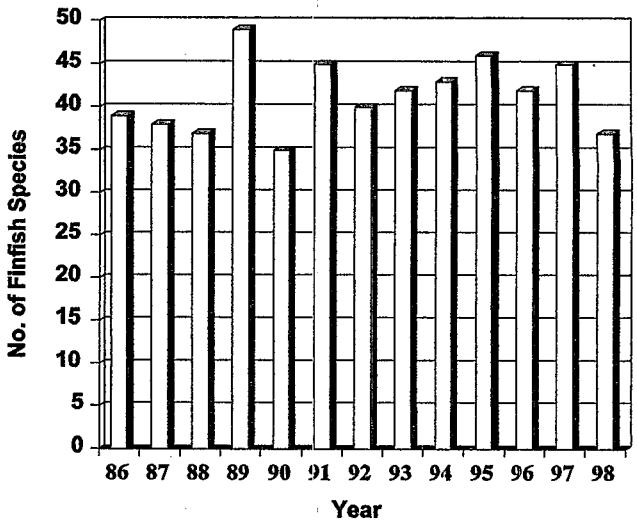
Commercial Catch Composition 1985 - 98



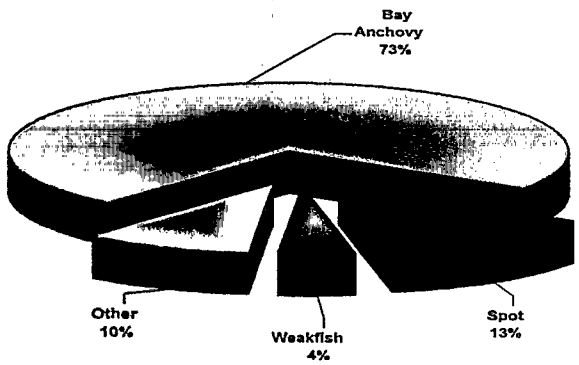


Juvenile trawl sampling sites in the Indian River and Rehoboth Bays.

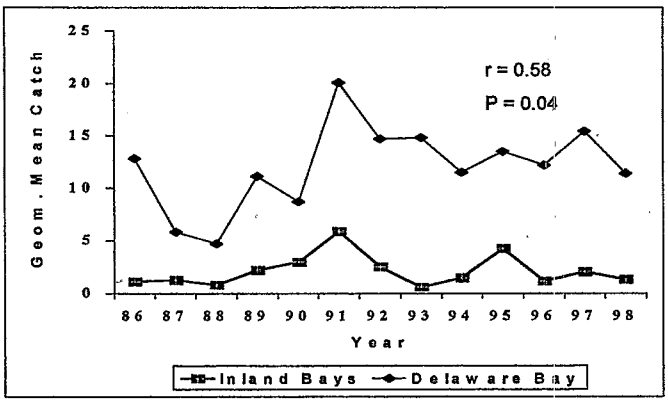
Annual number of species collected with a 16-foot bottom in Delaware's Inland Bays (1986-98).



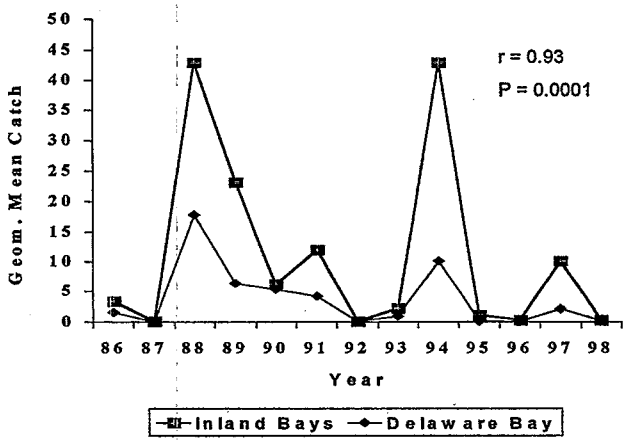
Delaware's Inland Bays 16-foot bottom composition (1986-1998).



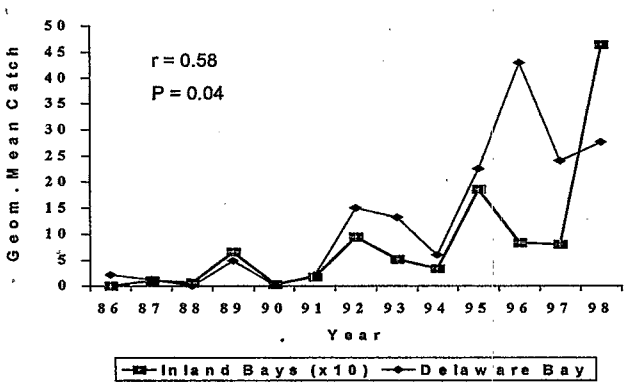
Young-of-the-year weakfish indices of relative abundance (1986 - 98) for the Delaware Estuary and Delaware's Inland Bays.



Young-of-the-year spot indices of relative abundance (1986 - 98) for the Delaware Estuary and Delaware's Inland Bays.



Young-of-the-year Atlantic croaker indices of relative abundance (1986 - 98) for the Delaware Estuary and Delaware's Inland Bays.



RECENT TRENDS IN BLUE CRAB FISHERY

JOHN MCCONAUGHA, PH.D.
OCEANOGRAPHY DEPARTMENT, OLD DOMINION UNIVERSITY

The blue crab, *Callinectes sapidus*, is an important ecological and commercial species in the estuaries, inland bays and lagoons along the Atlantic coast of the United States. With the decline in other fisheries throughout this region the blue crab has become a dominant fishery. This has resulted in rapid escalation of fishing pressure on this species (Virginia Marine Resources Commission and Maryland Department of Natural Resources data). Concern has been raised among managers, environmentalists, and watermen about the health and future of this important resource. It is the goal of this short review to examine the role that key life history stages of this species may have on population density and future fishery stability. It is not meant to be an in-depth review of the vast literature on this topic.

Examination of the annual harvest of blue crabs in Chesapeake Bay over the past 50 years indicates that this species has undergone wide fluctuations in abundance from year to year. Periodic drops in abundance over the last 100 years has often led to newspaper headlines suggesting the demise of the fishery. The blue crab, like many marine benthic invertebrates has a complex life history which includes a planktonic larval stage, a post-larval / juvenile recruitment stage, and the adult reproductive stage. Each of these life history stages can contribute to annual and inter-annual fluctuations in crab abundance. These natural fluctuations coupled with intense fishing pressure could have a long-term adverse effect on the fishery.

Early research on blue crabs concentrated on understanding the life history of this interesting estuarine species. In general, juvenile crabs, both male and female, migrate up the estuary to lower salinity waters during the fall and spring of their first year, mature during the summer and mate in the following fall (van Engel, 1958). Following mating, mature impregnated females begin their migration to the lower mouth of the estuary or lagoonal system where they spawn and release larvae in the second summer (van Engel, 1958).

Over the last 20 years ecological studies of the blue crab have focused on understanding the physical, biological and chemical factors that influence the life history. Ovigerious females with late stage embryos ("black sponge") migrate to the mouth and inner shelf regions adjacent to coastal bays and lagoons to release larvae. Hatching occurs on nighttime ebb tides (Provenzano *et al.*, 1983, McConaugha, 1988, 1992; Morgan, 1995). This hatching behavior insures that the positively photo-tactic and negatively geo-tactic larvae (Sulkin, 1984) are carried out of the estuary onto the continental shelf.

Because these larvae are concentrated in the upper one meter of the water column (McConaugha, 1988; 1992) larval transport and distribution are greatly influenced by wind forcing (Johnson, Hester and McConaugha, 1984; McConaugha, 1992; Garvine, *et al*, 1997). Prevailing winds in the mid-Atlantic Bight during the summer spawning season are from the south-southwest. This general wind pattern, depending on strength and duration, can establish an offshore northward flowing counter current at the surface and up-welling along the coast (Johnson, Hester, McConaugha, 1984; Garvine, *et al.*, 1997). This counter current forms a nursery ground for the development of the larval stages of the blue crab along the inner continental shelf region of the mid-Atlantic Bight (McConaugha, 1988). Cross-shelf transport of the post-larval megalopal stage has been correlated with northeast wind events (downwelling favorable winds) that force water across the shelf towards the landmass (Goodrich, *et al.*,1989).

Megalopae that are transported toward the estuary receive chemical cues emanating from the estuary and change behavior patterns (Forward, 1997). These behavior changes initiate selective tidal transport, which

results in larvae being in the water column only during nighttime flood tides. This allows megalopae to be transported into the estuaries while reducing visual predation. Variability in the strength and duration of both wind patterns from year-year can account for large shifts in post-larval recruitment into the estuaries. Using a simple model, Johnson and Hester (1989) estimated that 36 to 40% of the annual variation in observed harvest could be attributed to variations in the summer wind patterns and subsequent recruitment. Using the more sophisticated model of Garvine, *et al.* (1997) which incorporates both winding forcing processes and transformation of the raw harvest data from a calendar year to a biological year could demonstrate that the contribution of larval transport and recruitment to observed fluctuations in harvests greatly exceeds 50%.

While variability in environmental parameters contributes to the often wide inter-annual fluctuations in harvest (*Figure 1*), the offshore nursery ground can provide post-larval recruits to a region following an ecological catastrophe. During the period of 1990-1993 there was an out-break of the blood parasite *Hematodinium* sp. which attacked the adult crabs in the high salinity lagoons and inland bays of the Delmarva Peninsula. This disease reduced the commercial harvest from approximately 3 million pounds per year in 1989 to 0 for 1991-1992. By 1995 the fishery had recovered in large part due to a strong post-larval recruitment in 1994 (Brumbaugh, 1996).

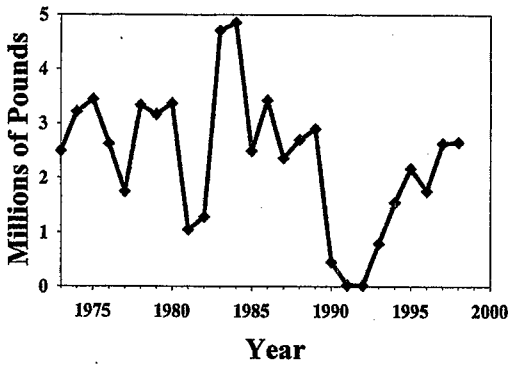


Figure 1. Hard Crab Harvest on Eastern Shore, Virginia

Following recruitment to the estuary, post-larval megalopae metamorphose into the first crab stage. These small crabs (2-3 mm) prefer architecturally complex habitats that can provide refuge from predation. In the Chesapeake Bay there is an extensive literature on the use of Submerged Aquatic Vegetation (SAV) (sea grasses) as a preferred habitat for juvenile blue crabs from the first crab stage to approximately 20mm in size (Orth et al.,1990). While SAV can enhance survival of juvenile blue crabs they are not essential for strong yearclasses since large harvests have occurred during periods of low SAV coverage (*Figure 2*). Along the Delmarva system of inland bays and lagoons most areas of sea grasses were lost to disease in the 1930's and have never recovered. In the absence of SAV, macro-algae and oyster reefs may provide the necessary structural refuges (Brumbaugh, 1996). The role of salt marshes as habitat for these early stage juvenile crabs is less clear. Because the marshes along the Delmarva Peninsula are inundated for longer periods they may function as habitat refuges in this system. However, the salt marshes are important habitats for the larger juveniles (>20mm).

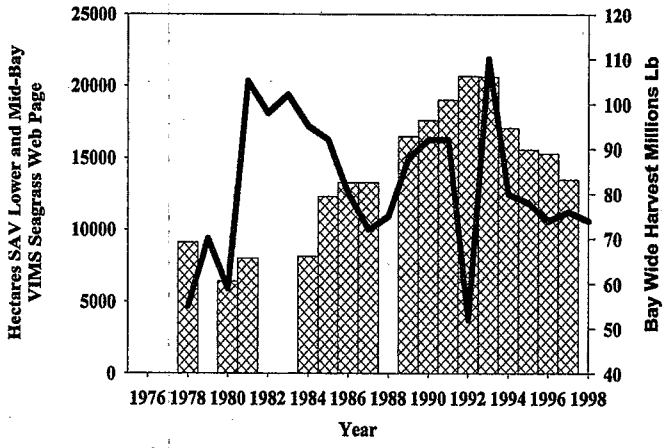


Figure 2. Hard Crab Harvest on Eastern Shore, Virginia

For the reproductive population there are two outstanding issues: what is the age structure of the population, and what is the cause of the observed decline in size of both mature male and female crabs. Knowing the age structure of an exploited population is an essential component of modern fisheries management. In many species age determinations are made by examination of hard parts that show incremental growth over time, i.e. otoliths, scales, molluscan shells, or teeth.

Animals generally grow at seasonally varying rates, which produce annual growth rings in these calcareous structures. Counting these rings ("annuli') provides an estimate of age in years. These techniques have proven successful in fish and molluscans. In crustaceans, however, the lack of a growth record in a permanent hard structure has curtailed the determination of chronological age. To overcome this problem, less precise methods like modal analysis of length frequency data have been used (Rothschild *et al.*, 1992). Unfortunately, these methods are inherently imprecise particularly when the spawning season is protracted as in the blue crab, resulting in a wide distribution of sizes in a single year class (Prager *et al.*, 1990). Age determination of crustaceans is particularly difficult since crustaceans molt their calcareous exoskeleton to accommodate future growth and in the

process abandon any external evidence of age or previous size. At each molt an internal space is created which is filled over time by the growth of soft tissue. Thus crustacean soft tissue growth may be continuous while carapace size, the most frequently used measure of growth and age, is a discontinuous function of time.

Every organism that uses oxygen generates free radicals and aldehydes during normal cellular metabolism. To reduce possible damage from these highly reactive molecules, cells use a series of reactions that cross link these compounds with unsaturated lipids, nucleic acids, proteins and other molecules to form conjugated schiff bases of the general structure, -N=C-C=C-N- (Tappal, 1975; Sohal and Donato, 1978; Hack and Helmsly, 1983). Termed lipofuscins, these lipoprotein complexes are highly stable, and accumulate in lysosomes over the life of the organism. These granules can be observed, counted and measured in histological sections of a crab brain using epifluorescent microscopy and image analysis techniques. Lipofuscin granules fluoresce a bright yellow-green. Since these granules accumulate as function of metabolic activity and age they can be used as an indicator of age.

Using laboratory reared (known age) animals, we have established that the area of lipofuscin granules in blue crab brains increases as a function of age. Applying this technique to small group of field collected animals the data suggest that blue crabs live to be 2.5 - 3 years of age. To confirm this preliminary conclusion will require the examination of a much larger group of animals.

In conjunction with a decline in abundance, the mean size of male and female blue crabs in Chesapeake Bay has declined in recent years. These observations are cited as evidence of both recruit and growth overfishing. Evidence supports the growth overfishing hypothesis in males but there may be an underlying biological explanation for the decline in mature female size. Two parameters that affect size at maturity are the age at maturity and overall fecundity of an animal at a given age/size. For decapod crustaceans, the number of eggs produced/brood is size dependent. In a stable environment, reduced population size should result in increased resources per individual. The number of reproductive events/female/year is partially dependent on energy resources. Reduced size at maturity may reflect trade-offs that allow females to produce smaller more numerous broods earlier in the life history of an animal and to extend spawning over two years. Fitness should increase since the number of offspring $\geq$ large females but are produced over two seasons. With development of the aging technique, this hypothesis can be directly tested.

Based on the life history phase of the blue crab, we can examine the potential management actions that can be used to improve the viability of the blue crab fishery in the region's bays and lagoonal systems. The larval phase is very important in determining the interannual variability of blue crab populations (Table 1).

Because the causes of variability are large-scale physical forces, which effect the retention or dispersal of blue crab larvae on the continental shelf, no direct management efforts can be applied. Only indirect management efforts are possible, such as the development of better predictive models of larval transport under varying environmental conditions. Variability associated with the early (<20 mm) juvenile life history phase is influenced by the availability of structured habitats such as SAV, macro-algae and oyster reefs. The availability of fine structured habitats can influence survival rates of megalopae and small juvenile crabs. Management efforts to increase SAV and oyster reefs will have an indirect effect on crab population dynamics. Management can act directly to regulate the exploitation rates on mature blue crabs by establishing size and season limits. But even here, if the cause of reduced female size is not over fishing, but a function of crab abundance then changing size limits or not harvesting mature females may have little impact on the long-term population dynamics of the blue crab.

Table 1. Management Implications of Life History Phases of the Blue Crab, *Callinectes sapidus*.

Life History Phase	Location	Effects on Yearclass Strength	Management Possibilities
Larval development	Offshore	Very Important	Predictive Model
Juveniles	Bays and Lagoons	Important	Indirect via Habitat Enhancement
Adult Reproduction	Lower Bay	Important	Management of Fisheries Regulations

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STATUS OF BLUE CRAB STOCKS IN MARYLAND'S COASTAL BAYS

ALAN WESCHE
MARYLAND DEPARTMENT OF NATURAL RESOURCES, FISHERIES SERVICE
COASTAL BAYS FISHERIES INVESTIGATION PROJECT

The blue crab (*Callinectes sapidus*) is one of the most economically important animals in Maryland's coastal bays. The warm, shallow waters of the coastal bays provide ideal habitat for all stages of the blue crab's life cycle, while waters near the Ocean City inlet provide the necessary conditions for development of the crab's early life stages. Shallow submerged aquatic vegetation (SAV) beds on the bay's eastern side provide an ideal nursery and overwintering area for the developing juveniles. The shallow waters of the bays are seasonally abundant with juvenile finfish, clams and other invertebrate forage which are vital to the crabs' development to marketable size.

Early colonists noted that the native people of the region included blue crab in their diet and colonists soon developed a taste for crabs. A commercial fishery was slow to develop because rapid spoilage restricted shipments to coastal communities until the advent of refrigeration in the 1870's. The management history of this important recreational and commercial fishery is interesting with many changes and additions to laws and regulations over the years (*Table 1, Genovese et al. 1999*). Differences exist in the rules for crabbing in the Chesapeake Bay and the Coastal Bays which recognize the differences in size and abundance of crabs available and the physical characteristics of the bays. The resultant rules for all of Maryland are necessarily extensive and complex to cover the varieties of gear used, the potential for gear conflicts, and the wide geographic distribution of the crabs.

Characterization of the Coastal Bays Population

An ongoing trawl and seine study, begun in 1972, has allowed the Maryland Fisheries Service to monitor the blue crab population in the coastal bays. We use a 16 foot wide bottom trawl with a 1 inch square mesh body and 1/4 inch square mesh cod end which retains most juvenile finfish and crabs. The trawl is pulled by boat for six minutes at fixed sites throughout the coastal bays. In addition a 100 foot long x 6 foot deep x 1/4 inch square mesh seine with a 6 foot x 6 foot x 6 foot pocket or bag in the center is used for sampling shallow water at 19 sites. Trawl sites are sampled monthly during the months of April through October and the seine sites are sampled only during June and September. All crabs are counted and size and sex are recorded for a random sample of the first fifty crabs for each site. A blue crab sampling program on the Chesapeake uses a similar trawl and comparison of catch from these two projects shows Chesapeake Bay crabs are larger than their coastal counterparts (*Table 2*). Blue crabs tend to reach a larger average size in waters of lower salinities and are more desirable to both commercial markets and recreational crabbers. However, crabs tend to mature at smaller sizes as temperature and salinity increase (Fisher, 1999). Temperatures in coastal bay waters have been recorded as high as 30 degrees C. (86 F.) with salinities as high as 37 ppt. Salinities in the Maryland portion of the Chesapeake range from 0 to 20 ppt.

Because of their smaller size, coastal bay hard crabs aren't as desirable in the commercial market. However, the shallow waters warm up faster and bring on an early spring peeler run, attracting many local and Chesapeake crabbers to take advantage of this valuable growth stage. In 1994 over eighty commercial crabbers used the coastal bays throughout the course of the year (Casey, 1994). A total of 18-20 local crabbers participate in the fishery annually and an additional 20-60 out of county crabbers may be expected in the first few months depending on the strength of the peeler run. Landings of soft and peeler crabs appear to parallel the landings of hard crabs except for a few years (*Figure 1*). All of these landings presently

Table 1. Summary of History of Blue Crab Management in Maryland

1873	Soft crab first introduced as a "food article", probably from Crisfield, MD
1878	Hard crabs were picked and packaged in Hampton, VA
1880	Demand for MD blue crabs is widespread and statistics collection begins
1906	MD establishes a closed season for crabs (Nov 1 - April 30)
1917	MD size limit of 5" (all waters of the state) and also bans taking and possession of sponge and green crabs
1928	First record of peeler crab scrape being used; MD begins collecting records from packers and shippers
1936	Crab pot invented, majority of harvest until this time was by trot line; pots not used until about 1939 in MD
1941	WWII displaces many watermen and harvest declines significantly.
1947	MD permits the taking of sponge crabs and the use of crab pots in ocean bays and tribs; also permits hand drawn dredge in Ocean bays during Nov 15 - March 15
1948	Crab pots legalized in Tangier and Pocomoke Sounds, limit increased to from 35 to 50/licensee in MD
1956	A new harvest reporting system is instituted
1959	MD pot limit increased to 100/licensee
1966	Size limit for mature females in Worcester County rescinded
1971	A landmark court decision removes county residency requirements for commercial fisheries
1972	MD allows waterfront homeowners a few unlicenced crab pots from their piers
1974	MD repeals winter season for Worcester County, season is now April 1 - Dec. 31 statewide
1979	Non-commercial crabber license established allowing the use of trotlines over 100 yards and a 3 bushel daily limit
1980	MD requires special license for Worcester Co. (limited to 150 pots, tags issued)
1981	Harvest of 60 million pounds, highest on record
1983	MD repeals prohibition on the taking of sponge crabs; license system restructured; allows nonresidents to purchase licenses and establishes the TFL license which allows unlimited # of crab pots; permits crabs caught in Worcester Co. waters to be landed out of state
1984	MD allows two bushels per boat for unlicensed crabbers
1985	300 pot limit for Coastal Bays
1989	MD re-adopts ban on taking of sponge crabs but allows possession of out of state sponge crabs; Chesapeake Bay Blue Crab Fishery Management Plan adopted
1994	Limited Entry Bill gives MDNR authority to establish a prescribed number of people to participate in any given fishery; different reporting system adopted; Cull rings required to be installed in crab pots; sport crab license eliminated
1995	MD's Coastal Bays Program Established
1999	MD's Coastal Bays recognized as a separate entity from the Chesapeake Bay and the need for separate management plans determined; sport crab license required for Chesapeake waters only.

come from crab pots. On an average year, over 950,000 pounds of hard crabs and over 69,000 pounds of peelers and soft crabs will be landed from the coastal bays, providing over $820,000 to the local economy. The percent of the total harvest comprised by soft/peeler crabs is much higher for the coastal bays than the Chesapeake Bay (*Figure 2*).

Harvest of hard crabs in the coastal bays has fluctuated with no apparent trend. Between 1979 and 1998 catch has varied from 375,000 pounds (170,099 kg) to 1.6 million pounds. The harvest of soft and peeler crabs is similar, varying from 17,000 pounds to 184,000 pounds (83,462 kg) (*Figure 3*). From 1980 to 1990, a comparison of coastal bay and Chesapeake Bay landings suggests only a weak relationship between the two. Since 1991 however, fluctuations in landings generally parallel each other (*Figure 4*).

Table 2. Mean Size of Blue Crabs from the Maryland Coastal Bays Trawl Survey and the Maryland Chesapeake Bay Blue Crab Survey, 1993-1998

Size Category	Coastal Bays	Chesapeake Bay
All sizes and sexes	57.3 mm (2.3")	87.4 mm (3.4")
Females mature	134.6 mm (5.3")	151.00 mm (5.9")
Males > 5 inches	137.8 mm (5.4")	146.7 mm (5.8")

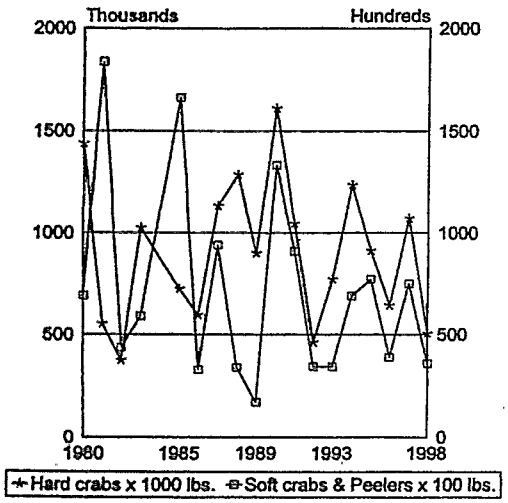

Figure 1. Coastal Bays Blue Crab Landings Comparison; Hard vs. Peelers/Soft, 1980-1998.

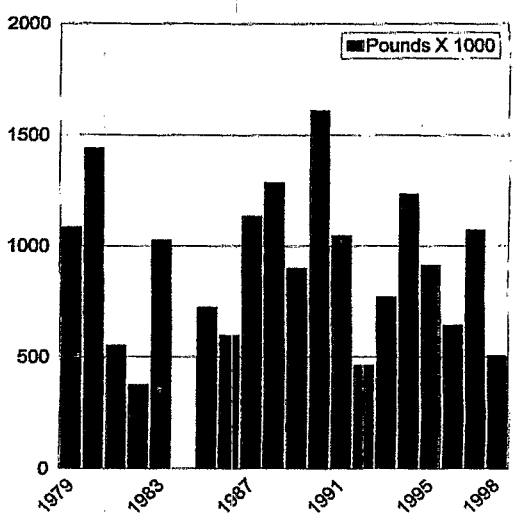

Figure 3. Coastal Bays Blue Crab Harvest, 1980-1998.

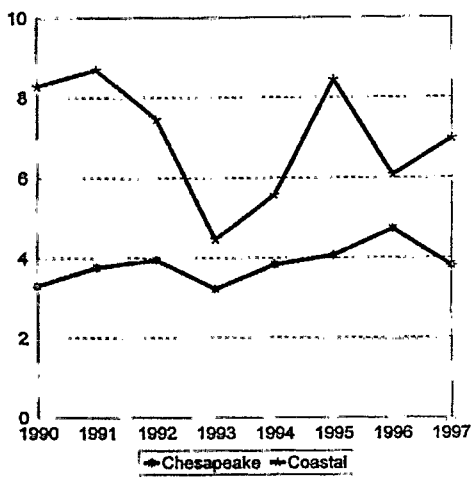

Figure 2. Peelers and Soft Crabs, Percent of Total Catch; Chesapeake Bay vs. Coastal Bays, 1990-1997.

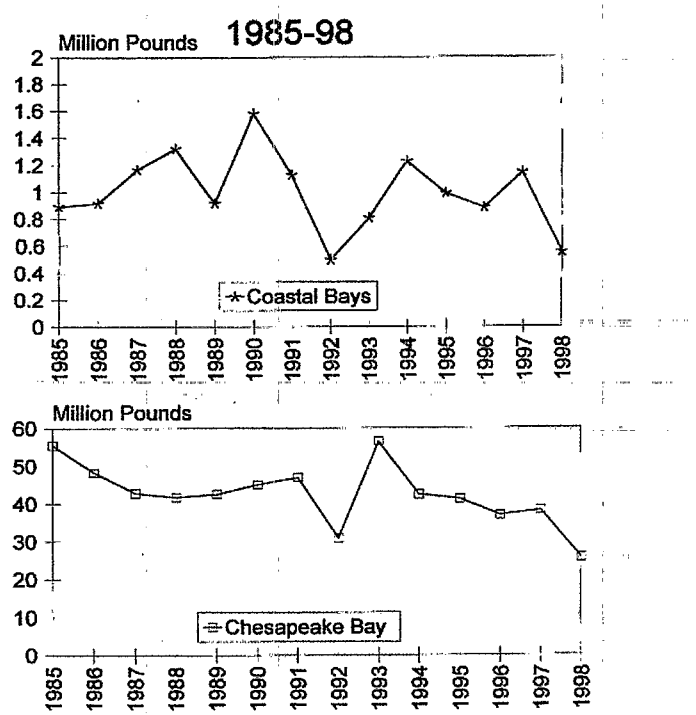

Figure 4. Maryland Coastal Bays and Chesapeake Bay Blue Crab Landings, 1985-1998.

Observations on the Coastal Bays Blue Crab Population from Trawl and Seine Survey

Over the past six years, the mean sizes of crabs from the 20 trawl sites varied from 1.7 in (42.5 mm) to 3.7 in (93.3 mm), averaging 2.3 in (57.3 mm). At the shallower seine sites, mean sizes varied from 1.6 in (41.2 mm) to 2.5 in (63.4 mm) and averaged 1.9 in (48.4 mm). Smaller crabs prefer the shallow water sampled by seine. There is some variation in average size between the five bay areas (Assawoman, Isle of Wight, Sinepuxent, Newport & Chincoteague), averages being from 2.0" to 2.4". Sample sites near the inlet frequently produce larger mature females. Their preference for this area may be related to spawning.

Legal crabs were more frequent in trawl sites deeper than four feet. Small crabs less than 2 inches were more than twice as likely to be found in trawl sites of depth four feet or less. Averages were 91.9 crabs/trawl in sites four feet or less and 41.8 for sites deeper than four feet. This preference for shallow water by the juveniles underscores the importance of these areas as nursery habitat.

Competition and Disease

The popularity of the spring and fall recreation tautog fishery has hastened the introduction of the green crab *Cancer maenas* (an European crab introduced to the U.S. in the mid-1800's) to the coastal bays. Release of this popular bait crab and its gradual colonization to the south from Delaware has resulted in an established and spreading population of this competitor of the blue crab. Since 1996, this crab has been found near the Ocean City inlet probably because of the presence of a good population of blue mussels (*Mytilus edulis*) which provide ample food. This crab has damaged the Dungeness crab and clam fisheries on the west coast and could develop into a nuisance here. Some of its preferred food items include mussels, clams, oysters, and other crabs.

In the last two years the Japanese shore crab (*Hemigrapsus sanguineus*) has been found around rocky areas, bulkheads and piers near the inlet. This crab is relatively small and prefers the intertidal zone. Its effect on the blue crab population is unknown.

Since 1998, the lesser blue crab (Callinectes similis) has been taken at several sites. This southern crab, which rarely exceeds 4 inches (101.6 mm), is not known to crossbreed with the blue crab but does compete with it for habitat and forage. At least six other species of crab are either occasionally or seasonally found in the coastal bays and compete with the blue crab to varying degrees.

The primary disease organism affecting blue crabs in the coastal bays is the dinoflagellate *Hematodinium perezi*. This organism affects crabs in most areas of the coastal bays particularly at the end of summer when water temperatures begin to cool. Its effects (dead, dying, listless or slightly discolored crabs) were first noticed by commercial harvesters in 1994 and it has occurred yearly to varying degrees. It has occasionally been severe enough to curtail crabbing in some areas. Grey crab disease and a chitinoclastic bacteria which causes black spot also are present in the coastal bays but have not presented significant problems.

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MOLLUSCAN INVENTORY OF THE MARYLAND COASTAL BAYS

MITCHELL L. TARNOWSKI
MARYLAND DEPARTMENT OF NATURAL RESOURCES, SHELLFISH PROGRAM

Introduction

Ever since the Yates oyster bar survey in 1907, MDNR and its predecessor organizations have been involved with shellfish in the coastal bays. For example, the state contributed funds to stabilize the Ocean City inlet when it was torn open by a hurricane, not only to provide access to the ocean for commercial fishing vessels but to improve growing conditions for shellfish in the bays. Various state sponsored shellfish projects have continued to today.

In 1993, the DNR Shellfish Program initiated a three year comprehensive effort to inventory the molluscan fauna of the Maryland coastal bays. Intended to establish baseline values for future management needs, both commercially important molluscs and ecologically valuable species have been targeted.

Oysters, Inlets, and Salinity Changes

The dynamic nature of coastal inlets has had a profound impact on the shellfish populations of this region. When Lt.Yates conducted his survey, conditions in the coastal bays were very different. Only one inlet existed for the entire system, down at the southern end in Chincoteague, Virginia. Consequently, salinities were much lower in the upper bays, unsuitable for growing oysters. Even in the northern portion of Chincoteague Bay, oysters were subjected to occasional killing freshets, and poor growth and sporadic spatfalls were the norm.

This is in sharp contrast to the period following the Civil War, when an inlet at Green Run, in the middle portion of Chincoteague Bay, was open. Oystermen, practicing a rudimentary form of oyster cultivation by planting seed on their own lots, found their endeavors so lucrative that they named the location Greenback after the recently introduced paper currency. Unlike other areas in Maryland, oyster farming became the standard practice in the coastal bays throughout the history of the industry.

The late 1800's were boom years around Chincoteague Bay. The newly constructed railroad vied with sailing ships to carry the prized Chincoteague oyster to the high end markets of New York and Philadelphia, with some even reaching Europe. Eventually, Green Run Inlet filled in and production slowly declined to the point where most activity was restricted to the southern half of Chincoteague Bay.

When the Ocean City Inlet opened in 1933 salinities throughout the bays quickly rose and there was a scramble to obtain leases for oyster growing bottom. This optimism was shortlived, however, as a host of problems associated with increased salinities ultimately proved ruinous to the oyster industry.

The elevated salinities allowed predators, particularly drills, to flourish. Fouling organisms that compete for food and cultch space also found conditions more suitable. Although the natural oyster populations rapidly declined, the culture based industry still managed to exist for several decades longer. The death knell of the oyster industry sounded with the first reports of oyster diseases in the coastal bays during the late 1950's and early 1960's. The last recorded landings were in 1983.

Oysters Today

In 1994 the MDNR Shellfish Program went back to survey the old Yates oyster bars in Chincoteague Bay. A total of 150 tows were made with a handscrape on the 28 bars. For all this effort, no live oysters were found. Furthermore, the bars were in very bad shape. The northern bars were buried in sediment, with very little surface shell. The southern bars had more exposed shell, but it was severely fouled.

To get an idea of the current level of oyster disease activity in Chincoteague Bay, hatchery-reared disease-free seed were suspended in cages at several locations in September 1994. Think of them like canaries in a coal

mine. Two summers later 27% were infected with SSO (*Haplosporidian costales*, or SeaSide Organism, a relative of MSX), almost entirely in advanced or terminal stages. That following December the prevalence of *Dermo* (*Perkinsus marinus*) was 73%, with lethal infections in 30% of all oysters. In other words, about 50% of the oysters succumbed to the two diseases in a little over two years. This study reaffirmed the fact that both *Dermo* and SSO remain problems in the coastal bays despite the long-term absence of any significant oyster populations.

Oysters still exist in the coastal bays, but only in the intertidal zone. Occassionally there will be a heavy set of oysters on some structure such as rip-rap or bridge pilings. Predators take an immediate toll, and then disease sets in, so that after three years most are gone.

Hard Clams

If opening the Ocean City Inlet helped to create conditions leading to the oyster's demise, it had the opposite effect on hard clams, which flourished in the higher salinities. To determine the condition of hard clam stocks, the Shellfish Program initiated a survey in 1993 as part of the Molluscan Inventory. A commercial clam boat equipped with a hydraulic escalator dredge was hired for the survey effort. Stations were selected at random from geographic strata. Tow lengths were standardized at 250 feet by means of a measured line attached to a weight. Clams and any other molluscs were picked off the fast moving escalator belt, identified, counted, and measured.

Since 1993, almost 1,000 samples have been taken. Aside from the St. Martin River, clams were found at 99% of the stations. The average clam density was highest in Sinepuxent Bay and lowest in St Martin River.

Although a wide range of sizes was found during the first two years of the survey, the population was top-heavy with older individuals, with few small clams. Apparently, recruitment had been very sporadic, despite the low level of fishing pressure during the previous 15 years. It is well documented that predators can limit clam populations. High predation pressure, particularly by blue crabs, could have been responsible for the continued recruitment failure. Predation may have been further exacerbated by the burial of the oyster bars, resulting in the loss of protective shell cover.

Something changed in 1995 that allowed a much higher set and young-of the-year survivorship in Sinepuxent and Isle of Wight Bays, a trend that continued in 1996 and 1997. As a result of this successful recruitment, the 1995 year class came to predominate the clam population in Sinepuxent Bay and clam abundance climbed. This profusion of prime sized clams (higher priced littlenecks) is what brought such a high concentration of commercial clammers to the upper bays in 1998.

Bay Scallops

Another species attempting a comeback in the coastal bays is the bay scallop. There is ample evidence of historically extensive populations of bay scallops in this region.Clam surveys have found scallop shells throughout the coastal bays, and the beaches of Assateague Island are littered with ancient scallop shells. In fact, Chincoteague, Va. was the center of a small but lucrative bay scallop fishery during the 1920's. However, when a blight wiped out the eelgrass beds in the 1930's, the scallops lost their preferred habitat, and also disappeared. It was estimated that 90% of the eelgrass was lost to the so-called "wasting disease" on both the North American and European coasts of the Atlantic.

Initially the recovery of the grasses was slow, on the order of decades, but now, some 65 years later, the seagrasses have come back and are thriving. Also, the Ocean City inlet increased the salinity throughout the coastal bays to a regime suitable for scallops. Despite these near optimal conditions, scallops had not returned by the mid-1990's.

It seemed that the primary hindrance to a scallop recovery was the absence of a nearby source of reproducing adults, coupled with the comparatively isolated location of the coastal bays. By introducing broodstock (that is, spawners) to Chincotegue Bay, it was thought that nature could be given a jump start. To this end the Shellfish Program was awarded a competitive grant from the National Marine Fisheries Service for two successive years of scallop plantings.

We decided that the most practical approach was to purchase and overwinter hatchery reared seed scallops, sheltering them until they spawned the following summer. This was accomplished by erecting predator exclosure pens constructed of plastic mesh to protect the young scallops. A total of 1.2 million scallops were planted in 1997 and 1998. Of these, better than 85% survived through the winter to their first spawning period in the following spring. From this standpoint the project was a success in meeting its primary objective of maximizing the number of reproducing adults.

Although this species generally spawns once, the scallops planted in 1997 spawned an unprecedented three times, including twice in one season. Scallops have yet to be found that can be positively identified as progeny of the 1997 planted scallops, but this was a limited effort on only one year class. The second year of recruitment, representing progeny from both the 1997 and 1998 plantings, will be evaluated during the spring of 2000.

Coincidentally, a good number of bay scallops that appear to be the southern subspecies were caught with a clam dredge in the southern portion of Chincoteague Bay. Interestingly, although most were found in eelgrass beds, some did occur on remnant oyster bars that were devoid of vegetation. It is uncertain how well established the population is. At least two year classes have been found, suggesting that the original colonizers have successfully reproduced in the bay. However, if these are indeed the southern subspecies, Chincoteague Bay is near the northern extreme of their range and they have not yet been subjected to a harsh winter.

Intertidal Zone Molluscs

The Molluscan Inventory also included surveys of shorelines and structures in the intertidal zone. Here the numerically dominant mollusc was the ribbed mussel, *Geukensia demissa*, which were found at densities of up to 5200 per square meter. Information collected includes the distribution, abundance, and population structure of this species, which is possibly one of the most ecologically important molluscs in Chincoteague Bay. This is because of their beneficial association with salt marshes.

The mussels live along the fringe of the marsh, where they filter algae from the water column when the tide inundates them. They promote growth along the marsh's edge by fertilizing the grasses and increasing the sedimentation rate with their waste products. In addition, their network of byssal threads, which the mussels use to secure themselves to the substrate, helps to stabilize the sediment and reduce erosion, such as from wave action.

Ecologically Important Species

The inventory of ecologically valuable molluscs included species that may not have an intrinsic commercial value but play important roles in the ecosystem of the coastal bays. In order to capture the smaller species, a ponar grab was the primary gear type for the survey. However, the tallies from the other sampling methods are included in the species distribution list. At least 73 molluscan species have been accounted for to date. Sixteen of these had not been reported in previously published accounts of the coastal bays, including three northward range extensions of southern species. This rich assemblage of molluscs is partly due to the biogeographic position of the coastal bays, which are located near the southern limits of many northern species overlapping with some southern species filtering up past Cape Hatteras.

In addition, there is a diversity of habitats in the coastal bays, including mud bottoms dotted with projecting worm tubes, bare sand, seagrasses, shell bars, salt marshes, fast currents, quiet coves, inlets, islands, and man-made structures, all of which contribute to this species richness.

Surprisingly, of all these species, only seven species were common to all of the coastal bays, suggesting that the community structures vary considerably among the bays. In fact, this is what we found, with differences in species composition, ranking, and abundance. There were also strong seasonal and interannual variability in the structure of the molluscan community.

For the first two years of the study the most abundant mollusc was *Bittium varium,* a tiny snail that gets no larger than a caraway seed. Densities at individual stations reached as high as 39,000 per square meter. Then, in 1995, the population crashed and individuals are rarely seen to this day, despite frequent visits to their preferred habitat, seagrasses, over the past few years.

Who cares about a seemingly insignificant little snail? These diminutive gastropods are grazers, cleaning the eelgrass blades of algae which competes with eelgrass for light and obstructs carbon intake. Researchers in Virginia concluded that seagrasses are dependent on micrograzing to increase growth, distribution, and abundance. They pointed out that the decline in eelgrass beds in the western Chesapeake coincided with the disappearance of *Bittium* after Tropical Storm Agnes.

Conclusion

The significance of molluscs to the estuarine ecosystem has long been recognized. Over one hundred years ago the concept of an ecological community was developed by Karl Möbius through his observations on the faunal assemblages of oyster reefs. Functionally, molluscs serve as a key trophic link between primary producers and higher consumers. Bivalves in particular are important as biogeochemical agents in benthic-pelagic coupling, cycling organic matter from the water column to the bottom. In addition, molluscs can have a pronounced impact on the physical structure of an ecosystem, whether by reworking the sediment, grazing, binding or securing existing substrate, or building new substrate such as oyster reefs. Many molluscs are commercially valuable, both directly as a harvestable resource and indirectly as a food source for commercially and recreationally important species including crabs, fish, and waterfowl. A knowledge of the coastal bays molluscs provide valuable insight into the workings of this ecosystem.

THE HORSESHOE CRAB STOCK ASSESSMENT PROCESS: SEARCHING FOR CLUES

MICHAEL J. MILLARD, PH.D.
NORTHEAST FISHERY CENTER U. S. FISH AND WILDLIFE SERVICE

Note: The following document is a transcription of the presentation by Dr. Millard. It has been reviewed and approved by the author for publication.

I would like to set the stage for the horseshoe crab controversy that is currently going on. There are fairly clear indications that horseshoe crab harvest has increased significantly over the last 5-10 years, due primarily to the increase in conch and eel fisheries in which horseshoe crabs are used for bait. Fueling this controversy is the horseshoe crab-migratory shorebird connection, primarily in the Delaware Bay. The current premise, endorsed by many, is that horseshoe crab eggs are the primary fuel source for these migrating shorebirds. Delaware Bay is one of the largest stopovers on the East Coast. The concern is that should horseshoe crab eggs become less available, this will, in fact, be detrimental to migratory shorebird populations. The horseshoe crab is also used in a very small, but very important, segment of the biomedical industry where a component of the blood is used as a marker, or indicator, for endotoxins, drugs, or implanted devices. It is the best component that we know of today to do that. Compounding the problem is that they are an interesting creature, but we haven't really done much science on them lately. There are a few individuals who have been working on them, but, in general, there's no real understanding of the population dynamics or life history. This made the task of the Horseshoe Crab Stock Assessment Committee much more difficult.

The Stock Assessment Committee for Atlantic States Marine Fisheries Commission (ASMFC) was put together quickly. In 1998 we first convened and were told to gather all the available data and evaluate it for its effectiveness in assessing the horseshoe crab stocks on the Atlantic Coast. During June through August, we whipped through this data analysis pretty quickly, but we were being pressured by ASMFC and the community to hurry up with some answers. In November 1998, we issued our report. It was reviewed by a review panel and the results are now published through the ASMFC process.

In January 1999, the group got together again and redesigned the spawner workshop. Again, most of this primarily refers to Delaware Bay. We redesigned a very important spawning survey that has been going on for approximately 10 years. There were a few inconsistencies that hopefully we have fixed by now and we look forward to, every year, continuing this survey and improving it. This summer, the spawning survey was conducted using this new and improved format. Now, we are in the process of hopefully making progress on alternate baits. That may be the key to relieving some of the pressure on the horseshoe crabs. The Stock Assessment Committee is also in the process of designing a statistically valid near-shore benthic trawl survey which will help us collect the data necessary for a formal stock assessment. To date, a formal stock assessment has only been approximated, because of the lack of data.

We were tasked, by the ASMFC to: 1) review and evaluate the available data, 2) assess the relative status and trends of the horseshoe crab population given the available reliable data, 3) investigate the multi-species interactions and potential management strategies, and 4) develop recommendations for research surveys to continue needed data collection.

The first indication that there was a problem was in the NMFS (National Marine Fisheries Service) landings data. It is well known that a lot of the horseshoe crab landings in the NMFS data are under-reported, so most of the states added on what they thought was appropriate to account for the under-reporting. There is a clear increase in the number of reported landings since the beginning of this decade. It is fairly high relative to the past baseline harvest.

The data that we (Stock Assessment Committee) assembled had to meet some acceptance criteria to be usable for the trend analysis. First, whatever variable was measured (catch, catch per unit effort (CPUE), numbers, weight, etc.) had to be what we felt was a true index of the abundance of the stock. Second, the sampling scheme had to be such that it would indeed provide this index--not just a hit-or-miss sampling scheme. Third, the time series had to be informative. We couldn't have one sample back in 1988 and one sample in 1998 and maybe one in between. We needed to have a fairly good, consistent time series to do a trend analysis. Finally, and most important, the sampling scenario over that time series needed to be consistent and comparable. If different techniques were used at different times, the numbers are not necessarily comparable. After running the data sets through this screening process, we ended up with five data sets that we felt were adequate for assessing trends.

We examined data on percent zero catches and that number was quite high. Most of the time the NMFS, in the survey, are not catching any crabs. This is not surprising since their gear is not designed to catch horseshoe crabs. They use 20-24 inch rollers on the bottom of the trawl and that is not very effective in catching an animal that lives on, or buried in, the substrate. But you do see a shift in plateaus centered around 1985. This is an indication that something happened in or around 1985. Whether you take out the zero catches, or leave them in, the trend doesn't really change that much.

We had data that was quite scattered, and only conclude that either there was so much variation that we were unable to detect a trend in the data, or that there was no trend in the data. We did a power analysis that allowed us to say, given the variation in the data, how much of a drop over the 15-year period examined would need to have existed for us to detect it 80% of the time. It turns out that it would have had to have been an 80% decline in CPUE for us to detect it 80% of the time, and that's a function of the variation in the data. Had the data been less variable, we'd have been able to detect a much smaller drop with more certainty. That leads us to believe that there is just too much variation to detect even a 50% or 40% decline. We examined the mean weights to determine if there was any difference in weights over time that might be indicative of overfishing, and they were fairly stable.

The other thing we looked at was the Delaware 30-foot trawl, which did show a decline in the CPUE trends. Catch frequency data in that 9-year time series shows that catches of horseshoe crabs are relatively rare. The highest frequency catch is zero, and there was only one catch of any significant numbers. The time series for the Delaware 30-foot trawl has fairly large variation, but does show a significant decline. We did see a downward trend in CPUE. Again, if you exclude the zeros, as some people feel you should since this gear isn't designed to catch horseshoe crabs, it made no difference to the results. In this case, we did have an 80% decline, and we were able to detect it. Using the power analysis, if it had been only a 60% decline, we would only have been able to detect it 40% of the time, given the variability of the data. This again comes from using gear that is not designed for catching this particular type of animal which lives buried in the substrate and is patchily distributed.

Our finding, after having gone through this process, was that there was no increasing or decreasing trend in the coastal horseshoe crab abundance. That was modified by the peer review panel to say that there's been no demonstrable impact. In other words, there may be an impact out there, but given the data that we have we are unable to detect it. We concluded that the data from these non-directed surveys, which were aimed at trawling mainly for finfish, are probably not a good indication of what's going on with the horseshoe crab population. It's a poor index of horseshoe crab abundance. Zero catches predominate. There may be a spatial-temporal mismatch in what the crabs are doing in relation to what the trawlers are doing for finfish. So the sampling design may not be optimally designed for horseshoe crabs. There's some indication that these crabs are clustered, patchily distributed, and there may be other sampling designs that would be better to capitalize on that distribution as opposed to random trawls at fixed stations.

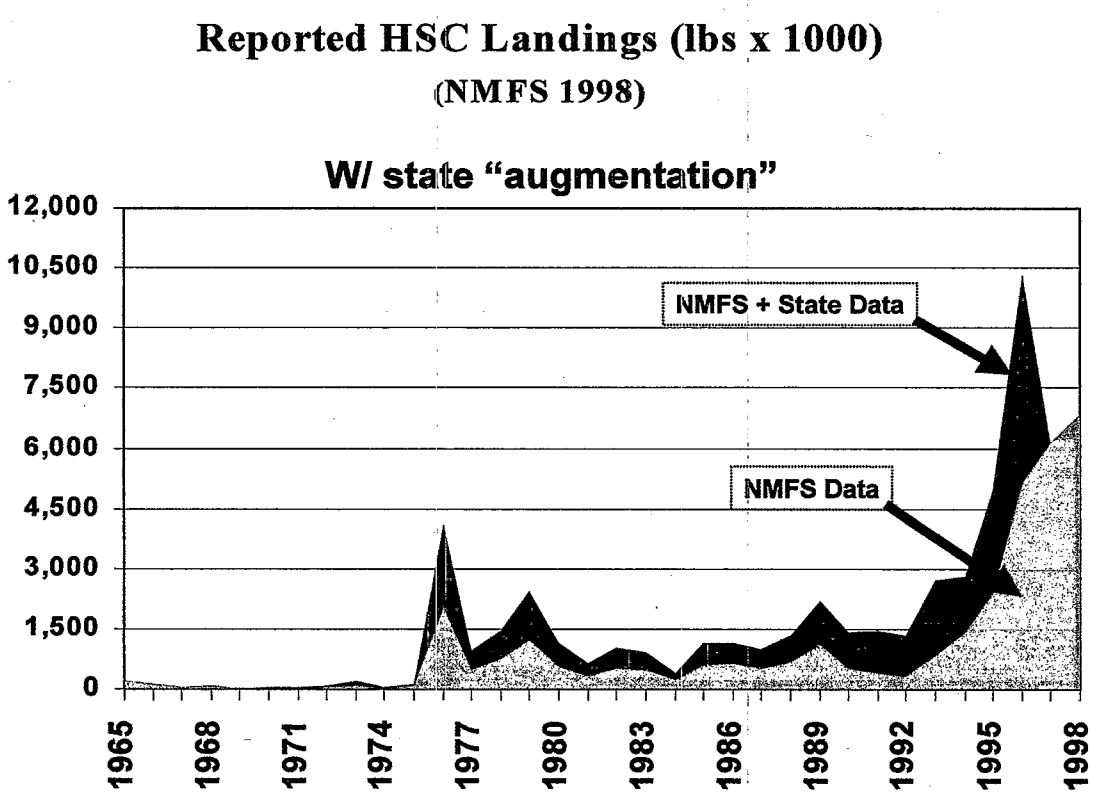
We need to develop appropriate abundance indices for horseshoe crabs. Optimal sampling designs specifically directed at this animal need to be developed. It is an expensive proposition. Where we can keep track of eight or more different finfish with one trawl, we may need a single vessel and separate gear for horseshoe crabs alone. Whether the resources will be available for this remains unknown. Results of the beach spawner survey conducted this summer from a USGS report on surveys of the Delaware and New Jersey beaches show some apparent declines, but most beaches were stable.

What Needs to Happen Now?

The Stock Assessment Committee will continue and optimize the beach spawner survey, hopefully every year. We wonder if we will have the resources to keep doing it, but right now it's the best tool that we have to monitor horseshoe crabs. Some of the committee members might begin simulating production models to look at some logical bounds on the population parameters and harvest guidelines. Right now we have no knowledge of the mortality rates that occur--fishing or natural mortality. Without any knowledge of those, the formal stock

assessment becomes untenable. We are also in the process of developing this near-shore benthic survey to help us conduct, in future years, a more accurate assessment.

Future work that needs to be done by biologists includes gathering a lot of life history information for the horseshoe crab. Not much is known about critical habitat and movement patterns, particularly for the young. Our work has all been focused on Delaware Bay because of shorebird issues, but we need to assess the coastal bays as well. We need to better characterize the horseshoe crab-shorebird relationship. There is a lot of science and there are a lot of statements that don't always match up, so we need to further continue to investigate these relationships. Most importantly, and this might diffuse the whole situation, we need to develop alternate bait strategies. Significant progress is already being made in this area.



MIGRANT SHOREBIRDS - ROLE OF THE DELMARVA COASTAL BAYS

BRYAN WATTS, PH.D.
CENTER FOR CONSERVATION BIOLOGY, COLLEGE OF WILLIAM AND MARY

Note: The following document is a transcription of the presentation by Dr. Watts. It has been reviewed and approved by the author for publication.

Shorebirds are a diverse group throughout North America, and we contain or support about 50 species. Most of these species are associated with aquatic habitats, at least during some part of their life cycle, and they contain some of the widely known groups such as the plovers and the sandpipers. Many of these species, over the past 20-30 years, have been shown to be experiencing some populations declines, and they have become of concern to the conservation community.

Shorebirds are some of the most mobile animals known to science. About 3/4 of the species that we support in North America actually migrate from the tropics. Many of these species migrate a round-trip distance of 30,000 km or more. Early on in the conservation-concerned community, when we began to see the population declines, a lot of our attention was focused on the breeding grounds and then later on the wintering grounds. What we've realized over time is that these species may spend as much as 5-6 months of the year in transit.

We used to think, in the early decades of this century, that migration was just going from point A to point B. We are realizing more and more that migration is a highly structured process and that many of these species' life history strategies have evolved around particular migration areas. What we see in the case of shorebirds is that they are migrating over very large distances and, unlike many of the landbird migrants, they are targeting specific locations where they are refueling. So they're not just moving and dropping out wherever they occur. They're specifically flying to targeted areas.

Each one of these areas, in itself, is an energetic bottleneck. These species are arriving energy-depleted, many of them below lean mass, and they are spending a variable period of time foraging frantically to rebuild those fat reserves before moving on to the next stopover area. These areas are, in fact, like stepping stones that they are using between winter and breeding areas. Not all stopover areas are of equal concern. The reason that's true is that many of these species breed in the Arctic and the breeding season in the Arctic is of very short duration. So many of these species need to arrive on the breeding grounds prepared to breed. Many of the females are actually forming eggs during the migration, so that when they get there, they are prepared to immediately breed, in order to produce a brood in a short period of time.

Those locations very close to the breeding grounds, particularly during spring migration, are of very high conservation significance. This is the position where we find ourselves in the mid-Atlantic. We are some of the northern-most staging areas, and therefore we have very high conservation significance. Our concern is that these staging areas may be degraded such that we will have a greater and greater impact on these species' ability to make it between breeding and wintering areas.

One of the reasons we're so concerned about some of these major staging areas is that significant portions of entire species may depend on specific sites. That's true of Delaware Bay, and many other sites in the Western Hemisphere--the Bay of Panama, the Bay of Fundy, Copper River Delta, Alaska. Many of these sites are where very large numbers of birds stage and significant proportions of entire species depend on those sites. These sites have true conservation significance.

What are these species doing in these staging areas? They're really only engaged in two activities. The first is that they are foraging frantically at these sites to gain the energy they need to move on. Second is that they are sleeping. So they are eating and sleeping, eating and sleeping, and they're trying to build up the fat reserves needed both for breeding and for migrating.

When we look at the distribution of the various energy sources worldwide (imagine how much energy it would take to fuel several hundred thousand of these birds in one small location), it turns out that areas worldwide that have the amount of free energy for these birds to utilize are very rare, and almost all of them are associated with coastal zones. So most of these birds are migrating along coastal zones and they're depending on those particular areas that have a lot of free energy, like Delaware Bay.

What do we know about the mid-Atlantic region? Many of you may know that the Delaware Bay is a hemispherically important migration staging area for shorebirds. It has actually been designated as a western hemisphere shorebird reserve with hemispheric importance, meaning that it is known to support at least 500,000 birds during some portion of the year. I have already mentioned that there are at least three species that Delaware Bay really seems important for - ruddy turnstones, semipalmated sandpipers, and the red knot. Along the Atlantic Coast, Delaware Bay is probably the most significant staging area we have, at least within the U.S. The Bay of Fundy is also significant to the north, particularly at fall migration.

What we know about the Delmarva Peninsula is much less than the Delaware Bay. There has been a long-term monitoring program along Delaware Bay that is capable of looking at trends over time, but we do not have that information for the Delmarva Peninsula. The outer portion of the Delmarva Peninsula has been designated as a western hemisphere shorebird reserve with international status, meaning it is known to support at least 100,000 birds in the course of a year. That designation was given based on some surveys done in the seventies and eighties here at Chincoteague National Wildlife Refuge, and also some preliminary flights that have been done on the outer barrier islands. We have known almost nothing about the use of the coastal bays here on the outer part of the Delmarva by shorebirds. In 1994, we initiated a study to see just a few basic things: What species are using these coastal bays? What kind of numbers are coming through? And what kind of habitats are they using?

We established a series of transects, beginning above the Virginia-Maryland line. We flew down from the outer barrier islands surveying birds - about 100 km of outer beach, then we also had ten transects that bisected the lagoon system that were flown. So a total of 200 km of transects. The lagoonal transects were spaced about 4 km apart. The idea here was to use low altitude aerial surveys to get an estimate of shorebird numbers. To do this, we fly low over the surface to scrub the birds off the surface. If you fly about 30 m off the ground, these birds will spontaneously fly up in front of you. That gives you an opportunity to estimate flock sizes and to get some idea of species composition. These flights were flown every 10 days or so from late April through early June and we were hoping to cover the peak of the spring migration period. We still know virtually nothing about the fall migration.

There were six species or species groups that dominated that system - the dunlin, black-bellied plover, short-billed dowitcher, semipalmated sandpiper, whimbrel, and willet. The semipalmated sandpiper is the predominant small sandpiper here. It is not possible to identify this species from the air. There are several of these species in the same genus, *Calidris*, not identifiable from the air, so we group them in a category called peeps. We know that this is the dominant one from ground work. Of all these six groups, the willet is the only species that actually breeds on the Delmarva. This is a large shorebird that migrates through this region, but also breeds here on the outer barrier islands and the marshes.

What are we seeing in terms of the numbers that are coming through the lagoon systems? Our time window was fairly good for some species and not so good for others. It happens that dunlin winter in large numbers here on the Delmarva, and we didn't encapsulate their full period, and in fact they turn out to be the most abundant species that we have in the coastal bays. At any rate, many of the species come through in early to mid May and reach fairly significant numbers. If we look at all of these species collectively, what we see is that these birds reach a density of about 1400-1500 birds per square kilometer of habitat within the coastal bays. Just to give you some comparison, that is a very significant density comparable to many of the large staging areas we have on the Pacific Coast. It is comparable to Delaware Bay. The difference is that we have less habitat, or less surface area available. So densities are similar, but our system is not as large as many of these other staging areas.

One of the things we need to consider when we think about habitat use of these shorebirds is that they are leg length limited. These species are not able to forage in deep water. The willet and the two yellowlegs are some of the longer legged species that we have and they are not capable of foraging in deep water. They are restricted to shallow water areas in emergent habitats. There are only two types of substrates in the coastal bays that these birds can forage on. One is the extensive salt marshes, cordgrass marshes, that we have in the lagoon system. The other substrate is the intertidal mud flats that we often see associated with the *Spartina* marshes. Of course, salt marshes are available throughout the day, mudflats are only available during low tide periods.

If we compare the density of these birds on these two available habitat types, what we see is that there is no comparison. Shorebirds on mudflats reach very high densities, something like 70-80 times higher than on the

available salt marsh habitats. So most of the birds that are coming through the lagoon systems are depending on these intertidal mudflats that are exposed at low tide.

By using some metabolic equations we can actually predict the energy requirements, just to break even, of these species. This is collectively, all of these birds together that are using these mudflats. This has been converted into prey biomass, so this would give you some indication of what prey biomass this density of birds would be extracting per km^2, just to break even. Because of their condition when they're coming through during migration, they may be extracting 2-3 times more than this. This is the period we have data for, but if we looked at these collectively, what I see is that on that km^2 basis, these birds are extracting something on the order of 600-700 kg of prey. If we project this to the lagoon system that is south of Chincoteague, what we see is that over the course of just this short time, these shorebirds would be extracting on the order of 100 metric tons of prey. What that suggests is that not only are the Delmarva bays important to these shorebirds, these shorebirds are a significant component of that ecosystem, even though they're only there for a short period of time.

This is still in the early stages of investigation and there are many things that we don't know. We are finding that these areas are very significant to shorebirds moving through. What we don't know is what these birds are feeding on. We presume that these birds are primarily feeding on marine worms that are found in this system. I do not believe that these birds on the lower Delmarva are feeding to any great extent on horseshoe crab eggs. We see no evidence of that. The only place in the lower Delmarva bays that we have any significant numbers of horseshoe crabs is on the delta islands in the major inlets. They do not occur, to any great extent, near these mudflats. I don't believe that they are providing the major source of energy to most of these birds. However, the shorebirds are opportunistic, and whenever you do see horseshoe crabs spawning, you see plenty of shorebirds feeding on their eggs. So they will feed on them, but I don't believe, in the broader scheme, that it represents much of their energy source.

There are a number of things that we need to know. We suspect that the salt marsh is providing some of the conversion of energy to these shorebirds. We know virtually nothing about what the energy changers in this system are. We heard earlier today about some of the algae that we have coming into this system, but we don't know how that plays into the general flow of energy.

One of the other things that we would like to know is just how many birds do our peak numbers represent. All we know is how many birds are in that system at a given point in time. We don't know how many birds that represents over the course of the season, because we don't know what the turnover rate is. We desperately need information on stopover times so that we can generate turnover estimates and be able to estimate how many total birds are using the system. If we use the available habitat in our survey data, we come up with a projected estimate of peak at about 250,000 birds within that system below Chincoteague. How many real birds are coming through? Is it 2, 3, or 4 times that? There is no way of knowing unless we generate some turnover rates.

We have some concerns. On the Delmarva peninsula, one of the main industries is farming. Many of the crops that are grown are very intensive in terms of chemical use, nutrient use, etc. What potential impact does it have on the invertebrate prey base that these species are depending on? Even when we use best management practices, such as the use of buffer areas, it's certain that during heavy rains a lot of these chemicals are coming into our estuaries. The other industry that we see on the lower Delmarva is the harvesting of water-based resources. What are the potential impacts or conflicts between some of the water-based industries and shorebird requirements? This is totally unstudied at this point. One obvious thing is that whenever you dredge clams from the surface, you're probably impacting the fauna there that these species depend on. So there may be the potential for conflict between the resources the birds need and some of the industry that we have there.

One of the other concerns that we have is illustrated by this. These birds are under tremendous time constraints. Their only access to these mudflat areas are during low tide periods and there are many other biological factors that influence, or restrict, the amount of time that they have to extract energy. Bird watching and nature-based tourism is the fastest growing sector of the tourism industry, accounting for billions of dollars of our national economy now. It is certainly true that in the future, it will become a growing part of the Delmarva economy. We need to be careful as we develop that industry that we don't impact the resources that people are coming to see. These shorebirds, originally when they're foraging, are very susceptible to disturbance. We want to make sure that when we design the tourism and public access that we're careful to keep the resource in mind.

In closing, I will say that the Delmarva is a significant staging area to many species. There is, in fact, increasing evidence, that it is a terminal staging area before some of these species go off the coast, inland to their breeding areas, and as such, we have to understand that these shorebirds are an international resource. They're not just private to North America, and we have an international responsibility to plan for the welfare of these species.

COMPLEX ISSUES, SIMPLE TRUTHS

Bill Matuszeski
EPA Chesapeake Bay Program Office

Note: The following document is a transcription of the presentation by Mr. Matuszeski. It has been reviewed and approved by the author for publication.

I was asked to come today to talk to you about a topic which really appeared in a monthly article that I write for *The Bay Journal.* Some of you may see *The Bay Journal* from time to time, it is a magnificent publication, that's put out by the Alliance for the Chesapeake Bay and it really is a terrific way of keeping up on issues. In fact, I always tell Carl Blakenship that if there's an issue that I don't really understand, like submerged grasses, or oyster reefs, that I ask him to do an article about it. Then when the article comes out, I can read it and I can understand the issue. It's a great technique, I recommend it to you. He's a great writer, and he really does understand a lot of these issues.

I think back when I took the Chesapeake Bay Program reins, and had the opportunity to begin working in the Chesapeake, I had to get used to the Chesapeake. One of the things I had to get used to on the Chesapeake was how hot people get over certain issues. One of the first articles I wrote in *The Bay Journal* was about oysters, and I said that I thought that there were some pretty simple things about oysters when it got down to it. I said that one of the things that's pretty clear is that we are managing the oysters for the annual harvest, and that we are not managing the oysters for the long-term viability of the economy surrounding the communities that are based upon oysters, and that we are not managing the oysters with respect to the ecological role they play in the Bay. That got me into a lot of hot water. In fact, I was called on the carpet before a state official and told in no uncertain terms I didn't know what I was talking about.

It is interesting, maybe I did know what I was talking about, and those were some simple truths. Today we find ourselves, half a dozen years later, about to commit, through a new Chesapeake Bay Agreement, to an oyster goal to increase the number of oysters in the Bay ten times by 2010. A remarkable change in attitude and a remarkable recognition of the role that the filterers play in the system--a willingness to set goals, not on this year's harvest, but upon getting a system in place that will really provide the necessary ecological function. So there really are simple truths out there and you may not think so the first time that you lay them out in front of somebody who wants to convince you that these issues are very complicated--that you couldn't possibly come up with any kind of a straight-forward way of dealing with them. I urge you not to be dissuaded by those who allege to know more about these issues, and to seek out the simple truths for those complex issues.

What Are Some of Those Complex Issues?

Growth Management

In a lot of these watersheds, and certainly here, we are dealing with a lot of problems--population increase, growth, and development. We know that there's a real complex set of issues surrounding that. We talk about low impact development, smart growth, and infrastructure management with respect to highways and sewer lines. We also talk about protecting areas, preserving lands, and using the various devices we have available, such as easements and development rights transfers, and focusing development. And we talk about dealing with all these issues in the context of a very strong set of interests which is insistent upon continuing to have a healthy, growing economy underneath it all. A pretty complex set of issues, and really hard to see our way through.

Or is it really? To me there are some simple truths about this set of issues. One is that it is unlikely to stop. We are not about to stop the growth of the counties that surround the coastal bays. One of them is called Delaware 1, which is coming in from the north, into the heart of this region. Another one is under construction out there on your way

west--a four lane highway. These decisions have been made--the growth is going to occur. So, I think one of the simple truths is we're not going to stop it.

Another one is that we're not going to get very far with carrying capacity arguments because, frankly, nobody buys carrying capacity arguments, except those of us who are already convinced that the carrying capacity has been met. So, we really can't expect to gain much in the way of progress by convincing public officials that we've overloaded the system with numbers of people. We could probably accommodate 300 million people in the Chesapeake Bay watershed if they were willing to live in the right places and live with the right lifestyles. The question is not numbers of people, and carrying capacity arguments will not carry us very far.

The issue is how you grow and how you accommodate development. A couple of things are pretty clear about that. There are places in this country that have managed to handle as much tourism-based development, as much outside influx of economic activity, as much in the way of percentage increases in population, and they've done well. Oregon and Vermont are two good examples. They've done it through a couple of really simple things. One, you have no right to put a sub-division on your property unless you are within a growth zone, within the boundaries of a growth area. I don't mean the Maryland approach to growth boundaries which is about 5 miles outside of town in the woods there's a sign up that says, "Prince Frederick Town Center". I mean real boundaries, that really say, this is where we are going to allow development.

Along those lines, there has to be a very clear set of limitations on how much commercial development will be allowed outside those areas. If you do that, if you're capable of establishing growth boundaries, and you're capable of establishing eco-tourism, or tourism zones, or economic development zones, where you will allow that development to occur, then the answers are going to be relatively simple. But, the job is to get people to agree that those things have to be done. It has been done elsewhere. Vermonters, particularly the natives, don't come any more set in their ways, and yet, it works there. The towns stop when you reach the country, while ski resorts are being built year after year in other places. So that can be done. There are relatively simple answers to relatively complex questions.

Toxic Blooms

What is going on with toxic blooms, with the red tides, the brown tides, the pfiesteria? A couple of things are really important here. One is, that for the first time ever, there is now a public health concern about the algae situation in our bays. Algae has been a nasty problem for years, and we said, we really have to do something about those blooms, *someday,* and we really have to do something about the drops in oxygen, *someday*. But, if you look at the laws, what we really focused on the first 30 years of the Clean Water Act were the so-called "conventional" pollutants--the bacteria-causing, problem pollutants that make people sick. We were concerned about toxics because of their long term effects on human health. But we didn't really care that much about the nutrient loadings that were going into our systems, primarily because they were not a direct threat to our human health. That's no longer the case.

We have a lot of potential factors to deal with. I think we have to deal with salinities, flow regimes, acidity, pH levels, rainfall, the interactions of fish with the algae, and nutrients. And so we look at those factors and we could argue a long time about what's causing our problems here, but the answer is really relatively simple. If you look at that list of possible causes, temperature, salinity, flow, acidity, rainfall, fish, and nutrients, there's only one of them that, in my opinion, we can readily affect. We cannot affect the temperature of the water, the salinity, the flow, the acidity, the rainfall, or even the presence of the type of fish species which seem to kick off these events. The only one we can really manage is nutrients. So I say to you, it's not that tough an issue to figure out. It's a matter of dealing with those things that we can control.

Now, if you want to argue that 300 years ago this was not a problem and therefore, nutrients must not be a cause, you can make that argument. But I don't think too many people are going to agree with you. I think a lot of people are going to believe that we're dealing with man-caused events here. Certainly the frequency and intensity of them is going to relate to our ability to control the effects of man, and that means our ability to deal with nutrients.

Agriculture

There is a lot of complexity about how to deal with agricultural activities. We have spent a tremendous amount of effort trying to look at the ways in which its appropriate to regulate the farm community, to regulate the integrators, and to what extent are we dealing with an agricultural industry problem or a single part of that industry. It seems to me that we can get into a lot of finger pointing in this area and we've ended up with a series of laws which vary somewhat, but primarily they deal with poultry industry, which is important to the Delmarva area. However, these laws differ from state to state, so the problem looks really complex.

But I believe there are some really simple truths out there that point to the fact that something needs to be done. There are 11 counties in the Chesapeake Bay watershed, many of which you share, where we are producing more than 250% of the manure which is needed to fertilize every single acre of crops grown in those counties. That's a clear, serious problem. When you look at what is going on with application rate, it is even more remarkable. If you look at the Delmarva peninsula, there are watersheds which are not close to the manure producing areas, for example the Chester River and north. Let's assume that the proper application rate for the crops that we would be talking about, corn and soybeans, would be around 100 lbs. per acre. That is a little high, but let's just assume for simplicity. If you look at the watersheds that are not manure dominated, you'll find that they're putting on about 10 lbs. of manure per acre average, and about 90 lbs. of commercial fertilizer. When you come south into this area, the manure dominated watersheds around the Pocomoke and Nanticoke rivers, I think you will find that the application rate is about 130 lbs/ acre, on land which can only absorb 100. But more than that, I believe they are still putting the 90 lbs. of commercial fertilizer on it, which is incredible. So we could be loading up at the rate of 220 lbs. per acre average in a system that can only absorb 100, and we are doing it by buying as much commercial fertilizer. We should not be buying a pound of commercial fertilizer south of the Chester River, unless it is being used to correct the balance between phosphorus and nitrogen.

Here is another very clear issue. We cannot continue to manage our nitrogen application because when we apply the right kind of levels to achieve what we need for nitrogen in our poultry growing areas, we are overapplying phosphorus by a factor of four. So if we're going to get our phosphorus under control, we have to haul away 3/4 of the manure. That's a pretty simple, straight-forward, set of mathematics. We've got to deal with realities. We've got to deal with the simple truths that we are nowhere near dealing with, in spite of all our laws, and in spite of all our arguments. We are nowhere near what needs to be done about this agriculture problem. But we have some pretty simple truths to work from.

Fisheries

There are a few simple truths about fisheries, I believe, and I think we're beginning to learn them in the Chesapeake, and I think you're probably beginning to learn them here. One is, you cannot manage year after year after year at the edge of a crash. And yet, species after species after species, that's exactly what we're doing. We're managing right at the edge, and we know that once we go over that edge, it could take a long, long time to get it back. We need to back away from the edge and set some limits.

Another thing that's true about fisheries is that we cannot accommodate everybody who thinks they want to make a living in commercial fishing in this country. We can accommodate a lot of people to do that. We can accommodate the traditional levels of fishery activity within our watersheds, but we cannot double, triple, or quadruple the number of people, or the number of crabpots, etc., that are putting the strain on our fisheries. To a large degree, we've gotten that way because we've allowed the industry to overcapitalize. We've encouraged people to invest and now they've got their life savings sunk into this equipment, and now we're beginning to realize we're overcapitalized. It isn't as though you couldn't have predicted that.

Finally, the reason we got into this mess is because we're under-regulated. We're under-regulated in fisheries because the fisheries regulation agencies are still controlled by the commercial fishing interests, and until that changes, we're not going to be able to get the simple truth brought forward to deal with the living resource of our system.

In closing, let me say, don't let anybody tell you that any of these issues are too complex to deal with, because they aren't. Every one of them comes back to some very simple basic truths, and those are, for the most part, common sense. With a little bit of reading, you're going to be articulate about how to present them to people. So, with a little bit of learning and with a lot of common sense, I think you will find that these issues can be worked through, and it is amazing how much light appears, and how clear the past becomes.

Questions

Could you talk about the issue of locating sanitary landfills in close proximity to the waterways?

I do not have a lot of expertise about sanitary landfills. My understanding is that the real issue is groundwater contamination, and that the ability to design and construct facilities that are able to contain the waste properly, without contaminating the groundwater, is something that we have the technology to do today. I do not know if the correct technologies allow us to move these kinds of facilities close to open waters, or how close. It seems to me that there are experts who can determine that, and there ought to be some consensus around materials used, and placement, in such a way, that the answer ought to be relatively clear. I am not dodging your answer, I just don't know what it is.

Is the over-application of manure pretty much the same over all of Delmarva, or just Delaware, or Maryland?

My impression is that the overapplications are occurring wherever we have high concentrations of poultry. I think most of you know that Sussex County, Delaware, has the highest concentration of poultry in the USA, if not the world. Two hundred fifty million chickens a year. More chickens than any other county in America. The underlying problem is that the transport of manure has not been established as an effective and profit making activity, as yet. One of the reasons is that we are not requiring that any of it be moved out. As some of these simple truths indicate to you, sooner or later we've got to face the reality that we cannot continue to absorb those levels of manure on the limited lands that we have in these very sensitive watersheds.

What about the situation in Virginia?

The question is whether or not the situation is nearly as bad down in Virginia. Since Representative Bob Boxum, from the Eastern Shore is in the room, and he's a good friend of mine, and I rely on him for a lot of the best legislation in Virginia, I am just going to say I am sure it's not as bad down there.

Is there anything you can do, or any advice you can give, to citizens who agree with you wholeheartedly that development zones should not be around the inland bays when the state is advocating that? Sussex County is advocating the entire circumference of the inland bays to be surrounded by development zone in spite of citizen protest? What do you do?

The question is why is Delaware being condemned to a system whereby it has big counties with very little local government below the counties, so that the citizens have relatively little influence within the local government? We are dealing here with a tragedy of American history, that Delaware ended up having inherited the county power system of the South and the big counties of the North when what it should have inherited was the opposite. It should have inherited the town meetings of the North and the small counties of the South. Either way it would have been better off, this way it's damned, because you've got a big county geographically, with a lot of varied interests in it and you cannot easily influence the decisions that are being made about land use at that level.

One answer is to incorporate as much land as you can into towns around the bays, which is virtually impossible under Delaware law. But Delaware law can be changed to allow incorporation of communities much more quickly and easily. That way, the local land use power would devolve to the locality where it would be more controlable.

Another answer is, however, to begin to educate and work with the economic interests that are located along the coast, because, ultimately, they are going to have a say. I do not believe the people who own these hotels realize what would happen to tourism in this county if the current development patterns continue and we end up with the kind of algae bloom fallouts, pfiesteria, and everything else that scares everybody away. I don't think they've thought that out, and it seems to me one of the odd things about Delaware politics right now is that the tourism industry has not risen up and demanded the kind of changes in land use that are going to be essential if they're going to protect their investments.

UPDATE ON THE ECOLOGICAL CONDITION OF THE DELMARVA COASTAL BAYS

FREDERICK W. KUTZ, PH.D.[1], JOHN F. PAUL, PH.D.[2], AND THOMAS B. DEMOSS[1]
U.S. ENVIRONMENTAL PROTECTION AGENCY

Abstract

The results of the 1993 assessment of the ecological condition of the Delaware and Maryland coastal bays were discussed at the Delmarva Coastal Bays Conference in 1996. The objective of this paper is to update our knowledge on the condition of the coastal bays with information from studies conducted since the last conference. Several studies have been conducted on the ecological condition, including the estuarine food chain and its stresses, in the intervening years. This paper focused on studies conducted by the U.S. Environmental Protection Agency (EPA) with partners from other Federal and State agencies. Other reports in this conference described information from several other efforts.

EPA published a report on the state of the Mid-Atlantic estuaries (U.S. EPA 1998) which included extensive information on the Delmarva coastal bays. This report compared the significant stresses facing each of the major estuarine systems in the Mid-Atlantic region. Encroaching urbanization was identified as the major source of stress in the watersheds of the Delmarva coastal bays.

In 1997 and 1998, EPA and the U.S. Park Service jointly studied the condition of Chincoteague, Sinepuxent and the Virginia coastal bays (geographically from Chincoteague Bay to Cape Charles). The 1993 study found that the most degraded conditions were in the Delaware coastal bays with conditions gradually improving further south into Maryland coastal bays.

Preliminary results from the 97-98 survey showed that the gradient of degraded condition found in the 1993 study did not continue into the Virginia coastal bays. The bottom-dwelling communities in the Virginia coastal bays appear to be about as degraded as those in Assawoman Bay and more degraded than those in Chincoteague Bay. Chincoteague Bay continued to be the least degraded of all of the Delmarva coastal bays. Information about the condition of the Virginia coastal bays and Sinepuxent Bay has been limited before this effort. With the addition of these data, this database available publicly via the Internet is the largest one covering the Delmarva coastal bays.

Introduction

The coastal bays of the Delmarva peninsula are important ecological and economic resources. The coastal bays are spawning and nursery areas for more than 100 species of fish, almost half of which have commercial or recreational value. The bays are surrounded by an extensive network of tidal wetlands which contributes to and sustains this nursery and many other crucial ecological functions. These areas represent unique and particularly important ecological resources, providing habitat for many species of animals and plants. Over 90 percent of commercial marine finfish and shellfish depend on estuaries for some part of their existence. The coastal bays also provide important habitat for migratory birds; the bays are part of the Atlantic flyway, one of four major migratory routes in the United States. For these reasons, the coastal bays of Delaware and Maryland are included in the National Estuary Program, an element of the Federal Clean Water Act. The coastal bays are also an important economic resource. More than 10 million people visit the Delmarva Peninsula annually. The primary recreational attractions of the region are boating, swimming, and fishing, with more than a half-million user-days of recreational fishing

[1] U.S. Environmental Protection Agency, 701 Mapes Road, Fort Meade, MD 20755-5350
[2] U.S. Environmental Protection Agency, Atlantic Ecology Division, 27 Tarzwell Drive, Narragansett, RI 02882

each year (Seagraves 1986). The coastal bays also support commercial fisheries for hard clams, blue crabs, sea trout, and several other species of fish. The total economic return from recreational and commercial activities associated with the coastal bays is estimated to exceed 3 billion dollars, and the bays support almost 50,000 jobs (Bohlen and Boynton 1997).

The physical characteristics and location of the coastal bays make them particularly vulnerable to the effects of pollutants. The northern bays of Delaware and Maryland are mostly land-locked and have few outlets to the ocean. This, combined with a limited volume of freshwater inflow, results in a low flushing rate (Pritchard 1960), making them susceptible to concentration of pollutants (Quinn et al. 1989). Water quality data suggest that several tidal creeks supplying the coastal bay's limited freshwater inflow are eutrophied (ANS 1988), largely as a result of nutrient enrichment from surrounding agricultural lands (Ritter 1986), enhancing this concern. The projected population increase in the watershed of almost 20% per year adds to the concerns for this resource (DIBEP 1995).

Objectives

The objectives of this report are three-fold: first, to review the findings of the 1993 assessment of Delaware and Maryland coastal bays; secondly to present some of the conclusions of "Condition of Mid-Atlantic Estuaries" Report published by EPA in 1998; and finally to describe some of the preliminary results of 1997-98 surveys of the Virginia coastal bays, Chincoteague and Sinepuxent Bays. For the purposes of this report, the Virginia coastal bays are identified as those bays which are found along the Atlantic Ocean coastline geographically from Chincoteague Bay to Cape Charles. The coastal bays in Virginia south of Cape Henry are not included.

1993 Assessment of Delaware and Maryland Coastal Bays

In 1993, the U.S. Environmental Protection Agency in conjunction with the States of Delaware and Maryland jointly assessed the ecological condition of the coastal bays in these two States (Chaillou et al. 1996). The conclusions of the study were as follows:

Major portions of the coastal bays had degraded environmental quality. Twenty-eight percent of the area in the coastal bays had degraded benthic (bottom-dwelling) communities. Sixty-eight percent of the area had at least one sediment contaminant exceeding the Long et al. (1995) ER-L concentration, which is a threshold of minimal biological concern. More than 75% of the area in the coastal bays failed the Chesapeake Bay Program's Submerged Aquatic Vegetation (SAV) restoration goals, which are a combination of measures that integrate nutrient, chlorophyll, and water clarity parameters (Dennison et al. 1993).

The sediment contaminants which occur at concentrations of biological concern were primarily persistent chlorinated pesticides that were probably a remnant of historic inputs. The contaminants occurring at levels of biological concern are primarily persistent pesticides, such as DDT, chlordane, and dieldrin, that are either no longer commercially available or strongly regulated, and whose input into the system has undoubtedly declined. The prevalence of these chemicals in the sediments result, to a large extent, from the unique physical characteristics of the coastal bays: 1) land use in the coastal bays is largely agricultural and a source of nonpoint pollution; 2) the system has a large perimeter to area ratio, enhancing the potential impact of nonpoint source inputs; and 3) the low flushing rate of the system enhances the likelihood that chemicals entering the bays will be retained for long periods of time. These characteristics present formidable management challenges for the coastal bays system.

Eutrophication threatened recolonization of SAV in the coastal bays, but was not severe enough to cause widespread hypoxia. Eutrophication, as measured by the SAV restoration goals, was widespread in the coastal bays. With the exception of some limited areas of management concern, eutrophication has not yet resulted in a severe hypoxia problem that threatens biota. Oxygen concentrations less than 5 ppm were measured in only 8% of the study area, though it was as high as 25% in Indian River and St. Martin River. Oxygen concentrations less than 2 ppm were measured only in dead-end canals. This is consistent with previous studies, in which concentrations of dissolved oxygen (DO) less than 5 ppm were measured rarely and were spatially limited to known areas of management concern. While we measured only 8% of the area as hypoxic, this amount may be larger during nighttime hours in a significant amount of area, given the shallow, well-mixed nature of the system.

Chincoteague Bay was in the best condition of the major subsystems within the Delaware and Maryland coastal bays. Indian River was in the worst condition. Of the four major subsystems that comprise the coastal bays, Chincoteague Bay was in the best condition. Only 11% of the area in Chincoteague Bay had degraded benthos. Almost 45% of the area in Chincoteague Bay met the Chesapeake Bay Program's SAV restoration goals, a figure which increased to almost 85% when only the nutrient and chlorophyll components of the goals were considered. In comparison, 77% of the area in Indian River had degraded benthos and less than 10% of its area met the SAV restoration goals.

The tributaries to the coastal bays were in poorer condition than the mainstems of the major subsystems. Previous studies have suggested that the major tributaries to the system: upper Indian River, St. Martin River, and Trappe Creek are in poorer condition than the mainstem water bodies. This study confirmed that finding. The percentage of area containing degraded benthos was generally two to three times greater in the tributaries compared to rest of the coastal bays. The percent of area with DO less than the state standard of 5 ppm was three to seven times greater in the tributaries. None of the samples collected in the tributaries met the SAV restoration goals. Among these systems, Trappe Creek contained the sites in the worst condition. Algal blooms were evident at two sites in the upper portion of Trappe Creek. It appears, however, that degraded conditions in the Trappe Creek system are spatially limited to Trappe Creek and have not spread to Newport Bay. Undoubtedly, this results from the low freshwater flow of this tributary compared to the other tributaries.

Dead-end canals were the most severely degraded areas in the coastal bays. Ninety-one percent of the area in dead-end canals had sediment contaminant concentrations exceeding levels of biological concern. Fifty-six percent of their area had DO concentrations less than state standards of 5 ppm. Dead-end canals were the only places in the coastal bays where concentrations of DO less than 2 ppm were measured. These stresses appear to have biological consequences: more than 85% of the area in the dead-end canals had degraded benthic communities.

The coastal bays were in as poor or worse condition than either Chesapeake Bay or Delaware Estuary with respect to sediment contaminant levels, water quality, and benthic (bottom-dwelling) community condition. Based on data collected in the estuaries of the mid-Atlantic region between 1990 and 1993, the coastal bays were found to have at least as high a prevalence of chemical contamination in the sediments as either Chesapeake Bay or Delaware Estuary. Sixty-eight percent of the area in the coastal bays had at least one sediment contaminant exceeding the Long et al. (1995) ER-L concentration, which is significantly greater and 50% higher than the spatial extent estimated for Chesapeake Bay using identical methods. It is 40% higher, though not statistically distinguishable, from that estimated for Delaware Estuary.

Twenty-eight percent of the area in the coastal bays had degraded benthic communities. This was (statistically) significantly greater than the 16% estimated for Delaware Estuary, and statistically indistinguishable from the 26% estimated for Chesapeake Bay.

The fish community structure in Maryland's coastal bays has remained relatively unchanged during the past twenty years while that of similar systems in Delaware have changed substantially. Fish communities of the Maryland coastal bays were dominated by Atlantic silversides, bay anchovy, Atlantic menhaden, and spot. This community structure is similar to that of the Delaware coastal bays 35 years ago. The fish fauna in Delaware's coastal bays has shifted toward species of the Family Cyprinodontidae (e.g., mummichog, killifish and sheepshead minnow) which are more tolerant to low oxygen stress, and salinity and temperature extremes.

State of the Estuaries Report

In 1998, the EPA in conjunction with other interested Federal and State agencies prepared a report on the condition of the mid-Atlantic estuaries (EPA 1998). Copies of this report were distributed to participants at this conference and are available at http://www.epa.gov/maia. The report indicated that the Delmarva coastal bays were the least degraded systems in the mid-Atlantic Region, but threatened by encroaching urbanization. These bays were moderately enriched, particularly in Delaware, largely from agricultural sources. Eutrophication was increasingly noticeable in the dead-end canals along developed shorelines in the Delaware and Maryland coastal systems. Submerged vascular plants (SAV) historically have been absent from the Delaware portion of the system because of high natural turbidity in these systems. Species composition of shore zone fish in the Delaware coastal bays indicated impacted environmental conditions. In contrast, the fish communities in Maryland coastal bays suggested a healthy habitat; however, researchers have observed evidence of early stages of degradation in northern areas. Encroaching urbanization is a rather generic term, so a few of the major environmental stresses resulting from conversion to urban land use are discussed below:

Major Land Use Changes

The coastal bays watershed was mainly forested with wetlands interfacing with the coastal bay waters when the first settlers arrived. Studies have shown that as man used the land, it was converted into agricultural fields, and finally as development continued, agricultural land was used to build houses and associated urban and suburban components. Studies by Bockstael (1996) and Geoghegan (1996) indicated that, all other factors being equal, an agricultural lot will be converted to development before a forested lot because of the higher conversion costs of the forested lot. However, distinct lot characteristics can cause a forested lot conversion to be more profitable and thus more likely. These changes

result in significant alterations in the kinds of ecological services provided by natural resources. For example, a recent simulation model has demonstrated that a reduction of as little as 20 to 25 percent in the forest cover of a forested watershed can result in the increase in nutrient export from the watershed almost equal to the amounts exported from predominately agricultural or urbanized watershed (Wickham and Wade 2000).

Loss of Riparian Buffer Zones & Wetlands

Riparian buffer zones and wetlands provide numerous ecological services. Of importance to shallow water bays is reduction in nutrients and in the amount of sediment in the water which passes through them. Wetlands are particularly effective in holding and trapping water, so the extent of flooding onto adjacent lands is diminished. While some development in the watershed might be inevitable, policies to protect and preserve these critical areas need to be maintained and strengthened.

More Sewage & Solid Waste

As populations increase, amounts of sewage and solid waste also proliferate. Waste water treatment in the coastal bays watershed vary greatly. In the more populated areas of the watershed, waste water treatment plants discharge treated effluents into both the bays and the ocean. Several of the treatment plants within the watershed employ modern techniques to limit nutrients from their effluent. In more rural areas individual septic systems are used. Overall, proper waste water treatment is a critical issue in the reduction of nutrient input into the groundwater and bays. It is imperative in developing areas to insure that waste water treatment plants and the individual, residential counterparts are effectively removing pollutants which would otherwise flow into coastal bays. Solid waste usually ends up in some type of land fill. Landfills in the coastal bays watershed are operated by municipalities as well as counties. Sites containing hazardous materials are also of concern. An industrial site near Millsboro, Delaware, has been determined to contain hazardous waste and is on the National Priority List for clean-up under the Superfund Act. The ground water around the site is contaminated with a toxic chemical from electronics manufacture. As this site is proximal to the headwaters of the Indian River, this contaminated groundwater potentially could reach the coastal bays system. It is critical that these facilities are operated in a manner preventing or treating groundwater contamination and subsequent movement of pollutants into coastal bay waters.

Increased Commerce and Agriculture

Commerce, particularly agribusiness, has been the topic of much discussion as a potential source of pollution for the coastal bays. Fertilizers, pesticides and animal wastes from agribusiness operations are a source of pollution; however, it has been difficult to ascertain their discrete contribution to the overall condition of the coastal bays. Data from Mallin (2000) suggested that animal operations allowed under current state and federal regulations in the eastern and midwestern United States pose serious risks for water quality, safety and marine ecology. From a broad perspective, agribusiness in the Delmarva coastal bays watershed is variable even though the watershed is relatively small in size. In the northern parts of the watershed, poultry farming has been identified as the most likely pollution source; whereas in the southern areas, "plastic" farming of potatoes and tomatoes appears to be the dominant type of agriculture.

More Parking Lots (Impervious Surfaces)

Research (Schueler 1994) has revealed that imperviousness is a powerful and important indicator of future water quality and that significant degradation occurs at relatively low levels of development. The conclusion of most of the studies to date converge toward a common conclusion – that it is extremely difficult to maintain pre-development water quality when the percentage of development in a watershed exceeds 10 to 15 percent impervious cover. The strong relationship between imperviousness and water quality presents a serious challenge for urban watershed management. It underscores the difficulty in maintaining urban water quality in the face of development. At the same time, imperviousness represents a common currency that can be measured and managed by those charged with land use planning (Arnold and Gibbons 1996). It links activities of individual development with its cumulative impact at a watershed scale. With further research, impervious cover can serve as an important foundation for more effective land use planning decisions.

Increased Storm Water Drainage

Untreated storm water draining directly into streams and bays provoke a variety of undesirable effects on water quality and the plants and animals which depend upon the aquatic environment for survival. Many incidents of storm water draining directly into the bays or man-made canals connected to the bays are apparent in our watershed. Studies by Maxted and Shaver (1996) suggest that using some type of mitigation (constructed wetlands, storm water management ponds, forested riparian zones, etc.) might assist in ameliorating these effects.

Invasive Species - Phragmites

Plants and animals play a critical role in coastal ecosystems like the Delmarva coastal bays watershed. They provide many ecological functions including provision of food, oxygen and habitat for other organisms that has evolved with them over millions of years. A critical balance among the organisms and their environment has developed naturally, so that disruptions caused by excess nutrients, man-made toxic chemicals or competition from exotic species may disturb or eliminate native species. When native species are stressed in these ways, exotic or invasive plants and animals may take their place.

Why should we be concerned, for example, when *Phragmites* reeds take the place of more native vegetation? After all, any plant produces oxygen, consumes carbon dioxide, uses nutrients and provides cover. The answer has to do with what we expect from our environment. Many exotic and/or invasive plants like *Phragmites* reeds grow profusely and literally outcompete native species. The result is a loss of the ecological services, such as provision of little food or cover, imbalance of plant matter, overabundance of decaying vegetation, etc., provided by native plants (Maryland Sea Grant Program, 1999).

Preliminary Results of 1997-1998 Field Activities

In the summers of 1997 and 1998, the EPA in partnership with other Federal and state programs conducted research on an integrated monitoring approach for Mid-Atlantic estuaries.

The objectives of this research program were to: (1) characterize the ecological condition of the Mid-Atlantic estuaries using a common set of measurements applied over the entire area, (2) focus research on small estuarine systems to determine better monitoring approaches for these critical systems, and (3) to demonstrate that effective partnerships can be established among Federal and state agencies with estuarine responsibilities in the pursuit of scientific data for resource management purposes.

Common Set of Measurements

A unique aspect of this collaborative research program was the sampling for a set of consistent measurements across the Mid-Atlantic estuaries. The list of the parameters collected was developed in conjunction with Federal, state, and county authorities to address critical scientific issues affecting these estuaries. These parameters focus on many aspects of the estuarine biotic community, both plants and animals, as well as provide important information about the exposure to stresses in the estuarine environment. In general, the measurements include data on fish and shellfish, benthic (bottom-dwelling) community structure, water quality, toxic contaminants in bottom sediment, and sediment toxicity. The general categories of measurements are found in Table 1.

Table 1. General Categories of Environmental Indicators Used in the 1997-1998 Estuarine Field Sampling

General Measurements
- Locational Data
- Date and Time of Sampling

Water Column Measurements
- Physical Measurements (Temperature, Dissolved Oxygen, Salinity, etc.)
- Water Clarity
- Water Column Chemistry (Nutrients)

Sediment Measurements
- Benthic (Bottom-dwelling) Organisms
- Submerged Aquatic Vegetation
- Sediment Chemistry (Pesticides and Other Toxic Chemicals)
- Sediment Bioassay (to Determine Toxic Response to a Benthic Organism)

Fish and Crabs
- Fish Community Composition and Other Observations
- Callinectin (Crabs)

In the summer of these two years, about 1,000 samples were taken from the watersheds of the Delaware Estuary, Delmarva coastal bays, Chesapeake Bay and the Albemarle-Pamlico Sound. Within the coastal bays, areas of the Chincoteague and Sinepuxent Bays, and the Virginia coastal bays were sampled in partnership with the Assateague National Seashore. Although previous surveys have sampled Chincoteague and Sinepuxent Bays, this effort represented the first extensive survey covering the Virginia coastal bays.

Some preliminary data analysis has been completed, and the tentative conclusions showed some interesting findings. The trend of better ecological condition from north to south did not continue into the Virginia coastal bays. The 1993 survey (Chaillou 1996) found that the most degraded ecological conditions were in the northern part of the Delmarva coastal bays in Delaware, while ecological condition improved in the southern part into Maryland. Chincoteague Bay was found to be in the best condition of all of the coastal bays.

Condition of Bottom-Dwelling Organisms in Delmarva Coastal Bays

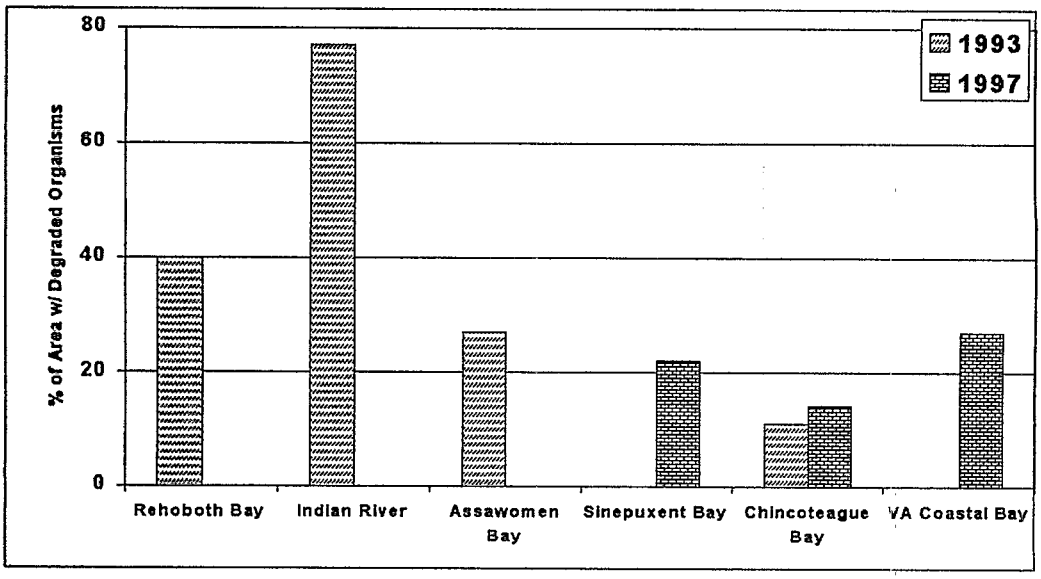


Figure 1. 1 Data from 1993 survey include DE and MD sites
Data from 1997 survey include MD and VA sites

The ecological condition of the Virginia coastal bays appeared to be equivalent to the condition found in the most northern of the coastal bays in Maryland – Assawoman Bay. The exact reasons for the moderately degraded conditions in the Virginia coastal bays must await further analysis.

Chincoteague Bay continued to be the least degraded of all of the Delmarva coastal bays. The condition of Sinepuxent Bay was between the condition of Assawoman and Chincoteague Bays which is exactly where it is located geographically. None of the areas sampled failed all five of the submerged aquatic vegetation (SAV) criteria proposed for the Chesapeake Bay (Dennison et al. 1993). However, most of the areas failed at least one of the proposed measures. The proposed SAV goals for the Chesapeake Bay include measures of nutrients, chlorophyll, suspended solids and light penetration through the water and is an comprehensive indicator of the ability of the aquatic system to support the growth of SAV.

Figure 1 depicts the condition of bottom-dwelling organisms in the major systems of the coastal bays. Bottom-dwelling organisms include worms, bugs and clams which are great fish food. They are excellent measures of the condition of an estuary because they are locationally stable and can not escape polluted areas. Both the 1993 and 1997 data were included in Figure 1.

An index has been used to summarize the information on the myriad of organisms found in the bottom sediment of the bays (Paul et al. 1999). The pollution gradient from north to south was readily apparent; however, the gradient did not continue into the Virginia coastal bays. Data were available from the two sampling periods for Chincoteague Bay and showed a close concurrence. The area with degraded bottom-dwelling organisms in 1993 was 11 percent of the entire bay, while in 1997, the areal extent of degradation was 14 percent.

Summary

Results of studies conducted since the 1993 assessment of the ecological condition of the Delaware and Maryland coastal bays confirmed the conclusions of that report. New data from the Virginia coastal bays (from Chincoteague Bay to Cape Charles) appeared to indicate that about 25 percent of the area of these bays showed degraded condition in the bottom-dwelling organisms. Major portions of the Delaware and Maryland coastal bays continued to show poor environmental quality. Some of the water quality measurements made in the 1993 assessment might be slightly more severe when compared to other data; however, this could be caused by the climatic conditions which existed during the 1993 sampling period. The composition of the fish communities in Delaware and Maryland were found to be the same as reported in the 1993. The fish communities in Delaware continued to be dominated by pollution-tolerant species.

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WATER AND HABITAT QUALITY EFFECTS ON LIVING RESOURCES

ROBERT MAGNIEN, PH.D.
TIDEWATER ECOSYSTEM ASSESSMENT
MARYLAND DEPARTMENT OF NATURAL RESOURCES

Note: The following document is a transcription of the presentation by Dr. Magnien. It has been reviewed and approved by the author for publication.

I am going to give a brief review of the major tidal habitat components, review some of the principal threats to the water column and the bottom sediments, show some recent information that illustrates some of the points, and then summarize. I thought I'd put together a little schematic to help us visualize some of these tidal habitats. If we start from the bottom up, we have the physical habitat level, the structure. Then sediment quality, including grain size, carbon, nutrients, and contaminants. This is the foundation of a lot of the habitat in the coastal bays. We have a number of living resources, the fish, crabs, and SAV.

You also heard a bit about the eutrophification issues--phytoplankton and benthic macro-algae overabundance, driven by a nutrient over-enrichment. Some of the issues of sediment from runoff, shore erosion, and resuspension, all of those conspiring to increase the turbidity of the systems and impact our SAV populations. These are the areas I've identified that other speakers have not covered: water column nutrient over-enrichment, water column suspended sediments, and bottom sediments.

Nutrient Over-Enrichment

I think most of you know this nutrient enrichment leads to excess production of phytoplankton, and in the coastal bays, macro-algae. I work mostly in the Chesapeake Bay where we don't have such a problem with macro-algae. It's a shallower system here. Light can penetrate to the bottom, and there's a lot of subsurface nutrient inputs involved as well. I'll probably point out a number of other contrasts with the Chesapeake Bay because there are a number of them that distinguish this system from that one we've been managing over there to the west.

We do have low dissolved oxygen problems from algal decomposition. For respiration, they are different from the problems that we see in the Chesapeake Bay where we've got a deep stratified system with dissolved oxygen that stays at 1-2 milligrams/liter almost all summer. Here the dissolved oxygen problems were transient.

Nutrient over-enrichment also leads to a reduction in water transparency due to excess phytoplankton growth when we have blooms. We saw that to a large extent this year with some of the brown tides. And of course, the macro-algae again, causes the "smothering" of SAV in the bottom habitats. I think we still have a lot to learn about what's stimulating this community, and what some of these impacts are.

I am going to touch briefly on the joint assessment Rick Kutz mentioned. This was a comprehensive sampling effort in 1993. We hit this system pretty hard during the summer of 1993. When we look at the chlorophyll levels reflected in the phytoplankton in the water column, we can see some patterns. We use as a cutoff, the percent of area above 15 milligrams per liter. That's a level of algae we've been using in the Chesapeake as the danger zone above which SAV have problems growing. If we use that measure, the Chincoteague Bay has a very low percentage of its area at or above the 15 mg/L level. But as you go to the northern bays, especially up into the river systems, that's where we see our highest levels of algae. And this is a pattern you'll see repeated again and again in the information we have about coastal bays habitats.

The dissolved oxygen picture is not as bad as many places. There's a patchwork of monitoring programs out there for dissolved oxygen. We have the National Park Service information, our new DNR *Pfiesteria* stations, and some very interesting information from DNREC, doing some continuous measurements throughout the daily cycle up in Indian River. I looked at the summer period, the same period we looked at in the joint assessment, using the same 5 mg/L cutoff, and did a rough estimate of stations that showed about 30% or more of their observations below that level. Low dissolved oxygen events are fairly prevalent throughout the bays and when we make these measurements, it's often daytime, when dissolved oxygen levels are higher than they might be early in the morning.

If we look at actual records from Newport Creek and in Delaware (courtesy of the National Park Service in the Newport Bay area), as we go through the year from January to December, we go through this cycle that we see in a lot of waters, whether freshwater or coastal waters, with high oxygen levels in the colder months and lower in the summer months. And we can see in June, July, and September, almost half the observations are below this 5 mg/L. So it's not insignificant, even when we're measuring the oxygen in the middle of the day. If we look at only a five day record, instead of the whole year, one of the major things we see is an oscillation here. That is the algae producing oxygen when the sun is out. In early morning, those oxygen levels rise as the algae are pumping out oxygen and photosynthesizing. Come evening, that starts to drop, as those algae respire, and bacteria and other organisms are using up oxygen. Sun comes up it goes up, sun goes down it goes down. Interestingly, the period from the 16-17th was cloudy, so obviously, the phytoplankton could not produce as much oxygen because they didn't have as much sun and they only weakly improved the oxygen situation. But there was just as much respiration, oxygen consumption, and you can see that driving the oxygen down. Now we're not talking 5 mg/L anymore, we're talking less than 2, or between 0 and 1 mg/L , and on the 20th in this area, a crab kill was recorded.

So you can see quite a neat pattern there, and it's hard for us to figure out whether we're capturing all the problems with the kind of monitoring program we have now. So one of the things we'd like to do is improve this type of monitoring and try to get at some of these areas. If you hit an area with 0 or 1 mg/L, it might only last for a few hours, but most the organisms are going to be wiped out and even though most of the time it's okay, that short-term event could be very important.

Suspended Sediments

Suspended sediments are the particles in the water column. They can be either inorganic or organic. The sources include runoff, shoreline erosion, and natural or anthropogenic resuspension. The impacts include water transparency, and "smothering" of SAV and bottom habitat. One of the things we found in the joint assessment was that the suspended sediment levels were really relatively high. We were getting 30s, 40s, and 50s in Chincoteague Bay. Bob Orth and colleagues were saying we need 15 mg/L in the Chesapeake Bay and we were scratching our heads. Here we have 40 or 50 and we have some nice SAV beds. This is something I think requires more study. It's more than likely that these are resuspended sand particles that are very heavy but are not really impacting light as much as some of the fine particles that we often get in the Chesapeake Bay.

Bottom Sediments

Not only are bottom sediments important in and of themselves, but they can be very important to the overlying water column. Especially in a shallow system, that sediment can have a profound effect on the overlying water column. Either pumping nutrients out, or demanding oxygen and driving those oxygen levels down. Many of our shellfish, SAV, and a variety of benthic organisms use this bottom as their home. And there are many other organisms--fish, crabs, and waterfowl— that feed in this environment. Much of the excess algal production associated with the nutrification that we talked about ends up on the bottom, enriching it with further organic matter, and leading to increased oxygen demand, nutrient releases, and degrading habitat quality. And finally, toxic contaminants. Fortunately, we don't have major problems here, just in some of the lagoons and more poorly flushed areas we have some elevated levels. But most toxic contaminants get associated with particles and end up in the bottom sediments.

The Maryland Geological Survey has done quite an extensive survey, at least in the Maryland portion of the coastal bays. Looking at high, medium, and low levels of mud, the gradient is higher muds on the western shore and in the tributaries and gets sandier as we go east. The pattern for carbon is similar. Again higher carbon levels up in the tributaries and toward the western shores. What are the implications of that? A lot of folks think that is a critical factor controlling the distribution of SAV. One sees most of our SAV on the eastern side of the coastal bays. Most of the contaminants, when we find them, are higher in the tributaries as well.

Summary

A number of anthropogenic impacts are seen, both in the water column and the sediment habitats. The impacts are generally more severe in the tributaries and western shores. We just don't have a consistent and appropriate monitoring system for determining the extent and severity of these trends for most of these impacts. We are trying to develop this as part of a CCMP. A monitoring plan was developed and included in the CCMP, and we're hoping that the governor will be forthcoming in sending a proposal for funding to the legislature this year.

Finally, I pointed at a number of areas where we just don't have basic understanding. These are just a few and we are trying to relate these habitat conditions to the living resources. Questions include: How does water and sediment quality affect SAV? What are these macro-algal impacts? What is the relationship between nutrients and harmful algal blooms? How important is the physical surface of bottom sediments? And trying to get at some of the mysteries of suspended sediments, where are they coming from and what's their composition?

IDENTIFYING AND RESOLVING FISHERIES MANAGEMENT CONFLICTS IN A RECOVERING SEAGRASS SYSTEM

ROBERT J. ORTH, PH.D.
SCHOOL OF MARINE SCIENCE, COLLEGE OF WILLIAM AND MARY,
VIRGINIA INSTITUTE OF MARINE SCIENCE

This paper forms the base of a larger manuscript that will be submitted in spring 2000 to a scientific journal on the submerged aquatic vegetation trends and management considerations and recovery. The abstract is presented here. If you would like further information, contact Dr. Orth.

The Delmarva coastal bays historically supported large seagrass populations, which in turn supported a valuable bay scallop fishery. These seagrass populations were devastated in the 1930s but have since shown significant recovery in several bays. The scallop fishery collapsed and has never rebounded, although scallops have recently been reported in low abundance in seagrass beds in Chincoteage Bay. Annual aerial photographic surveys of seagrass identified the appearance of many dredge scars indicating that there had been a sudden significant increase in clam dredging in 1995-1997 in the seagrass beds. Analysis of photography (1995-1997) revealed 251 individual circular scars (mean diameter of 80 m.) impacting 126 hectares of seagrass in Virginia, while in Maryland hydraulic clam dredging, which causes linear scars, impacted 508 hectares of seagrass. The rapid assessment from this annual survey of the extent of the damages facilitated passage of legislation and regulations in Virginia and Maryland that prohibited dredging within seagrass beds. Regulations in Virginia were effective as only 13 new circular scars were identified in 1998. Recovery of seagrass into the circular scars, assessed from field inspection of scars created in 1996, 1997, and 1998, indicates a slow recovery rate of most scars. Rapid protection of seagrass beds in the coastal bays was possible because of the strong linkage between science and management in this region.

AN OVERVIEW OF HARMFUL ALGAL BLOOMS IN DELAWARE AND MARYLAND'S COASTAL BAYS

BRUCE RICHARDS, PH.D.
DELAWARE CENTER FOR INLAND BAYS

Introduction

Increased attention on "Harmful Algal Blooms" (HABs) cannot be underestimated in Delaware and Maryland's coastal bays. Much of the recent focus has centered on the presence of *Pfiesteria*, a one-celled dinoflagellate, that has been linked to fish kills and even human health problems including memory loss, skin lesions and respiratory problems. First of all, let's make the distinction between HABs and the beneficial phytoplankton species that reside in the water column. Most of these beneficial organisms harness sunlight and produce oxygen and carbohydrates through photosynthesis processes. Phytoplankton comes in a variety of shapes and sizes and under a microscope, they are quite beautiful. Roughly two-thirds of all the photosynthesis occurring on the planet comes from our oceans with the remaining third coming from the growth of terrestrial plants. Phytoplankton is also called "autotrophic" which means they produce their own food energy from light and the chemical elements within seawater. Autotrophs are critical to heterotrophs (organisms that feed on the autotrophs). Heterotrophs are various stages of animals from larval stages of crabs, snails and fish to adult animals like clams that directly feed on the autotrophs for food. Certain HABs are counterproductive to marine systems especially when these creatures bloom rapidly and out-compete with the other organisms throughout the water column.

Pfiesteria

Nearly everyone has heard of *Pfiesteria*, the so-called "cell from hell", that has been linked to mass fish kills in Maryland and North Carolina. In 1987, Delaware's Inland Bays experienced a large fish kill. One Delaware scientist took a water sampled and preserved it for eight years. When this scientist heard of *Pfiesteria* and the link to fish kills, he sent a sample to North Carolina for testing and discovered that Delaware, too, had *Pfiesteria* in its water. Major studies and millions of dollars are now being spent on understanding the biology of *Pfiesteria*. Perhaps more is known about this dinoflagellate than any other, but public concern is putting perhaps too much attention on this organism, when other HABs need our attention as well.

Red Tides

Like *Pfiesteria,* red tides encompass several species of dinoflagellates that share one common feature; when they bloom, one sees a red color. Red tide blooms are linked to fish kills and the toxins emitted from red tides produce saxotoxins that cause serious human health problems. Ballast water release is the likely mechanism that brought red tides from Asian seas to American coastal systems. Invasive species, like red tides, are difficult to control, especially since shipping cargo around the world has increased in recent years. Despite the fact that red tides have been linked to ballast water exchange, other sources of HABs (like Brown Tide) are harder to pinpoint.

Brown Tides

It seems to me that *Pfiesteria* and Red Tides have overshadowed the threat of Brown Tides in coastal bays on the East Coast. What is Brown Tide? Brown Tide is a "picoplankton" species measuring two to three microns, slightly bigger than bacteria. This autotroph was only identified in the late 1980's. To date, we know of only two species, one on the Gulf Coast and the other in the Northeast Coast of North America. A recent study has found the presence of Brown Tide in South Africa. The range of this organism is still a major question to be answered with further research. Why should we become

concerned about Brown Tide? When Brown Tides bloom, the water column is filled with a brown murky color; light fails to reach the bottom and submerged vascular plants, like eelgrass, die-off in mass. Since Brown Tide is extremely small, and therefore, filter feeding clams and scallops are unable to feed on Brown Tide. Bloom levels occur when one milliliter of water (about 20 drops) reaches 10,000 cells. Where is Brown Tide found? Brown Tide is linked to shallow estuaries with nutrient-rich water. The organism was originally discovered from southern Maine to Barnegat Bay, New Jersey.

About two years ago I listened to a lecture by David Hutchins of the College of Marine Studies of the University of Delaware on HABs and became intrigued with the Brown Tide organism. Dr. Hutchins and I decided it would be prudent to test Delaware's Inland Bays for Brown Tide. With the help of Delaware's Department of Natural Resources and Environmental Control, water samples were collected throughout Delaware's Inland Bays as part of the *Pfiesteria* monitoring program, during the summer of 1998. We soon learned that Brown Tide was absent in Rehoboth and Indian River, but cell counts from 400 to 1,000 cells per milliliter were discovered int the Little Assawoman Bay. In December of 1998, Dr. Hutchins and I took additional water samples in Little Assawoman Bay and two samples were collected in Ocean City, Maryland. Even in December we found cell counts from 200 to 700 per milliliter in all samples collected. Maryland scientists took additional samples in the spring of 1999 and found cell counts as high as 300,000 per milliliter. In fact, 1992 overflight photographs of Maryland's Coastal Bays were re-examined and brown streaks, previously unidentified, are now thought to be former Brown Tide blooms. What causes Brown Tide? Current research indicates that Brown Tide is probably not due to inorganic nutrients or trace nutrients or minerals. Most believe that dissolved organic nutrients are likely suspects at this point, although few conclusions can be made.

In summary, HABs are worth continued exploration and concern for Delaware and Maryland's Coastal Bays. It is important that we consider a comprehensive approach to monitoring and identifying HABs and not get sidetracked on only those organisms that make news headlines.

INCREASING RISK FACTORS: PFIESTERIA

Dave Goshorn, Ph.D.
Living Resource Assessment, Maryland Department of Natural Resources

Note: The following document is a transcription of the presentation by Dr. Goshorn. It has been reviewed and approved by the author for publication.

What is *Pfiesteria*?

Pfiesteria is a very small, single-celled organism without a flagella. Its got an extremely complex life cycle. Most of the time populations are benign, feeding on algae and bacteria, but some populations, not all, are capable of producing a toxin which can cause fish health problems and, apparently, human health problems. In 1997, Maryland experienced four separate toxic outbreaks on three different Eastern Shore rivers. North Carolina has had its problems for quite some time.

What was Maryland's response?

First, an intensive monitoring and response program. The response part of that means that when we have something that might be a *Pfiesteria* outbreak, we have teams that respond to the situation and make an assessment of what's occurring. As for monitoring, we've been monitoring habitat quality and fish health intensively on eight lower Eastern Shore rivers, including two tributaries of the coastal bays, St. Martin's and Trappe Creek in Newport Bay area. We have water quality monitoring stations as part of this monitoring and response network that are monitored once or twice a month April-October. We are also intensively monitoring fish health along these rivers.

There is also the development of river closure guidelines that would be used to close a river if the problem was believed to be a threat to public health. Legislation has also been passed, in the form of the Water Quality Improvement Act of 1998, which set up all sorts of requirements for ultimately reducing nutrient inputs to Maryland tributaries.

Results of Monitoring

I am going to talk about some of our results from the two coastal bay rivers that we have been monitoring last year and this year, the St. Martin's River which flows into Isle of Wight, and Trappe Creek-Ayres Creek. We have water quality and algal monitoring stations that we are monitoring once or twice a month, April-October. Also, at a subset of these stations, two in each system, we've been collecting water samples and analyzing them for presence of *Pfiesteria* in 1999. There are also locations in each of these two tributaries where we collected sediment in 1998, and we are having those samples analyzed for the presence of *Pfiesteria*.

We have some results from those samplings. At four stations that were only sampled for water monthly this year we tested for the presence of *Pfiesteria* using one of the new technologies available and all those samples were negative. From several of our sediment sites we haven't gotten the results back yet. It is a very lengthy process to analyze sediment samples for the presence of *Pfiesteria*. At most of the stations where we have results, we tested the samples and did not find any *Pfiesteria* of *Pfiesteria*-like organisms in the samples. At one station in Trappe Creek, we did find a *Pfiesteria* species, but it is non-toxic. That means that in the lab, under ideal conditions to induce toxicity, it did not go toxic. This is what we've found in other areas, too. Not all populations of *Pfiesteria* are capable of producing a toxin.

There are two things to take from this. First, samples from these sites were not toxic when they were collected. They were our only populations that had the *potential* to go toxic. To my knowledge, they have not ever gone toxic in nature. Second, the location of these sample sites is not necessarily most important. It doesn't mean that one site is any more at risk than the others. The important thing is we found potentially toxic populations.

What habitat conditions induce toxic outbreaks?

There are five general habitat conditions that we believe induce toxic outbreaks. I am going to get back to the word "general" in a few minutes because that is extremely important.

1) Where we have seen toxic outbreaks, both in Maryland, and elsewhere, they generally occur near areas of moderate salinity, although, there are documented cases of outbreaks in almost freshwater to almost full strength sea water. But, generally, about the middle of the road is where you typically see outbreaks.

2) Warm water temperatures, above about 25°C is a common factor, but outbreaks can occur below that.

3) Outbreaks don't seem to occur in areas where you have a lot of tidal action or a lot of current, but in more quiet backwaters where there was slow water movement.

4) Elevated nutrients, it's believed, can induce *Pfiesteria* outbreaks through two pathways, one direct and one indirect. There's a fair amount of laboratory efforts that show dissolved organic nitrogen may directly encourage the growth of *Pfiesteria*. We also know that *Pfiesteria* feeds on algae, and we know that algal growth is promoted by the inorganic forms of nutrients. This may be an indirect pathway.

5) The final condition is concentrations of fish. The understanding at the moment is that these first four conditions set the stage. They allow the development of fairly large populations of this organism, and then when the large concentrations of fish come to the area, the *Pfiesteria* sometimes detects the presence of fish and releases the toxin.

What is important to know is that these are just the general habitat conditions. Hopefully you gathered from the talks that have gone before me that there's a lot of tremendously complex interactions going on between all these factors. These are simply the common denominators that we see in most of the outbreaks, but just because these conditions are met, does not guarantee, by any stretch of the imagination, that we will have a toxic outbreak. It just means that these are what we typically see in an outbreak. There are a lot of details on what is occurring which are poorly understood. It is the interactions of all these denominators that are determining the outbreaks. In the coastal bays, these conditions are met, but fortunately we haven't had a toxic outbreak.

Conditions in the Coastal Bays

I would like to examine some of our 1999 results, going through each of these parameters that I just outlined. For salinity, the results aren't surprising. There is freshwater in the upper reaches of the tributaries and then much more saline water as you get out into the tributaries. As far as what this means for *Pfiesteria*, we wouldn't really expect outbreaks in these freshwater areas, but anything beyond that, up toward 18 parts per thousand, is saline enough for a potential *Pfiesteria* outbreak.

August-September water temperature, the warmest months of the year, show a pattern of cooler temperatures in the upper portions of these tributaries and warmer temperatures as you move out into the main river. The high end is 24-28°C, which is certainly within the range, and I would think that even slightly lower temperatures are within the range where we've seen outbreaks before. So, certainly in August and September, the temperatures in this portion of the river, are in the ballpark for where we've seen outbreaks elsewhere.

The third parameter was slow water movement. If you go out on these rivers there are some areas that are certainly wide open and free flowing, and there are other areas that are not. Certainly all are of the nature similar to what we saw in the 3-4 sites of the Maryland outbreaks in 1997, and similar in hydrodynamics to what we've seen in North Carolina as well.

I want to spend most of my time on the nutrient aspect. There are two possible pathways, the direct pathway for organic forms, and an indirect pathway through inorganic forms. We have data on dissolved organic nitrogen and all the areas out in the main part of the river would be high, the point being that dissolved organic nitrogen levels on these rivers are quite high and could serve as a source of nutrition for *Pfiesteria* to consume directly, as has been demonstrated in the laboratory. Dissolved inorganic nitrogen is where it gets interesting. It follows the reverse pattern of what was found in some of the other conditions. High loadings in some of these upper tributaries. High concentrations of dissolved inorganic nitrogen is being supplied to the tributaries. And then it declines, considerably, out here at the main stems of the tributaries.

There are two possible explanations and both are probably operating. One is simple dilution, the volume of the water up at the source is lower than out in the river, and just by simple dilution the concentration declines. Also, I believe, its consumption by algae. Why isn't the algae up in these areas, where the concentration is very high? The water up here is very turbid, and the algae, of course, need sunlight. I think despite the high nitrogen

levels up here, the water is too turbid for a lot of algal growth. Once you get down in the lower reaches, the turbidity decreases, there is enough sunlight for algal growth, and the algae are consuming the dissolved inorganic nitrogen. That's why these levels drop.

Chlorophyll values are a measure of the amount of algae, and the pattern for chlorophyll is the reverse of inorganic nitrogen. Low values up in the tributaries where there are high inputs of nitrogen and low algal growth, but once we get out in the main stem, it is clear that we're getting a fair amount of algal growth. These are medians from April-July and are 20-40 microgram/liter, that's high for a median for that whole period of time. In some areas it's even higher, 40-60 micrograms/liter median for the months of April-July.

Now I want to focus in on one area to expand on this thought a little bit more--the tributary, Bishopville Prong. The dynamics that we see in this tributary are repeated for Shingle Landing Prong and in Trappe and Ayres Creeks. For dissolved inorganic nitrogen, concentration vs. river mile shows quite high levels of dissolved inorganic nitrogen coming out at the most upstream stations, then it drops precipitously as we go downstream, until low levels are reached when we are out here in the main part of the river. The chlorophyll is very low, almost near zero up where the nutrient levels are high, again because of the turbidity. Once you get out in the main stem of the river, there is a peak in June, almost to 150 micrograms/liter which is quite high. It drops back down, both in July and August, to the 30-60 micrograms/liter range. Those are pretty significant algal blooms that were seen consistently in the main portions of these rivers, resulting, I would suggest, from these dissolved inorganic nitrogen inputs from upstream.

I want to point out that these upstream areas are essentially tidal-fresh. When we get to the area where we've seen the chlorophyll peaks, this is where we going from freshwater to 18 or so parts per thousand. This is a very condensed and very quick change, and then salinity gets gradually greater from there. That's something that's somewhat unique about these coastal bay tributaries. They go from tidal fresh to 18-20 or more parts per thousand in very short spatial areas. In Chesapeake Bay tributaries, that's spread out over a much larger area. What that means for *Pfiesteria*, I don't know. It is interesting that any organism living in this area is going to see quite a range of salinities.

The most important part of the whole equation is probably fish health. We've been sampling fish in these two tributaries over the past two years. 1998 results were very similar to 1999. The good news is that the fish in these areas, despite all this are in quite good health. In fact, in some respects, better health than some of the Chesapeake tributaries. In the same part of the river, of 7301 fish that were sampled this year, only 0.3% had any kind of anomaly, and that's all sorts of anomalies. Menhaden, which are the species most often associated with *Pfiesteria* problems, only 1.1%. In a lot of areas of the Chesapeake Bay, 1-2% is easily the background level that we see.

In Newport Bay-Trappe Creek, a similar story. Only 0.4% of all fish had any kind of anomalies, and for 1998 it was only 0.8%. So, certainly, we're not seeing any fish health problems despite a lot of the habitat conditions that were just described. Now this is spread out over a whole summer. There are some times and places where we did see higher percentages of anomalies. Interestingly, one of those areas in Newport Bay was where we've also seen some low dissolved oxygen levels that Rob Magnien was talking about earlier. So, there's a lot to look at there. In general, the fish are quite healthy.

What does all this mean?

We know we have *potentially* toxic populations of *Pfiesteria* species present, at least in these two rivers. The general habitat conditions that we see with these toxic *Pfiesteria* outbreaks are met, but there are many areas where these general conditions are met that we do not have toxic outbreaks. Fish populations are healthy and, to the best of our knowledge, there are no known toxic outbreaks.

In conclusion, we need to be concerned. We know we are in the ballpark as far as habitat conditions are concerned. We know the organism is there. Fortunately, the specifics of how these habitat conditions are interacting with the organism haven't worked themselves out to result in toxic outbreaks. Because it is out there, what we have to do is make sure that we are diligent in our monitoring efforts, which we are, and I think this emphasizes the importance of what many other people have mentioned today, for many other reasons. The one factor that we can do something about is to lower nutrients in these rivers.

INCREASING RISK FACTORS: *Hematodinium* sp.

GRETCHEN A. MESSICK
NOAA, NATIONAL OCEAN SERVICE
CENTER FOR COASTAL ENVIRONMENTAL HEALTH AND BIOMOLECULAR RESEARCH

Abstract

In 1992 watermen from Maryland coastal bays reported crabs dying in pots. Upon investigation, adult and juvenile blue crabs from coastal bays of Maryland, Delaware, and Virginia were found infected with *Hematodinium* sp., a parasitic dinoflagellate. Dinoflagellates were found in hemolymph and tissues of sick crabs where the parasite proliferates and causes mortalities. In coastal bays of the Delmarva region, prevalence of infected crabs follows a seasonal pattern with up to 90% of crabs infected during early winter. Heavy mortalities are reported by watermen during summer months. Prevalence of infected crabs varies depending upon location and infections are found more often in shallow coastal bays than in deeper, larger estuaries. Crustaceans other than blue crabs are also affected by *Hematodinium* spp. dinoflagellates; these include amphipods, green crabs, Tanner crabs, and other commercially important species. A series of experiments held crabs at various water temperatures and salinities to investigate how infection intensity changes. The intensity of infection dropped when crabs were held at 9°C. Crabs held in water with 10 ppt salinity had a greater decrease in intensity than crabs held 29 ppt at 9°C for 73 days. In another experiment, infection intensity increased when crabs were held in 22 ppt seawater at either 12 or 16°C for 32-56 days. An additional experiment found crabs presumed to be uninfected presented infections after 14 days when held at 22°C in 28 ppt seawater.

Introduction

The parasitic dinoflagellate *Hematodinium* sp. infects and causes mortalities in blue crabs *Callinectes sapidus* from high salinity coastal embayments. The seasonal infection cycle and apparent salinity and temperature requirements for infections indicate that environmental factors influence the parasite's ability to proliferate within crab hemolymph. Additionally, host factors such as size influence the prevalence of infections.

Hematodinium perezi was originally reported as a rare parasite of portunid crabs *Carcinus maenas* and *Liocarcinus depurator* from Europe (Chatton & Poisson 1931). Numerous other crustacean species have been reported including occasional infections in the cancer crabs *Cancer irroratus* and *Cancer borealis* and in the portunid crab *Ovalipes ocellatus* from the New York Bight area of the northeastern United States (MacLean & Ruddell 1978). A 21% prevalence was found in the cancer crab *Cancer pagurus* from the west coast of France (Latrouite et al. 1988). A 100% prevalence has been reported in Tanner crabs *Chionoecetes bairdi* from southeast Alaskan waters, and *Chionoecetes opilio* from the Bering Sea (Meyers et al. 1987, 1990, Eaton et al. 1991).

Hematodinium-like parasites have been observed in 87% of the crab *Necora (Liocarcinus) puber* from France (Wilhelm & Boulo 1988), and in up to 70% of the Norway lobster *Nephrops novegicus* from the west coast of Scotland (Field et al. 1992). On the east coast of Australia a parasitic dinoflagellate infects the sand crab *Portunus pelagicus,* the mud crab *Scylla serrata*, and the coral crab *Trapezia aerolata* (Shields 1993). A dinoflagellate similar to *Hematodinium* has been reported in 13 species of benthic amphipods, with prevalences as high as 67% (Johnson 1986). Up to 18% of spot prawns *Pandalus platyceros* from British Columbia have been reported with a *Hematodinium*-like protozoan (Bower et al. 1993). In 1975 the parasite was reported in up to 30% of adult blue crabs *Callinectes sapidus* sampled from coastal areas of North Carolina, Georgia, Florida (Newman & Johnson 1975), and Gulf of Mexico (Couch & Martin 1982). A blue crab disease survey was initiated in late summer of 1992, following reports of reduced catches and mortality of

trapped crabs from coastal bays of the Delmarva region. This paper discusses the variation in disease prevalence and how physical and host characteristics can influence prevalence of infections.

Materials and Methods

Monthly samples of blue crabs were collected using both commercial traps and an otter trawl in coastal bays of Maryland, Delaware, and Virginia. Carapace width was measured from point to point, and sex was recorded; pre-molt and post-molt crabs were noted when molt stage was apparent. Crabs were bled from the hemal sinus at the joint between the carapace and the swimmer fin using a 1-cc insulin syringe equipped with a 0.5-inch, 28-gauge needle. Expressed cells were allowed to adhere to an acid-cleaned, 0.1% w/v poly-L-lysine-coated microscope slide. Cells were observed live using an inverted microscope with Hoffman modulation or phase contrast optics. Hemolymph preparations were then placed in fixative and stained with Mayer's hematoxylin and eosin (H&E) (Luna 1968). Selected crabs were either fixed whole or dissected and processed for histologic examination by standard methods (Johnson 1980, Howard & Smith 1983). To obtain a preliminary estimate of possible fishery reduction due to disease, the number of crabs caught in trawls in Maryland coastal bays by the Maryland Department of Natural Resources coastal bay fisheries project was averaged April through October from 1993 to 1997. This number was plotted against the average prevalence of *Hematodinium* sp. in crabs assayed from the same trawls.

Results

The prevalence of *Hematodinium* sp. infections in blue crabs followed the seasonal trend reported by Newman & Johnson (1975), with the highest prevalence observed from August through November. Prevalence was higher in small crabs (5-89 mm), than in larger crabs (90-180 mm) collected at salinities from 19-32 ppt, and temperatures from 4-26°C. There was no difference in prevalence of *Hematodinium* sp. infections between male and female crabs. Occasional gross signs of *Hematodinium* infection included sluggishness, opaque muscles seen ventrally, or a pinkish carapace. Hemolymph removed from some severely infected crabs appeared opaque, while gills and other tissues were occasionally pink. However, most infected crabs appeared normal externally. Several morphological forms of the parasite were observed. Trophonts with one nucleus were most common; but parasites that were obviously dividing, and multinucleated plasmodia were also observed. Some plasmodia, with multiple nuclei, were elongate and demonstrated amoeboid motility when observed live. The average diameter of fixed and stained parasites in hemolymph smears was 10.5µm. Severely infected crabs had reduced hemocyte numbers with apparent replacement by *Hematodinium* sp. Host response to the parasitic dinoflagellate included formation of nodules in hemal spaces.

A series of experiments held crabs at various water temperatures and salinities. Infection intensity decreased in infected crabs held in 10 ppt or 29 ppt seawater at 9°C; the decrease was significantly greater at 10 ppt than at 29 ppt. Mean intensity increased in infected crabs held in 22 ppt seawater at either 12 or 16°C. Presumably uninfected crabs held at 22°C presented infections after 14 days. Increased prevalence of *Hematodinium* sp. infections in September and October coincide with reduced numbers of crabs trawled from Maryland coastal bays during the Maryland Department of Natural Resources survey of coastal bays.

Discussion

The prevalence and intensity of *Hematodinium* sp. in blue crabs are seasonal and peak in late autumn and early winter. The apparent 0% prevalence from late winter through spring in coastal bays of the Delmarva region (Messick 1994) is likely caused by low water temperature reducing *Hematodinium* sp. numbers to unobservable levels within the hemolymph. Winter temperatures appear to provide a refuge from infection for crabs overwintering in coastal bays of Delmarva since crabs held at 9°C have reduced infection intensity (Messick et al. 1999), and water temperatures from December-March 1997 averaged 3.5-9.8°C (Phillip Wirth, University of Maryland Eastern Shore, personal communication).

Some coastal areas such as Chesapeake Bay, North Carolina, and Louisiana, sustain large blue crab fisheries, although some states have reported reduced catch per unit effort in recent years (Jordan & Rosenfield 1998). Natural sources of mortality reduce blue crab stocks, but the level of mortality caused by *Hematodinium* sp. is unknown. More information on how *Hematodinium* sp. induces mortality in blue crabs, and what level of infection is required to cause deaths, will allow fishery managers to make better estimates of stocks in the Delmarva region. Seasonal variation in *Hematodinium* spp. infections are coupled with environmental and host characteristics. Stations in Maryland coastal bays with the lowest prevalence were located north of the Ocean City inlet and in tributaries. In these bays the greatest drainage is in the upper portions (Sieling 1960). The increased drainage in the northern areas in comparison to the southern areas may explain, to some extent, the lower prevalence of infections in those areas. It is uncertain what parasite

characteristics or numbers are required to compromise the crab defense response, or what cellular and molecular changes occur in host tissues to cause mortality.

In summary, *Hematodinium* sp. infections in blue crabs are seasonal, widely distributed, and influenced by salinity, temperature, and host size. Numerous questions remain on how environmental and host characteristics affect parasite prevalence and proliferation, and how these may synergistically influence infections.

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HARVEST PRESSURES AND EQUIPMENT IMPACTS - HOW TO MAINTAIN A SUSTAINABLE CATCH

STANLEY LASKOWSKI, MODERATOR[1], BILL BAKER[2], HARLEY SPEIR[3], ROBERT ORTH, PH.D.[4], RICHARD WELTON[5], AND STEVE DAWSON[6]

PANEL DISCUSSION

Note: The following document is a transcription of the panel discussion.

Advances in commercial methods of harvesting fish and shellfish have added significantly to the pressures of maintaining sustainable catch levels. It has been suggested that the practices of taking fish and shellfish in the coastal bays return to more traditional harvest methods, at least in certain portions of the bays. For example, trot lining for crabs, mechanical bull rakes, and Chinicock clam rakes, and reduced fish net allowances. I would ask each of the panelists to comment.

Dawson: I am less inclined to point a finger at certain methods or techniques. Obviously there are some things that come under fire, such as monofilament gill nets, certainly the clam rigs are being scrutinized at this point, as well as things like stainless steel hooks. I am very concerned that we get away from politicizing the issue of resource use and at least try to get back to the dependence on science and management. We are all going to have to get together. Recreational fisherman have a tendency to look at the commercial guys and say this is a greedy handful of people that are lining their pockets with the results of their activities and these fish are much more valuable as a recreational item than as a piece of meat. The commercial interest tends to look at the recreational guy as out there having a good time while they are trying to earn a living as they have done for generations. Both groups are growing and the pie isn't getting any bigger. Look at what is happened with the striped bass and the management of the striped bass. Even though it was highly politicized, we made some good decisions and the striped bass fishery has come back. The same thing is happening with our flounder. A little bit of restraint goes a long way and I would like to see us make sure, and I might be naive, that this becomes a little less politicized and depends a little bit more on science.

Speir: I went back through some commercial catch records, and commercial methods of harvesting finfish in the back bays have actually changed very little over the past 50 years. I looked at the records from 1990-98. Eel pots, gill nets, hook-and-line, flag nets, fish pots, and a pound net one year, have been used to harvest anywhere from 60,000 pounds to 300,000 pounds of finfish per year from the coastal bays. All of these gears have been utilized for many years in Maryland commercial fisheries. Crab harvest ranged from a half million pounds to 1.5 million pounds over the same period. Dip nets, trot lines, pots, collapsible traps and rings, feint traps, and scrapes (in one year), have been used. The pots take about 90-95% of the landings every year. Pots have been used in the coastal bays since at least 1947. Trot lines have never been very successful in the coastal bays, as I think they are harder to use. One of the biggest issues has been clam dredges and they have been in use in the coastal bays, to some degree, over the past 35 years, although the use has increased here recently. They were actually invented on the Chesapeake Bay in 1954.

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[1] U.S. EPA Region III Environmental Services Division, 1650 Arch Street, Philadelphia, PA 19103-2029
[2] Bill's Sport Shop, 1566 S. Highway One, Lewes, DE 19958
[3] DNR Biological Monitoring and Analysis Program, 580 Taylor Avenue, Annapolis, MD 21401
[4] Virginia Institute of Marine Science, PO Box 1340, Gloucester Point, VA 23062
[5] Coastal Conservation Association of Virginia, 2100 Marina Shores Drive, Suite 108, Virginia Beach, VA 23451
[6] MDE Nontidal Wetlands, "Outdoor Report" WBOC-TV, 201 Baptist Street, Salisbury, MD 21801

We should not base decisions on desirability of commercial gear just on simple measures of time in use, or some notion that they are traditional or non-traditional. Commercial fishing, like any other business, seeks to minimize input of time and capital in order to turn a profit. Returning to labor-intensive methods of harvest would remove certain commercial fishing as profitable enterprise. We should look instead, at the effects on habitat from the use of certain gears. Whether or not they conflict with other water uses.

Baker: I have to agree with all of the above, except that in every business there is a bottom line, and the bottom line is always painful. We have got a problem in our inland bays, and we are going to have to address it. One of the areas has been addressed from the state of Delaware. We just don't have dredging in Delaware. We don't have dragging of nets. The only thing that the commercial clammer can use is the Chinicock rakes or the bull rakes, and the crabber can only use pots. We'll see them out there in Rehoboth Bay pulling their bull rakes, but there is no real commercial operation in the state of Delaware. Now, there are dredges out in the ocean, and there are loads of clams and crabs out in the ocean where it doesn't do any harm. So I think what we have to do with our resource is protect it, and if you want to make a living by the boat, go out there and do it where you can do it without doing harm to our inland bays.

We have several problems in Rehoboth Bay, and that is what I have to address because that is where I am from. Rehoboth Bay has no eelgrass. We get this stinky, smelly stuff called "crap grass". It chases tourists away. It rots things out. It just causes a big problem. This doesn't come from the commercial people. But we did take a section a couple years ago in Delaware and set it aside and planted eelgrass. All the tourists came in with their Chinicock rakes and raked it right up. So there has to be an address, not just commercially, but recreationwise too. We have to get some law enforcement in there. I can tell you as a tackle dealer, the fishery itself is back, it is wonderful. We have had a very good year this year. Some of the regulations that were put in for the inland bays were very good regulations. We have some good fishing and we can continue to have that. A lot of things that have happened are in a good direction and I think we should continue in that direction. We have got to protect our bays. The commercial stuff is more suited to the ocean where they won't do any harm.

Welton: I think that first of all, all the fisheries departments have to limit the entry. People are coming to realize that the bay and the ocean don't have an unlimited supply. You might have some kind of technique that not many people are doing, and it might not harm the environment in any measurable way, but when you have an unlimited number of people moving to the water and wanting to participate, if you are not planning to limit or cap the entry at this point, then you have your head in the sand and you are just putting off the inevitable. Our resources can't take that kind of pressure. There are a lot of advances. People say their grandfather, and their great-grandfather before him, made their living on the water, but they didn't have hydraulic net reels or hydraulic pot pullers. They didn't have GPS where they could go right back to the exact same spot. They didn't have a lot of the advances that we have today.

We don't advocate doing away with the advances. What we would like to see is the end of any method that harms the habitat. Everybody, whether it is recreational or commercial, has a responsibility to preserve that habitat. That is the only thing that is going to make sure that there is plenty there for all the user groups. CCA has seen already, in Texas where they have brought back grass beds, they are not only limiting the commercial harvest methods in those areas to ways that are compatible with grass, but they are also starting to set aside big areas where you have to go upwind and cut your motor off. You can only drift or pole across these areas because the props of outboard motors are bad for these beds. So recreational fishermen are recognizing and are willing to do their fair share.

To get to the bottom line, I think the problem is not there are too many advances in the gear, the problem is the fisheries managers, whether it be politicians or scientists or board members, have not put enough limits or caps or quotas on the number of participants and the amount of resources they can take. Once they do that, I don't think they should go out there and tell a guy, who is making his living and feeding his family on the water, that you have to have one hand and one leg tied behind your back to make a living. So that it will take 365 days to catch whatever is allowed by science and law what would take 100 days using more modern gear. I think to blame it on the gear is not really recognizing the problem. The problem is that we have to have limits and caps and quotas on the participants and the amount of resource harvested. Once you do that, let them be as efficient as they can without harming the habitat.

Orth: There is a concern that is emerging among scientists about the impact of certain types of gears on bottom structure, whether it is sea grass beds or live bottom. Some of these gears, like the dredges, have major destructive capabilities. They destroy the structure of the bottom and there is a concern that, in the long term, this is going to have a dramatic influence on the fisheries utilization of these areas. I think we really need to look very closely at certain types of gear because they really do destroy the bottom. We also need to look at alternative

uses of these areas such as aquaculture, which is an emerging issue in Virginia. I pointed out that in Florida, they brought out the gill net people, and they helped out very much in getting these people started in an aquaculture fishery. I think there are lots of opportunities there and the only way that I see this all happening is to bring everyone to the table and work together.

The sad thing is that there is no one at this table that is actually a commercial fisherman, to tell us how they feel. About three weeks ago, I had someone call who was a commercial fisherman, and for about an hour and a half, he was asking me questions about how we do things. It is unfortunate that we didn't have the opportunity to perhaps hear what they are thinking because they might at least provide us their perspective. I do know that after the hour and a half that I spent on the phone talking about sea grasses and how we map and how they are spreading, and that once I explained to him a little about how this plant spreads and its biology, I think he understood. And when I broached the subject of aquaculture, the response wasn't "no", it was "it's going to be really hard because I have all my money invested in this gear". When I said the state will be willing to work with him, that sort of opened the door. I would like to see Maryland, with this issue of hydraulic clammers, at least in the coastal bays, begin the issue of working with them to slowly move from hydraulic clamming to aquaculture. Certainly you are going to have a conflict with areas that have SAV, but it is less invasive and we may balance with a little bit of area that could be called "potential habitat", that may have more sea grass coming back because you are limiting all that destructive activity.

I heard a few things. Education, we are all in this together, we all have to work together on it, and that perhaps there is a need for more regulation--regulating time, regulating number of entries, more law enforcement, regulating the gear. Who should regulate this and at what level? If we had more regulation who should that be?

Orth: The Virginia Marine Resources Commission has authority to regulate fish as does the Maryland Department of Natural Resources, and Delaware NREC. The states individually have been the traditional regulators and I am sure will probably continue to regulate. There is a possibility of getting together some sort of tri-state effort. In the Chesapeake Bay, we have a bi-state effort with bi-state plans for crabs, stripers, and a number of other species, so that may be a possibility here. We will have the first meeting of the Coastal Bays Fisheries Advisory group this coming Thursday night. This is for Maryland and this is going to offer us an opportunity to hear all sides of the issues and look at potential regulations where we decide regulations may be needed.

If you had to name just one change that you would recommend in either present harvest technology, research, or data collection, to maintain sustainable catches, what would that change be?

Dawson: My training is not as a fisheries biologist, but as a wildlife biologist. One thing that has been very clear to me, based on my training, is that you have to protect those areas that are your production areas. Habitat is certainly the key to fisheries management as it is to wildlife management. Those areas that are critical habitats, and I think it has come out here today that SAV beds are one of those areas, have to be protected. I would strongly support the creation of sanctuaries where you couldn't use any type of gear that might have an impact on that particular habitat. Either zones that have been delineated, such as the SAV beds, or zones a certain distance off of the shoreline. I think that a very critical thing for the coastal bays to do at this point is to establish either sanctuary or refuge areas.

Speir: The question is what one change would I make in harvesting technology, and I think that is a little too broad because I think we have to deal with each fishery in turn. Each one of them is unique. We have 19 cooperatively managed species in Maryland. Some are more heavily exploited by sport fishermen and some are more heavily exploited by commercial fishermen. Each pattern of exploitation has its own particular problems. These can also vary from state to state. So, I don't know that I have a single technology change answer to that. However, I could answer the question by saying that I believe one of the major problems is by-catch and kill of unwanted species. This occurs in both recreational hook-and-line fisheries--you are catching small fish and throw them back, you are catching too many of a regulated species and throw them back--and by-catch in commercial nets of various sorts. I think this is a major problem and one that we are looking to overcome, in many cases with changes in technology, particularly with troll gears and pots and traps. We have a growing demand for recreational and commercial fisheries, and we have a limited, almost fixed, supply of fish. We need to find some way to make that supply of fish go further, to make it useable whenever we take it out of the water.

Baker: I came prepared to tell you we didn't have a problem in Delaware, then I saw all these presentations. But the problems we have in Delaware aren't from recreational or commercial fisheries, they are from pollution. The problems in Delaware are being addressed. They were dumping raw sewage from the campgrounds right into the inlet, now they are doing it through a sewage system. Rehoboth Beach has put in a sewage system. I really do expect to see that we are going to be your shining example. We are very proud of

our state and we are very proud of what we are doing, but we do have a couple of areas that have to be addressed. I would like to see the eelgrass come back in Rehoboth Bay. I would like to see more oxygenation. We have a very good fishery there. The fishery is improving. All of the regulations that have been put in place are working. So I am more on a positive side than a negative side. We do have a recreational gill net in Delaware. This to me is a problem, even though I am a recreational person. People can go to the state of Delaware and for five bucks, get a license and go flag gill netting. It has to be within 100 ft. of the bank, and it has to be attended, but everybody here knows that gill nets kill fish. If that is a problem in the other states, and this meeting is to put 3 states together to get something going, this is one area I think we all have to take a look at. Why does a recreational fisherman need a gill net? Why does he have to go out there and kill fish every day? He is limited to the limits of 14 trap per day at 14 inches, but how many more is he throwing back that are not alive? So here is an area in the recreational end that can be corrected in all the states.

Number two, nobody has mentioned the turtle. The other states have turtle excluders in crab pots, but Delaware doesn't. Since I have the opportunity here to speak, and I know people from Delaware are listening, it is no problem to put in a turtle excluder. We used to be able to drive down Route 1 twenty years ago and there were so many turtles migrating across the road, you would have to drive over them. We don't see the turtles today that we saw 20 years ago, they have all been drowned in these crab pots. It is one way that they are disappearing. I would like to see the turtle come back, I would like to see the bays come back, and these are two areas I feel we can address and correct, and get our population back where it should be.

Welton: I think in Virginia there are two things we would like to see. First, we shouldn't have to prove that something *is* harming the environment. The people that want to use that method have got to prove that it *doesn't* harm the environment. In Virginia, it can be a very long and rocky road to prove that something is doing damage in time to stop it before the damage is done. I think we need to end any harvest techniques that are bad for habitat, particularly submerged aquatic vegetation.

The other thing that we would really like to see in Virginia is recognition that we need to protect these marine resources, whether it be crabs or fish, until they have a chance to reproduce. If you kill them before they reproduce, and you get some bad years, you have a problem. Let them reproduce at least once. Constantly we are out there cropping them off before then. In Virginia, we are dredging pregnant female crabs in the wintertime, and then in the summer, we are taking loads of sponge crabs. And we are arguing over whether the sponges are orange or brown, because if they are brown you can't take them. There is not a judge in Virginia that can differentiate the degrees of orange or brown enough to convict somebody. We are bickering about that while we are killing billions and billions of crabs. Some scientists say there are not enough males to impregnate the females. Virginia Institute of Marine Science says there are not enough females. The sponge crabs are all females that found a male and while we are arguing over whether there are enough males or females they are killing everyone that did get pregnant. That's no way to manage for the future. I think the Marine Resources Commission in Virginia manages to protect the industry, both the recreational and the commercial industry. If the politicians and regulators would manage to protect the resource, then all the industries that depend on it would thrive, and that would really get to the bottom of the problem.

Orth: I am just going to add my perspective as a scientist in this panel. It has been really interesting, given where we were 20 years ago and where we are today in our knowledge of sea grass systems and the other things that are going on. I still think there is a significant role that we as scientists play in working with managers in helping them unravel some of these critical questions that still are unresolved. As an example, one of the questions I keep getting all the time is does crab scraping hurt sea grass beds? Now crab scraping is different than dredging. Scraping is a dredge without the teeth and the crabbers go in these grass beds, back and forth, and pull up a lot of crabs and the grass. People say they are out there pulling and killing the grass. I have been monitoring these grass beds in the areas where the scraping has been the heaviest and I personally photo-interpret all the photos every year. I look at 1700-2000 photos every single year and there are areas people scrape year in and year out and the grass beds are doing really well.

My concern now, and it ties in with the fact that the pressure on the blue crab has really been increasing, is that the scraping intensity is increasing more and earlier. If they start scraping at a time period that these plants, the eelgrass, are flowering, and pull off a flower before the seeds are mature, you are actually killing the future plants that are going to be revegetating these areas. So, a lot of my comments have been addressing, from what I see in these photos from year to year in areas that are heavily scraped, that we *do not* see grass beds being damaged. The damage actually comes primarily from the props, the motors of the boats, not the scrape itself. You see big prop scars in these areas, and I think there is a real educational component there. But generally, the scrapes do not damage the grass bed. Tangier Island is a key

area where they have been scraping for a century or more and the grass beds still are doing very well. But, because of the pressure on the peeler industry--there are more and more people scraping to get the peeler crabs because it is such a lucrative fishery-- we are now seeing scrapers in areas that we have never seen them before. It is unbelievable that in sites that have never been scraped, now you have two to four people scraping from the first sign of a peeler crab all the way through the end. The concern is that they may actually be influencing the regeneration of the grasses because they are pulling out all the reproductive shoots before they even are able to set flower. And that is a very basic question that needs to be addressed: At what point can we really pull a flowering shoot that has seeds, so that the seeds will at least be mature enough to continue growing and then be released? So there are some very basic questions that need to be addressed that are going to play a very important role in the habitat.

I am a scientist in a conservation group in Washington DC and one of the programs that our group works on are marine protected areas, where a portion of a bay (primarily in the Carribean) is set aside where you can't fish for a certain period of time during spawning aggregations in some cases, or you could do it during times when sea grass production is occurring. Basically there are times when people just don't go in at all to fish, and the idea is that this is a stocking mechanism, whereby you save some of the species to reproduce and hopefully, this will filter out into the rest of the area. Is this something that the panel feels is a viable option for coastal bays here?

Speir: Yes. I have to draw some examples from the Chesapeake because that is where most of the regulatory activity has occurred, but we have all sorts of restrictions on where you can fish. For the oyster beds, some of them are reserved for tongs, some are reserved for diving, some are reserved for dredging, some are off-limits. For striped bass, we don't allow fishing on the spawning grounds during a couple months in spring. We don't allow crabpots in the tributaries, although we do allow harvest by trot lines. There are all kinds of zoning arrangements that we have, to reduce fishing mortality on particular stocks during particular times of year. So, yes it is a viable option and it is one that is used worldwide.

When the Maryland Saltwater Sportsfishermen went to Annapolis to get legislation passed to move the trawlers out like in Virginia, we had to fight our own DNR. We are going back to Annapolis this year, and we are talking to the politicians about limiting the number of crab dredgers. We have 20-25 of them coming in our back bays in Ocean City, and just literally sweep them out, and the scrapers are doing it on the other side around Crisfield. They are scraping the same areas and leaving it bare. That is why the decline in the Tangier Sound. So you guys are doing great and I thank you for being here.

Baker: I thank you very much, I appreciate that. I would like to add to that, that as a tackle dealer, and dealing with all the recreational fishermen, I myself am at fault. Go back 20-25 years, we used to keep shark and we used to keep all the bluefish that we wanted before the regulations were put in and there is a whole new mind set now. I can tell you that many of the fishermen that I deal with in Delaware, and it is a lot of them, don't even keep their limit. They go out for the sport of fishing. Recreational fishermen, in my opinion, are not the problem. I think we release more fish than we keep, and I would tell you that 90% of my customers only keep what they eat.

What is the status of the diamondback terrapin population, and how do the several states vary in their approach to protecting the terrapin?

Speir: I am not sure I know all of the answers to that. Maryland still does allow commercial harvest, I believe it is a 5 inch minimum size, maybe 6. The harvest has not been very high the past 4 or 5 years. I don't know why, but it is not a really desirable commercial species. The only work done in Maryland has been done in the Patuxent River by William Rusenberg, and he has calculated mortality rates and they are apparently fairly high. One of the problems that he has found in the Patuxent is the loss of spawning beaches from harboring, either riprap or bulkhead, and that may be equally as important as by-catch mortality in some of the feint traps that were in use there. There is also a high rate of mortality in recreational crabpots. We do allow two pots per pier per landowner. We did require this year the use of turtle excluder devices in each one of the crabpots, and we are requiring air space in the crab banktraps to reduce the rates of mortality. Statewide, I couldn't tell you the status.

I haven't heard any mention of the precautionary principle or approach, and I know it's a very variably interpreted idea, and I would like to have some idea of what the panelists would do with that?

Speir: I am not sure I know exactly what the precautionary approach is, but a developing thought in fisheries management is the establishment of both targets and thresholds for fishing mortality rates. Targets are that level of fishing mortality that you would like to retain, and it is a safe level of mortality. You can go over it a little bit and not hurt the population. The threshold, or limit, is something you do not want to approach. In crab management now, we are debating where those two levels should be and I think we are coming pretty much to agreement that we don't want to harvest at potentially the

maximum rate. Someone suggested this morning that we are harvesting all of the fish at the maximum rate we can. That is not entirely true, because we are trying to set fishing mortality rates small enough to protect stocks in case of something unanticipated. So we are beginning to apply it. It is not universally applied, but it is an important thought.

Welton: I have been going to the Virgina Marine Resources Commission for 15 years and I have been talking to them about how, if we are going to make a mistake, let's make it on the side of the resource, which is my interpretation of the precautionary approach. In Virginia, we have 8 voting commissioners, 7 of them have family or financial or direct ties to the commercial fishing industry. All this fisheries management is so new and where Maryland has these thresholds and other things they are trying in these fisheries management plans, Virginia never did fisheries management plans until the fish were already in trouble. There are some fish out there in Virginia that are not being overharvested, and most of the ones that aren't being overharvested don't have management plans that are complete for them yet because they don't have the funds or manpower to do that. So we are taking care of the crisis first.

The Coastal Conservation Association, has found that the whole Gulf Coast and the whole Atlantic Coast has the same problem. It is not something that is just unique here to this area. In the last 15 years we have always managed after the depletion instead of ahead of time, which would be the precautionary approach. Now is the time to get to what you are talking about. I think you are seeing people beginning to get there as soon as they can get the time and the money and the manpower to get it done. Certainly Virginia and Maryland both are a lot different than they were 5 years ago. So we are headed in the right direction, but we still have a few little things to iron out.

I go to a lot of these conferences and there is always a slide showing infant fish in that area around the edge of a marsh where the grasses are. This is the feeding area, the nursery area, the spawing area, and so on. And yet there seems to be no way that, at least in Delaware, you can convince anybody to look at the cumulative effects of continuing to arm the entire shoreline. We have lost wetland after wetland after wetland because every permit is given as if it was the only one in the entire three bays. Is there any way that you can give us tools to convince goverments that habitat hinges not only on the fisheries side, but it also hinges on the nursery side? That you can't destroy one and save the other.

Dawson: I think the question is how do we convince our goverments that the critical habitats, either wetlands or shorelines, need to be protected, and that a little loss here is not a big thing--that we need to look at the cumulative effect. I think that there are programs that have come into effect in the last few years to try to address that issue. I particularly know the wetlands because that is what I work with. We have a "no net loss" mandate that says the state will not allow any more overall net loss of wetlands. All wetlands that are lost now have to be replaced, either by the individual, or the state has to pick up the tab and replace it. That is also true about other types of habitat as well, but particularly in wetlands, because those wetland habitats are the most critical habitats that we see that need to be protected.

Now, the shoreline situation is a little bit different because you have also got to balance the erosion factor there. If you don't armour some shorelines, you are going to lose those, and some shorelines can't be armoured just by vegetation. In some cases it is a tradeoff that you will allow some armouring of a shoreline, just to maintain it, as opposed to allowing it to erode back and losing it altogether. But that is still an issue. When you do these kinds of things, there is a tradeoff and there is a loss of habitat. As far as other critical types of habitat, particularly headwaters habitats and riparian habitats are concerned, I know that in the state of Maryland, we are in the process of trying to restore some of those habitats and protect the ones that are already there.

Baker: I can tell you that in Delaware, we have probably, per capita, more state park land that is protected than any other state if you were to take it by the square foot. So Delaware is really again the shining example, we are doing very good.

I am sorry, but I am from Delaware and you have a very rosy picture.

Baker: I have smelled the "crap grass" in Rehoboth Bay and I understand what you are saying. And I go to all the DNREC meetings in Delaware and I have to tell you that they are watching what they call the recruitment. They are very concerned about the flounder fishery. They tell us that the fishery is in good health. How they know what the recruitment is, and how they get their figures, I don't know that. But I do know that DNREC in Delaware is very concerned about recruitment, which means where they are spawning, and how the young are growing, and how they are endangered. We are all concerned about that. I am very concerned about it as a recreational fisherman. I want to see this fishery continue for years to come. But what I see in Delaware is that the homes being developed and the encroachment can't really happen a whole lot there because we have about 30 miles of shoreline and about 20 miles of it is state park land. So not a whole lot can hurt us there.

You are talking about the ocean beach, not the bays. The bays are being eaten up.

Welton: I can't tell you what is happening here in the coastal bays, but what is happening in Virginia Beach with us. I am on the Virginia Beach-Chesapeake Bay Preservation Board, and when I got on that board it dealt with the Chesapeake Bay Preservation Law which said you can't build within 50 feet of the water and then there is another landward 50 ft. buffer. So theoretically, you are not supposed to be able to build within 100 ft. of the edge of the water. When Virginia Beach adopted theirs, they went 100 ft. from the edge of the marsh grasses, which is the most restrictive in the state. When I got on there, there were builders who said if you own the land, you can do whatever you want with it and then there were tree huggers who said you can't do anything with the land, and I said there has to be a win-win situation here, and we started giving exemptions if they would give certain things to the land. One of the things that evolved in the last year, we have ended up with a "harm the shoreline" policy. We don't want to put in vertical bulkheads. We'll let you go 25 ft. too close to the water, but if you ever harm the shoreline, you have to put in riprap, and if the bottom is suitable, we'll make you move the riprap back and we'll make you spread it with marsh grass, cord grass, to try to get it re-established. To let you go 25 ft. or 10 ft. too close to the water, whatever the minimum necessary (somewhere between what you need and what you want) we might require that your whole back yard has to be left in a natural state, or there has to be a 6 ft. wide mulch bed parallel to the water with 6 inches of mulch in it to filter off the topsoil runoff or the chemicals.

So what we are doing is we are seeing all these people wanting to move to the water. We are not trying to stop them. How can they move and preserve it? Those are some of the things we are doing in the last year, where we are going with riprap and we are moving it back. We have had five cases this year where we have required them to put in marsh grass because when water hits a vertical bulkhead, there is too much energy, but with a riprap bulkhead at an angle, it doesn't. It is evolving to that, and the government agencies are getting there, but in Virginia Beach, we are doing that already.

Baker: That is exactly what is happening in Delaware. They are not allowing a bulkhead or piling to be put in, it is all riprap.

What do you see as the responsibility or role of the local government in this? Do you think we'll ever evolve to the point that we'll have a compact along the coastal bays?

Baker: Delaware has a very good organization at DNREC and they are quite powerful. They have their meetings and they follow through with everything. However, we have a limited law enforcement agency in Delaware. Our Coast Guard station is limited. They had non-enforcement personnel at the third busiest inlet on the East Coast, and they are trying to get more personnel and more funds raised to improve the Coast Guard Station. So, the law enforcement part that I alluded to earlier is still the biggest problem. People are going to fish and like I said, I don't have a problem with most of the recreational fishermen. I think it is a few that cause the biggest problems on that score. We need better law enforcement and we need to continue in the direction that we are going with the laws that we have. It goes back to the commercial fishery mostly that is damaging things, and they have got to be taken care of too.

Welton: It doesn't make sense that I can drive two hours down the shore and five miles to the right you can't build within 100 ft. of the water, and five miles to the left you can build anywhere you want - on top of the water if you want. What is good for the Chesapeake Bay is good for the coastal bays. The forces that be have not been able to move that yet, but it is coming, and it will come. That is not our agenda, but we are certainly in support of that. It is just a matter of when. In Virginia Beach , if it flows south to the Pamlico Sound you can do whatever you want. If it flows north to the Chesapeake Bay you can't. So that is just in one city you have got two different rules.

CLIMATE CHANGE AND IMPLICATIONS FOR THE COASTAL BAYS

ANN FISHER, PH.D.
PENNSYLVANIA STATE UNIVERSITY

Note: The following document is a transcription of the presentation by Dr. Fisher. It has been reviewed and approved by the author for publication.

I am delighted to be here. This group's diverse interests, backgrounds and expertise represent the kind of group I want to talk with about the work being done by our large interdisciplinary team.

This conference has discussed major issues for the Coastal Bays. Based on what we know from science and projections of how population and development might change, let's examine how these issues might change in the future and then ask whether climate change will make them better or worse. This is the strategy our team is using in the Mid-Atlantic Regional Assessment (MARA) of potential impacts from climate change.

We started with four questions: 1) What are the regional current status and stresses? 2) How might climate change affect those stresses? 3) What actions might be taken to reduce damages or take advantage of opportunities created by climate change? 4) What research and information are most important to help individual citizens and communities make smart decisions related to climate change? Earlier sessions have emphasized gaps in our understanding about the critical Coastal Bays systems and human interactions with those systems; considering potential impacts from climate change adds even more challenges to our understanding.

Our Mid-Atlantic Regional Assessment is one of 16 studies across the country asking the same questions. The results are being synthesized into a report for the nation as a whole. Our integrated assessment approach looks at the physical changes that might occur as a result of climate change, but recognizes that there are other sources of change. Thus we develop scenarios of what the future might be like under different conditions. These scenarios are a basis for "what if" analyses.

An important component in developing scenarios has been stakeholder participation. We all are stakeholders when it comes to climate change -- and when it comes to making decisions about the future of the Coastal Bays.

The 92 people on our Advisory Committee come from a variety of backgrounds, including business, government, public interest organizations, and academics to round out the needed scientific expertise. Our stakeholder involvement goal is to ensure that the Mid-Atlantic Regional Assessment addresses stakeholders' concerns. We also have learned that sometimes stakeholders have good information that we otherwise would not have access to. So stakeholder involvement has improved the assessment process as well as its outcomes, by facilitating access to good data and by stimulating new ways to think about issues. We also need stakeholders' help to get the message out about what we are learning and how it might be useful to all who could be affected by, or have interest in, climate change.

We originally planned to limit our focus to forests, agriculture, and fresh water. Stakeholders convinced us to think about additional linkages, especially impacts to coastal zones, human health, and ecological systems. This ambitious assessment menu would have been impossible without a lot of collaboration and support. In addition to funding from the U.S. Environmental Protection Agency (EPA), we are using a lot of data research approaches and results from EPA programs including the Mid-Atlantic Integrated Assessment and several of its labs. We also have collaborators at the Forest Service, NOAA, and other universities as well as the very important Advisory Committee. These collaborators are crucial to our work.

Figure 1 shows the Mid-Atlantic region, as defined for our assessment. It includes all (Maryland, Delaware, Pennsylvania, Virginia, West Virginia) or parts (New York,

New Jersey, North Carolina) of eight states and the District of Columbia. Note that its substantial coastline includes the Coastal Bays.

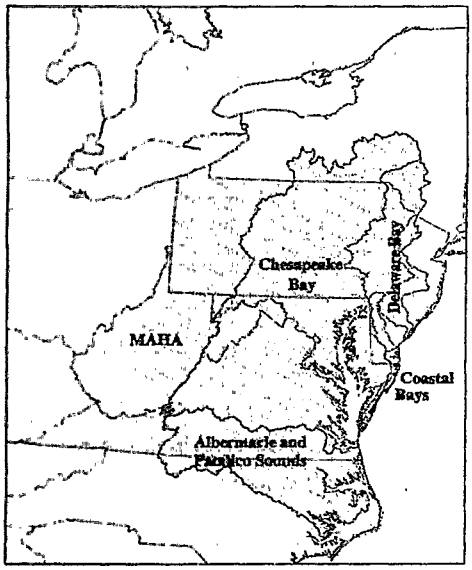

Figure 1. Proposed Mid-Atlantic Regional Assessment Area

One of the reports made available at this conference (**Conditions of the Mid-Atlantic Estuaries**, No. EPA600-R-98-147, November 1998) is helpful as a starting point for looking at the current situation and thinking about how it got that way, how it might change in the future, and how climate change might modify trends that will be happening anyway. For instance, the Estuaries report's maps of water clarity show some trouble spots in the Coastal Bays. Maps for other measures, such as nutrients, show generally good conditions for the Coastal Bays. However, combining layers of potential changes in agricultural practices, increased population, and increased development suggests additional nutrients and sediment. Nutrients and sediment contribute to algae blooms and turbidity, with substantial impact on ecological habitat because of reductions in submerged aquatic vegetation and dissolved oxygen.

Ducks are an interesting example for tracing potential impacts from climate change. Why ducks? There are several reasons. What happens in this region can affect the abundance of ducks elsewhere, and what happens to ducks elsewhere can effect the abundance of ducks here. Ducks are a common ecological indicator, so a lot of information appears in the literature. They fall into the "cute and cuddly" category, making it easier to get people's attention about ducks than about say, salamanders. More than that, ducks are important from recreation and economic perspectives because people spend money to go look at or hunt ducks in the Bays.

The collaborator who has helped us the most with ducks is Lisa Sorensen at Boston University. Although her information is for the Chesapeake Bay, I suspect it is indicative for the Coastal Bays. Table 1 shows dramatic changes over the last 40-50 years to selected species of ducks that winter in the Chesapeake Bay. Table 1 does not show the year-to-year variability, but note the large declines of mallards, northern pintails and canvasbacks, and the large increases in Canada goose and snow goose. Many reasons have been posited to explain these changes. Our question is how climate affects what has already happened and what might happen in the future.

Table 1. Waterfowl Wintering in Chesapeake Bay

	1950s	1990s
Mallard	71,000	60,000
Northern Pintail	40,000	3,000
Canvasback	179,000	57,000
Canada Goose	178,000	386,000
Snow Goose	4,000	90,000

Knowing what climate is like, and how it is changing, can be a starting point for the question about how climate might affect ducks in the Coastal Bays. Figure 2 shows the Mid-Atlantic region's history of temperature and precipitation for the last 100 years. The top portion shows temperature and the bottom portion shows precipitation. The heavier jagged line shows the five year running average. The straight line shows the trend if the variability is removed. Two things are notable in Figure 2. First is the variability, which clearly reflects major weather events such as droughts. The other is the rising trend line for precipitation; over the past 100 years, rainfall has increased in the Mid-Atlantic region. Temperatures, on the other hand, have shown only a slight upward trend.

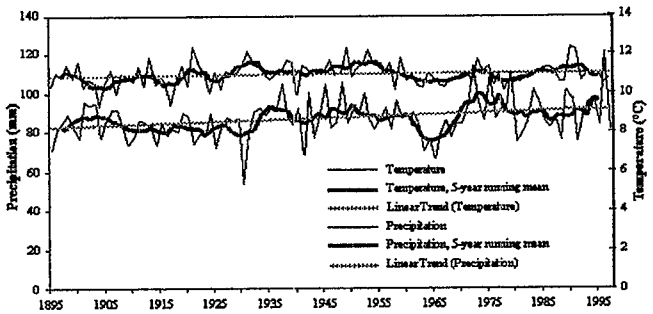

Figure 2. Present-Day Climate

Although we have substantial confidence in historical measurements, projecting the future is more difficult. General circulation models can be used to project future climate, based on historical observations such as those in Figure 2. These models also use input about what might be the most likely changes in "driving" factors. The most important factors are increased carbon dioxide from burning fossil fuels and aerosols which are from the sulfur in fossil fuels. These two factors tend to counteract one another, but the carbon dioxide increases are more dramatic. Plugging these factors into the models gives results that tend to fit one of two patterns.

Figure 3 shows temperature projections for the Mid-Atlantic Region, using two models. Figure 3a shows the increase in maximum temperature and Figure 3b shows the increase in minimum temperature. Because minimum temperatures are projected to rise more than maximum temperatures, Winters (on average) are expected to be milder and Summers (on average) are expected to be a bit hotter.

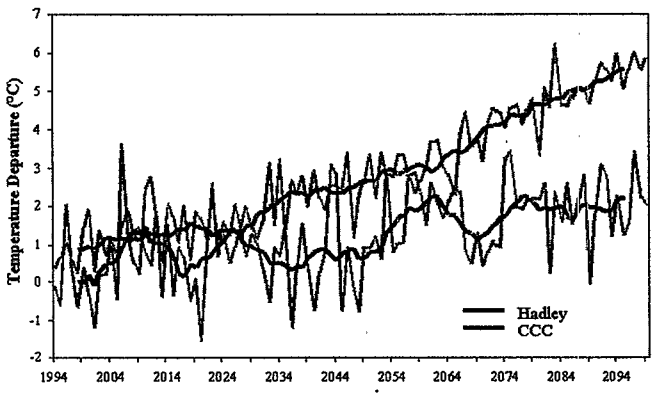

Figure 3a. GCM Projections, Maximum Temperature

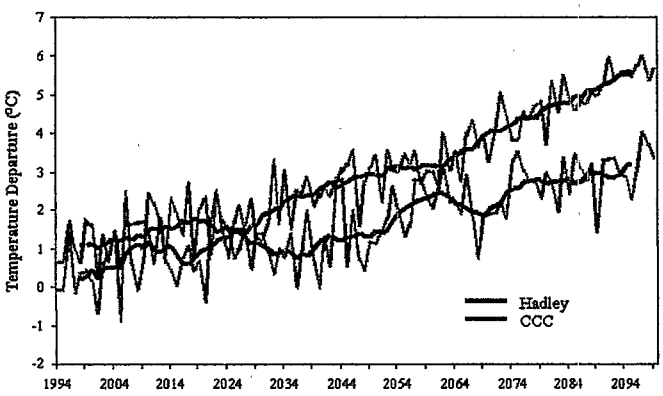

Figure 3b. GCM Projections, Minimum Temperature

The two models shown in Figure 3, the Hadley Model and the Canadian Climate Centre (CCC) Model, have been chosen for use in the National Assessment Activities because of the large uncertainties in projecting future climate and because they seem to be at the outer limits of the range of models available -- the two patterns mentioned above. Keep in mind that both models project that within the next 100 years, it will become warmer in the Mid-Atlantic region.

Projections from the same two models for precipitation show a somewhat different pattern (*Figure 4*). Note that the CCC projections were on top in Figure 3 but are on the bottom in Figure 4. The CCC model shows essentially no increase in precipitation, but the Hadley model shows a substantial increase. The consensus among our climatologists is that the MidAtlantic region is likely to be a little warmer and maybe a little wetter over the next 100 years.

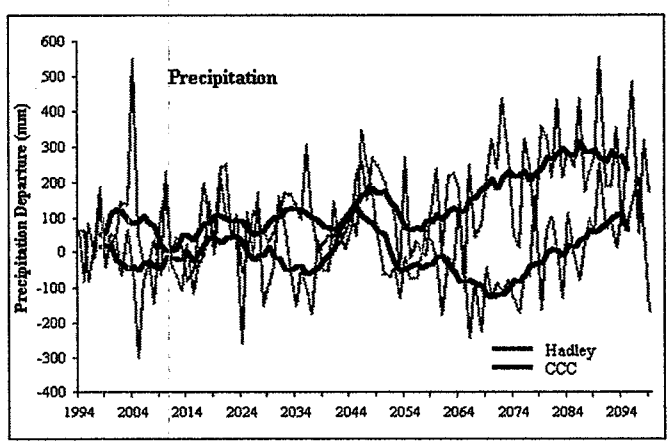

Figure 4. GCM Projections, Precipitation

The next assessment step is to explore how the projected climate might affect ducks. One reason that some ducks are doing better than others (Table 1) is because they have been able to change where they live or what they eat as their habitat has evolved. The Canada goose and the snow goose have shifted to finding food in agricultural areas in response to the decline in submerged aquatic vegetation. Other ducks are eating Baltic clams, which have become more prevalent--perhaps because of warmer water.

Note that 130,000 canvasback ducks wintered in the Chesapeake Bay 40-50 years ago, and fewer than half as many do now. Canvasbacks tend to breed in the Prairie Pot Hole region. About 40% of the ones that breed there end up in the Atlantic flyway. Between 90 and 99% of those are in the Mid-Atlantic region rather than further south or north in the Atlantic flyway. Projections from

general circulation models, similar to those for the Mid-Atlantic region shown in Figures 3 and 4, suggest a much drier future for the Prairie Pot Hole region. Drying of the pot holes will affect the breeding habitat for canvasback ducks. Lisa Sorensen projects a 20 to 40% decline in the next 30 years and between 7 and 70% in the next 100 years. The much wider range for the year 2100 compared with 2030 occurs partly because of uncertainty about what would happen further north in Canada; new habitat for ducks might exist there in 100 years but still be in transition 30 years from now. So impacts on ducks are one example of how climate change could affect the Coastal Bays because there might be fewer canvasback ducks (and possibly other waterfowl) for people to observe in this part of the Mid-Atlantic region.

Another potential impact from climate change is changes in the salinity of the Coastal Bays as well as the larger bays in the Mid-Atlantic region. The impact on salinity is hard to project because of uncertainty about precipitation, which in turn influences stream flows.

There is more certainty that a rise in air temperatures will lead to higher water temperatures. Fishermen at this conference noted that warmer water temperatures mean the fish come in later. But warmer average temperatures could affect the type of fish species that live in coastal areas over the longer time period, partly because warmer water cannot dissolve as much oxygen. Warmer water also increases the biological oxygen demand. Thus one impact in the shallow Coastal Bay is likely to be more time during the summer with water quality problems because of low oxygen levels.

Oysters might be an issue in terms of both salinity and water temperature. Oysters can tolerate a range of salinity, but the discussion above indicates uncertainty about what will happen to salinity. Warmer water temperatures could increase Dermo disease problems for oysters -- which could be worse if the salinity is near the end of oysters' preferred range.

Climate change also could affect sea level rise in the Delmarva peninsula. This part of the country already has relatively high sea level rise compared to many other parts of the world. Higher water temperatures and the changes in hydrology that go along with climate change are likely to mean more sea level rise. Figure 5 is based on digital elevation maps provided by the University of Delaware. Using GIS techniques, we combined this with land use information from EPA's Mid-Atlantic Integrated Assessment program. Figure 5 shows what would happen in Delaware if sea level rises by two feet. This is about what is projected over the next 100 years--but not tomorrow.

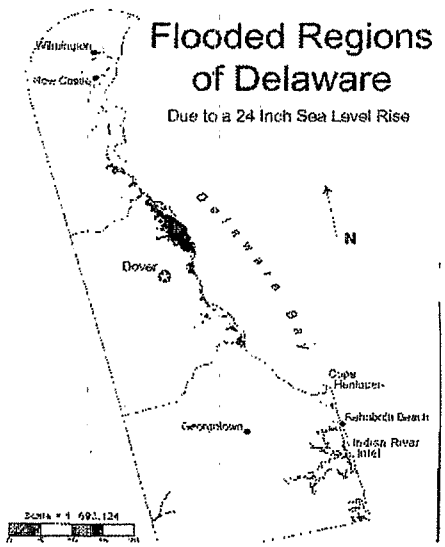

Figure 5. Flooded Regions of Delaware

The portion of Delaware that would be flooded is only 1-2% of the land mass. Looking at the type of land use provides additional insights: only 0.25% of the developed land would be flooded, but over 20% of the emerging wetlands would be flooded -- a habitat concern. Maps such as this also suggest concern because of expected increases in population, and the accompanying increase in development. Thus the future percentage of developed land potentially affected by sea level rise could be a lot larger, leading to concerns about property values.

Another concern about sea level rise is that there would be less shallow habitat. This depends on shoreline slope and whether the ecosystem can migrate. Ecosystem migration becomes more difficult as more of the shoreline becomes developed.

Sea level rise also could increase salt water intrusion, especially because the trend is to move away from surface water supplies and avoid the expenses that surface water treatment systems have to incur to meet the new Safe Drinking Water Act requirements

Another aspect of sea level rise is that wave surges from the same intensity of storms that we currently have will go further inland. Even without development, the current degree of storminess would result in more damages to both ecosystem and property because of sea level rise. Projecting future storminess is even harder than projecting what is going to happen to climate overall. But the best available information suggests that on average there will be more frequent and more intense winter storms. Combining increased storminess with sea level rise

means that what currently is a one-in-a-hundred year storm would happen once every 25-30 years.

Implications are rather substantial for property damages as well as ecological effects. In the period between 1978 and 1998, the four Mid-Atlantic states of New Jersey, Delaware, Maryland and Virginia had 178,000 National Flood Insurance policies. Those policies brought in 81 million dollars in revenues, but paid out 327 million dollars in claims. The shortfall comes from all of us as tax-payers. About 47,000 different insurance claims took the 327 million dollars, and more than 40% of the insurance claims were repetitive. Thus we paid twice for storm damage at the same property. Discussions about fixing the current system become even more important as we think about the potential for increased storminess in the Mid-Atlantic region.

Several actions can be taken now. One is to implement Coastal Zone Management Plans, recognizing that they create difficult conflicts among competing interests. But coastal zone management may be a way to reduce property damages. Combining the possibility for warmer temperatures with the American public's affinity for coastal areas and expected population growth implies more development in coastal areas. We have to be smarter about that development to avoid losses.

On the other hand there also will be some regional benefits from climate change. Warmer temperatures will extend the recreation season and increase tourism dollars. Unfortunately, hurricanes suggest a negative side to extending the tourism season. Although the Mid-Atlantic region has fewer hurricanes than other parts of the country, extending the tourism season into the Fall could increase the need for evacuation to get people out of harm's way.

The potential impacts described above can be put in perspective by placing them in the context of overall impacts assessed for agriculture, forests, fresh water, coastal zones, human health and ecosystems. Pulling together results for our first year and a half of work, our team has identified the direction and sometimes the sign of impact, and how much confidence we have in the assessment results.

Several points emerge from such a summary. One is that there are some positive impacts for the region as a whole, but not very many and they are not very big -- despite our best efforts to come up with benefits from climate change. Another point is that there are a lot of negative impacts and some of them are likely to be large. Coastal zones are likely to suffer from erosion and salt water intrusion. Although less certain, a substantial overall decrease in biodiversity is likely to accompany climate changes, partly because it will be difficult for species to migrate. Even more uncertain but potentially large (and certainly relevant for the Coastal Bays) are threats to ecological functioning as an impact of climate change.

Despite this discouraging description of potential impacts for climate change, there can be cautious optimism. Earlier discussions at this conference already stressed the need for coastal zone management, smart growth, and controlling nutrient runoff. The bottom line is that the way to make the Mid-Atlantic region, especially its coastal zones, more resilient to climate change is to make it more resilient to human development and to environmental and habitat problems it is suffering now and will continue to suffer -- even if we don't have climate change. Climate change projections gives us one more reason to do a lot of things that already make sense for other reasons.

WELCOME AND FRIDAY RECAP

SARAH TAYLOR-ROGERS, PH.D.
MARYLAND DEPARTMENT OF NATURAL RESOURCES

Note: The following document is a transcription of the presentation by Dr. Taylor-Rogers. It has been reviewed and approved by the author for publication.

Good morning everyone. It is a gorgeous day outside and I can tell you that I am extremely impressed by all of you being here inside. It reflects the dedication and the care that we have toward our coastal bays and what is going to happen to them, how we are going to handle the issues and the pressures that are focusing on these bays, and have been for quite some time.

I remember working in the Coastal Zone Management Program. At the time we were fostering and promoting a concept called a "marine sanctuary" for part of the coastal bays that would begin to focus on management of the key resources, but still allow some uses of these resources, particularly in the lower coastal bays. It was quite a controversy. I can remember a public hearing in which around 600 people attended. Two people were in favor of the concept and the rest were opposed. Today, there is an interest and a keen awareness of the value of the resources which draw us all to our coastal bays. It is so wonderful to see this resurgence in the resources, and it's especially wonderful to see the attention that you're giving to the balancing of the resources, the survivability of our fish, our bay grasses, the crabs, and our wetlands, and seeing how we can manage and deal with these resources, keeping in mind that these resources bring economic gain to the area as well. So I applaud you for being here sharing of your knowledge.

On behalf of Governor Parris Glendenning and all of my colleagues in the Department of Natural Resources, many of whom I see here today, I want to thank you for your stalwartness in being here. I really appreciate the expertise that you're bringing to this meeting. This is an important conference. You have many talents and energies to share, and this tri-state effort to protect the magnificent coastal bays won't go unnoticed. In Maryland, just as in Delaware and Virginia, those resources support our ecosystem and its wealth of wildlife and aquatic resources, promote a healthy economy by encouraging tourism and other commercial activities, and benefit our citizens' quality of life by offering a plethora of recreation opportunities. A strong partnership developed the actions endorsed by Governor Glendenning this summer, to restore and protect the coastal bays. In the past, we have worked hard to help create the Comprehensive Conservation and Management Plan for the Maryland Coastal Bays, and now we are supporting the Coastal Bays Foundation as it begins implementing its programs. I am happy to announce that we are working to develop fisheries management programs especially focused on our coastal bays.

The bottom line is that Maryland is going to put its money where its mouth is, and it has set aside funding in order to implement the management plan. Even though there are differences among the bays, it is critical to remember that they are connected and should be managed as such, with governments, citizens, businesses, non-profits, and environmental concerns from all three states and our federal agencies, working together toward common goals. By recognizing, in fact celebrating, that connection, this conference is presenting us with some exceptional opportunities: to jointly reflect on what has been accomplished, to review the activities that all three states are taking, to share and learn from our failures and our successes, and to chart a united course for the future to move together to restore and protect Delmarva's coastal bays.

Yesterday we learned about our aquatic resources in the coastal bays and some of the factors that impact them. The importance of coastal bays as a support to a wide variety of organisms was discussed; the importance to our environment, the importance to our economy, and ultimately to the unique way of life we all enjoy in this

region. We also learned about the many threats to those resources from both natural and human stressors--eutrophication, excess sediments in the water column, habitat degradation, harmful algal blooms, and disease. We also heard about the work that's been done, and is being done, to control these threats, such as working in the watersheds to reduce nutrients and toxins, implementation of erosion control practices, and research into diseases and harmful algal blooms. Submerged aquatic vegetation provides essential habitat for many of the aquatic animals, and the ongoing efforts of regular bay grass monitoring has allowed us to identify increased scarring from hydraulic clam dredging in the coastal bays. As you are all aware, this led to legislation, not only in Virginia, but also in Maryland, prohibiting dredging in SAV beds.

1. We can't manage the coastal bays like the Chesapeake or the Delaware. They are smaller, they are shallower, they experience warmer temperatures, and they have a unique hydrography. I also know we can't manage these coastal bays resources in the same way we do Chesapeake Bay resources, especially when we look at the blue crab as a key resource. There is the brown shell disease (caused by *Hematodinium* sp.) that affects the crabs in the coastal bays that is not experienced by the crabs in the Chesapeake Bay. In the coastal bays, crabs mature more quickly and at a smaller size, and therefore the fishery is primarily in peeler and soft crabs, which is not necessarily the case in the Chesapeake.

Yesterday, there was much mention of our finfish and shellfish, and that we're experiencing population declines and have done so for the last few decades, which can be traced to overfishing, weather changes, or disease. Some of our management plans, like the one for black sea bass, have begun to show signs of improving fish populations, and I am hoping this will be the same with other submersed species that are on the decline.

As we move into the final sessions of this meeting of minds to learn from each other and explore coastal bay problems and solutions, we want to hear your ideas. We want to translate them into action. And we want to answer one more question: How can we best continue to work together to accomplish our goals for the Delmarva coastal bays?

In closing, I ask you to join me in looking forward to participating in today's sessions, to take away with us new knowledge that will aid in our fight to ensure the health of our coastal resources, and to continue to celebrate the incredible bays that connect us. This is a very key interest issue of mine--starting this new effort on the coastal bays and working with my counterparts in Delaware and Virginia. We took the coastal bays message to the Department of Budget and Management and to the Chief of Staff for the Governor as we began to move our budget priorities forward. I can tell you that there was a keen interest in seeing if some funding could be provided into our next year's budget to support the effort that you are undertaking for our coastal bays. This is very important, because the first dollars that we managed to garner were dollars in-house, in the Department of Natural Resources, that we pulled from other programs. What we need to do is constantly keep elevated the flag of the coastal bays. This is important. We have begun raising that flag and it is getting attention. I would seek your help in doing this as well, because we have a long walk together, in restoring the resources and in managing them in the wisest way possible. I will pledge and ensure that the state does all that it can to implement the management plans.

THE FISHABLE WATERS ACT OF 1999

NORVILLE PROSSER
AMERICAN SPORTFISHING ASSOCIATION

The Problem

No one disputes that great progress has been made in improving the quality and safety of our nation's water resources in the 25 years since the Clean Water Act (CWA) was approved. Indeed, we have spent more than $70 billion to implement the Act's provisions primarily pertaining to point source pollution. But our work is not done. The Clean Water Act (the Federal Water Pollution Control Act of 1972 as amended) generally set out two goals for our nation. First, the Act would be used to restore water quality threatened by point source pollution. Second, the Act would restore our waterways to benefit fisheries and wildlife.

It is this second part where the Act has admittedly been less than successful. Despite the improvements we've seen in point source pollution reduction, we still face a lack of acceptable progress in dealing with the reduction of nonpoint source pollution and the degradation of fisheries habitat in many of our rivers, streams and lakes.

Today, 38% of our nation's waters are not considered *fishable or swimmable* and do not fully support a healthy aquatic community. Barely two percent of America's 3.6 million stream miles are healthy enough to be considered high quality. And 70 percent of the nation's riparian corridors have been damaged in some way or destroyed outright. At least 19,000 miles of sport-fishing streams have declined in terms of habitat and water quality. 41 percent of America's perennial rivers and streams are adversely affected by reduced flows, siltation, stream bank erosion, and channelization. Today, slightly more than half of the nation's wetlands have disappeared and nearly 75 percent of the remaining wetlands are privately owned.

What's more, the four most threatened, imperiled, or outright endangered groups of species have the pitiful luck to call our rivers, streams, lakes, and estuaries, home. They often provide the first signs that something is wrong and if left unchecked could ultimately affect human health. The single largest reasons for this are habitat degradation and nonpoint source pollution.

Water quality improvements are being achieved every day in Tennessee where water quality is generally considered decent. Yet even today 25 percent of Tennessee's streams are considered partially or severely impaired and 23 percent of the Volunteer State's lakes are considered threatened, or are partially or severely impaired.

Roughly 50 percent of America's existing water quality problems are generally considered to the be the result of nonpoint sources. As much as 75 percent of the problems associated with those nonpoint sources are related to agriculture. That's why a partnership relying on innovative solutions and methods focusing on overall watersheds is so critical to continued progress in our efforts to make sure that *all* of our streams, rivers, lakes, and estuaries are indeed *fishable and swimmable.*

The Solution

We have put together a voluntary, nonregulatory, partnership-based, incentive oriented plan that brings together the fisheries conservation community, state and federal fisheries managers, and the agriculture community, for the first time to begin to seriously address the water quality problems associated with nonpoint source pollution as partners rather than adversaries. And we have done this in a way that recognizes the realities of what is both politically acceptable and financially credible.

This concept is working on the ground in spots - Oregon, Washington, North Carolina, Florida - with a framework it can work nationally. The Fishable Waters Act of 1999, a proposed amendment to the Clean Water Act, establishes

a system of national support for locally led, incentive based, voluntary partnerships to boost watersheds.

We propose to pay for this innovative, partnership program to focus on overall watershed health through a new authorized program within the Clean Water Act. The Fishable Waters Act would also expand the spending authority that governs the use of funds deposited in the CWA's State Revolving Fund (SRF) so that up to 20 percent of the SRF funds allocated to each state could be deposited into a state's Fisheries Habitat Account in the form of grants and be used to implement approved programs established under this measure. If a state chooses to establish a program and approve the creation of locally driven, solution oriented watershed councils, the funds deposited into the state's fisheries Habitat Account could be used to provide for the financial and technical support needed to implement conservation projects and recommendations contained in approved plans to benefit the overall watershed by improving the watershed's fisheries, related habitat for fish and wildlife, and overall water quality.

What's Different About our Approach

- The focus will now be on protecting and restoring our fisheries habitat on an overall watershed basis. The approach relies on voluntary, nonregulatory, incentive based, locally led partnerships.

- If a governor or tribe does not want to make a commitment to this innovative program, they don't have to do so. Their respective state or tribe simply won't get access to funds appropriated under this program, not to mention the expanded spending authority provided relative to the CWA's State Revolving Fund, as well as its Section 319 funds.

- We create a new incentive for the use of existing federal conservation programs by allowing funds made available under this Act to be used to meet the nonfederal cost share requirement of those programs so long as the projects and agreements where this happens are part of approved plans established by the local watershed council.

- We include flexibility to allow for an urban, community based component to help improve waters in urban settings.

- Through the establishment of locally led watershed councils, we are bringing diverse parties to the conservation table and giving everyone an active stake in the future of our watersheds and fisheries.

- Given existing political realities, we are taking the most aggressive approach possible to achieve real results and improvements in the health of our watersheds. No one credibly disputes the fact that much work needs to be done, and most of it involves nonpoint source pollution where the EPA has largely failed to achieve the same level of success it has relative to point source pollution.

- Finally, the conservation recommendations and decisions about what is best for a particular watershed are made at the local and state level with technical assistance provided by federal agencies that administer federal conservation programs and manage public lands.

- It provides the incentives for a consistent national program to improve fisheries habitat and water quality that is also responsive to the needs of individual states, local communities, and those in agriculture.

Nick Karas wrote in his book Brook Trout that "Manhattan didn't always look the way it does now". Karas went on to write that brook trout fishing as "an American sport" got its start in many of Manhattan's creeks and streams that are today "covered with asphalt roads and cement sidewalks". This is symbolic of the importance, indeed, the necessity, for us to find innovative, creative ways to protect and restore America's vast fisheries for its citizenry. The Fishable Waters Act of 1999 is about providing the kind of creative partnerships to do just that. This legislation will provide the flexibility and encouragement necessary for citizens.

The Players

The following organizations have participated in the development of this proposal either in the drafting of its provisions, or providing recommendations to improve it, and support its objectives.

The Fisheries Conservation Community:

- The American Sportfishing Association
- Trout Unlimited
- The American Fisheries Society
- The BASS Anglers Sportsmen's Society
- The Izaak Walton League of America
- The Pacific Rivers Council
- American Rivers
- The International Association of Fish and Wildlife Agencies

The Agriculture Community:

- The National Corn Growers Association
- The National Council of Farmer Cooperatives

What's Next

With the endorsement of the Fishable Waters Coalition, which includes the American Sportfishing Association, Trout Unlimited, the Izaak Walton League of America, the National Corn Growers Association, the National Council of Farmer Cooperatives, American Rivers, the BASS Anglers Sportsmen's Society, the American Fisheries Society, the International Association of Fish and Wildlife Agencies, and the Pacific Rivers Council, the objective is to introduce the Fishable Waters Act of 1999 simultaneously in the House and Senate by Representative John Tanner and Senator Christopher "Kit" Bond this fall.

Questions

Is the Fishable Waters Act meant to replace the regulatory mandates of the Clean Water Act?

The short answer is no. It is meant to provide a national framework for locally led, voluntary, incentive-based partnerships between states, local communities, and other stakeholders to improve America's fisheries habitat on an overall watershed basis. The Fishable Waters Act is part of an ambitious effort to put significant resources on the ground where they can do the most good. So far, significant progress has been made relative to point source pollution, but physical habitat impairments and nonpoint source pollution have not been addressed with the same degree of urgency. Section 319 funding - both requests and appropriations - have typically not matched the needs regarding nonpoint source pollution. We believe an approach to restoring fisheries habitat that relies on partnerships and shared resources will accomplish far more than a regulatory regime. The Fishable Waters Act is focused on fisheries habitat and improving water quality on an overall watershed basis. This, we believe, is one of the Clean Water Act's failings to date when it comes to delivering on the Act's important promise of fishable and swimmable waters. The EPA is now pursuing a regulatory program that would require states to set Total Maximum Daily Loads (TMDLs) for waterways as a way to regulate nonpoint source pollution (see Section 303 of Clean Water Act). Administrator Browner recently said this process "is the last chapter in how we get to fishable, swimmable waters for the people of this country". But most observers agree that it will take at least ten years for this regulatory regime to be implemented on the ground, and that assumes that legal challenges will not derail the TMDL program before it even gets started. Moreover, regulatory hammers are not guaranteed to succeed since, in many cases, they don't allow the flexibility needed to achieve progress on the ground with private landowners through a collaborative watershed-based approach that brings everyone to the table as partners rather than adversaries and provides a national framework for creative conservation to meet our shared goals and objectives. The Fishable Waters Act provides a framework with the resources necessary to allow locally led partnerships to improve fisheries habitats to ultimately restore both native and non-native fisheries. The Fishable Waters Act and the resources - both financial and technical - it would bring to bear are meant to supplement the Section 319 program with a new effort that, for the first time, makes *fisheries* a priority and places *trust* in state and local stakeholders to address *local* needs.

How does the Fishable Waters Act ensure the balance and representation of stakeholders in a watershed?

In two ways. First, before a watershed council can be eligible for designation under an approved state or tribal program, membership must be "fairly balanced in terms of the points of view represented". Second, positions taken on projects or recommendations must be subject to public review, public meetings are required, the views of all council members must be considered throughout the planning process, and when recommendations or projects are not approved by the state or tribal authority clear reasons must be outlined.

What impact will the proposed fishable Waters Act have on federal oversight of existing environmental statutes? Will federal authority for pollution control be undermined as a result of enactment of the Fishable Waters Act?

This approach recognizes that states, local communities, and private landowners must be given a stake in the process of restoring our watersheds. It relies on the important principles of locally led partnerships and voluntary participation. While we believe it establishes the most effective tool yet for local communities to deal with habitat issues in their local watershed, it does not alter existing programs established under the Clean Water Act.

Why is the U.S. Department of Agriculture (USDA) given the leading role in implementing the goals and objectives of the Fishable Waters Act when the Environmental Protection Agency (EPA) has traditionally been the primary implementing agency for the Clean Water Act?

This is by no means unprecedented. While the EPA is recognized as the primary agency administering existing

provisions of the Clean Water Act, it is not alone in its authority under the Act. Like the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, USDA already has a role in the Clean Water Act in two areas. The Department has administered Section 208(j) of the Clean Water Act, and the NRCS has for some time assisted in wetlands jurisdictional determinations on agriculture lands with the Corps of Engineers under Section 404. USDA has an infrastructure on the ground in virtually every county, while other agencies, such as the EPA, do not. And USDA has, since the enactment of the 1985 Farm Bill, successfully administered a variety of conservation and water quality programs, including the Wetlands Reserve Program, the Conservation Reserve Program, WHIP, the Environmental Quality Incentives Program, the Cooperative Forestry Assistance Program, to name just a few. Hundreds of millions of dollars for conservation and water quality work has been provided under these programs, and has led to proven success in the conservation of more than 50 million acres of land and water. It bears emphasizing that the Fishable Waters Act does not create a top down program in which federal agency involvement is central to successful implementation. This new program would rely on *state* and *local* decision making, with USDA assigned the role of ensuring that state programs include the basic, necessary authorities. There is no need for the traditional hands-on management style that EPA applies to its oversight of the Act's command-and-control programs.

Why focus on urban waters in the Fishable Waters Act?

Intensive urban development creates special challenges in protecting and restoring aquatic systems so that they meet the physical and biological integrity targets envisioned under the Clean Water Act. Our collective purpose is to reconnect urban families with quality water resources that provide both economic and recreational rewards. This kind of partnership is not a new idea. The EPA administers an Urban Resources Partnership program, which makes funds available through a series of USDA grants. The U.S. Fish & Wildlife Service also administers a Community Fisheries Habitat program. The Fishable Waters Act's provisions directed toward urban waters would place even greater emphasis on protecting and restoring these import habitats.

Why is improving access a part of the Act?

The FWA encourages landowners to provide access to fisheries that have not in the past been open to fishing. Many fishing spots can only be reached by crossing private lands, but access cannot be allowed to detract from habitat restoration objectives embodied in plans approved by Watershed Councils. It is not the intent of this program to open up wilderness areas on public lands through structural development such as roads. Funds made available by this Act are expressly prohibited from being used to build roads on public lands. The simple goal here is to not forget about America's anglers who have contributed nearly $4 billion to sportfish restoration and fisheries conservation over the past five decades.

How will the Fishable Waters Act be funded? Since a change in cost-share and funding limitations is proposed in the Act, is there a way to ensure that those funds won't be used in a way that is counter-productive in terms of addressing nonpoint source pollution on an overall watershed basis?

Funding would be authorized under the FWA for planning and implementation of approved projects, and states are given the authority to utilize up to 20% of funds made available to participating states under Section 319 and the CWA's State Revolving Fund. This is not a mandate or set-aside; rather it is an attempt to provide the states with additional funding flexibility in a way that doesn't harm those programs and supports a national framework to deliver on the Clean Water Act's promise of fishable waters. These choices are left entirely up to the states. The EPA expects that as many as 30 states already are planning to use SRF funds for nonpoint source projects, and even with this expanded authority the SRFs will continue to revolve at a level of at least $2 billion. Funds made available under the FWA must be used consistent with recommendations in approved plans and the state programs approved pursuant to this legislation. Several categories of funding are provided:

- Authorizes up to $250 million to be apportioned annually in Fisheries Habitat Accounts established as part of approved programs by participating states,
- Authorizes up to $25 million annually to be used to assist willing farmers and ranchers to provide for livestock fencing near rivers and streams and in turn help establish alternative water sources for livestock,
- Authorizes up to $50 million to annually be used to purchase, through voluntary agreements, water rights to benefit fisheries so long as they are consistent with existing state water law, and
- Authorizes states to reserve and transfer up to 20% of their Section 319 and SRF allocations into a Fisheries Habitat Account.

Will this funding mechanism harm the Section 319 program?

This proposed funding regime is optional for each state, and will not harm the Section 319 program. It will however, provide flexibility so that states can use available funding for a variety of efforts to restore riverine systems, improve fisheries habitat, and build on existing water quality improvements.

USE OF MARINE ZONING IN THE FLORIDA KEYS NATIONAL MARINE SANCTUARY TO BALANCE RESOURCE PROTECTION WITH UTILIZATION

BILLY CAUSEY
FLORIDA KEYS NATIONAL MARINE SANCTUARY

Note: The following document is a transcription of the presentation by Mr. Causey. It has been reviewed and approved by the author for publication.

The National Marine Sanctuary program has twelve sanctuaries administered by the U.S. Department of Commerce, specifically in the National Oceanic and Atmospheric Administration. We are in the National Ocean Service portion, specifically the Office of Ocean Coastal Resources Management which also manages the Coastal Program. On the East Coast we have the Stellwagen Bank National Marine Sanctuary, the Monitor, Gray's Reef - a sedimentary rock reef off of Georgia, the Florida Keys, and another coral reef environment, Flower Garden Banks, off the Texas and Louisiana coast about 100 miles out in the Gulf of Mexico. We have the Olympic Coast NMS up in the Northwest, Cordell Bank off of California, the Gulf of Farallones, and Monterey Bay which is the largest National Marine Sanctuary. It encompasses over 5300 square miles of ocean. Then we also have the Channel Islands, the Hawaiian Humpback Whale NMS, and in American Samoa we have Fagatele Bay.

I want to focus on the Florida Keys and the coral reef environment. We just heard the keynote speaker talk about the importance of habitat and we are watching habitat decline, not only in the coral reefs of the Florida Keys, but all around the globe. In the mid-eighties we started seeing diseases such as black band disease which was affecting coral heads at an alarming rate. The cyanobacteria eats away at the coral, killing it at an alarming rate. In fact, in 1986, we watched 200-year-old coral beds die before our very eyes as a result of an outbreak of black band disease. We also have seen other diseases that have popped up around the Carribean, such as white band disease. This showed up in the Keys in the nineties and has had another severe impact on our reefs. We have also heard about the phenomenon called "coral bleaching". This is something that has not only occurred just in the Florida Keys, but also around the globe. It seems to be synchronized with El Nino events, very warm water events. It has a very devastating impact. Although in the eighties the corals would recover from coral bleaching, in the nineties and particularly in 1997 and 1998, we saw 95% of some coral reefs in the remote parts of the Indo-West Pacific die as a result of coral bleaching stress.

In the Florida Keys, I want to discuss something that I think you can relate to and that is the intense development that we have in the area. We have 85,000 year-round residents. It gets up to 130,000 residents during the height of the season. We have over 25,000 septic tanks, 9,000 illegal cess pits, 900 shallow injection wells, and our geology is very porous. It is an old fossil reef, and scientists have been able to flush a tracer virus into the toilets and within seven hours it gets into our canals. You may have heard about some of the problems we were having in and around Key West this year where coliform bacteria was being picked up in the near shore waters. Certainly, there is a drive now to do something about our water quality problems.

Not only are coral reefs suffering, we are also seeing other water quality related problems in the Florida Keys. Florida Bay in the mid-seventies was crystal clear. A fisherman could drop a fly in front of a tarpan and see him take the fly. In the early 1990s, Florida Bay was on the verge of collapse. We couldn't figure it out, but we knew that the problems were diverse. But really, the problems affecting Florida Bay and the Keys were coming from upstream. The Corps of Engineers had built over 1400 miles of canals to change the way the freshwater flows across the landscape and it changed Florida Bay from an estuary to a hyper-saline lagoon. Over time, as we started to get into the warmer period of the eighties and the even warmer

period of the nineties, this led to decline, algal outbreaks, algal blooms, and serious problems. Of course we were getting all kinds of pollution coming from various sources upstream of the Florida Keys and off the mainland of South Florida. We have learned, around the globe, that coral reefs are in the greatest state of decline in areas where they are located close to population centers, such as South Florida.

We also get about three million visitors to the Keys every year. Sixty percent of them are snorkelers and scuba divers that leave some sort of impact, whether it be physically touching the coral or standing on the coral. About 20% of those visitors are recreational fishermen. Recreational fishermen and divers, of all the visitors to the Keys, spend about 13.3 million visitor days while they are in the area. Important to the businesses is the money they spend.

This has led to problems resulting from boating. People don't pay a lot of attention to what their props are doing to the seagrasses. We have lost over 10,000 acres of seagrass as a result of prop scarring and intense use of shallow water areas. We have also had some major ship groundings over the years. In 1989, there were three ship groundings within a 17 day time frame where those ships, as a result of negligent navigation destroyed thousands of square meters of reef surface. That was the last straw along with the problems of water quality and everything that had been accumulating.

Congress designated the Florida Keys National Marine Sanctuary in 1990. It is a 2800 square nautical mile area. It runs from roughly off of Miami 220 miles to the Dry Tortugas National Park and all the way back to the Everglades National Park. What is important here is Biscayne National Park, Everglades National Park which includes a portion of Florida Bay, and the Dry Tortugas National Park are not within our boundary. However, we do overlap four wildlife refuges and several state parks and aquatic preserves. Sixty-five percent of the sanctuary lies within state waters, so we have a state partnership in the management of the sanctuary.

We were able to start managing from on shore - our jurisdiction does not go above any high water - but we were able to start addressing impacts coming from onshore affecting the health of sanctuary resources, running through the seagrass communities, all the way through the coral reef communities. Coral reefs require clear, clean, sediment-free water which is low in nutrients. In the seventies, every day our visibility would be 100+ feet. In the eighties, it started diminishing. Now when you get 50 feet of visibility, that is a good day. Every once in a while, we will get 100 feet visibility days and it reminds everyone of what it used to be like.

As a result of the designation of the sanctuary, Congress immediately prohibited oil drilling within its boundaries. They prohibited ships greater than 50 meters in length from coming within certain areas to be avoided established within the sanctuary boundary. They also directed EPA to work with the state, the county, and with NOAA, to develop a water quality protection program for the sanctuary. NOAA was directed to develop a comprehensive management plan. We started working on it in 1991, and we just implemented the management plan in July of 1997. There is a lot of complexity in putting a plan together and what I am going to focus on is the zoning.

Congress really did something different for us when they designated the sanctuary in that not only was it the first congressionally designated sanctuary, but in the designation itself they asked us to consider temporal and geographical zoning to ensure protection of sanctuary resources. This has been done successfully all over the world - in New Zealand, Australia, the Philippines, Bermuda, Cayman Islands. In the Keys, management zones already exist within places like the National Wildlife Refuges, State Parks, and Looe Key.

The consideration of zoning in the sanctuary was mentioned in the Florida Keys National Marine Sancturary Act, and the Final Management Plan ended up with five different types of zones in our comprehensive zoning plan: Wildlife Management Areas, Ecological Reserves, Sanctuary Preservation Areas, Special Use Areas, and Existing Management Areas. I am going to go through each one of these and point out what they are.

The Wildlife Management Areas are set aside to restrict access to sensitive wildlife habitat. There are 27 in the Final Plan. Twenty are actually managed by the U.S. Fish and Wildlife Service and were put into our management plan by the recommendation of the Fish and Wildlife Service. These areas protect turtle nesting beaches, bird foraging areas, and bird rookeries. We have restrictions on seasonal access. Some of them are closed year-round, where we have, for instance, bald eagle nests. There are certain activities that are restricted within the Wildlife Management Areas, but only five of the 27 are no access. People can get into most of them by canoeing, kayaking, and various non-combustible means of transportation.

We have 18 Sanctuary Preservation Areas. These are areas, although they are small and people were at first criticizing us because they were so small, that capture 65% of the shallow reef habitat - the area where most of the people go. In fact, 80-85% of the diving activity takes place in this particular habitat along the shallow reefs. By setting aside a half of a square nautical mile, or maybe

one square nautical mile, we were able to encompass the majority of the area used with a small amount of geographical area. In these sanctuary preservation areas, no one takes anything. Both recreational and commercial fishing are prohibited. Spearfishing is prohibited. Tropical fish collecting is prohibited. We don't even let scientists take anything in those areas. Consumptive research is directed to other locations. In an effort to reduce socioeconomic costs from the Preservation Areas, regulations allow catch and release fishing by trolling in four of the Sanctuary Preservation Areas: Conch Reef, Alligator Reef, Sombrero Key, and Sand Key.

Another zoning type is what people most often call "marine reserves". "Ecological Reserves" is what we call them. These are larger "no take" areas, and they are almost the same by regulation, but they are different by definition and intent. These areas are to set aside a large portion of the ecosystem to protect the biodiversity of the area, to protect the resources and the habitats found throughout the sanctuary. We only ended up with one in the Final Management Plan, though we promised to establish a second within a two year time frame. This gave us the opportunity to manage the resources from the mangrove fringed shorelines through the seagrasses, which are very important as nursery and resident areas for many of the commercially and recreationally important species. We also manage all the way out to the reef track to protect the biodiversity of the area. People often mistake our action here with thinking that we are trying to manage these areas for fisheries intent. That is a benefit. We are focusing on managing these areas for protection of the biodiversity. We want to protect the food and the home of the many species that help maintain the important commercial and recreational fisheries.

We set aside four Special Use Areas, Conch Reef, Tennessee Reef, Looe Key (patch reef), and Eastern Sambos Reef. These research-only areas allow only persons as specifically authorized by a valid permit. This way we can tease out impacts coming from all the diving activity, all the other uses. Or is it really water quality and habitat degradation? Or is it all of the above? We also can use these Special Use Areas for restoration. We do coral reef restoration after we have a ship grounding or one of these other problems, and we actually come back and rebuild the reef to the best extent possible.

We have established a Zone Monitoring Program to be able to detect whether or not these zones are being successful. We set up a three level monitoring program. One to measure the benthic community changes inside and outside of the zones and to evaluate the effectiveness of the "no take" zones, and also to determine the socio-economic effect of the zones.

Has it been easy? I don't want to leave you with a feeling that this has been easy. That is why it took from 1991 to 1997 to get the plan in place. That is why we had to come back later, to make a promise to do another ecological reserve in the future, because people were getting really upset. The fishermen were outright serious that they did not want to hear this new concept called marine zoning. There was a lot of resistance in that time frame to testing this new tool in the coastal waters of the United States.

The final management plan ended up with the zones that I have already described, but at the bottom of the sanctuary you will see that Ecological Reserve Study Area. The area to the West, around the Tortugas region, was set aside as an area where we needed to have special protection. We started working in that study area to set aside an area for long term protection. We called the project Tortugas 2000 and we approached it in a completely different way than we did in the first process.

We started working with people at the waterfront level. We started working with the watermen, the fishermen, the divers. We started working with scientists and the environmental community and fisheries managers. We started a process to set aside something in the very special region of the Tortugas. An area that is rich in coral reefs and protected species. An area with some of the best remaining corals in the Florida Keys. An area with some of the best water quality and some of the best benthic communities remaining in the Florida Keys. We have over 45-50% coral cover in some of those areas around the Tortugas. We started using science and oceanography information. We have a scientist who has dropped in over two dozen satellite tracking meters. He drops them in off Shark River Slough and they zigzag around in different patterns. These examples showed the fishermen that anything spawned out in these areas could end up replenishing the entire Florida Keys. Clearly, the area is under threat from overfishing, too much anchoring in the area, and vessel discharges. We have seen declines in some of the major fisheries groups. Five of 16 species of grouper are overfished. Nine of 13 species of snapper are overfished. The use of Dry Tortugas National Park in 1984 was 18,000 visitors and in 1998 it was up to 72,000 visitors.

We put together a working group of diverse interests, people we felt could make a difference. This group came together with a recommended, preferred alternative for a boundary in that region. It is 185 square nautical miles set around five different jurisdictions within the Tortugas region. This major step has been unanimously accepted every step of the way by all of the groups involved. This is a tool I think can help keep our resources be sustainable. I think it is a tool that is long overdue in the coastal communities around the United States.

Questions

Are there copies of the management plan on your website? If not, how can people get them?

Yes, if anyone is interested, we have a web page for Tortugas 2000 and we also have a web page for the sanctuary. You can get copies of all this information with any one of those web sites.

When you started the project, did you already have a lot of existing research or was it necessary to put a lot of extra money into research?

When we started initially, we didn't realize the extent of research and information that we would need. More importantly, the first time around we didn't value the importance of socio-economic information. So the second time around we had invested heavily into understanding who uses the area, where they use it, how often, and so on. We also invested heavily into oceanographic research and understanding the marine community in the area. We have had to come back and invest heavily in understanding the area from both the scientific viewpoint, as well as an economic viewpoint.

Can you address how effective you have been at keeping the targeted users out of these zones and the need for enforcement to follow up?

There was a lot of suspect over whether or not we could get compliance. Enforcement is extremely important in these areas. We implemented the zones in July of 1997, and in August every year, we have a two day sport diving season where people come down and catch lobster. Ten thousand boats are on the water during those days. This year, we had 10,000 boats down there, 23 different zones, and in two days, our officers only gave 25 citations and written warnings. The first year, boats were lined around the edges, so we are getting excellent compliance. But you have to have education and outreach out in front. Now, over a full year, we only write 300 written warnings and citations. I think we are getting excellent compliance.

How do you get the word out about the zones to the people coming down to use the area?

We have several programs. We have a very active education program. One of our most effective tools is a program we call Team OCEAN. That is where we get volunteers and staff that go out to all the dive shops and marinas with all kinds of information. We have all kinds of brochures with the zones marked. But they also actually go out on the water and do boat-to-boat encounters. They actually will occupy the zones during high use days and get the word out. The word is out and what is really becoming great here is that within two years, the people that opposed the zones are now supporting them because they see the difference. Peer pressure is enormous, and that is where we get the greatest support, from the community telling others.

Where does the funding come from--state vs. federal vs. businesses?

The majority of the funding comes from an appropriation from Congress. All National Marine Sanctuaries are funded from Congress through appropriations. We have various partners. We have partners with CNC, TNC (The Nature Conservancy), a lot of different groups, and everyone brings a little bit to the table. So we try to squeeze a dollar and try to make a dollar and ten out of it.

How big a staff do you have?

I have 42 team members and that includes both state and federal. We fund our state staff 100% through the federal appropriations, and over half of my staff are state employees. I have the largest staff of any National Marine Sanctuary in the system, I have double the staff of the Monterey Bay NMS. For comparison, Everglades National Park will have 240 staff, and it gets up to over 300 during the season.

RHODE ISLANDS'S SALT POND REGIONAL MANAGEMENT PLAN: A CASE STUDY

VIRGINIA LEE, PH.D.

RHODE ISLAND SEA GRANT ADVISORY SERVICES IN COASTAL MANAGEMENT

Rhode Island's salt ponds are smaller, shallow water systems, basically what you call inland bays or coastal bays (*Figure 1*). Like the Delmarva coastal bays, our salt pond systems are similar in salinity (18-20 parts per thousand), are fed largely by groundwater/freshwater flow into the system, and are part of barrier reef systems. As a management area, however, we include not just the water, but the watershed and airshed around it.

The salt pond region encompasses all of Rhode Island's south shore - 25 miles long, 5 miles wide. This area is a major resource recreationally, from an endangered species perspective, and to real estate. Other than Cape Cod, the area has the closest beach for Southern New England and is a huge day trip, seasonal, and weekend tourism destination. The area is also important as a pilot area for coastal zone management internationally.

In our management of coastal waters, we have identified six uses or zones, ranging from conservation to recreation to commercial navigation and industrial. Specific activities are promoted and/or prohibited in each specific use zone. As in the coastal bays, there are lot of issues - beach development, bridgeways, declining water quality, declining fisheries, and development in the salt ponds watersheds. Our management policies seem to have held the line and stopped dramatic declines. However, we continue to see dramatic changes. We lost most of our sea grasses in the 1930s. They came back, but now they are declining again. We have also lost forests to house lots. These lots have wells and septic tanks, and much of our groundwater is getting recycled through this system. Many of these homes were originally rental houses which have now converted to year round use, and the system is becoming overloaded.

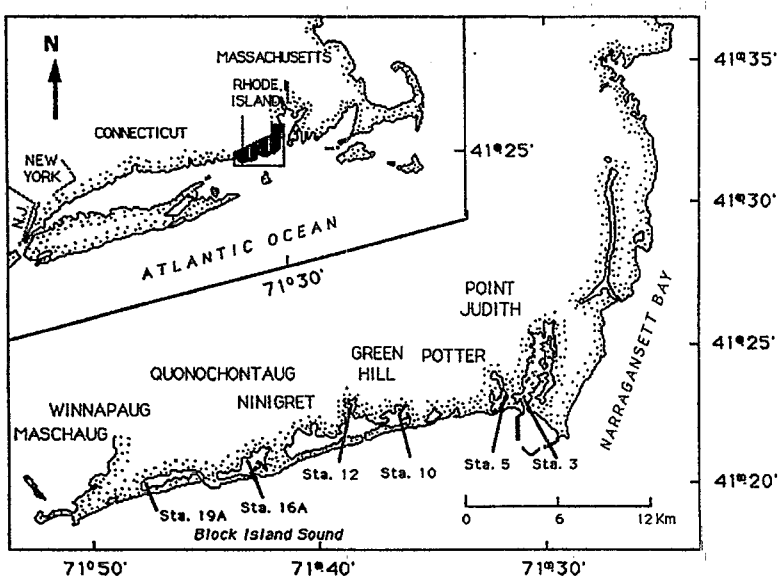

Figure 1. The Salt Ponds Region.

Types of Use in the Salt Ponds Region

- Residential development (*Figure 2*)
- Commercial development-retail, turf farms, gravel mines
- Tourism
- Port - commercial fishing fleet, charter fleet, Block Island Ferry, marinas
- Conserved open space - US Fish and Wildlife refuge, state and town parks (beaches and campgrounds), Nature Conservancy and land trusts
- Narragansett Indian Tribe
- Regional hospitals, mental health clinic, churches
- State University, research area, student housing

Land use in the county is currently 22% developed, 8% in agriculture, and 40% undeveloped, but developable. There is the potential in the future for double the amount of development seen in recent years. Given this wide variety of use, it is important that any management plan first, promote mixed uses, not single mandates, and second, allow for change.

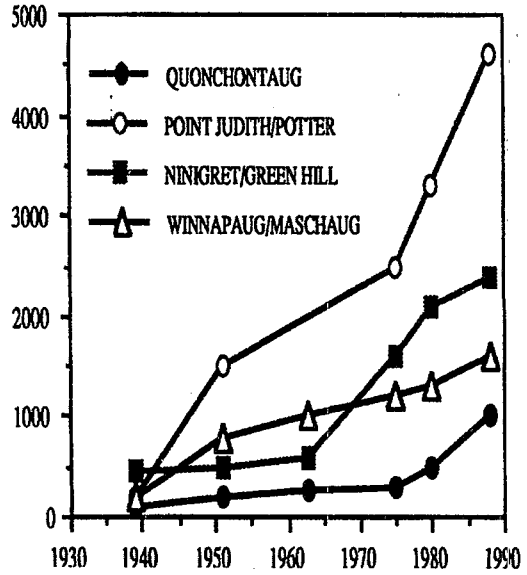

Figure 2. Trends in Housing Development, Number of houses in pond watersheds, 1939-1988

Techniques for Balancing Uses

Formulate Effective Coastal Management Regulations

- Clear policies and standards
- Simplified permit procedures
- Fair and equal enforcement
- Special Area Management Plan (1984, 1999)-treaties between local, state, and federal governments for whole ecosystem

Example: Rhode Island Coastal Zone Policies

1. Hazard Mitigation
   - Erosion based construction set backs (headlands & beaches)
   - Designated undeveloped barrier beach segments
   - Prohibition of infrastructure on barriers
   - Vegetated buffer policy for contiguous wetlands and tributaries

2. Balancing Commercial/Recreational Uses
   - Zoned shoreline and tidal waters
   - Encourage or prohibit activities specified for each zone
   - Variances must show overriding public benefit

Build Constituency for Sound Management

- Water quality improvements - Salt Pond Watchers, Salt Pond Coalition, Special state Individual Sewage Disposal Systems (ISDS) standards, University outreach
- Landscape conservation - Land Trusts, Nature Conservancy, Audubon, Watershed management, Municipal training, State policy

Creating and Sustaining Constituencies through Participation

"Everyone has the right and the duty to influence decision making and to understand the results. Participatory management guarantees that decisions will not be arbitrary, secret or closed to questioning." (DePree 1989)

We need to get the scientific community involved in critiquing policies, get public interested and engaged, as well as government to act it, not just speak it. It is not just enough to get the local people to join together for participation in the management. It is a mega-opolis from Richmond to Boston. We are part of a global population increase. Larger alliances need to be built.

Attributes of Successful Participation

- Carefully plan participatory activities
- Weave participatory activities into CZM design
- Give participatory activities the same attention as scientific and technical activities
- Listen to, understand and respond to a wide diversity of local and national stakeholders
- Don't be hijacked by one or two powerful, well-organized community interest groups

THE CREATION OF A WATER USE CONFLICT MEMORANDUM OF AGREEMENT FOR THE NORTH LANDING RIVER

ERIC WALBERG
HAMPTON ROADS PLANNING DISTRICT COMMISSION

Introduction

The North Landing River is located in Southeastern Virginia in the Cities of Chesapeake and Virginia Beach. Due to the configuration of the River and the broad range of on-water uses the number of conflicts between users of the River is on the rise. The River is narrow and winding and is a designated channel of the Intracoastal Waterway. The Intracoastal Waterway serves a large volume of commercial and private boat traffic. The river is also very popular for recreational boating, water skiing and jet skiing. The combination of a broad range of users and a narrow, winding river sets the stage for a variety of potential conflicts between users.

A second set of concerns is based on the fact that the North Landing River watershed is home to several rare and unique wetlands types. The Nature Conservancy and the Virginia Department of Conservation and Recreation have purchased large tracts of wetlands along the shoreline of the River to preserve them. The type and location of on water uses has an impact on the ecological and aesthetic integrity of these protected areas.

To address these concerns the Hampton Roads Planning District Commission is coordinating the creation of a Water Use Conflict Memorandum of Agreement. The MOA is intended to establish a set of voluntary water use areas to segregate potentially conflicting uses and protect fragile wetlands areas. The creation of the MOA is one aspect of the Southern Watershed Area Management Program (SWAMP). SWAMP is a partnership of the Virginia Coastal Program, the Cities of Chesapeake and Virginia Beach and the HRPDC. Funding for the program is through a grant from the National Oceanographic and Atmospheric Administration. The overarching goal of SWAMP is the achievement of a set of management enhancements for the Southern Watershed Area (SWA) that balance natural resource protection and sustainable economic development. The SWA includes the watersheds of the Northwest and North Landing Rivers and Back Bay in Chesapeake and Virginia Beach.

The draft MOA establishes four water use categories; non-motorized recreation, motorized recreation, high speed recreation and commercial. A map included with the MOA designates the channel as being for commercial and through traffic, the smaller tributaries as being for non-motorized recreation, the broader southern portion of the River as being for motorized recreation and a portion of the southern area as being suitable for high speed recreation. The intent of the MOA is that the two cities and the resource agencies with management responsibility on the North Landing River and adjacent lands will utilize the map and use categories in boater safety and other educational programs.

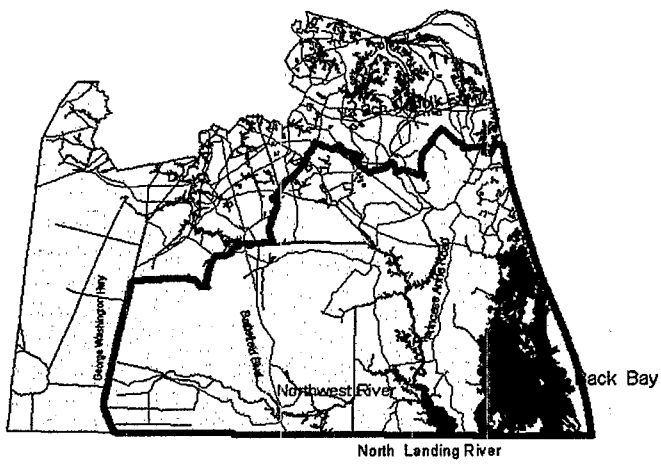

Figure 1. The Southern Watershed Area.

The Southern Watershed Area

- The SWA is bounded by the Atlantic Ocean to the east, the Dismal Swamp to the West, and the North Carolina border to the south.
- It is approximately 325 square miles in area.
- It contains Back Bay, North Landing and Northwest Rivers.
- The SWA is predominantly urban and suburban in the headwaters, rural and agricultural in the southern portion.

The North Landing River

- The configuration of the North Landing River creates the potential for water use conflicts.
- The River is narrow and winding for most of its length.
- The main channel of the River is part of the Intracoastal Waterway.
- The River is home to a broad range of commercial and private uses including barge traffic, fishing, skiing and jet skiing, canoeing and kayaking.
- A second set of concerns is based on the fact that the North Landing River watershed is home to several rare wetlands types.
- The Nature Conservancy and the Virginia Department of Conservation and Recreation have purchased large tracts of wetlands along the shore line of the River to preserve them.
- The type and location of on water uses has an impact on the ecological and aesthetic integrity of the protected areas.

Development of the MOA

- The HRPDC is coordinating the development of a Water Use Conflict Memorandum of Agreement.
- Participants in the process include the Cities of Chesapeake and Virginia Beach, the HRPDC, the Virginia Departments of Conservation and Recreation, Environmental Quality, and Game and Inland Fisheries, and the Unites States Army Corps of Engineers, Coast Guard, and Fish and Wildlife Service.
- The next step in the development of the MOA will involve various user groups in the process.
- The MOA is intended to establish a set of voluntary water use areas to segregate potentially conflicting uses and protect fragile wetlands.
- A map has been developed depicting the use areas.

Water Use Categories

- A draft set of water use categories has been created for use in the MOA.
- Adherence to the water use areas is voluntary and no enforcement action will be associated with them.
- The intent is that the map and the water use categories will be used in boater safety programs and other educational and outreach efforts targeted at users of the North Landing River.
- The water use categories include Low Impact Recreation, General Recreation, and Special Use/High Speed Recreation.

Low Impact Recreation

- Objective: Promote safe boating by separating conflicting uses, protect and preserve wetlands areas.
- Policies: Motorized boating at no wake speeds, high speed recreation should be avoided, best suited for wildlife observation, canoeing, kayaking and fishing.

General Recreation

- Objective: Promote motorized recreational activities in the safest areas and minimize adverse environmental impact.
- Policies: Motorized boating should remain 500 feet from shore where possible, no wake speeds within 500 feet of shore or low impact uses and non-motorized craft.

Special Use/High Speed Recreation

- Objective: Focus high speed motorized recreation in the safest and least environmentally sensitive areas.
- Policies: Encourage jet skiing, water skiing and other high speed uses only in these areas. Discourage other recreational activities in these areas.

Completing the Process

- The next step will involve soliciting comments on the draft MOA from a variety of user groups, including the Virginia Ecotourism Association, jet ski user groups, marina owners, fishing clubs, etc.
- A revised draft will be produced and participant agencies will be asked to approve and sign it.
- The signatory agencies will agree to use the map and use categories in educational programs.
- A survey of River users will be performed before and after implementation of the MOA to determine its impact on awareness of safety and environmental impact issues.
- Survey results will be used in further refinement of the map and use categories.

WATER-USE PLANNING IN DELMARVA'S COASTAL BAYS: ADDRESSING CARRYING CAPACITY ISSUES

JAMES M. FALK
UNIVERSITY OF DELAWARE SEA GRANT COLLEGE PROGRAM

Delmarva's Coastal Bays are a series of shallow-water coastal lagoons located along the Atlantic Ocean coastline. Over the years, many of the bays have seen rapid residential, shoreside development. This development and increase in permanent and seasonal residents has placed intense demands, especially during the summer months, on the bays and their resources. Boat traffic has been increasing and changes in the types of vessel have also been apparent. In recent years, jet skiers and board sailors compete with traditional fishermen and recreational crabbers. Along with the increases and changing activity patterns comes new competition between users which creates crowding and safety issues, as well as impacts to the environment. One method to deal with the problems and concerns associated with these increased pressures is through the development of water-use plans.

Why Develop a Water-Use Plan?

In addition to actually observing increased multi-use activity on our nations waterways and in the coastal bays of Delmarva in particular, articles in local and national newspapers indicate the need to manage use activity on intensely used water bodies. Many federal, state, and local agencies are beginning to realize that multiple-use waterways need to be properly managed. Issues related to dredging, the growth of personal watercraft (PWC's), limited public access, environmental impacts associated with heavy use are all concerns that need to be addressed in a systematic fashion. A key component of the planning process must insure input is acquired from all concerned stakeholders. If this is accomplished, it can be a very effective way to deal with the multiple-use issues associated with waterway management.

What Is Water-Use Planning?

Water-use planning can involve a number of very complex elements. Some of the basic elements that should be considered when contemplating the development of a water-use plan include:

- Managing on-water use activities to minimize environmental impacts
- Insure safety of all water users
- Avoid conflicts between competing users
- Education role to insure compliance of laws and regulations
- Encourage public access to resources

Developing a Water-Use Plan

When developing a water-use plan a number of initial steps must be undertaken. Initially, it is important to determine that there is a need to manage use activities in a waterway. The important questions to ask are: Is heavy use occurring? Are safety issues and potential accidents a problem? Is the environment facing degradation from users? Secondly, there needs to be a basic understanding of who the users are (e.g. fishermen, water skiers, jet skiers, kayakers, etc.) and how they interact or conflict with each other. Thirdly, there is probably additional data on users that still needs to be collected. This can be compiled through observations (either aerial or on-water) during peak use time periods, or through surveying users. Both field intercept surveys, as well as mail-out data collection efforts have worked well. Input from water users is critical to the overall success of any planning effort. Finally, it is important to focus your planning efforts to a few key areas. Try to determine which concerns are most important to achieve the desired results. These may include enforcement, regulatory issues, or education and awareness approaches.

Water-Use Planning in Delmarva's Coastal Bays: A Voyage Underway

There are a number of past and current efforts in the Delmarva coastal bays region that have focused on water-use planning. Activities in the states of Delaware and Maryland will be highlighted chronologically to demonstrate these efforts.

Delaware

Water-use planning in Delaware has a long and continuous history. One of the earliest attempts to document recreation use activities in Delaware's inland bays occurred in 1986 as the Greely-Polhemus Group Inc. completed a recreation survey of the inland bays. In 1989, the Delaware Department of Natural Resources and Environmental Control completed aerial surveys to document peak use boating activity. Also in 1989, the consulting firm Hollander, Cohen Associates, Inc. completed telephone surveys of 300 residents living in Sussex County, Delaware (the county where the inland bays are located). This survey effort attempted to gauge public opinion on a number of issues related to water-use planning in the bays. Finally in 1989, the DNREC formed a Water-Use Plan Work Group to oversee a water-use plan and marina assessment study being prepared by the Battelle Memorial Institute. In 1990, the Battelle Group completed its plan which fell short of making firm recommendations to control water-use activities in the bays. In 1992, the University of Delaware Sea Grant Program completed a study (which included both field and mail survey of bay users) which identified the key concerns of various user groups who used the inland bays for recreation. In 1995, the Inland Bays Estuary Program completed its Comprehensive Conservation and Management Plan (CCMP) and in the plan it specifically identified the need to develop a comprehensive water-use plan for the bays. A contract was awarded to the University of Delaware Sea Grant Program to complete this task. In 1999, the Inland Bays Comprehensive Water-Use Plan was completed.

Maryland

Water-use planning in Maryland's coastal bays also has a long history, yet it has not been a continuous voyage. As early as 1976, Roy Mann Associates, Inc. examined recreational boating on tidal waters of Maryland. In addition to examining boating in the Chesapeake Bay and its tributaries, the firm also examined recreational boating in the coastal bays to assess the conditions and whether carrying capacity concerns existed. After this initial work was completed there was limited work done in the coastal bays region until 1992, when researchers from the University of Maryland Eastern Shore completed an inventory of marina sites and characterized peak boating uses based on aerial surveys. In the late 1990's the Coastal Bays of Maryland were designated a National Estuary by the Environmental Protection Agency (EPA). A water-based activities subcommittee was formed to begin dealing with water-use issues. A draft CCMP completed in 1999 identified recreation and navigation issues in the bays as key concerns that needed to be addressed. Also in 1999, the Maryland Department of Natural Resources completed a series of aerial flights over the bays to observe peak use activities occurring on the waters. This effort was augmented by field intercept surveys coordinated by the University of Delaware Sea Grant College Program. More than 200 boaters were interviewed to collect information on their activity patterns and perceptions related to boating in the coastal bays.

Delaware Inland Bays Water-Use Plan: A Case Study

With the population of Sussex County, Delaware projected to increase by 35% to 181,000 by the year 2020 and tourism growth in the coastal areas of the county also continuing to rise, the demands on the resources of the inland bays will continue to escalate. This increase in growth and resource use requires careful planning to insure that negative environmental impacts are minimized and user safety is insured. Water-use planning is often overlooked in many resource management plans or not considered until serious problems arise.

The development of a water-use plan was one of the nine key goals addressed in the Inland Bays CCMP. Other planning elements included establishing and implementing a comprehensive non-point source pollution control plan, a comprehensive wastewater management program, and a shoreline protection program that addresses both natural processes and human activities. The water-use plan tactic was strategically placed under the Habitat Protection Action Plan within the CCMP to ensure the ecosystem's natural resources were given priority status. Valuable aquatic habitats, living resources, and human activities were all considered in the plan.

The water-use plan outlines acceptable uses of the water to ensure that user conflicts and environmental impacts are minimized. The plan addresses the many competing and potentially conflicting uses of the bay waters and strives for a balance between protecting the bays' natural resources and allowing for public use for current and future generations.

More specifically the plan attempts to: 1) provide safe and enjoyable recreational experiences for the general public,

2) benefit and protect existing bay uses, 3) provide convenient and adequate access to the bays, and 4) protect and enhance the bays' living resources, habitat, and water quality.

There are a number of basic facts that laid the groundwork for the development of the inland bays' water-use plan. These include:

- The inland bays are Public Trust waters that the Delaware DNREC is charged with managing and protecting for the citizens of the state.
- Inland bay waters are considered "ERES" (exceptional recreational and ecological significance) waters. These waters are accorded a level of protection greater than that provided most other state waters.
- Peak use is seasonal (May 15 - September 15) with intense use occurring on weekends and holidays.
- It is expected that water-use activities will increase in the future.
- The bays are shallow and bottom features change due to storms or other weather events.
- Most of the current boating regulations are designed to protect property and insure personal safety, not to address environmental concerns.
- Additional piers, docks, and shoreline stabilization structures will continue to increase.
- Major tributaries (e.g. Love Creek, Herring Creek, Whites Creek, etc.) provide important habitat for fish and wildlife resources to spawn, nursery, and grow.
- Public access to bay waters will not keep pace with the increased demand.
- As Delaware's Clean Vessel Act Program matures, concerns about boater wastes impacting the bay waters will decrease.
- The use of less-polluting 4-cycle outboard engines will continue to increase.
- The cumulative impact of water-use activities and shoreline development, rather than individual activities or events, need to be further evaluated.
- Use activities will change in the future based on changing technology, new and different types of equipment, or changes in the resource base.

With these underlying tenets, the water-use planning process began. The plan did not address all of the issues and problems facing the bay waters. For instance, it does not address concerns related to the agriculture industry, such as nutrient runoff and manure management. It does not address concerns related to land development or land use concerns on a large scale. At the current time there is no attempt to eliminate any traditional bay uses or create zones for any specific uses.

The plan does identify conflicts between uses and various users. It also identifies a number of user impacts on the environment. It recommends actions to decrease environmental impacts and encourages safer uses of the bays to minimize accidents and personal injuries.

The final plan represented a consensus between the public and private sectors to develop action items to achieve the identified goals. In order to ensure the water-use plan would become an action plan, all bay stakeholders were invited to become involved. The stakeholders included private citizens, individuals with a business interest in the bays, representatives from state, county and local governments and others who were interested in the long-term future of the bays. Fact-finding meetings, public workshops and other informal gatherings were held to discuss the key issues which were vital to the development of the plan. In addition existing literature, technical reports, and other water-use planning documents from other states were reviewed, as well as pertinent Delaware literature.

Fifteen key issues were identified by stakeholder interest groups and were organized into three major classifications: 1) Habitat issues are those that address impacts to the environment of the bays, 2) Use issues pertain to activities and water user concerns of safety, conflicts, or other people impacts, and 3) Habitat/Use issues relate to both environmental and user concerns.

Habitat Issues

- Boaters cruising in shallow water areas cause bottom scouring, shoreline erosion and turbidity.
- Inland bays' users enter resource protection areas and habitat restoration sites and cause damage to experimental test plots.
- Marinas, boatyards and other boating facilities are sites where pollutants are discharged into the bays' waters.
- Inland bays' boaters are unfamiliar with the impacts of boat-related pollution on the bays' ecosystem.
- Degraded habitat areas (caused by human influences) result in an ecosystem less likely to support living resources.

Use Issues

- PWC's are operated carelessly and safety concerns need to be addressed.
- Increased private development (both residential and commercial) diminishes the public's access to the bays.
- Boating congestion in certain areas of the bays decreases boater satisfaction and increases the potential for conflicts and accidents.
- Existing navigation channels in the bays are not adequately maintained.
- Unattended or unmarked recreational crab pots pose hazards to watercraft and impact living resources.

Habitat/Use Issues

- There are too few marine enforcement officers to adequately enforce existing laws and regulations in the inland bays watershed.
- Buoys and markers for dredged channels are ineffective at directing boaters in the bays.
- High speed boats, especially in narrow tributaries, cause shoreline erosion and safety concerns.
- Unrestricted development of marinas, docks, and piers in the inland bays' watershed causes negative impacts on the environment and may restrict the public's use of water areas.
- Future Increases in boating use on the bays may exceed an identified carrying capacity for the resource.

From these 15 issues, more than 45 targeted actions were recommended to help remedy the problem situations. A number of action approaches were identified including enforcement, education and awareness, administrative, regulatory, waterway improvement, and other.

Conclusions

Since the completion of the water-use plan in June 1999, a water-use plan implementation committee has been appointed to oversee progress on the actions. Various state agencies and organizations, that have a vital interest in the bays', have been charged with taking leadership roles to insure that the actions are completed. An annual review of recommendations will take place to note progress and accomplishments.

This work was supported by the Center for the Inland Bays and the University of Delaware Sea Grant College Program. Co-authors of the Comprehensive Water-Use Plan for Delaware's Inland Bays include: James Poling, Alan Graefe and Bennett Anderson.

DEVELOPMENT OF A MARYLAND COASTAL BAYS WATER-USE MANAGEMENT PLAN

ERIC SCHWAAB

DIRECTOR, MARYLAND DEPARTMENT OF NATURAL RESOURCES FISHERIES SERVICE

Note: The following document is a transcription of the presentation by Mr. Schwaab. It has been reviewed and approved by the author for publication.

The Conservation Management Plan that was signed last year was the culmination of much work, but it also laid out the challenges for a significant new implementation phase of the coastal bays management effort. The convergence of several issues, particularly commercial clamming and recreational boating, led to this management planning effort. I will be describing what the Maryland Department of Natural Resources is doing to implement the water-based components of that plan.

Purpose of the Water Use Management Plan

The purpose of the Water Use Management Plan is to address water use issues as they relate to recreational and commercial fishing, navigation, dredging, and sensitive areas to maximize recreational and economic benefits while maintaining sustainability of the coastal bays' natural resources. This component of the comprehensive management plan is specific to use of water surface, water column, and water bottom. It is separate from land use issues.

We formed a DNR workgroup consisting of Fisheries, Coastal Zone Management, Resource Assessment, Land and Water Conservation, Natural Resource Police, and Maryland Coastal Bays Program. This focused our activities to move forward with implementing the plan in conjunction with existing stakeholder advisory groups of Navigation and Dredging Advisory Group, Sensitive Areas Interagency Task Force, and Fishery Advisory Committee.

We have both resource capacity issues, which are those things that threaten the long-term sustainability of the resources themselves, and social capacity issues, which are user conflicts, economic limitations, safety issues, etc. Carrying capacity, which drives management and to which Jim Falk referred, will be the more limiting of these two.

Our goal is to have the following completed by July 1, 2000: Activities of Concern, Objectives, Management Recommendations, and Implementation Strategies.

Potential management responses being reviewed include restriction of activities by area, restriction of activities by time (hour, day, season, etc.), harvest regulation (quotas, size limits, creel limits, gear type, etc.), restoration activities, and public education. These may be used singularly or in various combinations as determined by the appropriate need.

One related issue I would like to briefly mention is hydraulic clamming, because there has been no mention of specific steps that DNR is taking to address that issue. Current efforts include expedited delineation of SAV beds, additional marking, enhanced enforcement, and priority review under water use plan.

Research and Monitoring Projects

We have begun to gather data to set the stage for management decisions. Secretary of DNR, Dr. Sarah Taylor-Rodgers, in her commitment to funding the Comprehensive Management Plan, has included $300,000 to fund research and monitoring projects in the following areas:

Fisheries

- Catch, Effort and Economic Data
- Analyze Existing Data
- Shellfish Stock Assessment Program
- Aerial Boat Survey
- Blue Crab Parasite Research
- Restore Hard Clam Habitat

Sensitive Areas

- Bathymetry Survey
- Digitize Waterfowl Staging Areas

Navigation and Dredging

- Evaluate PWC Impacts on Recreational Boating

Resource Assessment

- Evaluate Boating Impacts on SAV

Aerial Boat Survey of Maryland's Coastal Bays

The purpose of this survey was to determine the number and distribution of all boating activities (*Figures 1-4*). To work from an existing base line, the 1991 survey by the University of Maryland Eastern Shore was replicated, using the parameters of Delaware-Virginia state lines, weekends (July 31-August 29) 11:00 am-1:30 pm.

Through this survey, although limited, we were able to look at the distribution of boats over a single day, and then, over all the days of the survey to determine concentration areas. For example, a popular fishing area had lots of anchored and drifting boats, while in other areas, concentrations of jet skis were found. The total daily number of boats ranged from 300 to nearly 500 during the survey period. This helps us determine areas which may be subject to some type of management over time. We also can compare the results of this survey to the similar survey done in 1991. Preliminary results show substantial declines in some boat traffic, but substantial increases in jet ski traffic. This data can be combined with that from the Access-Intercept Survey.

Access-Intercept Survey of Recreational Boaters and Fishermen

The coordinators for this survey included the Maryland Coastal Bays Program Water-Based Activities Subcommittee and University of Delaware. The purpose was to characterize user groups and obtain an understanding of current satisfaction levels for boaters and fishermen in the coastal bays area. The survey was conducted August 21, 22 and 28, 29, 1999.

Information Obtained

- Years of Boating on Maryland's Coastal Bays
- Number of Days Boating in 1999
- Activities Engaged in During Boating Trip
- Perception on Current Level of Crowding
- Number of Boaters that have taken Boating Safety Course
- Satisfaction Level of Boating Experience
- Percent of Respondents who fish in Maryland's Coastal Bays
- Targeted Species
- Number of people who understand how Maryland's fishing policies & regulations are determined
- Satisfaction level of fishing experience
- Support for various fishery management tools

Information gleaned from both the Aerial Boat Survey and the Access-Intercept Survey will form the basis for the kind of management decisions that we need to make in the future.

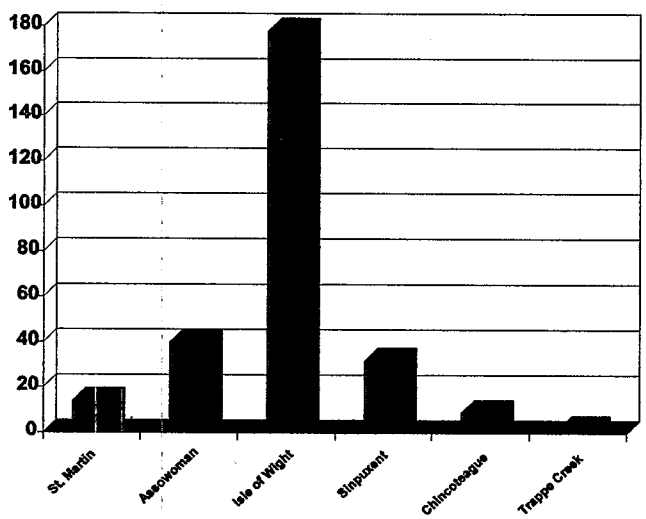

Figure 1. Average Number of Boats by Area

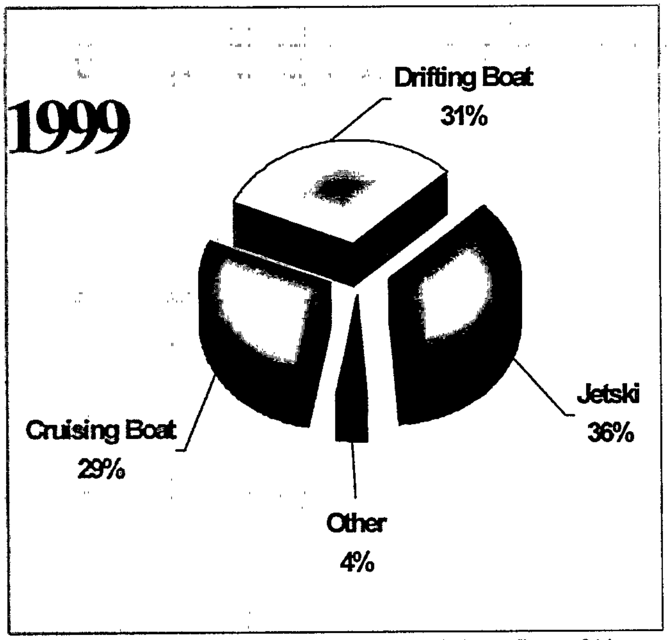

Figure 2. Boating Activity in Sinepuxent Bay (Inlet to Route 611 Bridge)

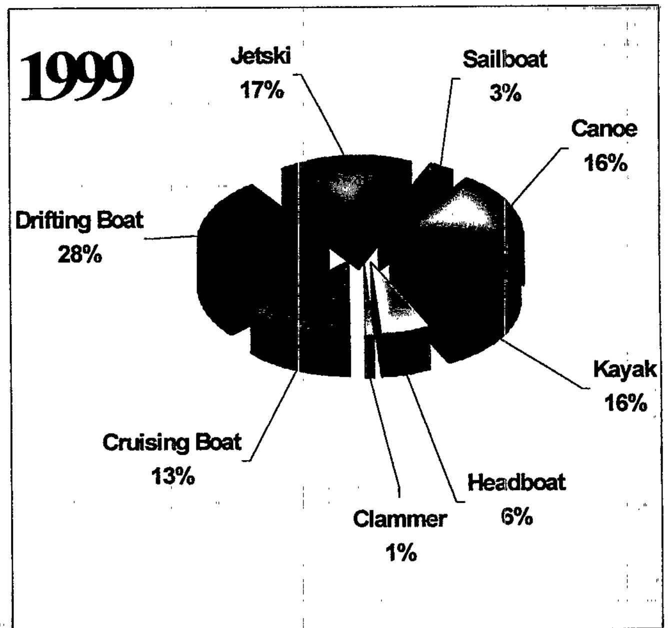

Figure 3. Boating Activity in Lower Sinepuxent Bay (Route 611 Bridge to South Point)

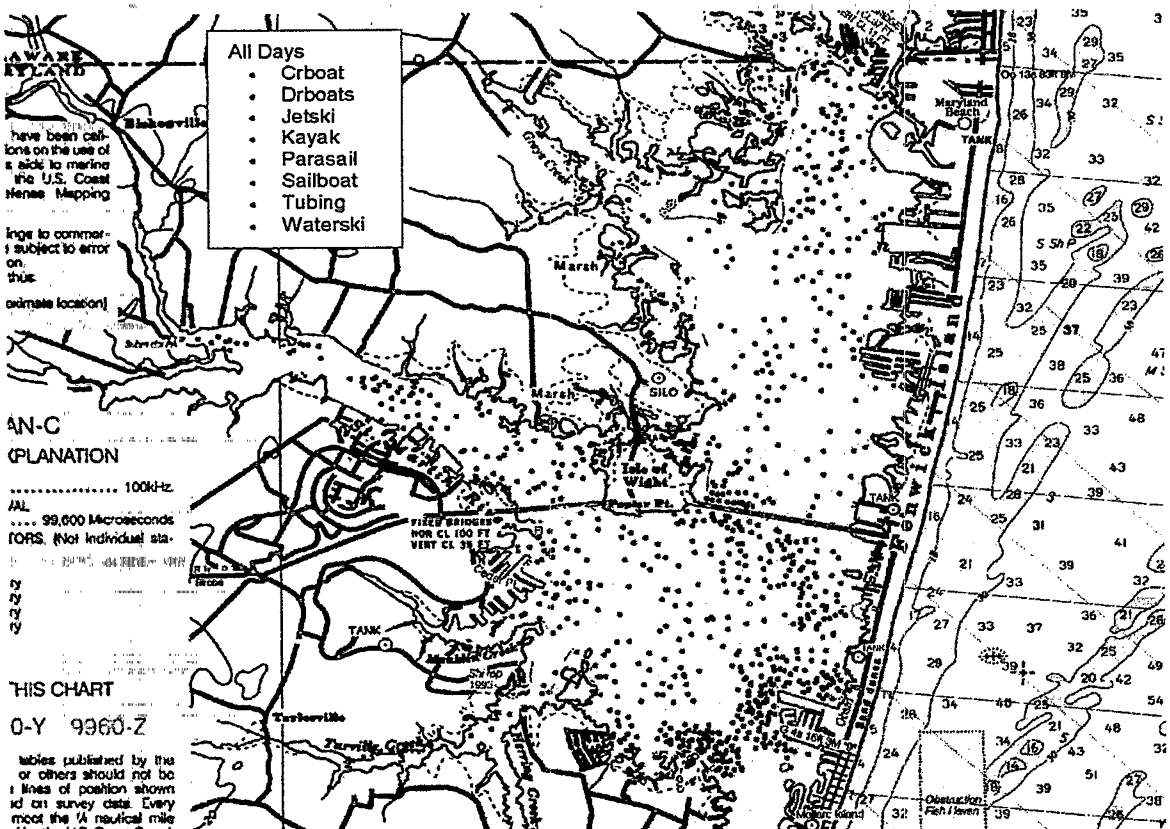

Figure 4. Boating Activity on All Days in Sinepuxent Bay, 1999.

MARINE RESOURCE PROTECTION INITIATIVES AT ASSATEAGUE ISLAND NATIONAL SEASHORE

CARL S. ZIMMERMAN
ASSATEAGUE ISLAND NATIONAL SEASHORE

Assateague Island National Seashore was established as a unit of the National Park System in 1965 to protect and conserve the natural resources and values of Assateague Island and adjacent coastal waters. Although the land base for the National Seashore is primarily located in Maryland, the authorized boundary includes the oceanic and estuarine waters surrounding the entire Island, including significant portions of Chincoteague and Sinepuxent Bays. In all, the park includes more than 25,000 acres of marine and estuarine waters.

Through most of the park's history, its resource management and protection programs have focused on terrestrial species and habitats. Over the past decade, however, increasing attention has been directed towards understanding, monitoring, and protecting the park's estuarine environment. Much of this effort has focused on Chincoteague Bay – the largest of Delmarva's coastal bays and, by most measures, the least impacted by human activities.

Notable among recent initiatives are cooperative efforts between the National Park Service and state of Maryland to protect submerged aquatic vegetation (SAV) from the adverse effects of hydraulic clam dredging. More than 15,000 acres of SAV habitat, most within the boundary of the National Seashore in Chincoteague Bay, have been closed to commercial clam dredging since 1998. Unlike other closures in the Coastal Bays, and indeed the remainder of the State, the Chincoteague Bay sanctuary includes both vegetated *and* adjacent non-vegetated habitat. By including substantial areas of non-vegetated bottom, the Chincoteague Bay sanctuary provides important benefits not found elsewhere, including the opportunity for unhindered SAV expansion, and protection of non-vegetated habitats and associated biotic communities from the physical disturbance caused by clam dredging. The rationale for this approach in Chincoteague Bay was that most of the SAV occurs within the boundary of the National Seashore and that, as such, those habitats merited a higher standard of protection.

In 1998, the National Park Service proposed a nationwide regulation to prohibit the operation, landing, or launching of personal watercraft (PWC) within all units of the National Park System unless such use was found to be compatible with an individual park's enabling legislation and overall management objectives. In other words, PWC use must be explicitly determined appropriate to a specific park or else it is prohibited. The regulation was developed to address the impacts that PWC use have on the natural resources of parks, including wildlife and water quality, as well as visitor safety and protection of the visitor experience of non-PWC users.

Assateague Island National Seashore was one of a relatively small number of parks nationwide where PWC use has been occurring, and where there was potential that PWC's *might* be found compatible with the park's purpose. An evaluation was completed in 1999 with the decision that PWC use is, in fact, an appropriate use of Assateague waters under certain very specific circumstances – when used as transportation to and from traditional mooring points on the Island. As a result of this determination, PWC use at Assateague Island National Seashore will be restricted to two relatively small areas at either end of the Island beginning in the year 2000.

At the southern end of the park in Virginia, PWC's will be allowed only within a small transportation corridor linking boat launch points on Chincoteague Island with a traditional landing spot at Assateague Point on the north side of Toms Cove. At the north end of the park in Maryland where PWC use has traditionally been heaviest, there will be a second small transportation corridor providing access to the Island at the northern tip. These

corridors will allow those visitors using PWC's *as transportation* to land on the Island at traditional mooring spots. All PWC use elsewhere within the boundary of the National Seashore will be prohibited.

A final initiative stems from the renewal of Congressional interest in the designation of a federal wilderness area on Assateague Island. During the mid -1970's, Assateague was formally evaluated for potential inclusion in the National Wilderness Preservation system. The study resulted in a portion of Assateague Island being identified as *potential* wilderness – an area not suitable for wilderness status due to several incompatible land uses that were occurring at the time. Since then, however, most of the incompatible uses have been eliminated, and the park recently certified that lands previously identified as potential wilderness do, in fact, meet the criteria for formal wilderness designation.

The area in question is located in the central portion of Assateague Island and includes approximately 6,500 acres. Although water areas were specifically excluded during the initial study, there may now be an opportunity to expand the wilderness designation to include portions of Chincoteague Bay. If the designation process comes to fruition, a federal wilderness on Assateague Island could provide an important stimulus towards the creation of a "no-take" marine protected area in the Coastal Bays. No-take sanctuaries, or marine refugia, have been demonstrated to provide a variety of resource management benefits, including increased abundance and reproductive output of targeted fishery species, increased species diversity and community stability, and enhanced habitat complexity and quality.

RESOURCE SUPPLEMENTATION THROUGH AQUACULTURE OR FROM COTTAGE INDUSTRY TO AN ECONOMIC MAINSTAY

MARK LUCKENBACH, PH.D.
VIRGINIA INSTITUTE OF MARINE SCIENCE, EASTERN SHORE LABORATORY

Note: The following document is a transcription of the presentation by Dr. Luckenbach. It has been reviewed and approved by the author for publication.

I plan to address three issues today: 1) the absolute inevitability of growth in aquaculture in the coastal bays; 2) some of the procedures and the requirements for shellfish aquaculture; and 3) our need to get smart about how we manage the growth of aquaculture in our coastal bays.

Aquaculture, as many of you know, has long been touted as the future of coastal fisheries. For molluscan aquaculture, that statement is not true. Aquaculture is not the future of molluscan shell fisheries, it is the present. Worldwide, over 80% of oysters produced come from intensive aquaculture, with probably similar figures for mussels. In the U.S., approximately 60% of the oysters that are produced are from aquaculture. Along the eastern coast of the United States, the production of hard clams from aquaculture far outstrips the production from wild harvest. In Virginia both the number and dollar value from aquacultured clams exceeds that from wild harvest. Here on Delmarva there are several species that are currently cultured, and many more possibilities.

What I am going to do is to concentrate on the two current largest production species of shellfish on Delmarva coastal bays and that is the hard clam and the oyster, but many of my comments apply to other potential aquaculture species. The hard clam aquaculture industry has been well established in Virginia for decades. Estimated dockside value this past year is about 15 million dollars, and growing. The hard clam aquaculture industry employs hundreds of people on the Virginia coastal bays and the lower part of the Chesapeake Bay. Another indicator of its recent success is that, beginning this year, the USDA federal crop insurance program is issuing policies that insure hard clam seeds, further confirming that this is farming and not fishing.

We also have a small, but growing oyster aquaculture in Virginia, mostly on the Delmarva peninsula. I estimate it at about one million dollars this past year. A really large and growing, non-commercial component of this is termed "oyster gardening", and there are also a few people growing scallops. What is emerging is a shellfish aquaculture industry in Virginia that is growing several species now and will be growing more in the future.

Presumably, this is a good deal. We have heard in this conference aquaculture suggested as a solution to some of the problems facing our coastal bays. It's presumed to be sustainable and environmentally friendly, particularly shellfish aquaculture which does not involve the addition of artificial feeds. And it has very high dollar value per acre. One major clam grower in Virginia reports a net return of $65,000 per acre per year. This is an extremely high value per acre.

Shellfish aquaculture begins with a hatchery phase. This phase involves spawning brood stock, rearing larvae in tanks, growing algae for food and changing water frequently. After a few weeks in a hatchery, the shellfish larvae metamorphose into a bottom-dwelling juvenile and are transferred to a flow-through nursery facility. Both hatcheries and nurseries generally require waterfront property, a place to put in some water pumps, and a place to discharge water. The most critical need for this early phase is excellent water quality. It is an absolute requirement for shellfish aquaculture.

There are, of course, numerous threats to good water quality on aquaculture. Obviously, development in and around the coastal zone and around the coastal bays can threaten water quality and threaten these operations.

Improperly managed agriculture can pose a threat to water quality and aquaculture. High profile issues related to this on Delmarva over the past few years include runoff from commercial tomato farms and high-density chicken production operations. Bivalve larvae are extremely sensitive to some pesticides, including those used for mosquito control, reducing the feasibility of operating a hatchery in some localities that spray pesticides for mosquito control.

Farming practices for clams are fairly straightforward. The bottom is "tilled", "seed" clams planted in the field and nets put over the rows. The nets then need to be maintained by removing algae and other fouling organisms and inspected for predators. Generally, within two years the clams are then harvested. In essence it is a farm located in shallow, near-shore water.

Farms, of course, imply property lines. We use terms like "leases" and "shellfish grounds" but the bottom line is that property lines are a necessary component of private farming. I suggest that this is an important reason for us to think seriously about the implications of developing aquaculture in our coastal bays. I am not suggesting that aquaculture is a bad thing, merely that we need to carefully consider its impacts and implications.

Oyster farming, at the hatchery and nursery stages, has the same basic needs for water quality and waterfront property. The basic farming practices that are being quite successful in Virginia are based on selective breeding, management around disease, and rapid growth to market size. Oysters not only can be grown, and are being grown in this area, but they can be grown profitably by these means. With a few modifications to suit our area, this is the way oysters are grown worldwide.

But again, with these oysters, we're talking about putting out mooring pilings and structures in the water. There is considerable infrastructure and investment involved in setting up an oyster farm. It is hard to imagine that there are not going to be property lines if that happens.

Next, I would like to consider some of the ecological and social issues that I think are raised by doing these practices. First, as I have previously noted, aquaculture is very dependent upon good water quality. We have seen in Virginia and elsewhere, that the aquaculturists become strong advocates for water quality issues. Many of them have taken pro-active steps that have led to small tributaries being cleaned up and shellfish closure areas being opened. One case here on Delmarva has led to litigation between shellfish aquaculturists and corporate tomato farm.

I have already spent some time referring to this property rights issue and I will elaborate. In Virginia we have a century-old law permitting leasing of the bottom, developed to support an old fishery approach of moving oysters around. Individuals may lease shellfish growing areas from the state, which continues to own the bottom habitats. But, if you look at the details of the lease structure, it conveys most of the rights of property ownership to the individuals who hold that lease. And again, that's justifiably worrisome, because we might call it leasing, but at some level, we're talking about private property rights on what's historically been public resources. We need to think about that and about how we want to manage it.

In Virginia, this industry can, and does, employ a lot of individuals. Seasonally, hundreds of individuals, and increasingly, it's a year-round employment opportunity. In some cases, those individuals are traditional watermen, but increasingly, it is a work force that requires new skills, including training in biology.

Clearly, aquaculture brings the need for new sets of regulations related to habitat use, public safety, use of the product, and environmental impacts. In many places, including Maryland, aquaculture development is being stymied for lack of appropriate regulations. Even where we're seeing aquaculture developing rapidly, one of my contentions is that we're not dealing with these needs in an integrated fashion. We're doing it piecemeal and in the long run both aquaculture and competing interests suffer from this lack of planning.

We have generally presumed that the direct impacts of shellfish aquaculture on water quality are good, but this has not been thoroughly investigated. We know, for instance that in terms of nutrient cycling, shellfish can remove a lot of phytoplankton (and, hence, excess nutrients) from the water column. But, in turn they give off considerable ammonia waste that can contribute to macro-algal blooms. The clam farmers sweep this macro-algae off their nets, but we don't know its fate or effects on local ecosystem dynamics.

In summary, shellfish farming is here in the coastal bays and it will continue to grow. It brings with it new opportunities for economic development and sustainable harvests of seafood, but it also poses many new issues related to resource management and conflicting uses of our coastal waters.

To my colleagues in the research community, I urge that we begin to incorporate these subaqueous agro-ecosystems into our pictures of the landscape and into our model of the coastal bay systems. We have typically had aquaculture scientists studying aquaculture and marine

ecologists studying processes in the coastal bays, and not linking the two. In the same way that terrestrial ecologists came to realize several decades ago that agriculture is an important part of terrestrial ecosystems, we need to include aquaculture in our study of coastal ecosystem dynamics.

To resource managers, I suggest that we need to develop rational, integrated approaches towards dealing with issues related to siting of hatcheries and leasing of grow-out areas. Integrated, rational approaches that allow us to address a whole array of resource conflict issues are necessary to ensure the continued, but wise growth of aquaculture in the region.

I have only addressed a few issues related to aquaculture in Delmarva's coastal bays. I am sure there are more to come, but we at least need to consider the implications of zoning uses in our coastal zone.

Questions

What about the impacts of disease, such as the oyster disease, MSX? Couldn't a similar disease destroy clam mariculture?

Absolutely, disease could. In fact one of the things we've seen is that disease, at times, has a very big impact on wild fisheries as well. We heard that about blue crabs yesterday and the disease problems they are facing. I haven't talked a lot about oysters here, but certainly oyster diseases have had an impact on oyster resources. So one part of the answer is that diseases are around in any wild harvest or animal husbandry that we do. There is always the concern with agriculture, which is essentially monocrops, that you make yourself more susceptible to disease. For example, when you put single strains of clams in and you have millions and millions of them in an acre. I think the approaches that marine shallow water agriculture is going to have to take are some of the same ones that terrestrial agriculture has taken and that would be by diversifying the crop base, conduct selective breeding programs to improve stocks, and try to maintain some genetic diversity in the population. One of the things we don't have the option of doing in shallow marine farms, which is common in terrestrial agriculture, is the use of chemical pesticides.

I am interested in the ecological reasons, not so much the economic ones. It seems to me that oysters and clams are filter feeders, and we all have a turbidity problem, and when they're market size, they're a big hunk of protein, which is a lot of nitrogen to get out of the system. Are these things a viable way to treat the water and to remove nitrogen from our overloaded nitrogen systems?

The question is, "Is bivalve aquaculture, shellfish aquaculture, a viable way to remove excess nitrogen from our bays?" Yes, in one sense it is, and I didn't mean, by using the example of the macro-algae, to say that it wasn't. Certainly, it is a way that a lot of nitrogen that made it into the phytoplankton, gets into something we eat and moves out of the water, but we need to move in our studies beyond that to understand more about their role in nutrient cycling. That part of the story is true, but it's also rather simplistic, and we don't know what happens to the macro-algae when they bloom and the rest of the nitrogen that's still there.

MANAGING CONFLICTS IN LIGHT OF INCREASING USER PRESSURES AND STRESSED RESOURCES

JONATHAN PHINNEY, MODERATOR[1], RICKS SAVAGE[2], NORVILLE PROSSER[3], JACK TRAVELSTEAD[4], JIM MATHIAS[5], MARC KOENINGS[6], HENRY KOELLEIN[7], AND BILLY CAUSEY[8]

PANEL DISCUSSION

Note: The following document is a transcription of the panel discussion.

The increased harvest pressures on limited, and in some cases, declining resources, has created increased competition and conflict among user groups in coastal waters around the country, and Delmarva is no exception. One suggested strategy for helping deal with this situation is to establish sanctuary areas for resource conservation, usage zones that maximize both recreation and commercial catch, as well as active (i.e. jet skis and boats) and passive recreation. Please comment. Also, what would you recommend as first priority to minimize the conflict among user groups and sustain the resource?

Prosser: I think everyone knows that I represent the sportfishing industry. About a million people provide services for those 60 million Americans that participate in recreational fishing. Our association is only involved in this from the long-term perspective. When it comes to zoning as it relates to resource issues, it is non-negotiable as far as we are concerned, in applying whatever is required to protect living resources in the long term. Having said that of course, the devil is always in the details, and there are a lot of ways to go about doing that and there is a multitude of management strategies that can accomplish that.

One thing of concern to us in the longer term is that while recreational anglers have some bad actors in their midst, they have largely been the forefront of aquatic resource conservation. Why? Self-interest. The healthy aquatic resources provide their recreational activities and they want to maintain healthy aquatic systems. So as we go about managing conflict and applying zoning and other practices, we have to make absolutely certain that we do it in the least Draconian way possible, so we can continue to involve families and people in recreational fishing opportunities. We have recreational fishing allowed in wilderness areas, in the national wildlife refuges, in the national park system. There is a whole range of things that we can do. The bottom line is that zoning, in terms of recreational fishing, is the proper response in some cases. We heard some well thought out applications earlier today. Just be very sensitive in the way you do that and make sure you reach out and touch base with user groups as you develop zoning strategies.

Travelstead: Certainly sanctuaries are a good thing. We have heard a number of examples of excellent sanctuaries this morning and yesterday. Let me provide you with just a few examples of how sanctuaries work in Virginia. Just this year we established a sanctuary for

[1] Center for Marine Conservation, 1725 DeSales Street, NW, Suite 600, Washington, DC 20036
[2] Mid-Atlantic Fisheries Council, 11824 Porfin Drive, Berlin, MD 21811
[3] American Sportsfishing Association, 1033 N. Fairfax Street, Suite 200, Alexandria, VA 22314
[4] Virginia Marine Resources Commission, 2600 Washington Avenue, Newport News, VA 23607
[5] Mayor, Ocean City, PO Box 158, Ocean City, MD 21842
[6] Assateague Island National Seashore, 7206 National Seashore Lane, Berlin, MD 21811
[7] Atlantic Coast Chapter, Saltwater Sportsfishing Association, 538 Marlinspike Drive, Severna Park, MD 21146
[8] Florida Keys National Marine Sanctuary, PO Box 500368, Marathon, FL 33050

horseshoe crabs - their spawning beaches along the Atlantic shoreline. Typically horseshoe crabs will spawn on those beaches. They are very easily harvested by hand, it doesn't take any special type of gear. They are very vulnerable where the females come to spawn. Earlier this year, we closed all beaches to the hand-harvest of horseshoe crabs during their spawning migration. Dr. Orth spoke yesterday about an SAV sanctuary in Chincoteague Bay. We have heard a number of discussions about that, and it has been very successful. We have had a striped bass spawning ground sanctuary that has been in existence since 1982 and still continues today. We have a blue crab spawning sanctuary at the mouth of the Chesapeake Bay, some 90,000 acres that are protected from harvest during the spawning season. We have other types of sanctuaries that seem to be socially based. For instance, we prohibit the setting of gill nets around the Chesapeake Bay Bridge-Tunnel to allow recreational fishing opportunities for striped bass. There are obviously some safety concerns about gill nets in relation to that structure.

All of those sanctuaries, and the ones you heard about this morning have two things in common. Number one, they are based on good science - good sound information, statistics, and data. That makes them believable and fairly reasonable to the public. Number two, there has been a general buy-in from the public that these things make sense and that they are good, and that by participating in the development and continuation of that sanctuary, the individual is contributing to the benefit of that species or that habitat or the problem that is trying to be solved. There is no regulatory agency on the Atlantic Coast or anywhere else that can enforce a sanctuary without that buy-in. It is absolutely critical that the public perceives whatever sanctuary we try to develop to be a good thing and to be reasonably based.

Now a little bit of negative comment about sanctuaries. Keep in mind that when you develop a sanctuary, you are focusing the unwanted activity out of one area and into another. So, if you draw a line in the water and say we won't have jet skis here, you are going to concentrate jet ski effort somewhere else. So you have to focus on those types of things, focus not only in the sanctuary, but what is going to happen outside of the sanctuary. Certainly we have seen this problem with the blue crab. We have a tremendous spawning sanctuary at the mouth of the Bay in Virginia that provides protection for the female crabs to spawn in the summertime, but we have allowed a tremendous fishery to develop outside of that sanctuary. So as those crabs migrate to that spawning sanctuary, they are impeded by a number of different fisheries that exist from Baltimore to Norfolk. We have to become more innovative in our thinking about sanctuaries, and for this reason, Virginia Institute of Marine Science is now investigating a network of protected habitats that will provide some amount of protection in all of the various habitats where you find blue crab and along its migratory pathways to its spawning grounds. Again, keep in mind that the focusing and concentrating of activities away from sanctuaries can backfire.

Savage: Jack Travelstead and I both sit on the Mid-Atlantic Fisheries Management Council and we use sanctuaries fairly regularly. We had an area closed off in Ocean City here - a small area about three miles wide and six miles long - and it was closed for several years for surf clams. It opened in 1990 and a fleet of clam boats in Ocean City have worked in that spot from 1990 until now and it has been very successful. Yesterday, I was in Boston for scalloping and they opened a closed area too this year for scalloping and that was very successful. It had been closed for four years. They allowed them to take 9.5 million pounds this year and that worked well. There are presently deep closed areas off the mouth of the Chesapeake Bay for scallops and everyone is looking forward to that opening at the end of next year. One downside of closed areas that most fishermen feel is that people are afraid that when you close something, it is never going to open again, and that scares them off. The more we educate them and the more they buy into the system, then it can work and it does work.

As for conflicts, as far as the fisheries management process goes, I will give an example. The Mid-Atlantic Council manages summer flounder. We have some possible potential conflicts between recreational fishermen and the commercial fishermen. We have a quota and we split the quota 60-40. Sixty percent goes to the commercial fishermen and 40% to the recreational fishermen. The commercial quota is a hard, fast quota - when they catch it they quit. The recreational quota is a target. When they get to the target, they keep right on fishing. That has happened the last two years. The recreational flounder has gone over its quota by 100% each year. This year, the Council is making a serious effort to reduce the recreational quotas.

As far as jet skis, I won't even go there. I think the sanctuary for them ought to be back in Japan. My friends in city hall will issue a business license to anybody to have a jet ski business and they will say, we will give you a license, but you can't do it here. So they all come down the bay. I live on Sinepuxent Bay right by the bridge to Assateague and it is nothing to stand on my front yard and see 25 jet skis going round and round like a swarm of bees all summer long. Now the Park Service is going to close off their half of the bay. I don't know how we are going to resolve that. I have a daughter who is 27, and she has to have a certificate of competency to say she can operate a boat, but some 15-year old kid can come

down here, put his money down, and take that jet ski and run around in my front yard. Something needs to be done, but I don't know what. I understand they have the right to be there, but it is something that is grossly overlooked.

Koenings: What I try to do on a daily basis is to manage 2.2 million visitors versus trying to manage a wilderness area. Basically, I am trying to manage an endangered species program at the same time that we have hunting programs. Balancing off-road vehicle use versus the need for back country camping. And the list goes on and on. It is kind of like the job of mayor - trying to look at the resource and balance that resource.

In the National Park Service for the last few years we have been looking at some parks across the country that might be used as sanctuaries. Channel Islands in California is certainly one of them and Assateague is the other one that we may, in the next year or so, move forward on. There has been a lot of discussion here about sanctuaries and a lot of very positive comments. I am going to have to take my hat off to Billy Causey. He has done a remarkable job in the Florida Keys. He did a very hard thing and a very brave thing. To me sanctuaries may be a very important part of a three-legged stool. Let me talk very briefly about what I think are the other two legs that are equally important.

One is education. It is absolutely critical. We all have a role as stewards. We all, regardless of who we are, have a role as stewards in protecting these areas and trying to enhancing their values. Many of you have heard about the learning center we hope to establish opposite the park headquarters in cooperation with the University of Maryland Eastern Shore, Salisbury State, DNR, and a number of others. That is not only going to be a formal educational laboratory but at least half the property will be an adult educational laboratory that I hope would facilitate the opportunity for us to continue this dialogue here in a more formal setting. The center would have adult education classes dealing with a lot of the issues that we are dealing with here. So adult education is extremely important. One of the things I hope to do at the park this year is start a field seminar program, where we bring in respected leaders in the field, use the park as a living laboratory, and more fully explore some of the things we have been talking about for the last day and a half here.

The third leg of the stool is habitat. We can talk about sanctuaries, and indeed in a simplistic fashion, if you look at the map and you see the national park and you see the national wildlife refuge and you see the property the Nature Conservancy maintains south of us, there is a core of existing sanctuary that can be built upon. I think a lot of people in this room worked long and hard to come to a consensus on these action items that show the values here. Without all of us working together to prevent the runoff that comes into these bays, we could basically put all the sanctuaries we want into place, but what will happen is eventually that runoff will destroy the fabric of the very thing we are trying to preserve.

The partnership of the Worcester County 2000 Program, the visioning process that is going on in the Coastal Bays Program, the things that Jim Mathias will be doing in Ocean City to help out, it is all of us working together to maintain that quality of the bays. That was driven home to me years ago when I first met Billy Causey. I was superintendent of the National Parks in the Virgin Islands. We had put in sanctuaries, and we had zoned off boats, and we had "no anchor" zones. I had it under control. We were protecting the coral reef. Then I went to a conference that involved NASA and they had this great map of a satellite view of the Caribbean Basin. They showed the sediment coming out of the Orinoco River in Brazil, and they showed it flowing around the hump of Brazil and it lightly touched St. Johns in the Virgin Islands. Here I was dealing with a global phenomenon, that literally started 2000 miles away, that was completely beyond my control, that was having far more impact on the coral reefs than anything I was doing with the boats. So again, as we pointed out before, we need to think globally on many of these issues, especially when they are dealing with water quality or other water issues.

Mathias: As the mayor, my challenge is that people want to use the resources. We will host over eight million people in Ocean City. Our challenge is enabling them to use the resource responsibly. Yet looking at folks whose legacy and history has been fishing commercially in our back bays, when they speak, and we look at the success of Ocean City and the legacy that they have left us, as the mayor, I have to listen. And when those eight million people come to Ocean City to use that resource, we have to make sure that we provide them their best expectation. So that is our challenge - trying to find that balance and sense of responsibility and make it all work and come together. It has happened here, I think, with the coastal bays program. We try to bring a working responsibility. Look at what we have been able to do with the recreational fishery. When I came to Ocean City, I had heard about the catches and the "White Marlin Capital of the World". I was born and raised in Baltimore City. I played in the alley, not in the back bay. But now, my daughter loves coming home to Ocean City, and she truly appreciates the place that she is from because of the resources that she left behind. Clearly, I have learned the understanding of what this area has meant.

As a trustee and as a steward, as the mayor, I try to shepherd that consensus on the city council. Very fortunately we have Nancy Howard from the Department

of Natural Resources who works with us every day--she is out there, she hears what is going on, and it is her job to get the message out. And we have Erin Fitzsimmons, whose outreach goes back into Annapolis, back into the regions and the groups that are making this happen. Quite frankly, I have learned one thing in politics. When I want to know what is going on, I go into the trenches. I find out from the person that is rolling up their sleeves and doing the job. You are the ones that are giving us the information that we need as a sustainable resource. But the commercial fishermen are also out there with a history and I have to listen to their practicality. Henry Koellein and his group with recreational fisheries are bringing their information to the table. Being able to put it all together and continue to have an Ocean City and a coastal community that will survive well into this next millennium is my charge and my responsibility. Balance is the issue. Practicality is the manner in which we operate.

Koellein: The Maryland Chapter of the American Saltwater Sportsfishing Association is proud to have 16 delegates at this conference. We are trying to be responsible. Our primary purpose is to protect the fisheries so that my ten grandchildren, and your children, and your children's children will know the good things that we know. We have been in the forefront of protecting the fisheries. The Maryland Saltwater Sportsfisherman was the leading advocate to shut down our rock fish industry in the bays. Not just for the commercial industry, but for us too. Now we are living with one fish in the spring, two fish in the summer. But we want fairness. We want the other users of this group of fish to be planed out with us.

This summer was the worst summer I have seen for flounder in the Ocean City area, and I have been fishing here since 1946. We keep records of the flounder we catch and the ratio of keepers. My best day this year on flounder fishing on the back bays here was 38 flounder, four of them were keepers. I am not complaining. The commercial boys have a smaller size limit. We know when they take those fish, there is a certain amount of kill off that comes from the by-catch before he gets back, and we would like to see them match that on their allotment.

I heard the gentleman talk about quotas. I don't know where we would get the enforcement people to tell us when we have caught the quota, because we keep better records than the Department of Natural Resources do on the number of flounder caught in these back bays. The number of flounder has decreased. It has been overfished, I agree. But as the flounder grow in size, they don't come into our bay, they go north. The majority of them go across Delaware and into New Jersey and New York. So, we are not getting that many flounder. Last year, we realized 0.95, or just under one flounder, per year per trip per angler. This year we are hitting around a half of a flounder. We know what we are catching and we are able to present that. Last year we sat down with the Department of Natural Resources, and we worked out the agreement for eight flounder at 15.5 inches with the season running from the end of April until the end of November. We are actually catching more flounder outside in the ocean, out on the bass grounds, offshore around the wrecks, so we know this fishery is being overfished, but it is being overfished north of us.

We heard yesterday Bill Baker say that Delaware is light years ahead of Maryland. No hydraulic clam dredging in the back bays of Delaware. No trawling in the state waters. Virginia the same thing. Maryland is the only one that allows all these clam dredgers and Maryland is the only one that allows trawling in state waters (state waters being out to the three mile line). They have the whole EEZ out to the 200 mile line to do their trawling. We went to Annapolis and tried to battle that, but we were not successful. Department of Natural Resources didn't help us, they worked against us on it for the commercial watermen. We are going to be back. We are going to be fighting. We are talking to some of the politicians because it is a political solution that we need.

The commercial fishermen are not our enemies, we just want to share fairly with them. We realize that you can't get enough flounder in the back bays to satisfy Jim Mathias' millions that come down here. But we want a little bit more access to the fishery. We negotiated with the commercial fishermen to have a half-mile sanctuary at the opening of the inlet at the sea buoy, which is one mile out from the inlet, but it really hasn't been enough. That was the first time in history that we sat down and worked on something. So we're working on these areas. The challenge for the Atlantic States Marine Fisheries or the National Marine Fisheries Commission is to proportionately cut back on the resource among that ratio of fishermen where the fish are being caught. This didn't happen in the last cut back, and I don't know if it will happen this time, but it's almost impossible to do. We want fairness and we will be responsible.

Causey: Over 185 million tourists visit the nation's coasts every year, and in doing so, spend about 52 billion dollars. There is no wonder why we question the crowded state of our coastal areas and the changes that we have seen in recent years. Decades ago, we started using zoning to deal with various conflicts terrestrially. We didn't have a bar built next to schools or churches, or we didn't have cement plants in the middle of downtown city areas. Zoning has been used terrestrially for years to solve a lot of social, economic, and development questions. It has been long overdue in the marine environment and I think now we are starting to hit that awareness around the coastal waters of the United States to start making a

difference where it can really count, and to start using this tool to balance use with protection. Zoning can focus actions in areas, whether they are fragile coral reefs or delicate coastal bay bottoms, with the activities that are taking place. Balance those activities and at the same time, be able to focus on the broader regional threats, such as water quality and habitat degradation.

Speaking of fairness, the recreational and commercial fishermen both evenly and fairly, blasted me during the development of our management plan. I heard as much from the commercial guys as I did from the recreational industry, only because people did not really know what this mood was. It was more one of suspicion and one of fear about what this was going to do to their industry personally. I knew it was going to be a long process when I saw at one of our meetings that the commercial industry leaders and the recreational industry leaders, all going out of the back of the room slapping each others backs and going to the bar.

Federally, we can't place blame or place lack of progress in this area on any one group. I think it is more important that we haven't gotten out the educational message that it will work. Marine zoning has worked. I will give you one quick example and this is the one that is helping pull a lot of the recreational industry around accordingly. Cape Canaveral was made a marine reserve by accident years ago for security purposes. All the bays around that area were protected because they didn't want people in there as they were carrying out various activities around the launch pads. Now, if you look at the maps, they would show you that the majority of recreational world record catches are coming all around the fringes of Canaveral. So it is working. It does produce more fish and larger fish and they do help reduce user conflicts of various sorts.

Regarding jet skis. Our sanctuary advisory council wanted to, at their very first meeting in February 1992, ban them to the fourth shipping lanes, about 40 miles offshore. Of all the issues that we have dealt with, jet skis have been the most controversial. On our draft management plan, we had approximately 6500 written and verbal comments. Over 55% of them addressed jet skis and jet ski problems. My dilemma, of the 13.3 million visitor days in the Florida Keys, 11% of the visitors coming to the Keys use jet skis. That is an incredible number. It is not like in the Channel Islands where the water is cold and you will freeze to death or you are afraid if you fall in you will be gobbled up by a white shark. We are talking about people constantly on the water.

We have to try to balance the uses. We started off in our final management plan treating jet skis as all other vessels and trying to set in place the kind of common sense regulations that addressed all the vessels equally. And it is not working. We are still getting a lot of conflicts and a lot of problems. We have a lot of work to do in that particular area. So again, returning to zoning as a tool, over time we will address that problem.

There are 28 clam dredgers that come here, not from this locality, but from the bay and all around, Crisfield etc. They come in and they are going to dredge clams until every last clam is gone. What about the tourists that like to clam?

Savage: Having clammed all my life, I can answer that one. The last clam that leaves here is going to be with one of you folks with a rig that is going to get it. Dredgers will leave when something else looks better for them, that is the way it has been forever. Years ago when those guys first came in the 50s and early 60s, you had to work in the county where you lived. The oysters all died down in the bay and all the guys from the southern part of the bay went north to work, because the only live oysters in the Chesapeake Bay were up the bay. They all went up there and got written up for being out of their counties.

This went through the court system, through the court of appeals, and the court of appeals said if you live in Maryland you can work in Maryland. Personally, I think that is a good law. I would rather those guys weren't here, but it is there for me if I want to go over there. You won't catch all the clams, you can't catch all the clams in the ocean. There is one sure thing. If you folks want to stop it, if you want to stop the draggers out there catching fish, you can do it, and you can do it fast. Just stop buying any. If you don't want the scallop poachers to catch scallops in the ocean, stop buying them. That is the simple way. I clammed in the ocean for 21 years and never ever caught a clam that I couldn't sell. But the day I couldn't sell them, I wasn't going to go. That is a fact of life. People like to eat that stuff and that is why people like me go and catch them. We are not rapers of resource, we have as much responsibility as anyone else could.

Mathias: Gentlemen, you tell us about the clammers that are out there. We are working very aggressively with the DNR on the whole issue of balance. We are out there. We have the beds marked. We are looking at catch limits, perhaps. You look at where the grasses were gone and now they are coming back. Here are the folks that work it, and maybe it is in their best interest, but they are telling us that it is healthy. However, we went to the people who understand it technologically the best and scientifically the best. They have appropriated some money, they are out there in the back bays, and they have sent some law enforcement down here. We are out to sustain that resource and we are there getting the job done to the best of our learned ability, and we ask you to be patient.

UPDATE ON FEDERAL LEGISLATION REGARDING THE COASTAL BAYS

ERIKA FELLER
OFFICE OF CONGRESSMAN WAYNE GILCHRIST, U.S. REPRESENTATIVE, MARYLAND

Note: The following document is a transcription of the presentation by Ms. Feller. It has been reviewed and approved by the author for publication.

Congressman Gilchrest is sorry he couldn't make it here today. He would have enjoyed the presentations this morning. It has been our top priority this session, to authorize spending $315 million over the next five years to restore estuary habitat with the goal of restoring a million acres of estuary habitat by the year 2010. This bill is not a long one. It spends a lot of money and it's got a little bit of process. It runs through the Corps of Engineers and it has a lot of input from state and local levels of government, the resource agencies, the Department of Transportation, and the Department of Agriculture. It looks like it will become law next Congress. It has been marked up in a couple of subcommittees so far this session, and we are hoping to get a full committee mark up next week before Congress adjourns.

I would like to answer any questions about what is going on legislatively. If I can answer, I will. If I can't, I will be happy to take your card and get you an answer.

There's seems to be a lot of interest here in jet skis, I wonder if you could say anything about the bill to promote responsible use of jet skis?

This bill was introduced by Congressman Jim Saxton of New Jersey, just a couple of months ago. Wayne was an original co-sponsor. He feels very strongly that there are just some places that jet skis shouldn't be. There's a lot of places that are okay for them to be, but he definitely thinks that sensitive shallow water habitats don't need that kind of additional burden. I think the bill has been referred to Wayne's subcommittee. We haven't started talking about next year's agenda yet, but I am hoping we can talk about having a couple of hearings and maybe even mark it up. To be perfectly candid though, I think Wayne's subcommittee is about as far as it will get. But we'll do our best. Mr. Saxton feels very strongly about this issue, and really pushed it in the re-authorization of the Coastal Zone Management Act, but ultimately had to take it out.

You were talking about the restoration of estuarine habitat. It wouldn't be at the expense of bay bottom that provides the bottom of the food chain for the fish and other organisms that live in the bay would it? I know that here they're talking about creation of spoil islands, but I am concerned that you're losing valuable habitat off the bay bottom by filling areas to create those islands.

The bill addresses estuary habitat very broadly. It goes from benthic habitats all the way to upland forest and wetlands that can be restored with this money. The bill does not talk about "beneficial use" projects. There will likely be an amendment offered at full committee markup by Gene Taylor from Mississippi to expand on authority granted to the Corps in the 1996 Water Resource Development Act with regard to beneficial use projects. This would require the Corps to go forward and do more pro-active work in terms of identifying opportunities for beneficial use. Our preference is that our bill make the world a better place and not a worse one. There is a priority on projects that actually have a net benefit and are likely to result in permanent restoration of habitat. Projects that are not going to fall apart after five years. For example, places where you have programs in place to address long-term sources of point and non-point pollution. Basically, where these programs can fit into a larger management framework is where we would like them to be. Hopefully, those management frameworks should address the issue of dredging. They don't now but that is another high priority issue for the Congressman.

What is the number of that bill?

It's HR 1775. The bill that you will find on the Internet is not the bill that was reported out of committee. It was

substantially revised before subcommittee mark up. Subcommittee mark up is on Monday for Transportation and there are a lot of changes. The basic gist is the same and the definitions are the same, but the process is a little different. If you want the updated version, you can email me and I'll send it you.

What is the prognosis for the Coastal Zone Management Act, particularly the non-point program?

The CZMA reauthorization will not likely come to the floor this fall and this is probably a good thing. Non-point and property rights are two big issues in the Coastal Zone Management Act. I don't know how familiar folks are with this, but we actually had a pretty good bill going into full committee mark up and an amendment was offered to strip the non-point provisions. Another amendment was offered to prohibit the federal government from requiring the states to do anything that would limit the commercial or private use of property without compensation. It sounds like a restatement of the fifth amendment, but it really goes beyond the fifth amendment. Unfortunately, property rights and non-point are two really tough issues on the floor. We have not had a good record on those. My boss is a moderate and we have been really successful with a block of moderates in making the right thing happen on the floor of the House of Representatives. However, on property rights we have lost frequently, by pretty good margins. Same with non-point. The last non-point vote I remember on the floor was one to increase funding for 6217 program - the coastal non-point program under CZMA - and we were defeated.

If anybody has any questions, you can always feel free to give me a call. I am in the Washington office at (202) 225-5311.

COMMUNITY AQUACULTURE IN VIRGINIA

FRANCIS X. O'BEIRN, PH.D.
VIRGINIA INSTITUTE OF MARINE SCIENCE, COLLEGE OF WILLIAM AND MARY

Note: The following document is a transcription of the presentation by Dr. O'Beirn. It has been reviewed and approved by the author for publication.

Introduction

Most are aware that oyster resources in the Chesapeake Bay and along the entire Atlantic seaboard have been greatly depleted over the last number of decades. The reasons for the declines are as varied as the individuals that offer those reasons. Suffice it to say, there is a problem and a number of agencies, both in Virginia and elsewhere, have been addressing it from a number of different perspectives.

One such strategy has been repletion efforts or shellfish restoration. This primarily takes the form of planting a substrate, generally on footprints of previous oyster beds, in the hope that oysters will naturally recruit to these areas and establish viable oyster populations. Fresh or fossil oyster shell is the preferred substrate however, other shell substrates (clam, whelks) have been used, with varying degrees of success. Such shell planting is currently being carried out in many states along the eastern seaboard.

Dr. Mark Luckenbach, in his article, refers to promotion of oyster aquaculture as a strategy that's receiving much attention in Virginia. Aquaculture is promoted from a restoration perspective to take the stress off the natural populations. Efforts to promote aquaculture have focused on, 1) the development of disease tolerant stocks, 2) selecting for faster growth in stocks and, 3) identifying areas where disease exposure is minimized and growth is maximized. Allied to these strategies are efforts that have been directed at the development of efficient and effective culture and containment systems.

Oyster Culture Criteria and System Development

Recent efforts in developing oyster culture systems have focused primarily on off-bottom culture and/or suspended culture. The advantages of suspended culture is that the oysters are easier to access – individuals avoid the vagaries of the tides that would dictate access in on-bottom culture methods. In the water column, silt loading is reduced and presumably algal concentration is increased. These reasons are attributed to the observed faster growth in oysters in suspended culture rather than those kept on the bottom.

While investigating the potential of suspended culture techniques, we have operated with certain criteria in mind. The criteria are, 1) the system must be easy to handle and operate, 2) the system must afford adequate protection from potential predators and outside interference and 3) the system must be cost effective (this is more of a concern for the commercial and larger scale operators).

A system the that fulfills some of these requirements is called the Taylor float which was designed by Jake Taylor at the Virginia Institute of Marine Science (VIMS). It's simple in its construction, deployment and maintenance. Simply put, the float is a wire mesh basket that extends into the water about 1 foot with a PVC collar or ring that acts as a float.

Typically, the commercial people would use 8'floats and the non-commercial prefer the smaller 4' version. Large numbers of the floats can be secured on a long-line in a shallow creek or body of water where they can run parallel with the shoreline. This makes them somewhat discrete and less of a navigational hazard. They're flexible in that when they're not in use, they can be inverted with the basket above the water line so that any attached organism and plants can be dried off and removed.

A manual has been produced (entitled An Introduction to Culturing Oysters in Virginia), that outlines float construction and culturing protocols and is available from Virginia Institute of Marine Science. The manual is intended for individuals contemplating a commercial startup venture as well as private individuals whose goal is to grow a small numbers of oysters off their dock!

Aquaculture Programs

Waterman Retraining Program

Who is culturing oysters in Virginia? Many involved in the hard clam aquaculture industry are increasing their crop base to include oysters. In addition, a waterman retraining program, with which VIMS assisted, was sponsored by the Virginia Marine Resources Commission (VMRC) on the Eastern Shore, whereby existing watermen were trained in the culturing of oysters. They were given the seed and the materials, and instruction on how to tend the oysters. Of the original ten growers selected, five individuals have continued to grow oysters. Given the success of the first run of this program a second program is currently underway with ten new watermen involved. Finally the third group growing oysters are Oyster Gardeners.

Oyster Gardening

Oyster gardening commenced in Virginia in 1989 with a single grower. The first oyster gardener was a retired surgeon, Dr. Armisted Williams. Former governor of Virginia, Linwood Holton quickly became involved and has since provided considerable moral and logistical support for the concept. Both individuals have since worked very closely with Dr. Mark Luckenbach to develop this program. Oyster gardeners are individuals who grow oysters for non-commercial motives. Their reasons for growing oysters are varied but fall under three general categories, 1) for their own personal consumption, 2) for restoration activities and, 3) for environmental benefits (or perceived benefits). Another reason is that oyster gardening provides a wonderful social outlet, particularly for people within a waterfront community.

Oyster gardeners in Virginia extend from the Potomac River to the Lynnhaven River, and now can be found on both sides (bay and ocean-side) of the Eastern Shore of Virginia. Typically, oyster gardeners are individuals with waterfront property. Most have access to a dock or fixed structure to which they secure their floats, mostly in a discrete manner. The majority of oyster gardeners are either retired or semi-retired individuals. However, some also include the entire family in the culturing operation. Given the large numbers involved in oyster gardening, it has resulted in many adaptation of culturing technique to suit the particular grower or location. The flexibility of the culturing systems and protocols, while still a attaining acceptable growth and survival of the oysters, has been a welcome development of the oyster gardening phenomenon.

Overview

As a brief overview, in Virginia, there are approximately 2000 oyster gardeners. Each individual gardener can fit 1000-1500 oysters in a float. Most of them have more than one float, so if you have an inlet or water body with moderate to low flushing, with many oyster gardeners, you potentially can have a very real effect on water quality in the system. Also, the number of gardeners has increased such that they have organized themselves into a number of associations, based on their location. There are three primary ones in Virginia. These oyster growers associations hold workshops where seed can be purchased. The workshops also facilitate the construction of floats and also handle questions related to the culturing of oysters. The interest in oyster gardening has grown so much that one growers association has developed a master oyster gardener (MOG) program based on the horticultural master gardener program. The MOG program has been a great success. There are always too many applicants for the number of spaces. The participants undergo a week long course in oyster culture and maintenance, and general biology and ecology of oysters. However, they are committed upon completion of the course to be available to field questions from all interested parties for up 2 years after they've taken the course.

Another enormous educational benefit from gardening is that the Chesapeake Bay Foundation (CBF) -primarily all of their oyster activities are for restoration only - have trained over 200 Virginia families in the culturing oysters. The CBF actually sponsor the purchase of seed and the families will then have to give the seed back to the Bay Foundation for planting on their restored reefs. Many families will purchase additional batches of seed, to be used for their own personal uses (consumption or reef establishment in their own location). The CBF also sponsors their Student Oyster Corps which has trained 90 school groups in Virginia and 40-50 in Maryland, to grow oysters in floats. All of the oysters grown in this manner are used in conjunction with reef restoration activities.

Benefits

Oyster gardening has resulted in increased environmental awareness on the part of the growers. Individuals are taking a greater interest in the water their oysters are exposed to, or the systems within which the oysters are

grown. People's awareness of water quality issues are heightened. Gardening has also proven to be a wonderful educational tool. People are learning more about marine ecology and molluscan biology. Also, for the scientific community, it's proven to be a valuable research tool. Consider that the growers encompass a wide range of environmental conditions, we therefore, have the luxury of planting stocks (and most of the gardeners are amenable to this) under these variable conditions. This allows us to select stocks suitable for culture under a variety of environmental conditions.

One of the more important benefits to oyster gardening has been the tremendous agency cooperation without much overlap in terms of effort. In Virginia, two state agencies (VIMS and VMRC), a private organization (CBF), and the federal government (Environmental Protection Agency) are all involved in various aspects of the oyster culture. There's been excellent exchange of information among the various groups and very little territoriality. Another benefit has been industrial development. It has been estimated that about 10 million seed were purchased in Virginia last year, just for gardeners alone. Many hardware stores areas now supply all the materials for people to construct an individual float. One store in Virginia Beach actually sells the floats which they have constructed themselves. For people that are buying one or two floats, they don't mind the extra expense that they incur by purchasing their supplies in this manner.

Future of Community Aquaculture

What is the future of such community aquaculture programs? The future is bright, but does face some potential pitfalls. On the positive side, such programs will continue to highlight water quality issues and environmental awareness on the part of the growers. The continued educational benefits are also apparent.

Potential pitfalls could manifest themselves in the form of user conflicts associated with oyster culture, especially if people continue with floating structures. Objections may surface based on navigational or aesthetic concerns. Continued expansion of aquaculture activities may be constrained by the recurrent need for seed in Virginia. To date, a single hatchery supplies the majority of the seed for gardening activities in Virginia. While demand has been met for the most part, for the program to expand the need for alternate source of seed is obvious. Rather than import oyster seed from out-of-state, it would be good to develop more hatcheries within state.

Areas that will require further research on the part of the managers and scientific community relate to stock management. We need to try to develop stocks that are suited to particular areas, rather than moving seed all over the State and risk introducing diseases from one part to the other, as has been a problem previously. Further research should be directed at handling and growing protocols. Protocols and systems require continuous assessment and development such that effort and cost can be minimized while returns (either satisfaction or monetary in the case of commercial growers) can be maximized.

THE ROLE OF WATER KEEPER PROGRAMS IN ESTUARY PROTECTION

JOHN TORGAN
NARRAGANSETT BAYKEEPER, SAVE THE BAY, PROVIDENCE, RHODE ISLAND

Good afternoon, I hope these remarks help re-energize you all after the lunch break. It may seem far-afield from Delmarva Coastal Bay issues to talk about our efforts in Narragansett Bay. But, since this panel is about citizen action, I want to share with you some thoughts on our approach to environmental advocacy that could be applied anywhere. I am going to attempt this without slides, and without a net, so catch me if I fall.

I have served as Narragansett BayKeeper since 1994. My program is a part of Save The Bay, Southeastern New England's largest non-profit environmental group focused on protecting Narragansett Bay and its rivers. Save The Bay has been well-established in Rhode Island since 1970, but added the BayKeeper program in 1993 to improve its effectiveness on marine pollution, enforcement, and on-the-water issues. A Keeper is a full-time privately-funded non-governmental ombudsperson whose special responsibility is to advocate for a specific water body. Since the first official Keeper program was founded on the Hudson River in 1981, more than 40 now exist throughout the United States and internationally, and the movement is growing.

Whether a Keeper acts as an independent organization or as part of a larger non-profit environmental group, the objectives and activities of each program are similar:

- To respond to citizen complaints about pollution and environmental mismanagement, and to act promptly and responsibly to remedy the problems.
- Leading direct advocacy and community organizing efforts for improved environmental laws, regulations, and to minimize or eliminate the impacts of specific development proposals.
- The use of citizen lawsuits for environmental enforcement and compliance.
- Establishing a visible presence on the water, and serving as a local expert and spokesperson for the water body.

Keeper programs also serve as public clearing houses of environmental information about their water bodies. The Keeper approach has been highly successful to date, with an impressive docket of legal victories against polluters, major environmental policy changes, and countless local achievements for their respective water bodies. Perhaps most significantly, Keeper programs have reinvigorated communities to become stewards of their rivers and coastal waters - to care for these places and to recognize the importance of clean healthy waters to our quality of life.

Much of this conference so far has focused on characterizing ecological trends and the implications of these observations for management. A Keeper program is one effective way to translate scientific knowledge about the ecological health of a water body into direct action. When we receive a pollution complaint, we typically head out into the field to investigate it, document it through photos and video, sampling and analysis, and report it to the appropriate agencies along with a request for action. We will then follow up on the complaint to ensure that the agency has taken appropriate action. If they have not, we bring pressure in a number of ways. First, we will elevate the issue to a higher level of government, and give the agencies an opportunity to respond. Where that fails, we will generally bring the issue to the attention of the media, elected officials, and the public. If this fails, and the problem remains a significant threat, we may take legal action.

It is also common for citizens to seek our assistance with proposed development projects. Here, we do our best to understand the issues and to advise communities on how to prevent pollution and irresponsible construction, dredging, filling, dumping, etc. One of the reasons I was invited to address this conference is that a number of groups in this region have expressed interest in starting Keeper programs, and want to know more about this. A

number of you who I have spoken with have expressed frustration over the lack of progress on pollution and conservation issues through existing government programs in this region. While the role of government in environmental research and protection is stronger here than perhaps anywhere else in the country, many have expressed the need for a non-governmental advocate to serve as an independent third-party to keep the pressure on existing programs. Where there are problems with overly-bureaucratic or complacent regulatory agencies, and where citizens are not getting the kind of responsiveness they expect from their agencies, a Keeper can help.

Today, the environmentally-concerned public is faced with increasing pressure from all directions to compromise conservation and protection standards in the interest of "economic progress" or to reach middle-ground accommodations with developers and industry. Terms like "customer friendly" and " permit streamlining" are becoming part of the vernacular of environmental agencies nationwide.

Let me say this: Be careful! Be careful with what you have, and what you trade away. Let's remember that, ultimately, we have the right and the power to choose the kind of river or coastal bay we want. We can choose to have waters that are clean and healthy, that are safe for swimming and fishing everywhere. We can choose to assert our right to participate in coastal management, policy and planning. We can hold government and industry accountable for pollution, and spur the actions needed for positive change. It is not enough to rely on the work of others to protect the coast, or to expect scientists and policy makers to determine what is best. You must decide what you want and work for it, because inertia favors the status quo and inaction will inevitably mean further losses.

The Keeper approach is only one way to strengthen coastal advocacy and protection, and we do not evangelize. There are many effective and successful non-governmental environmental groups that do this kind of work without a formal Keeper program. It is important that the approach be focused, sustainable, and locally specific. But, for those of you who have expressed interest in starting Keeper programs, I would certainly be happy to help out, and to answer any questions that you may have. Thank you.

PARTNERSHIP PUTS IDEALS INTO ACTION--DELMARVA LOW IMPACT TOURISM EXPERIENCES (DLITE)

STEVE PARKER
VIRGINIA COAST RESERVE, THE NATURE CONSERVANCY

Note: The following document is a transcription of the presentation by Mr. Parker. It has been reviewed and approved by the author for publication.

One important principle of ecotourism is less is more. There are probably some gurus here in the audience who know a whole lot more about ecotourism than I do, but we have looked at it down at the Virginia Coast Reserve. The travel business is the largest industry in the world. The fastest growing segment of the world's largest business is ecotourism, or nature-based tourism or sustainable tourism or low impact tourism or adventure tourism. Nobody is quite sure what to call this phenomenon. There is an international non-profit organization set up serving that part of the business, called the Ecotourism Society. They have over 1600 members representing 66 countries and 55 different professions. So it is a real business, it is a big business and it is a growing business.

While definitions are hard to agree on, this type of travel is described as providing visitor access to, and interpretation of, significant natural, historical, and/or cultural sites with a strong educational component that serves to protect and enhance those sites and resources, while sustainably benefitting local peoples and their economies.

I am here to talk about a local organization that has grown up from grassroots here on the Delmarva. The focus has been initially in Worcester County. It is called the Delmarva Low Impact Tourism Experience. It is a non-profit group organized to devise and implement locally appropriate policies, practices and protocols, and ethics for nature and culture based tourism operations in this region. The two key points here is it is business driven, and it is local operators who are involved, joining together to come up with guidelines and ideas of what is appropriate for the natural and cultural resources of this region.

Ecotourism has taken a lot of criticism, and a lot of it, from my experience, quite appropriately. Is an airplane ride over the Grand Canyon ecotourism? It's debatable. Is 10 per day ecotourism, or is 100 per day a nuisance? It has been characterized by critics as simply being a marketing gambit that disrupts indigenous communities, harms the environment, and exports profits to international corporations. And believe me, that is occurring and does occur.

There is not a lot of agreement on what various terms mean on a global level between practitioners, promoters, and local people. There is a lot of controversy over what constitutes sustainable practices, and how the local community, which is the key to this concept, gains economic benefit. On the other hand, if you are talking about such a locally placed-based phenomenon as low impact tourism (it occurs in a specific place at a specific time), I am not sure it is possible to come up with widely accepted definitions.

DLITE was created as a grassroots, market-driven approach to protect Delmarva's unique cultural and natural resources through training and voluntary policing. We have gone back and forth between the need for regulations and the desirability for market-driven and voluntary solutions to problems of local ecosystems, particularly in the coastal bays area. I think it takes both. Having local businesses step up and say we know this resource needs to be protected, we need to agree how to do it and agree about what is appropriate to accomplish that goal, is a major step forward. The power of locally vested economic self-interest in resource protection and the intimate contact and knowledge these operators have of each other and the resources, and the willingness of operators to formally agree to a common mission statement, operating principles, and code of ethics, should be an effective approach to creating a financially

significant local travel industry that is in harmony with its environment and beneficial to the local community.

There are three types of participants in the organization, currently all volunteer. One type are providers of various services and goods for low impact tourism. Another are members who are actually customers of these providers and users of the services. And the third are supporters. People or businesses that don't quite fit the criteria as a provider, but are interested in seeing this concept expanded and cultivated here on the Delmarva.

The mission of Delmarva LITE is to promote the low impact use of Delmarva's natural and cultural resources to enhance local economies and to ensure preservation of our quality of life. In addition, there are principles and a code of ethics that operators or providers of services are assigning and agreeing on. Low impact tourism can play an important role. It can bring some benefits to a local community, both in terms of economic benefits and the simple idea of uniting humanity with the rest of nature. Mark Koenings said today that we are all stewards, and this is a way on a very grassroots level, to spread the word, to spread the knowledge and the information about how important a healthy, functioning ecosystem is to this coastal bay community.

A second advantage, is the economic clout on local land and water management practices. Working for the Nature Conservancy, I show up at a meeting, and everyone pretty much knows what my agenda is and what I am looking to do. Having a group of 10, 15 or 50 local business people show up at a meeting and talk about land use planning that might protect a seaside farm, or might influence how dredge spoils are handled, or other issues that were brought up at this meeting, I think would carry a lot of clout and get a much better audience. As for economic clout, eight million visitors come to Ocean City every year. In terms of low impact tourism, if you could get those eight million visitors to spend one extra day, during which they spend $100, you're looking at an increase of $800 million per year in this local economy. By extending the visitation one day on either side of a visit, people go out to Berlin, or Snow Hill, or the Pocomoke River, or the other amazing assets that are here, cultural and natural. That is what the potential market impact is. You spread it around Worcester County and neighboring states of Virginia and Delaware. This would help a lot of local businesses.

A last benefit to the local community is that if you are going to save the world, you ought to have fun doing it. Nature tourism, low impact tourism is fun. I went to check out of my hotel room here this morning and took a look out the balcony and there were a small pod of bottle-nosed dolphin going past my balcony. I spent five minutes watching them, doing some low impact tourism. The rule needs to be resource protection comes first. Without the resource, as my mother used to say, if you eat the chicken you're not going to collect many eggs. I think that's a good business principle. On an education level, we need to think about replacing short-term greed with long-term greed where we are spending the interest and not the principal. I think this Delmarva LITE organization has a great potential for this area. It is business-based, it is resource driven, and the people who have worked so hard on establishing it should be proud.

Questions

Could you give me an example of what is a low impact tourist package? What would they include? Your looking out the window here is a perfect example except that this building itself is a tremendous environmental impact.

Let me address that about this building. It was interesting to me that when you check in they have this little thing to put your key in when you go into the room and when you take it out, it shuts all the electricity down. That is done for energy saving purposes. They make a nice speech about the environment, but it also saves them a lot of money. It is a good idea, it is good for business and it's good for the environment. Some other things that they could do here--soap dispensers. You have 15 little bars of soap around your room, and if you get them wet, they throw the rest of it out. Soap dispensers are commonly used, they would save quite a number of bars of soap, and again would save them money. Towels and sheets. I shouldn't admit this but at home, I don't wash my sheets everyday and I don't wash my towels every day and hotels don't need to do that either. And again I think it would be profitable for them to do that and it would also make customers feel like they were doing something. How many hotel rooms are there in Ocean City? 10000? Every gallon of water or bar of soap that we save, multiply by 10000. It makes a difference.

As far as low impact tourism, it could be anything. It could be a trip to Furnacetown. It could be a walking tour of Berlin. It could be a canoe ride down the Pocomoke or a kayak ride in the surf here. Essentially, the concept is that it's not consumptive. You don't use anything while you do it. And it's very, very low impact. The slogan is "Only take pictures, only leave footprints", but it relates to everything that's cultural, historical, and natural. It is a very broad definition, and again, not always agreed upon amongst people.

DEVELOPING ACTION ITEMS FOR THE TRI-STATE REGION

SARAH COOKSEY, MODERATOR[1], JEANNE LYNCH[2], CHARLES R. JENKINS, SR.[3], MARGO JACKSON[4], HONORABLE SHIRLEY PRICE[5], ERIC SCHWAAB[6], AND SUZANNE SCHWARTZ[7]

PANEL DISCUSSION

Note: The following document is a transcription of the panel discussion.

Cooksey: I would like to also introduce Gwynne Schultz. Gwynne is the person who helped me cajole all these people to spend their Saturday in Ocean City, to help us set the stage for what is to come. Gwunne and I kicked around the purpose of the conference and where we hoped to go from there. A lot of people wanted to have the three governors from Delaware, Maryland, and Virginia, and the administrator of the National Ocean Service here during this conference, to sign a tri-state agreement. Gwynne and I, who know how difficult it is to get one governor to attend anything, thought that if we are going to make that happen, then we are really going to have to show them what we are all about. We hope that this panel will set some type of framework so that in the near future, a year or perhaps in two years, we could get all those participants here. We hope this will help set the stage for what we want to do on the Delmarva peninsula and that they would help us implement it. I am going to come out of the closet here and say that I am one of those people who likes regulations. Regulations make my job a lot easier. And I think that if they are fair and reasonable it is good for business.

Our first question of the panel asks what each panelist's organization can bring to bear in terms of action items to better manage our coastal bays. We have heard some ideas both yesterday and today. We have heard about fisheries management plans. We have talked about the financial piece of this. I mentioned regulations. What I am taking away from this is what Sarah Taylor-Rogers said this morning. That we are on a long walk together. I think we have a long way to go, but I think we can get there.

What can your organization or business bring to bear in terms of action items to better manage these coastal bays?

Jackson: Normally, I don't go into much background on NOAA because my audience is familiar with it. But I talked to a few people here who either don't know what NOAA is or don't know what OCRM is - Office of Coastal and Resource Management. So I'll take a few minutes and orient you.

The National Oceanic and Atmospheric Administration is part of the U.S. Department of Commerce. Unknown to most people, it is the largest part of the Department of Commerce and the biggest part of its budget. It includes five large areas including the National Weather Service where you get your weather and your Doppler. We have a satellite service, ocean and atmospheric research, NMFS (National Marine Fisheries Service) which I am

[1] Delaware Coastal Management Program, 89 Kings Highway, Dover, DE 19901
[2] Worcester County Commissioner, One W. Market Street, Room 112, Snow Hill, MD 21863
[3] Bay Shore Development Corp., PO Box 572, Ocean City, MD 21843
[4] NOAA Office of Ocean and Coastal Resource Management, 1305 East-West Highway, SSMC4, Silver Spring, MD 20910
[5] Delaware State Representative, RD 2, Box 120, Millville, DE 19970
[6] DNR Division of Fisheries, 580 Taylor Avenue, B-2, Annapolis, MD 21401
[7] U.S. EPA Ocean and Coastal Protection Division, 401 M Street, SW (4504F), Washington, DC 20460

sure you are all familiar with, and then we have the National Ocean Service. My office is located within the National Ocean Service (NOS). There are a number of different offices, in addition to mine, that can help states in your situation such as our Science Center and the Coastal Services Center in South Carolina.

Our mission at NOS is ocean stewardship, information management and leadership. Dr. Nancy Foster is the assistant administrator for NOS and OCRM is one of its six main areas. Within OCRM, we are divided into three divisions. Marine Sanctuaries Division has twelve sanctuaries located around the country, some very large like Florida Keys and Monterey Bay, and others very discrete, like the Monitor off of North Carolina. We also have the Coastal Programs Divisions that work with your states, the Coastal Zone Management Program which has been in existence for over 25 years, and the Estuarine Research Reserve Division which is growing. We had three new reserves that came online this year.

The issues that you have talked about since I have been here are ones that we deal with in some very real ways on a daily basis. I have been asked to talk about ways in which we could work together and look towards the future. A lot of the future depends on funding, so some of this may be pie in the sky, but it is at least worth talking about. Then maybe we can move more funding down the line to implement some of this.

One area in which we presently work and will continue to work is the Coastal Zone Management Program (CZMP). Under that program your states' programs are funded on a yearly basis. In addition, states have a great deal to say about what happens in their coastal zone as a result of having a program and being part of the Coastal Zone Management Program. One of the key areas in which the CZMP has been involved recently is called Section 6217. It is a non-point source pollution program. Several years ago, Congress bid that EPA and NOAA would work together with the coastal zone management regimes from the states and come up with programs to reduce non-point source pollution from a myriad of sources, based on scientific measures that EPA developed. It has been a long process, but we have approved, additionally from all the states in the program, a non-point source plan. We are in the process of working with those states to satisfy those conditions and fully approve those plans. It appears that Maryland is likely to be the very first state to get unconditional approval and I applaud you for that. I hope, once that is done, to celebrate with you and make it known, because this is an area that is contentious on Capitol Hill, and we would like to let people know as many success stories as possible. Perhaps it could turn the tide on some of the upcoming budget negotiations.

Another area where we can be helpful is enhancing the local management capacity. You are basically looking at some big problems here and some of what we do, not just within OCRM, but other areas of NOAA such as the Coastal Services Center, is meet with people to figure out what the problems and the issues are, then figure out what resources we can bring to bear, everything from our science office to our GIS capabilities. Sometimes we have training sessions on GIS, so people can look at how to address specific issues such as public access, sustainable recreational use, and planning for tourism impacts by looking at GIS maps showing various present impacts.

NOAA really does a wide range of things - everything from weather service to fishing and everything inbetween, and one of the things we do as well, is surveying. We survey the oceans and we also do nautical and aeronautical chartings. Along the nautical realm, we could work with you to make up-to-date charts, especially of the inland bays, to put things on the charts that aren't customarily there that may be of help to you. It may be third party information regarding where things are, or the impact that they have, that could be put on a chart that would be of importance to you locally. We certainly are willing to talk to you about such issues and see what we can do to help you. In the long run, it helps us as well.

Another capability that NOAA has is photogrammetry. We have a division that basically overflies the coast and takes photogrammetric readings. We can find out what overflights we have of these areas and when they are going to do more, or if there are certain areas that could be targeted, or have pictures taken at a certain definition or something that would help in terms of science or that would help your efforts.

NOS has an Office of Habitat Restoration, as part of OR&R (Office of Resource and Restoration). There are two areas that we work in quite often. The NOS office works with situations like the Exxon Valdez and much smaller spills, trying to restore the environment. The NMFS office concentrates on fisheries in some relatively small areas and how to bring them back.

Last, but not least, a reiteration of what Billy Causey said on marine zoning. Because of the sanctuary program, we do have experience in marine zoning. Not only in Florida, but also in Monterey Bay, where we zoned the use of jet skis and successfully stood the legal challenge - both the district court and the court of appeals.

These are some areas where we have experience. We would be happy to work with you or talk to you about them. We learn from you and hopefully, you will be able to learn from us as well.

Schwaab: I am here to represent the fisheries perspective on these future actions, but I will just make a few comments briefly about some of the things that we see on the horizon. Let me start with an overview of the fisheries management planning process. There are essentially three levels that we deal with. We do state fishery management plans for a number of species. That is an authority that is provided to us under the legislature. We also work with, for example, the other Chesapeake Bay states under the auspices of the Chesapeake Bay Program to develop joint fishery management plans with these partners. That is a situation that could be applicable here. Then, finally, we work as members of the Atlantic States Marine Fisheries Commission to develop management plans for migratory stocks that range up and down the coast. I think it is important to understand those different levels to understand the basic framework in which we manage fish species.

One of the first steps that we have taken on the Maryland coastal bays was the establishment of a local fisheries advisory committee. We could use that committee as the basis for the development of some specific management plans for species that are important to this area. Many of the species, even within Maryland, that we have management plans for are predominantly on the Chesapeake Bay. The management is focused on where the bulk of those species are. There are often some very distinct differences here that warrant the development of separate management plans. We envision undertaking that kind of approach with this local fisheries advisory committee. I believe there might come a time when it might be appropriate for us to develop joint management plans in conjunction with the other states involved in the coastal bays. Certainly the governors of the states could agree to undertake a planning effort of that sort as they have done in the Chesapeake Bay model.

With respect to the Atlantic States Marine Fisheries Commission, often we work together within the Chesapeake Bay states to carry forward our Chesapeake Bay agenda to the management planning process at ASMFC. That can be done with the coastal bays as well. With that being the framework, I just wanted to mention that there are some real opportunities for us to work specifically on species here to accomplish that.

There are a couple of things on the horizon that we are seeing generally, in relation to fisheries management planning. First of all, traditionally we built management plans on a species by species approach. There is a lot of interest now in developing multi-species management plans that might take into account trophic levels and predator-prey relationships where one species or multiple species are interdependent. Single species management plans stop short of doing the full job. We are spending a lot of time right now on the Chesapeake Bay talking about menhaden. The menhaden fishery is important in its own right, but it is also an important prey species for striped bass. So there is a lot of interest in exploring those relationships in the fisheries management planning process. There are also many by-catch implications where there is a target species, and ancillary species are being affected by that fishery. Those are the things that fall under the context of this multi-species management planning process.

There are also, beyond multi-species, ecosystem based implications that we are beginning to explore with the fisheries management planning process. Things like habitat considerations. Set-asides for environmental goals. Menhaden are filter feeders and their mere presence in our waters has the same kind of effect as might have clams or oysters with respect to filtering and cleaning the water. Those are the kinds of considerations we are talking about. Making sure we have stocks that are of a sufficient size to satisfy those ecological needs first are issues that are going to be on the horizon. Related to that are the SAV issues and the sanctuary concept that we heard mentioned here earlier today.

I will also mention something that I think is going to be a fairly prominent part of the discussion on the coastal bays, particularly as we get further into this water use plan. It was brought up earlier by several of the presenters and was the focus of several of the presentations - the whole issue of aquaculture. Aquaculture, among other things, is an alternative economic opportunity for some of the fishermen that might be involved now in commercial catch of wild specimens. That is something that we envision to be a subject of further discussion as well.

Finally, we haven't really formulated any kind of position on it, but there is considerable interest, beyond the fisheries advisory committee at the local level, in establishing some sort of local commission or local authority to essentially separate out some of these management decisions from decisions related to Chesapeake Bay management of species. That is something I think is going to continue to be talked about in the coming months and years.

Lynch: The thrust of this, as we have said, is cooperation between the three entities to restore and protect coastal bays. Let's fast forward to 2099. The population of the world in 2099 is 12 billion, maybe more. It took us all human history to the year 1800 to reach a population of one billion. Another 100 years to reach two billion. 50 years later we reached three billion. Only 25 years later, we reached four billion. In 1985, only 10 years later, we reached five billion. And recently, the world just topped out at six billion and people were celebrating. So you do

the math. Where will we be in another 100 years? How many people are we going to have in the coastal bays watershed - Maryland, Virginia, Delaware? In Worcester County, we doubled our population from 1975, and the figures are projecting another 20,000 people within the next 20 years.

What does this do to consumption? How many clams do you need? How many rockfish, how many flounder are going to be needed to satisfy the appetites of so many? Common sense tells us we really need to begin to work together more, and I think more management decisions need to be made jointly. So here are a couple of practical solutions or suggestions.

This conference tried to get the governors of each of the states to come here and that is difficult for them at this particular point in time. So we need to try another approach, and that is from the bottom up. That takes more time, but it usually works. If we can form alliances among ourselves - the inland bays, the coastal bays, if we can encourage Virginia to get some funds and to do something there, and if the citizens advisory committees get involved, we have a much better chance. There is a proposal for Wallops Island that will bring, if it happens, 4000 jobs to this area. They are talking about private satellite launches at Wallops, and they can do it cheaper at Wallops than they can about anywhere else in the country. Four thousand jobs in a very short time. Twelve thousand people. How many of them in the coastal bays watershed? A bunch.

Let's also concentrate on the data that we really need. I heard a lot of talk yesterday about data, data, data. We didn't have this and we didn't have that. Let's concentrate on what we really need and let's make sure that it is in a form that all jurisdictions can use together - you can put it in your computer and you can analyze it and determine what it means to you. If Virginia is doing something, what does it mean to Maryland and what does it mean to Delaware.

We can have joint meetings of implementation groups and staffs. Not every month, maybe not even every quarter, but at least let's try to get together once or twice a year to discuss progress, to discuss what the needs are, and network among colleagues and state and federal agencies.

Let's try to make a policy, where it is appropriate, that we will accept the consensus of the preponderance of evidence of scientists. That is tough, but let's try it. How many years have we been talking about global warming and sea level rise and all of the sudden it is happening. Could we have reacted sooner? I don't know. But do we need to try out every thesis of every fringe group and wait years for their answers? I don't think we have the time. Not when you look at the tide line and we are going to get more billions of people. If we are wrong, we are wrong. But if we subscribe to the maxim of "do no harm" to begin with, which I think we also need to do, then that can't hurt. It can help. It can cut years off of decisions.

Let us manage for sustainability of the species. Let that be the driving factor. Where we displace people, we need to try to accommodate them in other paths, as has been mentioned before in aquaculture. Or train them to do some of the monitoring. We need to live off the interest, not squander the principle. Let's get our stocks back up to where we get some interest out of them. Right now, on some of these things, we don't even know if we have principle left.

I think we also need to include and examine some of the socio-economic issues. I just want to say a quick word about enforcement. I think that when something is wrong, it is wrong. Enforcement needs to be swift, it needs to be consistent, and it needs to be fair.

Then let's reevaluate next year. Let's set a date and reevaluate. I don't mean we have to have another whole conference, but let's get some people together and look at where we are on this. Let's do the steps to get there. As Bill Matuszeski said the other day, complex issues, simple answers. I didn't agree with everything he said, but here are some simple things. They seem simple, I know they are complex, but let's try.

Jenkins: Most everything that I would have said has already been said. Being a business man, I tend to go to the bottom line and look at the root cause of things. My friend Jeanne, just hit on the root cause. The root cause is people and too few resources. That is the bottom line. Given that as a problem, they are here, we are not going to get rid of them, it is a fact of life. It does no good to talk about some failed policies of the past. What we have to learn to do is to take that challenge and create positive things from some things that are very negative.

Now I have always believed in a great mathematician and philosopher, and I have never seen one formula that he talked about constantly, ever fail. That is, for every action there is an equal and opposite reaction. Nothing goes up without coming down. Nothing is ever empty without getting refilled. There is always an action and an opposite and equal reaction. So if we, in the name of conservation, in the name of protecting natural resources, expect to fulfill our goals and our missions, we very simply have to give something back in return.

In order for that to happen, there has to be an adaptation process. Many of our scientists talk about adaptation. It

is the ability of the marshes to grow and the ability of the forests to move, the ability of the plant kingdom to change, the ability of the animal kingdom to adapt, to ever changing outside conditions. We have people changes that need to occur, and those occurrences can happen through the type of organization that I have become a spokesperson for - Delmarva LITE (Low Impact Tourism Experiences). If we are going to have a natural resource and if we want the public to use that natural resource, and if we want the public to become educated about that natural resource, then what we must do is have the public *experience* that natural resource.

If we want this movement to stay sustained into the future, we have to bring all the diverse and adversarial groups into this movement. Currently, the adversarial groups would be business types and special interest groups that live in fear primarily because of ignorance, but also because they haven't been brought into the process in the proper way. Delmarva LITE is making an effort to bring in providers. Providers could be a hotelier, such as me, or a man that owns a charter fishing boat or a kayak canoe operator or a bicycle tour operator or a tour agent, where they use the environment, with qualifications or controls, in a low impact way, and make money by doing it.

Now what does this do? It takes the vast population that has no awareness of what you in this room have an awareness of - to become experienced with riding a bike on a bike trail. In Maryland we have developed some nice bike trails. It lets them have the experience of taking a kayak or a canoe trip. We have developed water trails and we are continuing to do that. Marc Koenings has someone helping us develop one for Worcester County where you can have the most exciting kayak experience of your life. You can go across Chincoteague Bay and tour those beautiful creeks and sloughs on Assateague Island and return. We have developed a system of inns and hotels. And we have done all this in under a year.

We have accomplished it by taking a diverse group of people -political representatives, agencies representatives, business owners. We all met in one room and we thrashed and beat meeting after meeting to refocus them - to let them be a cohesive unit. Because we are one part of a chain. Everybody in this room and every speaker that you have heard over the last two days represents a part of the chain. A link, if you will. What we must do is take that link that we represent as Delmarva LITE and use it for an educational experience.

There is a reason that this group is now totaling 300, instead of 150-200 last year. You can thank General Motors and Chrysler Corporation because today they are producing in excess of 50% of the vehicles in the forms of vans and trucks and 4-wheel drives. They have created an awareness of back-to-nature for profit. Many people are in this room today because subliminally, they have gotten the message. You can thank your travel agents. Subliminally, they have given you the message that when you see that cruise ship with the beautiful girl in the bikini sitting on the beach, you want to get on it. It is carrying you to an ecological destination. It could be Costa Rica or the Galapagos Islands. It could be anywhere. So we have this great movement now, that has exploded. In my lifetime, I have never seen a movement like this explode this fast. Everybody is getting on board. Steve Parker talked about ecotourism. What we have to do is take each link of these chains, forge them together, have a cohesive unit, and protect the resource, because all we have to offer is the resource.

Delmarva LITE is not just Worcester County. The vision that I have for Delmarva LITE is a vision that runs from Delaware, linked with inns, bicycle paths, canoe operators, that will allow you to come through Maryland, go through Virginia and to North Carolina - an East Coast vision. If you want, it can run all the way to the Appalachians. A vision where it is run by a group of people that have a mission and a quality goal and a quality standard of ethics. We will get those providers, if you have a standard seal of approval, that requires quality on your part.

We are beginning Phase 2 of Delmarva LITE. We have had a very productive year. We have 20 great board members, we are increasing membership, we have received exposure, we have a web site. I would give us a 9 out of 10 for that effort. Our next phase is where you roll your sleeves up and you go to work, and that is going to be the real task. That task is to increase membership. We need hundreds and hundreds of members. Why? Linkage. If we can get a member in Delmarva LITE, we have him where we want him, because then we can send him a newsletter. We can keep him abreast of environmental issues. We can show him how he can have a good time with his family and how he can be a part of it. We can take that list and use it to entice the providers to come in and become a part of this operation. The vision is there. There is no reason we can't sweep the entire East Coast. We are all links in the chain, and we have to be ever mindful of the big picture above all.

Price: I want to share with you something that we are doing in Delaware. It started in 1998 when there was request for rezoning on a very small body of water in the Oceanview area called the Salt Pond. It is pretty pristine compared to what most of our inland bays are like and as the state representative, I got involved in this process because I was concerned about impacts on the waterways. What I found is that while I waited for somebody, either the state or the county, to address

through the processes we have in place, the environmental standards that needed to be met in order for that commercial development to occur, it never happened. And that bothers me. Especially this past year, we spent a lot of time in Delaware with the agricultural community dealing with TMDLs. We were concerned about toxic pfiesteria outbreaks. The process just wasn't in place. So I began to talk to people to try and put together a plan to make it be in place. That's why I would like House Resolution 32.

This resolution was drafted as a combined effort with DNREC and the Office of State Planning to help us put together a technical team of people to make recommendations to some members of the General Assembly (including myself and my colleague to the North, John Schroeder), about what we could address to make sure that we did everything that we could do as non-agricultural stake holders in the inland bays watershed to improve water quality.

When we first began I told them I am not a scientist. I certainly am a user of the resource and I hope that I am a careful one. I have in my mind some things that we need to address, but I want those people within the state and within the communities, to work together to explore issues and put together an agenda of items that we can look at and assess where they fall. So we put together the Sussex County government officials, and representatives from the Department of Agriculture and various departments of DNREC. We included the Sussex County Association of Towns because we wanted the municipalities in the inland bays area to buy-in to the importance of this and hopefully adopt recommendations on the local level if necessary. The Center for the Inland Bays, which has the ability to research items and give us information, was also involved.

We are also dealing with a lot of land use issues in the state and the Office of State Planning Coordination also became a member of this team. The idea and the concept was to develop changes in the land use process and to investigate and estimate the environmental improvements that would come with these changes. We started meeting in September and we have been meeting every 2 or 3 weeks. We have been exploring issues and I want to share some of the things we have been talking about.

We are talking about density. Density is real important in the inland bays area. One controversy that has been going on is that a couple of years ago our inland bays area was considered a development zone by the county for the purposes of securing funding for sewer and water. But just the mind set that we call it a development zone, lends itself to that.

We are looking at issues associated with septic systems, particularly cesspools (which we know we have a good many of in the inland bays watershed area), and the fact that maybe if you sell your property and it has a cesspool on it, you have to agree to a different system. We are looking at holding tanks. Apparently there is a problem. Most of us aren't on central water, so it is hard to measure what is going in. People are required to pump them periodically and they are not doing it. They are doing the "midnight dipper" kind of thing where they pump the gray water out into a ditch and we don't have any way to monitor that. But you know that if somebody is only pumping it once or twice a year that maybe they are doing something else with the effluent.

We are looking at buffer areas. In the Rhode Island report, it was mentioned that a 200 ft. buffer zone could reduce 80% of the nutrient going into the inland bays. That is an area for which we formed a separate subcommittee consisting of an attorney and some of the technical people. We looked at environmental impact statements. Newcastle County has recently adopted a program where they require those. You do an assessment of the environmental qualities of the piece of land and come back with some specific recommendations that have to be followed.

We are also looking at what things should be county, what things should be state, and what things should be done by regulation. We are going to examine all these issues and try to figure out who is best suited to implement them. When the CCMP was adopted, it was like a wish list. There are things in it that if they had been implemented, would have led to better water quality and a better quality of life in the inland bays area today. They weren't. So, we will make recommendations and do what we can on a local level because that is how we think it is best to do it. But, if that doesn't happen this time, then I think we will go ahead and try to do it legislatively.

There are several things that I believe are going to make this work legislatively. It is going to work because we are specifically talking about the inland bays watershed, not the whole state. We are determined to bite off a small corner where we can make the most difference. I think the timing is right. We have seen the agriculture community in Delaware struggle with their share of the burden and it is time for the rest of us to ante up too. I have a large group of environmentally sensitive constituents who, I am hopeful, will help lobby for changes that have to be made because we have an interest in the quality of life issues. I hope that my determination and that of my colleague John Schroeder will help push this issue further. One of the little assets is that a lot of my colleagues in the General Assembly have summer places in the inland bays watershed area. They have shared

their concerns about where we might be going with the zest for development on the eastern side of our state. We go back in session in the middle of January and we hope to have something soon. It is not important that we hit a deadline, it is important that we do it right.

Schwartz: In my responsibilities at EPA, I am responsible for programs that are regulatory in nature, programs like the National Estuary Program that are local and consensus based in nature, and voluntary programs that we are making up as we go along because the other two types of programs don't seem to address what needs to be addressed. I am a believer in a good mix of all of those things, the comprehensive picture. It is very hard to get everything covered with one program or another.

I would like to make a couple of basic points. First, that the National Estuary Program and the other related programs we have at EPA and some of the other agencies have as well, are a really good basis for coming together on Delmarva's coastal environment. Two of the National Estuary Programs are in the Delmarva bays - the Maryland Coastal Bays and the Delaware Inland Bays. I do have to say that you all should be proud of both of them of course, but particularly the Maryland Coastal Bays which was first in its class of seven National Estuary Programs to get their plan approved by EPA. They moved quickly and did a good job and we think they are on target. I am really excited to see this kind of conference, to see the momentum continuing and perhaps see the impacts of the two NEPs expanding beyond just the scope of those specific action items and plans.

I know there has been a lot of talk about trying to move forward on a tri-state plan. I would recommend to people to look at the two Comprehensive Conservation and Management Plans (CCMP) that were developed for the framework. I think, while you do need a lot of site specific research and you need to know as much as you can - a lot *is* known. A lot has been done and I think the whole area could really take advantage of what has been done and work off of that. I want to mention a couple of specific things of an NEP aspect. One, is land use planning. That is not something the federal government does, but working with the National Estuary Program we can. In fact, working with the Maryland Coastal Bays on their futures pilot, we had community members essentially establishing and identifying their vision of the type of future growth and the type of community that they wanted. It was interesting in Worcester County, that we found there was generally an interest in preserving the rural natural resource nature of the county.

The futures project helped to focus people on what they have, what they want to keep, and then the next step of how they are going to keep those things. I would suggest that would be a good example for other communities in the Delmarva and we would certainly be happy to assist with that, for those interested in proceeding. We also are doing a lot of work on helping to develop guiding principles for smart growth, and we can improvise some references and assistance if there is interest.

We have heard a lot about habitat protection and both the Maryland Coastal Bays and Delaware Inland Bays programs address those issues, particularly with respect to those species that move around a lot. Again I think they lend themselves to integration with other areas and other programs.

We have talked about the need for public education and awareness. I agree that this is really important. If you don't have the public interested and behind you, then your government agencies are not going to be able to accomplish much of anything. We really don't do this stuff by ourselves. We don't make it up by ourselves. We are responding and reacting to what the local interests tend to be. Outreach, in particular, is an area where volunteers and interested citizens can really make a difference.

Beyond the National Estuary Program we have some other programs that you might be able to take advantage of as you move forward. Regarding *Pfiesteria,* there are several federal activities under way to support the states. We have supported Maryland and Delaware and Virginia in the past, and we will continue to do so should the need continue. We are also working with other agencies on algal blooms more broadly, including discussions that are under way regarding the possibility of EPA supporting some monitoring on the brown tide in Delaware Inland Bays, which was mentioned earlier. We are also working with the Interstate Shellfish Sanitation Conference to look more at harmful algal blooms and toxins and focus more in that area than we have in the past. Historically, they have tended to be pathogen related and not looking so much at these algae related impacts.

The message I would like to leave you with is that there is clearly a need for cooperative efforts and program integration. One is state involvement. I was very pleased with the level of state involvement here because it is important not to underestimate the role states have, not only in terms of managing the resources generally, but in terms of managing a lot of the federal programs. Some folks have mentioned the SRF funding program and the 319 funding program and "no discharge" zones. All those are state-level programs. The state has to get involved, whether it is by determining the priorities for funding or whether it is by petitioning EPA to set a "no discharge" zone. I can't say enough about how important it is for the state to be involved and agree with priorities that are being set locally.

We talked a lot about agricultural impacts and how Maryland was the first state to participate with USDA in their dubiously acronymed CREEP program to establish more buffer areas. I think that is again something the other states could be participating in. The Corps of Engineers does dredging as many of you know, and a lot of that material has beneficial uses. I couldn't help thinking, as I was hearing about the SAV that was scarred by clam dredging and where there were one foot depressions, that perhaps a program to bring clean dredge material to backfill some of those sites might prevent some of the problems you have been having. I don't know technically if that will work, I don't know what the logistics are, but I think there are always opportunities if we think about the whole variety in front of us. The Federal Emergency Management Agency (FEMA) is moving more and more into flood prevention and working with them on protecting and restoring wetlands is a real opportunity.

Finally, one of the things we try to do at EPA, the soft side of EPA not the regulatory side, is to provide information. I would encourage folks, if they haven't gone to EPA's web site, www.epa.gov, to do that. Particularly the Office of Waters site, and the ever popular OWOW site. We have "surf your watershed", which has virtually all the watershed databases we could get. So if you want to find out just about anything that people have in organized format about the Delmarva coastal bays, you could pull those up. We have the National Estuary Program sites. We have information on *Pfiesteria*. There is a wealth of information there.

One last thought that I would like to leave you with is that I would certainly encourage you to continue to think about bringing the three governors together and the other appropriate folks from the federal agencies and get some sort of tri-state agreement going. But I would echo what Jeanne said that it is really important that you think things through and work things out from the bottom up. Those kinds of things are very tricky to develop and to get top down. You really need to have that broad base of support for that, then start to push up the chain in order to make something like that happen. We would be happy to work with you as you try to do that.

My question is directed to Representative Price. How can interested citizen stakeholders in the Indian River inland bays estuary become actively involved by sitting in on an HR32 committee?

Price: The committee is set by legislation so the membership is set. It is a public meeting and you can always come and listen. We do allow a comment period - fifteen minutes at the end for questions or concerns. We are always available to take questions and comments outside of meetings. We have almost concluded discussions about different issues with the exception of the tributary teams that the Center for the Inland Bays have been working on. They are going to come to our next meeting with written recommendations that they would like to have us look at as part of this. Obviously, we will get your help and your support as we go forward in the lobbying effort. It went through really quietly. Until it hit the front page of the *News Journal* just recently, things were really quiet. But there are some realtors who have some concerns. There are also some realtors who are very supportive of it. So we are going to try and focus on those. I will be writing things in the newspaper that will help get you involved. I hope you will participate at that time.

I was wondering if any of the participants can discuss the need for wider riparian buffers here in the coastal bay area. In order to protect the resource, I think we have to have wider buffers. I hear Rhode Island has 200 ft. Here the highway department can have limited access to highways, so why can't we have limited access to our bays?

Schwartz: We could have that, but in my opinion, you have to have some really strong leadership to put something like that forward. You have to have a balanced approach to those people who own property for a long time if you are telling them that they can't do what they plan to do for that property. We have some data that shows that you need 250 ft. minimum to really provide habitat protection. There are some animals, salamanders and birds, that need much wider corridors. For people that are pro-active, and for the landowners that do want to cooperate, there are federal programs where they can recoup some of that financial loss, if it was a loss for agricultural land that was taken out of production. We can have those buffers, we just have to have a ground swell of support.

WRAP UP

BRUCE RICHARDS, PH.D.
DELAWARE CENTER FOR THE INLAND BAYS

Note: The following document is a transcription of the closing remarks by Dr. Richards.

What have we learned at this third Delmarva Coastal Bays Conference? Some basic things we've covered are marine science issues, some management issues, and some policy considerations but one theme that's run through the whole conference has been about people. People can affect the bays. We've had a real diversity of people in this room--sportsfishermen, students, scientists, managers, administrators. We had three National Estuary Programs represented and the Secretary of Agriculture from Delaware. In 1996 when we had our conference, we invited the mayor of Ocean City, but he didn't come. This year, the mayor of Ocean City came and he participated. That says a lot about the emphasis on the environment now. Hopefully we didn't use too much jargon. We tried to use terms that communicated the information clearly. It was good to see some solid citizen participation like we did today. We've got great citizen advocates for the bays.

I'll go over some key wrap-up points. Number one is water quality. We've learned that we can't control tides or currents. We can do very little to deal with sea level rise or to halt turbidity. But we can get people to do something. Bill Matuszeski said it. We can reduce nutrients like nitrogen and phosphorus.

Number two is fisheries. We learned that there are several species of fish that are dwindling. We have parasites that are killing crabs. We have the real possibility that pre-historic animals that have been around for millions of years, horseshoe crabs, may be overharvested. When that happens, we also lose valuable eggs that are food for the migrating birds from across the world. We can do something about that. We can reduce our overharvesting and we can generate stocks through aquaculture and mericulture.

Third is habitat. We've learned the importance of critical habitats, from sea grass beds to coral reefs. I am sure you can guess who can preserve those habitats--we can. We can help preserve it by reducing our boating activities.

Each of us here has shown dedication to Delmarva's coastal bays. I applaud each of you and encourage you to continue your stewardship of the coastal bays and remain ambassadors of that knowledge. Share this knowledge with your friends, families, and neighbors, so that we can truly take that long walk together.

WRAP-UP

DAVID BLAZER
MARYLAND COASTAL BAYS PROGRAM

Note: The following document is a transcription of the closing remarks by Mr. Blazer.

Even though this is the end of the conference and I am the last speaker of the day, the conference really doesn't end here. We will all go back home, and we will analyze all the information, the data and the discussions that have taken place here. So we need to take this effort and begin. Let's move on from here.

We have written down ideas of what we can do in the future and what action we can take. When we get the proceedings, we need to look at those, and start to strategize where we go from here. There have been a lot of great ideas. We've had a lot of positives out of this conference and we've also had a lot of challenges out of this conference.

The one thing I would like to do is to look at the goals that were set out to us initially for this program. When I first heard about it, we had five basic goals for this conference.

1) To focus on resource management and on the unique challenges of shallow water estuarine systems. We looked at a lot of different resource management and the challenges that are here. We talked about regional partnerships and tri-state approaches for resolving common issues. It was tremendous that we had representatives from Delaware, Maryland, and Virginia, all here at this conference. Delegate Bob Bloxum from Virginia's Eastern Shore was here this weekend. Jack Travelstead from Virginia. We had a whole host of people from Maryland, Bennett Bozman, Representative Gilchrest's staff, Sarah Taylor-Rogers, the Secretary of DNR, Worcester County Commissioners, and the mayor of Ocean City. That's a pretty impressive crowd to have to start working on these regional aspects and the tri-state effort. I think we really succeeded on that goal. But we still have some work to do to try to get the governors together as everybody has discussed recently.

2) Provide a forum for successful initiatives, both within and outside the region. We had some speakers from Florida and Rhode Island talk about some of the things that they do and their successes and challenges. We may be able to translate a lot of that here.

3) Develop local, bottom-up involvement in resource management. That's probably the most obvious thing we've achieved. Look at the crowd we have here and the number of citizens. This has been a well attended program.

4) Share viewpoints and provide direction to minimize user conflicts. We've spent most of the morning talking about that.

5) Propose action items to work toward future strategies for resource sustainability. Toward that goal, I think we ended up with about seven pages of action items at the end of the last panel.

Looking back at the conference goals, we really have succeeded. This has been an outstanding conference, and really just the beginning. We need to take this and move on from here, but this has been a great beginning. There are a lot of opportunities for citizen involvement--oyster gardening, Maryland Coastal Bays Program has volunteer monitoring, you can sign up for newsletters, there are more conferences coming up.

Two last points. I want to thank the Assateague Coastal Trust for a great weekend, especially Phyllis Koenings for a fantastic job. And finally, I want to close by saying, thank you all for staying until the bitter end. While you are here, if you haven't had a chance to, walk around on the beach. It's still a Delmarva-lous day and when you leave, hopefully you'll enjoy the splendor of the Maryland coastal bays or Delaware inland bays, whichever direction you go.

APPENDIX A

WEB SITE RESOURCE LIST

American Sportfishing Association ..... www.asafishing.org
Speaker: Norville Prosser, Fishable Waters Act 100

Assateague Coastal Trust ..... www.actforbays.org
Speaker: Tom Patton, Welcome 5
Exhibit: Assateague Coastal Trust 140
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Assateague Island National Seashore ..... www.nps.gov/asis/
Speaker: Carl Zimmerman, Marine Resource Protection Initiatives 95
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Biohabitats, Inc. ..... www.biohabitat.com
Exhibit: Biohabitats - Ecological Restoration 141

Chincoteague National Wildlife Refuge/U.S. Fish & Wildlife Service .... northeast.fws.gov/va/chn.htm
Sponsor

College of William and Mary ..... www.wm.edu
Speaker: Bryan Watts, Migrant Shorebirds - Role of the Delmarva Coastal Bays 36

Community Foundation of the Eastern Shore ..... www.intercom.net/npo/commfnd/index.html
Sponsor

Conectiv ..... www.conectiv.com
Sponsor

Delaware Center for the Inland Bays ..... www.udel.edu/CIB
Exhibit: Delaware Center for the Inland Bays 142
Speaker: Bruce A. Richards, An Overview of Harmful Algal Blooms 54
Sponsor

Delaware Coastal Management Program ..... www.nos.noaa.gov/OCRM/czm/czmdelaware.html
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APPENDIX B

PARTICIPANTS

Bob Abele
MD Coastal Bays Foundation
63 Wood Duck Drive
Berlin, MD 21811
ph: 410-208-1294
irabele@ezy.net

Helen Abrams
Inland Bays Citizen Montoring
Pinewater Farms, 4 Blackberry Lane
Harbeson, DE 19951

Laurie Adelhardt
Owl Creek Consulting
45 Drawbridge Road
Berlin, MD 21811
ph: 410-208-9701 fax: 410-208-9704
adelhardt@owlcreek.8m.com

Irvin Ailes
US F&WS - Chincoteague
P. O. Box 62
Chincoteague, VA 23336
ph: 757-336-6122 fax: 757-336-5273
irvin_ailes@fws.gov

Jim Alderman
Center for the Inland Bays
467 Highway One
Lewes, DE 19958
ph: 302-645-7325 fax: 302-645-5765
restore@udel.edu

Alex Almario
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
alex_almario@nps.gov

Fatima Alves
U of MD Center for Environ. Science
P. O. Box 775
Cambridge, MD 21613
ph: 410-228-9250 fax: 410-228-3843
flopez@hpl.umces.edu

Ed Ambrogio
US EPA / Region III
1650 Arch Street
Phildelphia, PA 19103
ph: 215-814-2758 fax: 215-814-2782
ambrogio.edward@epa.gov

Ben Anderson
DE DNREC
820 Silverlake Blvd., Suite 220
Dover, DE 19901
ph: 302-739-4590
benanderson@state.de.us

Gretchen Arnold
VIMS Eastern Shore Lab
P.O. Box 350
Wachapreague, VA 23480
ph: 757-787-5816 fax: 757-787-5831
gretchen@vims.edu

Kim Ayvazian
312 Pilottown Road
Lewes, DE 19958

Bill Baker
1566 South Highway One
Lewes, DE 19958
ph: 302-645-7654

Angela Baldwin
MD Conservation Corps
12302 Jamaica Avenue #303
Ocean City, MD 21842
ph: 410-250-1997
bertb@ezy.net

Tonya Barker
MD Conservation Corps
6719 Lenape Place
Snow Hill, MD 21863
ph: 410-632-4509
tbark23@aol.com

Jim Belote
Virginia Tech Extension Service
P. O. Box 60
Accomac, VA 23301
ph: 757-787-1361 fax: 757-787-1044

Lenore Bennett
7845 Worcester Highway
Berlin, MD 21811
ph: 410-641-1899
lenore.bennett@perdue.com

Kerri Bentkowski
Chesapeake Bay Trust
60 West Street, Suite 200A
Annapolis, MD 21401
ph: 410-974-2941
cbt@ari.net

Paul Berge
Accomack-Northampton P. D. C.
P.O. Box 417
Accomac, VA 23301
ph: 757-787-2936 fax: 757-787-4221
anpdcpfb@esva.net

Don Berger
Caine Woods Community Assoc.
14000 Sand Dune Road
Ocean City, MD 21842
ph: 410-250-7693

Kimberly Black
DE Nature Society
P. O. Box 700
Hockessin, DE 19707
ph: 302-239-2334 fax: 302-239-2473
kim@dnsashland.org

David Blazer
MD Coastal Bays Program
9609 Stephen Decatur Highway
Berlin, MD 21811
ph: 410-213-2297 fax: 410-213-2574
dblazer@dnr.state.md.us

Bob Bloxom
Virginia House of Delegates
P. O. Box 27
Mappsville, VA 23407
ph: 757-824-3456 fax: 757-824-3786

Pat Bloxom
P. O. Box 27
Mappsville, VA 23407
ph: 757-824-3456 fax: 757-824-3786

Capt. Michael Bloxom
MD Natural Resources Police
32144 Mt. Olive Road
Salisbury, MD 21804
ph: 410-548-7070 fax: 410-543-6908
mbloxom@dnr.state.md.us

Dixie Bounds
MD Cooperative F & W / UMES
9822 Keyser Point Road
Ocean City, MD 21842
ph: 410-651-6913 fax: 410-651-7662
dlbounds@mail.umes.edu

George Boyce
Blue Heron Oyster Co.
11584 Long Point Road
Dames Quarters, MD 21820
ph: 410-784-2364
canineeye@aol.com

Dr. Walter Boynton
Chesapeake Biological Laboratory
P. O. Box 38
Solomons, MD 20688
ph: 410-326-7275 fax: 410-326-7378

Gregory Breese
US Fish & Wildlife Service
2610 Whitehall Neck Road
Smyrna, DE 19977
ph: 302-653-9152 fax: 302-653-9421

Tim Brower
MD Dept. of Natural Resources
201 Baptist Street
Salisbury, MD 21801
ph: 410-543-6738 fax: 410-543-6768
tbrower@dnr.state.md.us

Erin Browning
Salisbury State University
SSU, Box 1132
Salisbury, MD 21801
ph: 410-548-2797
eeb4328@students.ssu.edu

Pearl Burbage
DE DNREC
820 Silverlake Blvd., Suite 220
Dover, DE 19901
ph: 302-739-4590 fax: 302-739-6140
pburbage@state.de.us

Myrl Burkett
Chesapeake Shellfish Aquaculture
S3-E Muirfield Drive
Reading, PA 19607
ph: 610-775-9793 fax: 610-796-7756
mburkett@epix.net

Robert Bussell
MD Dept. of Natural Resources
P. O. Box 198
Piney Point, MD 20674
ph: 301-994-9205
uhazoo@US.HSAvet.net

Jim Butch
Environmental Protection Agency
1650 Arch Street (3ES10)
Phildelphia, PA 19103
ph: 215-814-2762 fax: 215-814-2782
butch.jim@epamail.epa.gov

Nancy Butowski
MD Dept. of Natural Resources
580 Taylor Avenue, B-2
Annapolis, MD 21401
ph: 410-260-8268 fax: 410-260-8279
nbutowski@dnr.state.md.us

Wayne Cannon
WGMD - FM Radio
P. O. Box 530
Reboboth Beach, DE 19971
ph: 800-933-0127 fax: 302-945-3781

Wendy Carey
U of DE Sea Grant College Program
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4258 fax: 302-645-4213
wcarey@udel.edu

Kristen Carson
MD Conservation Corps
710 Goldsborough Street
Salisbury, MD 21801
ph: 410-543-7909

Luther Carter
Independent Journalist
2722 Chain Bridge Road, NW
Washington, DC 20016
ph: 202-966-3579 fax: 202-537-3143
lcarter345@aol.com

Marsha Carter
2722 Chain Bridge Road, NW
Washington, DC 20016
ph: 202-966-3579 fax: 202-537-3143
lcarter345@aol.com

Ron Cascio
MD Coastal Bays Program
10046 Silver Point Lane
Berlin, MD 21811
ph: 410-213-2017
rcascio@beachin.net

Jim Casey
MD Dept. of Natural Resources
301 Marine Academy Drive
Stevensville, MD 21666
ph: 410-643-4601 fax: 410-643-4136
mata-fish-2@dnr.state.md.us

Billy Causey
Florida Keys Nat'l Marine Sanctuary
P. O. Box 500368
Marathon, FL 33050
ph: 305-743-2437 X26
billy.causey@noaa.gov

Lisa Challenger
Worcester County Tourism
113 Franklin Street
Snow Hill , MD 21863
ph: 410-632-3110 fax: 410-632-3158
econ@ezy.net

Chris Clark
S. Schultz Wetlands Assoc.
703 S. Schultz Road
Fenwick Island, DE 19944
ph: 302-539-4485 fax: 302-539-7878
clark@ilandert.com

Jessica Clark
703 S. Schultz Road
Fenwick Island, DE 19944

John Clark
DE Fish & Wildlife
P. O. Box 330
Little Creek, DE 19961
ph: 302-739-4782 fax: 302-739-6780
jclark@state.de.us

Kimberly Cole
DE Coastal Programs
89 Kings Highway
Dover, DE 19901
ph: 302-739-3451 fax: 302-739-2048
kcole@state.de.us

Bob Collins
E.S. Assn. of Golf Course Superndts.
946 Heron Drive
Bethany Beach, DE 19930
ph: 302-539-8882 fax: 302-539-5647
ccmaint@compucenter.net

Mary Conley
MD DNR Coastal Zone Management
580 Taylor Avenue, E-2
Annapolis, MD 21401
ph: 410-260-8984 fax: 410-260-8739
mconley@dnr.state.md.us

Joan Cook
United States Power Squadron
239 Ocean Parkway
Berlin, MD 21811
ph: 410-641-6168
jvcooke1@juno.com

Sarah Cooksey
DE Coastal Management Program
89 Kings Highway
Dover, DE 19901
ph: 302-739-3451 fax: 302-739-2048
scooksey@dnrec.state.de.us

Cathy Cooper
Assateague Coastal Trust
4862 Chevy Chase Drive
Chevy Chase , MD 20815
ph: 301-718-1691
coopercw@gwu.edu

Sandy Coyman
Worcester Co. Comp. Planning
111 Franklin Street, Unit 1
Snow Hill, MD 21863
ph: 410-632-5651 fax: 410-632-5654

Elizabeth Crager
MD Conservation Corps
909 Sumac Circle
Salisbury, MD 21804
ph: 410-546-2101
efcolol@students.ssu.edu

Beth Creamer
SSAI / NASA
Goddard Space Flight Center
Greenbelt, MD 20771
ph: 301-614-5582
bcreamer@see.gsfc.nasa.gov

Carolyn Cummins
West Ocean City Assoc., MCBP
9628 Oceanview Lane
Ocean City, MD 21842
ph: 410-213-0586

Rachelle Daigneault
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
rachelle_daigneault@nps.gov

Dennis Dare
Town of Ocean City
P. O. Box 158
Ocean City, MD 21843
ph: 410-289-8837 fax: 410-289-7385
ddare@ococean.com

Liz Davis
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
liz_davis@nps.gov

Steve Dawson
MDE / Non-tidal Wetlands
Multi-Service Ctr., 201 Baptist Street
Salisbury, MD 21801
ph: 410-543-6703
sdawson@mde.state.md.us

Natalee DeHart
Carl M. Freeman Communities
400 Freeport Court
Bethany Beach, DE 19930
ph: 302-536-7203
ndehart@seacolony.com

Tom DeMoss
U S Environmental Protection Agency
701 Mapes Road
Fort Meade, MD 20755
ph: 410-305-2739 fax: 410-305-3095
demoss.tom@epa.gov

Charles Dobroski
Roy F. Weston, Inc
P. O. Box 2653
West Chester, PA 19380-1469
ph: 610-701-7216 fax: 610-701-7401
dobroske@mail.rfweston.com

Charles Epifanio
U of DE College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4272 fax: 302-645-4007
epi@udel.edu

Dennis Evans
10321 Hayes Landing Road
Berlin, MD 21811
ph: 410-641-2519

John Ewart
U of DE Marine Advisory Service
700 Pilottown Road
Lewes , DE 19958
ph: 302-645-4060 fax: 302-645-4213
ewart@udel.edu

Jim Falk
U of DE Marine Advisory Service
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4235
jfalk@udel.edu

Joe Farrel
U of DE Sea Grant Program
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4250 fax: 302-645-4007
jfarrel@udel.edu

Kimberly Fehrer
Assateague Coastal Trust
P. O. Box 731
Berlin, MD 21811
ph: 410-629-1538 fax: 410-629-1059
fehrer@shore.intercom.net

Ilia Fehrer
Worcester Environmental Trust
110 W. Federal Street
Snow Hill, MD 21863
ph: 410-632-2640 fax: 410-632-2640
Ilia-JoeFehrer@webtv.net

Ann Fisher
Dept. of Ag. Economics & Rural Soc.
Penn State Univ., 107 Armsby Bldg.
University Park, PA 16802
ph: 814-865-3143 fax: 814-865-3746
fisherann@psu.edu

Tom Ford
Land Design, Inc.
Oak Square, Suite 3
Ocean View, DE 19970
ph: 302-537-1919
landzn@aol.com

Judith Freeman
Nat'l. Oceanic & Atmospheric Admin.
410 Severn Avenue, Suite 107A
Annapolis , MD 21403
ph: 410-267-5661 fax: 410-267-5666
judith.freeman@noaa.gov

Todd Fritchman
Indian River High School
#10 South Lake Terrrace
Rehoboth Beach, DE 19971
ph: 302-226-5474 fax: 302-732-5491

Mary Jo Garreis
MJG Enterprises
129 Severn Way
Arnold, MD 21012
ph: 410-757-1232 fax: 410-349-8511

Wallace Garrett
U of MD Cooperative Extension
P. O. Box 219
Snow Hill, MD 21863
ph: 410-632-1972 fax: 410-632-3023
wg2@umail.umd.edu

Jessica Glass
MD Conservation Corps
381 Mallard Lakes
Selbyville, DE 19975
ph: 302-436-6190

Charles Glover
Ocean Pines / O.C. Power Squadron
16 Sandpiper Lane
Berlin, MD 21811
ph: 410-641-8488

Ray Godman
Beachcomber
209 Sunset Drive
Ocean City, MD 21842
ph: 410-289-5818
flco@aol.com

Christy Gordon
Gordon Shellfish LLC
P.O. Box 725
Pocomoke, MD 21851
ph: 410-957-4100 fax: 410-957-1303
sgordon@mafi.com

Steve Gordon
Gordon Shellfish LLC
P.O. Box 725
Pocomoke, MD 21851
ph: 410-957-4100 fax: 410-957-1303
sgordon@mafi.com

Laura Belle Gordy
VA Marine Resource Commision
25518 Main Street
Onley, VA 23418
ph: 757-787-3658

Dr. Dave Goshorn
MD Dept. of Natural Resources
580 Taylor Avenue, D-2
Annapolis, MD 21401
ph: 410-260-8640 fax: 410-260-8640
dgoshorn@dnr.state.md.us

Robert Grady
MD Saltwtr. Sportfishermen's Assn
358 Ocean Parkway
Berlin, MD 21811
ph: 410-208-0530

Matt Graves
NPS Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
matt_graves@nps.gov

Lowell Grimaud
Bethany Marina
33 Yacht Basin Road
Ocean View, DE 19970
ph: 302-539-7099
lgrimaud1@juno.com

Louise Gulyas
Worcester County Commissioner
One W. Market Street, Rm 112
Snow Hill , MD 21863
ph: 410-632-1194 fax: 410-632-3131

William Haag
16 Whaler Lane
Berlin, MD 21811
ph: 410-208-1561
carbil@prodigy.net

David Hall
Vanguard Communications
1019 19th Street, NW, #1200
Washington, DC 20036
ph: 202-331-4323 fax: 202-331-9420
dhall@vancomm.com

Helen Hamilton
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099

Robert Hammond
MD Saltwtr. Sportsfishermen's Assn
117 Red Cedar Drive
Milton, DE 19968
ph: 302-684-2666

Audrey Hansen
Marine Biologist
9137 Libertytown Road
Berlin, MD 21811
ph: 410-641-4932
surfish@ccisp.net

Juliana Harding
Dept. of Fisheries Science
VIMS, PO Box 1346
Gloucester Point, VA 23062
ph: 804-684-7302
jharding@vims.edu

William Harkum
MD Saltwtr. Sportsfishermen's Assn
5 Roycreek Lane
Selbyville, DE 19975

Robyn Harris
MD Conservation Corps
8543 North Prong Lane
Delmar, MD 21875

Cindy Harris
Macro International Inc.
P.O. Box 303
Ocean City, MD 21843
ph: 410-289-0039 fax: 410-289-2463

Frances Hart
Inland Bays Citizen Monitoring
5406 Juliet Street
Springfield, VA 22151

Edward Hartman
MD Saltwtr. Sportsfishermen's Assn
29 Grant Avenue
Selbyville, DE 19975
ph: 302-436-4611

Bill Haughey
Indian River Tributary Action Team
R. D. 1, Box 291
Long Neck, DE 19966
ph: 302-945-9300

Lamere Hennessee
MD Geological Survey
2300 St. Paul Street
Baltimore, MD 21218
ph: 410-554-5519 fax: 410-554-5502
lhennessee@mgs.md.gov

John (Jack) Hett
MD State Highway Admin.
P.O. Box 2679
Salisbury, MD 21802
ph: 410-677-4027 fax: 410-543-6598
jhett@sha.state.md.us

Jim Hewes
DE DNR / DE Coastal Programs
89 Kings Highway
Dover, DE 19901
ph: 302-739-3451 fax: 302-739-2048

Bill Hibschman
Harford Community College
401 Thomas Run Road
Bel Air, MD 21015
ph: 410-836-4306 fax: 410-836-4410
bhibschm@harford.cc.md.us

Terry Higgins
Wesley College
120 N. State Street
Dover, DE 19901
ph: 302-736-2477 fax: 302-736-2301
higginte@mail.wesley.edu

Louise Hildreth
Assateague Coastal Trust
912 Rolandvue Road
Baltimore, MD 21204
ph: 410-337-8657

Lisa Hoeben
MD Conservation Corps
1012 Adams Avenue, Apt. 3-C
Salisbury, MD 21804
ph: 410-219-3663

Jesse Houston
Town of Ocean City
P. O. Box 158
Ocean City, MD 21843
ph: 410-289-8855 fax: 410-289-7385
jhouston@ococean.com

Bob Hulburd
C. R. A. S. H.
10 Whaler Lane
Berlin, MD 21811
ph: 410-641-3939 fax: 410-641-9555

Edythe Humphries
DE DNREC
89 Kings Highway
Dover, DE 19901
ph: 302-739-4771 fax: 302-739-3491
ehumphries@state.de.us

Margo Jackson
NOAA Oceans & Coastal Resources
1305 East-West Hwy, SSMC4
Silver Spring, MD 20910
ph: 301-713-3155 fax: 301-713-4012

Charles "Buddy" Jenkins
Bay Shore Development Corp.
P. O. Box 572
Ocean City, MD 21843
ph: 410-289-9100
SGAAL@aol.com

Bud Jenkins
MD Tributary Strategies Team
405 Edgewater Road
Pasadena, MD 21122-5635
ph: 410-255-8220

Jim Johnson
Anne Arundel Planning & Codes
P.O. Box 6675
Annapolis, MD 21401
ph: 410-222-7441 fax: 410-222-7255

Judy Johnson
Assateague Coastal Trust
P.O. Box 731
Berlin, MD 21811

Chris Judy
MD DNR Shellfish Division
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8259 fax: 410-260-8279
cjudy@dnr.state.md.us

Betty Ann Kane
Rehoboth Beach Commissioner
56 Maryland Avenue
Rehoboth Beach, DE 19971
ph: 302-546-9062 fax: 302-547-9598
bettyannkane@sprintmail.com

Lee Karrh
MD Dept. of Natural Resources
580 Taylor Avenue, D-2
Annapolis, MD 21401
ph: 410-260-8650 fax: 410-260-8640
lkarrh@dnr.state.md.us

Vic Kennedy
U of MD Horn Point Laboratory
Box 775
Cambridge, MD 21613
ph: 410-221-8286 fax: 410-221-8490
kennedy@hpl.umces.edu

Suresh Kikkeri
MD Dept. of the Environment
2500 Broening Highway
Baltimore, MD 21224
ph: 410-631-3602 fax: 410-631-3998
skikkeri@mde.state.md.us

William Killinger
1264 Ocean Parkway
Berlin, MD 21811
ph: 410-208-9355
billk@ezy.net

Joleen Killinger
1264 Ocean Parkway
Berlin, MD 21811
ph: 410-208-9355
billk@ezy.net

Forsyth Kineon
DE Estuary Program
P.O. Box 7360
W. Trenton, NJ 08628-0360
ph: 609-883-9500 fax: 609-883-9522
fkineon@drbc.state.nj.us

Howard King
MD Dept. of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8260
hking@dnr.state.md.us

Gretchen Knapp
Nat'l Park Service-Assateague Island
P. O. Box 38
Chincoteague, VA 23336
ph: 757-336-6577 fax: 757-336-5203
gretchen_knapp@nps.gov

Henry Koellein
MD Saltwtr. Sportsfishermen's Assn
538 Marlinspike Drive
Severna Park, MD 21146
ph: 410-647-8218

Phyllis Koenings
Assateague Coastal Trust
P. O. Box 731
Berlin, MD 21811
ph: 410-629-1538 fax: 410-629-1059
act@beachin.net

Marc A. Koenings
Assateague Island Nat'l Seashore
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
marc_koenings@nps.gov

Ralph Kraft
Commercial Fishing
13226 Pine Beach Road
Princess Anne, MD 21853
ph: 410-651-9213

Dr. Jonathan Kramer
MD Sea Grant
University of Maryland
College Park, MD 20742
ph: 301-405-6371 fax: 301-314-9581
kramer@mdsg.umd.edu

Gloria Kupstas
CNO N45
2211 S. Clark Place
Arlington, VA 22244-4642
ph: 703-604-5431 fax: 703-602-4642
kupstas.gloria@hq.navy.mil

Dr. Rick Kutz
US EPA MidAtlantic Assess.Team
701 Mapes Road
Fort Meade, MD 20755-5350
ph: 410-305-2742 fax: 410-305-3095
kutz.rick@epamail.epa.gov

Albert Lakeland
Assateague Coastal Trust
4315 Chestnut Street
Bethesda, MD 20814
ph: 301-656-1640
peteral@erols.com

Abigail Lambert
Lower Shore Land Trust
213 Downtown Plaza, Suite 305
Salisbury, MD 21801
ph: 410-341-6575

Stanley Laskowski
US EPA Region III Env. Services Div.
1650 Arch Street
Philadelphia, PA 19103-2029
ph: 215-814-2989 fax: 215-814-2782
laskowski.stanley@epamail.epa.gov

Dr. Virginia Lee
Sea Grant-Coastal Resources Center
Univ.of Rhode Island Bay Campus
Narragansett, RI 02882
ph: 401-874-6490 fax: 401-789-4670
vlee@gso.uri.edu

Mark Lewandowski
MD Dept. of Natural Resources
580 Taylor Avenue, E-2
Annapolis, MD 21401
ph: 410-260-8809 fax: 410-260-8709
mlewandowski@dnr.state.md.us

Connie Lewis
MD DNR Fisheries Service
580 Taylor Avenue, B-2
Annapolis, MD 21401
ph: 410-260-8296 fax: 410-260-8279
clewis@dnr.state.md.us

Jim Lobo
MD Saltwtr. Sportfishermen's Assn
35 Seafarer
Berlin, MD 21811
ph: 410-641-7614
lobo@ezy.net

Dick Loos
Chinoteague Bay Foundation
6900 Ridgewood Avenue
Chevy Chase, MD 20815
ph: 301-365-1288

Dr. Mark Luckenbach
VA Institute of Marine Science
Eastern Shore Lab, PO Box 350
Wachapreague, VA 23480
ph: 757-787-5816 fax: 757-787-5831
luck@vims.edu

Jeanne Lynch
Worcester County Commissioner
One W. Market Street, Rm 112
Snow Hill, MD 21863
ph: 410-632-1194 fax: 410-632-3131
nlynch@shore.intercom.net

Elsie MacMullin
MD Coastal Bays Program
68 Wood Duck Drive
Berlin, MD 21811
ph: 410-208-9604 fax: 410-208-9614
kingfisher68@prodigy.net

Ken MacMullin
MD Coastal Bays Program
68 Wood Duck Drive
Berlin, MD 21811
ph: 410-208-9604 fax: 410-208-9614
kingfisher68@prodigy.net

Rob Magnien
MD Dept. of Natural Resources
580 Taylor Avenue, D-2
Annapolis, MD 21401
ph: 410-260-8630
rmagnien@mde.state.md.us

Becky Manteria
Center for Marine Conservation
1725 DeSales Street, NW, Suite 600
Washington, DC 20036
ph: 202-429-2355
bmanteria@dccmc.org

Sam Martin
Martin Fish Company, Inc.
12929 Harbor Road
Ocean City, MD 21842
ph: 410-213-2195

Jim Mathias
Mayor, Ocean City
P. O. Box 158
Ocean City, MD 21842
ph: 410-289-8931
ocmayor@ococean.com

Bill Matuszeski
EPA Chesapeake Bay Program Office
410 Severn Avenue
Annapolis, MD 21403
ph: 410-267-5709

Keri Maull
Center for Inland Bays
1 Kensington Road
Rehoboth Beach, DE 19971
ph: 302-227-8056
kam0099@aol.com

Dr. Eric May
MD Fish & Wildlife Coop. Res. Unit
UMES, 1120 Trigg Hall
Princess Anne, MD 21853
ph: 410-651-6069 fax: 410-651-7662
ebmay@mail.umes.edu

Dr. John McConaugha
Old Dominion Univ. / Oceanography
46 Elkhorn Drive
Norfolk, VA 23529
ph: 757-683-4698
jmcconau@odu.edu

Joel McCord
Baltimore Sun
501 N. Calvert Street
Baltimore, MD 21278
ph: 410-332-6465 fax: 410-752-6049
joelmcc47@aol.com

John McFalls
MD Saltwtr. Sportsfishermen's Assn
682 Ocean Parkway
Berlin, MD 21811
ph: 410-208-1291

Jim McGowan
Accomack-Northampton P. D. C.
P. O. Box 417
Accomac, VA 23301
ph: 757-787-2936 fax: 757-787-4221
anpdcjmcg@esva.net

Pat McIlvaine
Loudoun Soil & Water Conserv. Dist.
30 Catoctin Circle, SE, Suite H
Leesburg, VA 20175
ph: 703-777-2075 fax: 703-443-0187

Bruce McNeil
MD Saltwtr. Sportsfishermen's Assn
38 Anchor Way Drive
Berlin, MD 21811
ph: 410-213-2557

Cornelia Melvin
24 Pack Lane
Lewes, DE 19958
ph: 302-945-4708
cornelia.melvin@aol.net

Mark Mendelsohn
Corps of Engineers-Planning Division
P. O. Box 1715, MS11700-M
Baltimore, MD 21203
ph: 410-962-9499 fax: 410-962-4698
mark.mendelsohn@usace.army

Gretchen Messick
NOAA, Nat'l Ocean Svc., Oxford Lab
904 S. Morris Street
Oxford, MD 21654
ph: 410-226-5193 fax: 410-226-5925
gretchen.messick@noaa.gov

Stewart F. Michels
DNREC Division of Fish & Wildlife
89 Kings Highway
Dover, DE 19901
ph: 302-739-4782 fax: 302-739-6780
smichels@Bangate.state.de.us

Dr. Michael J. Millard
US Fish & Wildlife Service
Northeast Fisheries Ctr., PO Box 75
Lamar, PA 16848
ph: 570-726-4247 fax: 570-726-2416
mike_millard@fws.gov

Kent Minichiello
3118-18th Street, NW
Washington, DC 20010
ph: 202-265-7396 fax: 202-462-4253
jkmmdm@aol.com

Marcia Minichiello
3118-18th Street, NW
Washington, DC 20010
ph: 202-265-7396 fax: 202-462-4253

Judith Modlin
MD Dept. of Natural Resources
580 Taylor Avenue, B-4
Annapolis, MD 21401
ph: 410-260-8418 fax: 410-260-8404
jmodlin@dnr.state.md.us

Claude Montane
P.O.Box 214
Ocean City, MD 21843
ph: 410-289-0628

Edward Morgereth
Biohabitats, Inc.
15 W. Aylesbury Road
Timonium, MD 21093
ph: 410-337-3659 fax: 410-583-5678
edward@biohabitat.com

Bill Mowitt
MD Dept. of Natural Resources
580 Taylor Avenue, C-2
Annapolis, MD 21401
ph: 410-260-8263
bmowitt@dnr.state.md.us

Dave Munchel
Inland Bays Citizen Montoring
P. O. Box 984
Rehoboth Beach, DE 19971

Katherine Munson
Worcester Co. Comp. Planning
111 Franklin Street, Unit 1
Snow Hill, MD 21863
ph: 410-632-5651 fax: 410-632-5654
ppicom@beachin.net

Bob Nelson
Worcester Co. Comp. Planning
111 Franklin Street, Unit 1
Snow Hill, MD 21863
ph: 410-6325651 fax: 410-632-5654

Dave Nemazie
U of MD Center for Environ. Science
P O. Box 775
Cambridge, MD 21613
ph: 410-228-9250 fax: 410-228-3843
nemazie@ca.umces.edu

Vivian Newman
Sierra Club
11194 Douglas Avenue
Marriottsville, MD 21104
ph: 410-442-5639 fax: 410-442-0094
vivian.newman@sierraclub.org

Dr. Scott Nixon
Graduate School of Oceanography
Univ. of Rhode Island, South Ferry Rd.
Narragansett, RI 02882-1197
ph: 401-874-6800 fax: 401-789-8340
snixon@gsosun1.gso.uri.edu

Dr. Francis O'Beirn
VIMS Eastern Shore Lab
P. O. Box 350
Wachapreague, VA 23480
ph: 757-787-5837 fax: 757-787-5831
francis@vims.edu

Tom O'Connell
MD Dept. of Natural Resources
15935 Brooks Haven Drive
Goldsboro, MD 21636
ph: 410-260-8271 fax: 410-260-8278
toconnell@dnr.state.md.us

Joe O'Hara
MD Coastal Bays Program
1919 Marlin Drive
Ocean City, MD 21842
ph: 410-289-0852

Mary Ochse
Assateague Coastal Trust
P. O. Box 551
Ocean City, MD 21842
ph: 410-352-5289 fax: 410-289-5726
lbeahm511@aol.com

Dr. Robert J. Orth
VA Institute of Marine Science
P. O. Box 1340
Gloucester Point, VA 23062
ph: 804-684-7392 fax: 804-684-7293
jorth@vims.edu

Janice Outen
MD Dept. of Environment
2500 Broening Highway
Baltimore, MD 21224
ph: 410-631-8059

Christopher Overbaugh
MD Coastal Bays Program
11647 Beauchamp Road
Berlin, MD 21811
ph: 410-208-6103

Thomas Parham
MD Dept. of Natural Resources
580 Taylor Avenue, D-2
Annapolis, MD 21401
ph: 410-260-8633 fax: 410-260-8640
tparham@dnr.state.md.us

Steve Parker
Nature Conservancy/VA Coast Resv.
P. O. Box 158
Nassawadox, VA 23413
ph: 757-442-3049 fax: 757-442-5418
steveparker@esva.net

Jim Parsons
Perdue Farms Inc.
P. O. Box 1537
Salisbury, MD 21801
ph: 410-352-2378 fax: 410-352-2300
jim.parsons@perdue.com

Joe Pasko
MD Saltwtr. Sportfishermen's Assn
53 Anchor Way Drive
Berlin, MD 21811
ph: 410-213-1760

Tom Patton
Assateague Coastal Trust
P.O.Box 578
Berlin, MD 21811
ph: 410-641-2355 fax: 410-641-0056

Joe Perry
Town of O.C., Eagles Landing Golf
8828 Bald Eagle Lane
Berlin, MD 21811
ph: 410-213-0830 fax: 410-213-7748

Nina Petrovich
Nat'l Oceanic & Atmo. Admin./CSC
2234 S. Hobson Avenue
Charleston, SC 29405
ph: 843-740-1203 fax: 843-740-1313
npetrovich@csc.noaa.gov

Jeff Phillips
2004 Philadelphia Avenue
Ocean City, MD 21842
ph: 410-289-2722

Janet Phillips
2004 Philadelphia Avenue
Ocean City, MD 21842
ph: 410-289-2722

Carmen Phillips
2004 Philadelphia Avenue
Ocean City, MD 21842

Joe Phillips
2004 Philadelphia Avenue
Ocean City, MD 21842

Jonathan Phinney
Center for Marine Conservation
1725 DeSales Street, NW, Suite 600
Washington, DC 20036
ph: 202-429-5609 fax: 202-872-0619
jphinney@dccmc.org

Dave Phoebus
200 South Chester Street
Baltimore, MD 21231
ph: 410-327-1610

Grace Pierce-Beck
Center for the Inland Bays
20 Muirfield Court
Dover, DE 19904
ph: 302-674-5568 fax: 302-674-4159

Ron Pilling
Assateague Coastal Trust
3024 North Calvert Street
Baltimore, MD 21218
ph: 410-662-9630 fax: 410-662-9631
pilling@erols.com

Pat Pilling
3024 North Calvert Street
Baltimore, MD 21218
ph: 410-662-9630 fax: 410-662-9631
pilling@erols.com

Jack Pingree
DE DNR & Environmental Control
P. O. Box 1401
Dover, DE 19903
ph: 302-739-4590 fax: 302-739-6140
jpingree@dnrec.state.de.us

Joyce Ponsell
Assateague Coastal Trust
165 Teal Circle
Berlin, MD 21811
ph: 410-641-8552
jgponsell@gateway.net

Linda Popels
U of DE, College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4265
lcpope@udel.edu

Hon. Shirley Price
Delaware State Representative
RD 2 , Box 120
Millville, DE 19970
ph: 302-539-6738 fax: 302-739-2313

Kent Price
U of DE & Center for the Inland Bays
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4256 fax: 302-645-4312
ksprice@udel.edu

Jim Price
Chesapeake Bay Acid Rain Fnd.
P. O. Box 1538
Easton, MD 21601
ph: 410-822-5398 fax: 410-822-3697
staff@chesbay.org

Henrietta Price
Chesapeake Bay Acid Rain Fnd.
P. O. Box 1538
Easton, MD 21601
ph: 410-822-5398

Norville Prosser
American Sportfishing Assoc.
1033 N. Fairfax Street, Suite 200
Alexandria, VA 22314
ph: 703-519-9691 fax: 703-519-1872
info@asafishing.org

Til Purnell
Inland Bays Citizen Monitoring
Rt. 6 Box 98
Millsboro, DE 19966
ph: 302-945-1317
purnell@ce.net

Dr Kim Quillin
Horn Point Laboratory
5705 Waterside Drive
Berlin, MD 21811
ph: 410-629-1356 fax: 410-629-1466
kquillin@shore.intercom.net

Shanna Ramsey
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443
shanna_ramsey@nps.gov

Dr. Bruce Richards
Center for the Inland Bays
467 Highway One
Lewes, DE 19958
ph: 302-645-7325 fax: 302-645-5765
brichard@udel.edu

David Rickards
Indian River Tributary Action Team
R. D. 2 Box 195
Frankford, DE 19945
ph: 302-539-9034 fax: 302-539-2372
dorickards@aol.com

Bill Rodney
MD DNR-RAS-MANTA
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8610 fax: 410-260-8620
brodney@dnr.state.us

John Roeder
Assateague State Park
186 Sandyhook Road
Berlin, MD 21811
ph: 410-208-0920
jollyrog@shore.intercom.net

Paige Ross
VIMS Eastern Shore Lab
P. O. Box 350
Wachapreague, VA 23480
ph: 757-787-0959
pg@vims.edu

Debbie Rouse
DE DNR & Environmental Control
P. O. Box 1401
Dover, DE 19903
ph: 302-739-4590 fax: 302-739-6140
drouse@dnrec.state.de.us

Monda Sagalkin
Defenders of Wildlife
17407 Taylors Landing Road
Sharpsburg, MD 21782
ph: 301-432-6847 fax: 301-766-0089

Ricks Savage
Mid-Atlantic Fisheries Adv. Council
11824 Porfin Drive
Berlin, MD 21811
ph: 410-641-1837 fax: 410-289-7800
savageclam@aol.com

Jackie Savitz
Coast Alliance
600 Pennsylvania Ave., SE
Washington, DC 20003
ph: 202-546-9554
coast@coastalliance.org

Bob Scarborough
DE DNR Coastal Programs
89 Kings Highway
Dover, DE 19901
ph: 302-739-3451 fax: 302-739-2048

Dr. A. David Scarfe
Chesapeake Shellfish Aquaculture
S3-E Muirfield Drive
Reading, PA 19607
ph: 610-775-9793 fax: 610-796-7756

Don Schaefer
USCG Auxiliary
78 Bluebill Court
Berlin, MD 21811
ph: 410-641-8898
donaldschaef@prodigy.net

Charles Schonder
94 Sugarland Run Drive
Sterling, VA 20164
ph: 703-941-7216

Chuck Schonder
DNREC, Delaware Coastal Programs
89 Kings Highway
Dover, DE 19901
ph: 302-739-3451 fax: 302-739-2048

John Schroer
US F&WS - Chincoteague
P. O. Box 62
Chincoteague, VA 23336
ph: 757-336-6122 fax: 757-336-5273
john_d_schroer@fws.gov

Gwynne Schultz
MD DNR Coastal Zone Management
580 Taylor Avenue, E-2
Annapolis, MD 21401
ph: 410-260-8730 fax: 410-260-8739
gschultz@dnr.state.md.us

Eric Schwaab
MD DNR Fisheries Service
580 Taylor Avenue, B-2
Annapolis, MD 21401
ph: 410-260-8283
eschwaab@dnr.state.md.us

Suzanne Schwartz
Oceans & Coastal Protection Division
US EPA, 401 M Street, SW (4504F)
Washington, DC 20460
ph: 202-260-6426 fax: 202-260-9960
schwartz.suzanne@epa.gov

Chris Seymour
Nat'l Park Service-Assateague Island
7206 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
chris_seymour@nps.gov

Michael Short
Cape Gazette
P.O.Box 213
Lewes, DE 19958
ph: 302-645-7327 fax: 302-645-1664
mshort@capegazette.com

Tom Shuster
Ocean City Recreation & Parks
200 125th Street
Ocean City, MD 21842
ph: 410-250-0125

Debbie Shuster
12517 Deer Point Circle
Berlin, MD 21811
ph: 410-213-9658

Ward Slacum
U of MD Eastern Shore
1120 Trigg Hall
Princess Anne, MD 21853
ph: 410-651-6291 fax: 410-651-7662
hslacum@umes-bird.umd.edu

John Slowik
731-B Bradley Road
Ocean City, MD 21842
ph: 410-524-3869

Kevin Smith
DNR Watershed Restoration Div.
580 Taylor Avenue
Annapolis, MD 21403
ph: 410-260-8797 fax: 410-260-8779
kmsmith@dnr.state.md

Harley Speir
MD Dept. of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8271
hspeir@dnr.state.md.us

Jack Stewart
Indian River Tributary Action Team
P. O. Box 1252
Ocean View, DE 19970
ph: 302-537-2682

Jennifer Stott
MD Geological Survey
2300 St. Paul Street
Baltimore, MD 21218
ph: 410-554-5571 fax: 410-554-5502
jstott@mgs.dnr.md.gov

Jack Tarburton
DE Dept. of Agriculture
2320 S. DuPont Highway
Dover, DE 19901
ph: 302-739-4811 fax: 302-697-4463
jackt@state.de.us

Mitchell Tarnowski
MD Dept. of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8258
mtarnowski@aya.yale.edu

Jack Tawil
MD Dept. of Natural Resources
580 Taylor Avenue, E-2
Annapolis, MD 21401
ph: 410-260-8711 fax: 410-260-8709

Dr. Sarah Taylor-Rogers
MD Dept. of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8100 fax: 410-260-8111

James Thomas
Izaak Walton League
2 W. Ring Factory Road
Bel Air, MD 21014-5302
ph: 410-838-3966

Suzanne Thurman
Carmine Environmental Center
RR 2 Box 161
Lewes, DE 19958
ph: 302-945-0677

Shuli Tor
P.O. Box 1221
Chincoteague, VA 23336
ph: 757-336-3673

John Torgan
Narragansett BayKeeper
Save The Bay, 434 Smith Street
Providence, RI 2906
ph: 401-272-3540 fax: 401-273-7153
narragansbay@keeper.org

Jack Travelstead
VA Marine Resources Commission
2600 Washington Avenue
Newport News, VA 23607
ph: 757-247-2248
Jtravelste@mrc.state.va.us

Tim Tull
Commercial Fishing / MCBP
4508 Outten Road
Snow Hill, MD 21863
ph: 410-632-3056

Paryse Turgeon
MD Dept. of the Environment
2500 Broening Highway
Baltimore, MD 21224
ph: 410-631-6749 fax: 410-631-3873
pturgeon@mde.state.md.us

Thomas Turner
Loudoun Soil & Water Conserv. Dist.
30 Catoctin Circle, SE, Suite H
Leesburg, VA 20175
ph: 703-777-2075 fax: 703-443-0187

Alice Tweedy
MD Coastal Bays Program
3522 Figgs Landing Road
Snow Hill, MD 21863
ph: 410-632-0991

Bud Tweedy
MD Coastal Bays Program
3522 Figgs Landing Road
Snow Hill, MD 21863
ph: 410-632-0991

Dr. William Ullman
U of DE College of Marine Studies
700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4302 fax: 302-645-4007
ullman@udel.edu

Wolfgang von Baumgart
Solutions to Avoid Red Tide
37 Comanche Circle
Millsboro, DE 19966
ph: 302-945-2646

Adele von Baumgart
Indian River Tributary Team
37 Comanche Circle
Millsboro, DE 19966
ph: 302-945-2646

Eric Walbeck
US EPA, Region III / MAIA team
110 Marykay Road
Timonium, MD 21093
ph: 410-305-2760 fax: 410-305-3095
walbeck.eric@epa.gov

Eric Walberg
Hampton Rds. Planning Dist. Comm.
723 Woodlake Drive
Chesapeake, VA 23320
ph: 757-420-8300
ewalberg@hrpdc.seva.net

George E. Ward, Jr.
6125 George Island Landing Road
Stockton, MD 21864
ph: 410-632-0499

Al Wesche
MD DNR - Fisheris Service
12917 Harbor Road
Ocean City, MD 21842
ph: 410-213-1531 fax: 410-213-2846

Bob Wilson
US F&WS - Chincoteague
P.O. Box 62
Chincoteague, VA 23336
ph: 757-336-6122 fax: 757-336-5273
robert_e_wilson@fws.gov

Dr. Bryan Watts
Center for Conservation Biology
College of William and Mary
Williamsburg, VA 23187-8795
ph; 757-481-1226
bdwatt@mail.wm.edu

Lee Whaley
Senator Paul Sarbanes Office
110 West Church Street, Suite D
Salisbury, MD 21801
ph: 410-860-2131 fax: 410-860-2134
lee_whaley@sarbanes.senate.gov

Bob Wilson
Assateague Coastal Trust
6302 Knoll Hill Drive
Berlin, MD 21811
ph: 410-629-1434

Cathy Wazniak
MD Coastal Bays Program
9609 Stephen Decatur Highway
Berlin, MD 21811
ph: 410-260-8638 fax: 410-260-8640
cwazniak@dnr.state.md.us

Ed Whereat
Inland Bays Citizen Montoring
Univ. of Delaware, 700 Pilottown Road
Lewes, DE 19958
ph: 302-645-4252
whereat@udel.edu

Donald Winslow
Assateague Coastal Trust
63 Lookout Point
Berlin, MD 21811
ph: 410-208-6613
dwin63@bigfoot.com

Jessica Webber
Entrix, Inc
200 Bellevue Parkway, Suite 200
Wilmington, DE 19809
ph: 302-792-9310 fax: 302-792-9329
jwebber@entrix.com

Marguerite Whilden
MD DNR Fisheries Service
580 Taylor Avenue, B-4
Annapolis, MD 21401
ph: 410-260-8269 fax: 410-260-8278
mwhilden@dnr.state.md.us

Marion Winslow
Assateague Coastal Trust
63 Lookout Point
Berlin, MD 21811
ph: 410-208-6613

Darlene Wells
MD Geological Survey
2300 St. Paul Street
Baltimore, MD 21218
ph: 410-554-5518 fax: 410--554--5502
dwells@mgs.md.gov

Jack White
Va Marine Resource Commission
1 Randolph Avenue
Cape Charles, VA 23310
ph: 57-678-0440

Philip Wirth
Versar Inc.
9200 Rumsey Road
Columbia, MD 21045
ph: 410-740-6066 fax: 410-964-5156
wirthphi@versar.com

Carol Wells
Inland Bays Citizen Montoring
Pinewater Farms, 4 Blackberry Lane
Harbeson, DE 19951

Larry Whitlock
CWRAC, SWQAC
3409 Coastal Highway
Ocean City, MD 21842
ph: 410-289-3202

Walter Witt
MD Conservation Corps
4011 Old Furnance Road
Snow Hill, MD 21863
ph: 410-632-3561
walter-witt@email.msn.com

Richard Welton
Coastal Conservation Assoc.,VA
2100 Marina Shores Drive, Suite 108
Virginia Beach, VA 23451
ph: 757-481-1226
CCAVAST@aol.com

Robert Whitman
Delaware General Assembly
814 Dallam Road
Newark, DE 19711
ph: 302-731-4208
rwhitman@ix.netcom.com

John Wolflin
US Fish & Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401
ph: 410-573-4573 fax: 410-269-0832
john_wolflin@fws.gov

Al Werner
MD Saltwtr. Sportsfishermen's Assn
31 Pintail Drive
Berlin, MD 21811
ph: 410-208-0768

Dave Wilson
MD Coastal Bays Program
9609 Stephen Decatur Highway
Berlin, MD 21811
ph: 410-213-2297 fax: 410-213-2574
dwilson@dnr.state.md.us

Harry Womack
Salisbury State University
1101 Camden Avenue
Salisbury, MD 21801
ph: 410-546-3692
HEWOMACK@ssu.edu

Susan Woods
MD Dept of the Environment
2500 Broening Highway
Baltimore, MD 21224
ph: 410-631-3172 fax: 410--631-3936
estierstorfer@mde.state.md.us

Helen Woods
VA Institute of Marine Science
P. O. Box 995
Gloucester Point, VA 23062
ph: 804-684-7663
hwoods@vims.edu

Carl Yetter
DE DNR/ DE Coastal Programs
89 Kings Highway
Dover , DE 19901
ph: 302-739-3451 fax: 302-739-2048

Nancy Zapotocki
Worcester County Comp. Planning
111 Franklin Street, Unit 1
Snow Hill, MD 21863
ph: 410-632-5651 fax: 410-632-5654

Jian Zhou
MD Dept. of Natural Resources
580 Taylor Avenue
Annapolis, MD 21401
ph: 410-260-8297 fax: 410-260-8278
jzhou@dnr.state.md.us

Carl Zimmerman
Assateague Island National Seashore
7604 National Seashore Lane
Berlin, MD 21811
ph: 410-641-1443 fax: 410-641-1099
carl_zimmerman@nps.gov

APPENDIX C

EXHIBITORS

What is the History and Current Status of Maryland's Eel Populations?

Julie A. Weeder and William P. Mowitt, Fisheries Service, Maryland Dept. of Natural Resources
Tawes State Office Building C-2, 580 Taylor Avenue, Annapolis MD 21401
ph: 410-643-6785; fax: 410-643-4136; mata-fish-2@dnr.state.md.us

The American Eel (anguilla rostrata) fishery is economically important in Maryland's coastal bays and Chesapeake Bay. In recent years, coast-wide commercial catches of the American eel have been declining, while Maryland catches have increased in the 1990s. The U.S. eel fishery is driven by European and Asian demand for live eels for consumption and fishery restoration. The number and weight of eels have declined substantially between the early 1980s and the late 1990s. We determined the size and age of eels caught in the commercial fishery from 1997 to 1999. Growth rates between rivers varied significantly. The fishery was dominated by young, small eels, and eels were entering the fishery at a very young age. Few large, old eels were observed. Declining harvest, high rates of growth and the relative scarcity of large, older eels is consistent with a fishery which is not attaining maximum yield due to natural or induced pressures.

Assateague Coastal Trust

P. O. Box 731, Berlin MD 21811
ph: 410-629-1538; fax: 410-629-1059; act@beachin.net

The Assateague Coastal Trust (ACT) is the only Delmarva grassroots, non-profit organization working to preserve Assateague Island and the living resources of the coastal ecosystem. ACT is nationally recognized for its long history of protecting Assateague Island National Seashore, Assateague State Park, Chincoteague National Wildlife Refuge and the Delmarva coastal bays through advocacy efforts and by sponsoring outreach programs to promote awareness among Delmarva's citizens and visitors about these natural resources and their long-term sustainability. Since its inception in 1970, the organization (originally known as the Committee to Preserve Assateague Island) has successfully led efforts to protect the ecological health of Assateague Island and its rich resources, the adjacent coastal bays as well as other threatened areas where land meets water in the mid-Atlantic region.

Bacterial Contamination in Maryland's Coastal Bay Canals

Dr. Harry Womack / Students, Salisbury State University
1101 Camden Avenue, Salisbury MD 21801
ph: 410-543-6492; fax: 410-543-6433; HEWOMACK@ssu.edu

Coliform bacteria, used widely as a measure of water contamination by intestinal waste, were periodically measured for a year in seven Coastal Bay dead-end canals. The canals were shown to be massively contaminated with coliforms, especially during summer months. These studies, combined with previous physical and chemical characteristics assessment, indicate very poor water quality due to heavy nutrient and waste contamination and lack of adequate flushing.

BayScapes - Landscaping to Benefit People and Wildlife

US Fish and Wildlife Service, Chesapeake Bay Field Office
177 Admiral Cochrane Drive, Annapolis MD 21401
ph: 410-573-4581; http://www.fws.gov/r5cbfo

BayScapes are environmentally sound landscapes benefitting people, wildlife, and water quality. Using BayScapes principles, you can create: low-input landscapes, requiring less mowing, fertilizing, and pesticide use; attractive, colorful landscapes with hundreds of colorful and beneficial plants to choose from; diverse habitats for songbirds, small mammals, butterflies and other creatures. Beneficial plants are well adapted to local climate and soil types. As a result, they require minimal maintenance and often help wildlife as well, by providing food, shelter, and places to raise their young.

Biohabitats - Ecological Restoration

Edward Morgereth

15 W. Aylelsbury Road, Timonium MD 21093

ph: 410-337-3659; about@biohabitat.com

Biohabitats, Inc. is an environmental consulting and design firm specializing in ecological assessments, planning, and restoration. Founded in 1982, Biohabitats operates throughout the Mid Atlantic region providing comprehensive solutions to environmental problems for a wide variety of projects. Biohabitats has a multi-disciplinary staff that includes environmental scientists, field ecologists, landscape architects, and cartographers. Biohabitats Inc. works with private land developers, industrial and commercial corporations, utilities and federal, state, and local government agencies to produce environmentally sensitive land use plans and ecological restoration designs.

Chincoteague National Wildlife Refuge, U.S. Fish and Wildlife Service

P.O. Box 62

Chincoteague, VA 23336

ph: 757-336-6122 fax: 757-336-5273; R5RW-chnwr@fws.gov; www.chinco.fws.gov

The Chincoteague National Wildlife Refuge was established in 1943 to provide habitat and protection for migrating birds in response to the dwindling of once enormous waterfowl populations in the Delmarva region. During the early 1900's wholesale conversion of wetlands to agriculture and private development, coupled with outlaw market gunning for food and plumage had threatened many bird species. The location of the refuge, most of which is on the Virginia end of Assateague Island, is along the Atlantic flyway and provides essential coastal habitat for migrating and nesting birds and indigenous wildlife. Chincoteague refuge is known as one of the East's finest birdwatching areas.

CISNet Program: Collaborative Research in Delaware's Inland Bays

Dr. William J. Ullman, College of Marine Studies

University of Delaware, Lewes DE 19958-1298

ph: 302-645-4302; ullman@udel.edu

Delaware's Inland Bays were chosen in 1998 as one of eleven sites of the Coastal Intensive Site Network (CISNet). At each CISNet site, there are one or more long-term monitoring and research projects to use ecological indicators to monitor the environmental conditions of the site and to integrate the response of the site to environmental stress. These investigations provide information that will help environmental managers facing similar environmental issues at other estuarine sites. The Inland Bays Program focuses on nutrient sources, sinks, transport and utilization within Indian River and Rehoboth Bays and their watersheds, and represents the largest coordinated research effort concerning Delaware's Inland Bays and its watershed in the history of such studies. The National CISNet Program is a collaboration of the U.S. Environmental Protection Agency, the National Oceanic & Atmospheric Admin. and the National Aeronautics & Space Admin. Additional support for this program comes from the Delaware Sea Grant College Program, the Delaware Dept. of Natural Resources & Environmental Control, the Delaware Geological Survey, and the Center for the Inland Bays.

Climate Change Outreach Program - U.S. Environmental Protection Agency (EPA)

David Hall, EPA Climate Change Outreach Program

1019 19th Street, NW, Suite 1200, Washington DC 20036

ph: 202-331-4323; fax: 202-331-9420; dhall@vancomm.com

The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases -- primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy. At EPA's Climate Change Program booth learn how climate change and sea level rise may affect the Delmarva area's coastal communities, wildlife, and ecosystems.

Delaware Center for the Inland Bays
467 Highway One, Lewes DE 19958
ph: 302-645-7325; fax: 302-645-5765; www.udel.edu/CIB

The Delaware Center for the Inland Bays was established as a nonprofit organization in 1994 under the Inland Bays Watershed Enhancement Act. Its mission is to oversee the implementation of the Inland Bays Comprehensive Conservation and Management Plan and to facilitate a long-term approach for the wise use and enhancement of the inland bays watershed by conducting public outreach and education, developing and implementing conservation projects, and establishing a long-term process for the preservation of the inland bays watershed. The goals of the Center for the Inland Bays are: 1) To sponsor and support educational activities, restoration efforts, and land acquisition programs that lead to the present and future preservation and enhancement of the inland bays watershed; 2) To build, maintain, and foster the partnership among the general public; the private sector; and local, state, and federal governments, which is essential for establishing and sustaining policy, programs, and the political will to preserve and restore the resources of the inland bays watershed; and 3) To serve as a neutral forum where inland bays watershed issues may be analyzed and considered for the purposes of providing responsible officials and the public with a basis for making informed decisions concerning the management of the resources of the inland bays watershed.

Delmarva Low Impact Tourism Experiences (DLITE)
Lisa Challenger, Worcester County Economic Development
113 Franklin Street, #1, Snow Hill MD 21863
ph: 410-632-3110; fax: 410-632-3158; econ@ezy.net; www.delmarvalite.com

Delmarva Low Impact Tourism Experiences is a 501(c)(3) organization organized to devise and implement locally-appropriate policies, practices, protocols and ethics for nature and culture-based tourism operations on Delmarva. It is comprised of tourism-oriented businesses, local and regional organizations and individuals who recognize the important values, both human and economic, of the area's distinctive natural and cultural histories. Memberships are available.

Eelgrass: Habitat Fragmentation and Patchiness in Transplanted Eelgrass Beds - Effects on Decapods and Fish
Helen Woods, Virginia Institute of Marine Science
Gloucester Point VA 23062
ph: 804-684-7663; fax: 804-684-7140; www.vims.edu/~hwoods

Exotic Species Research: Veined Rapa Whelk
Juliana Harding , VA Institute of Marine Science, Department of Fisheries Science
P.O. Box 1346, Gloucester Point VA 23062-1346
ph: 804-684-7302; jharding@vims.edu; www.vims.edu/fish/oyreef/rapven.html

The recent discovery of the Veined Rapa whelk (Rapana venosa) in the lower Chesapeake Bay has potentially serious ecological and economic consequences. This large gastropod is native to the orient but has also been introduced into the Black, Aegean, and Adriatic Seas. The presence of this animal poses ecological consequences for native gastropod and shellfish populations in that Rapa Whelks are voracious predators and have been identified as major contributors to the decimation of shellfish stocks in the Black Sea since their introduction. Economically, the two most favored prey items for this animal are also the targets of viable Chesapeake Bay commercial fisheries: hard clams (Mercenaria mercenaria) and oyster (Crassostrea virginica). The Rapa whelk's life history, habitat preferences, and distinguishing characteristics will be discussed in the context of the lower Chesapeake Bay and the ongoing research effort at the Virginia Institute of Marine Science (VIMS). Research updates are available from the VIMS Rapa Whelk Research.

Florida Keys National Marine Sanctuary
P. O. Box 500368, Marathon FL 33050
ph: 305-743-2437; fax: 305-743-2357; fknms@ocean.nos.noaa.gov;
www.wave.nos.noaa.gov/nmsp/fknms

Developed to protect America's coral reef and its surrounding marine communities for the use and enjoyment of future generations, the Florida Keys National Marine Sanctuary (FKNMS) has established five types of zones: Wildlife Management Areas, Ecological Reserves, Sanctuary Preservation Areas, Existing Management Areas and Special Use Areas. Information and posters about the FKNMS.

Haplosporidium Coastale - Still Active in the Waters of Chincoteague Bay in 1999

D. Howard, C.A. Farley, and G. Ward, NOAA / Cooperative Oxford Lab
904 S. Morris Street, Oxford MD 21654

Haplosporidium coastale (seaside organism or SSO) is still prevalent in Chincoteague Bay 30 years after it was discovered and described by Wood and Andrews in 1962. Researchers were interested to see if SSO would develop in oysters transferred to Chincoteague Bay from an area in Chesapeake Bay where the disease was not present. The objective was to find out if the oysters would contract the disease by exposing them to the parameters described by J. Couch and Rosenfield in 1967.

Hard Clam Aquaculture

Steve and Christy Gordon, Gordon Shellfish, LLC
P. O. Box 336, Pocomoke City MD 21851
ph: 410-957-4100; fax: 410-957-1301; sgordon@mafi.com

Local residents can learn about the business of hard clam aquaculture.

Horseshoe Crabs - Raising HSC in the Classroom

Cindy Grove, Maryland Department of Natural Resources
Tawes State Office Building, 580 Taylor Avenue, Annapolis MD 21401
ph: 410-260-8716; cgrove@dnr.state.md.us

Maryland students and teachers are learning about horseshoe crabs through this new program developed by the MD Dep. Of Natural Resources, Aquatic Resources Education Program, Conservation Education Unit, and the Maryland Fisheries Service. A cooperative program piloted in the 1998-99 school year, the horseshoe crab project allows students in grades 4 - 8 to study management issues, connections to the bio-medical industry, life history and ecological roles, and economic issues involving horseshoe crabs. Classroom presentations are conducted by TEAM DNR (Teaching Environmental Awareness in Maryland) and volunteers and participating classrooms are outfitted with equipment, horseshoe crab eggs, resources materials, and a teachers packet with activities and writing prompts. This program allows Maryland students to get involved in real life management issues while working across multiple subject areas.

Maryland Coastal Bays Program

Dave Wilson, Outreach Director
9609 Stephen Decatur Highway, Berlin MD 21811
ph: 410-213-2297; fax: 410-213-2574; dwilson@dnr.state.md.us; www.dnr.state.md.us/mcbp

As part of the National Estuary Program, the Maryland Coastal Bays Program (MCBP) is a cooperative effort between Worcester County, Berlin, Ocean City, the State of Maryland, and the Environmental Protection Agency, which have come together to work with the citizens of Worcester County to produce the first ever management plan for their bays. The MCBP is involved in hands-on volunteer projects, public education and outreach and implementation of the Comprehensive Conservation Management Plan (CCMP). The exhibit provides photographs of Worcester County, copies of the CCMP and information about the Maryland Coastal Bays Foundation.

Maryland Conservation Council

Millie Kriemelmeyer
16900 Mattawoman Lane, Waldorf MD 20603
ph: 301-372-8766; fax: 301-782-7615; hkriemel@radix.net

The Maryland Conservation Council (MCC) is a statewide coalition of environmental organizations and concerned citizens, incorporated in 1969. MCC's purpose is to provide an effective and continuing coordinating structure to work for the preservation and appreciation of Maryland's rich natural heritage, to sustain the vitality of its biological diversity and of its varied ecological systems, and to ensure the wise use of its resources. MCC meets monthly around the state. MCC also publishes the weekly "Conservation Report" during the MD State Legislature session to keep members updated on important environmental legislation.

Maryland Saltwater Sportfishermen's Association - Atlantic Coast Chapter

Henry Koellein, Jr.
538 Marlinspike Drive, Severna Park MD 21146
ph: 410-208-0567; barck@erols.com

The Maryland Saltwater Sportfishermen's Association works to provide a unified voice to preserve and protect the rights, traditions, and future of recreational fishing. The Atlantic Coast Chapter, with 300 members, is an area leader in that effort.

Maryland Terrapin Station Project
Marguerite Whilden, Maryland DNR, Fisheries Service Outreach & Advancement
Tawes State Office Building, 580 Taylor Avenue, Annapolis MD 21401
ph: 410-260-8269; mwhilden@dnr.state.md.us

The Maryland Terrapin Station Project includes outreach and advancement of Fisheries among the non-traditional audiences, new crab pot regulations to reduce by-catch, terrapin nesting sanctuaries, the terrapin head-start and repatriation program, and stock monitoring and management measures. The Terrapin Research Consortium, convened to discuss range-wide research, management and conservation of the diamondback terrapin, will also be introduced.

Narragansett BayKeeper / Water Keeper Alliance
John Torgan, Save The Bay
434 Smith Street, Providence RI 02906
ph: 401-272-3540; fax: 410-273-7153; narraganbay@keeper.org

National Oceanic and Atmospheric Administration
1305 East-West Highway, SSMC-4, Silver Spring MD 20910
ph: 301-713-3155; fax: 301-713-4012

NOAA's Office of Ocean and Coastal Resource Management includes Coastal zone Management - a voluntary partnership of federal and state government to reduce conflicts between land and water uses in the coastal zone and conserve coastal resources. The crux of the CZMA is that responsible development and conservation of coastal resources can and must go hand-in-hand to keep our economy strong, our waters clean and our resources healthy and productive.

Ocean City Power Squadron
Joan Cook
239 Ocean Parkway, Berlin MD 21811
ph: 410-641-6168; jvcooke1@juno.com

The Ocean City Power Squadron (member of the United States Power Squadron) is a social and fraternal organization dedicated to safe boating operation. Safe boating is promoted through education and community involvement.

Oyster Aquaculture and Oyster Reef Restoration
Mark Luckenbach, Virginia Institute of Marine Science Eastern Shore Laboratory
P. O. Box 350 Wachapreague VA 23480
ph: 757-787-5816; fax: 757-787-5831; luck@vims.edu; www.vims.edu

Oyster Gardening Project - Assateague Coastal Trust
Ron Pilling
P. O. Box 731, Berlin MD 21811
ph: 410-629-1538; act@beachin.net or pilling@erols.com

In an effort to assist with research to help build a sustainable population of oysters that will reproduce and increase the Assateague Coastal Trust will be partnering with the Oyster Alliance (Chesapeake Bay Foundation, Maryland Sea Grant Extension Program, University of MD Center for Environmental Science and the Oyster Recovery Partnership) in an oyster gardening project. Individuals and school groups interested in volunteering will build a Taylor float to hold oyster spat and then learn how to monitor the growing oysters, maintain the float and collect data. Information from the oyster gardeners up and down the coast will assist scientists find the species of oysters that are resistant to disease and determine where and how oysters are most likely to survive in the Coastal Bays.

Plasticulture: Evaluating the Impacts of Runoff from Vegetable Farms on Living Resources In Tidal Creeks

G. Arnold, M. Luckenbach
Virginia Institute of Marine Science, Eastern Shore Laboratory, Wachapreague VA 23480
M. Roberts, Jr., M. Newman, D. Powell, M. Unger, G. Vadas, M. Vogelbein
Virginia Institute of Marine Science, Gloucester Point, VA 23062
ph: 757-787-5816; gretchen@vims.edu

In North America, commercial vegetable growers are increasingly using impermeable plastic as a crop mulch. This farming practice, termed plasticulture, increases surface water runoff that can carry increased loadings of pesticides to nearby estuarine waters. In coastal Virginia, cultivation of tomatoes, peppers, and eggplant in plasticulture is thought to cause adverse effects on living resources in tidal creeks. We have used a multi-faceted approach that combines field and laboratory bioassays, chemical analyses of runoff from fields, and characterization of benthos and nekton in receiving tidal creeks to assess the impacts of plasticulture use. Six watersheds that contain different amounts of plasticulture have been examined for several years. Our initial results emphasized the importance of managing storm water runoff from these fields. Current efforts are focused on evaluating the efficacy of management practices presently used by farmers to address these concerns.

Restoring The Bay Scallop *Argopecten Irradians* To Chincoteague Bay, Maryland

Mitchell L. Tarnowski, Robert Bussell and Mark Homer, Maryland Dept. of Natural Resources
Tawes State Office Building, 580 Taylor Avenue, Annapolis MD 21401

Bay scallops were once found throughout the coastal bays system and formed the basis of a small but lucrative fishery centered around Chincoteague, Va. However, when a blight eradicated the eelgrass meadows in the early 1930's, the scallops lost their preferred habitat and also disappeared. In recent years sea grasses have made a remarkable recovery in this region. With thousands of acres of sea grass meadows now in existence, and stable, relatively high year-round salinities afforded through the stabilization of the Ocean City (Md.) Inlet, conditions appear to be optimal for the return of the bay scallop. It seemed that the primary hindrance to the return of the bay scallop was the absence of a near-by source of reproducing adults. A restoration effort by the MDNR Shellfish Program resulted in the planting of 1.2 million seed scallops in Chincoteague Bay in 1997 and 1998. It was intended that these would serve as brood stock whose progeny would begin to repopulate the bay. Using a combination of fenced exclosures and crab pots to protect the young scallops from predators, over 85% of the plantings survived to sexual maturity. Although this species generally spawns once, the scallops planted in 1997 spawned an unprecedented three times, including twice in one season. Growth rates have been disappointing however, with few scallops reaching market size. Progeny from the 1997 planting have yet to be confirmed. The second year of recruitment will be evaluated next spring.

SAV - Assessment of Submerged Aquatic Vegetation and Aquaculture Bottom Land Use in the Lower Chesapeake Bay Estuary

A.V. Lombana, R.J. Orth, J.van Montfrans, R.N. Lipcius, D.J. Wilcox, K.A. Moore, J.R. Fishman
Virginia Institute of Marine Science; School of Marine Science, College of William and Mary
Gloucester Point VA 23062
ph: 804-684-7392; fax: 804-684-7293; http://www.vims.edu/bio/sav

SAV - Identifying & Resolving Fisheries Management Conflicts in a Recovering Seagrass System

R.J. Orth, D.J. Wilcox, K.A. Moore, J.R. Fishman
Virginia Institute of Marine Science; School of Marine Science, College of William and Mary
Gloucester Point VA 23062
ph: 804-684-7392; fax: 804-684-7293; http://www.vims.edu/bio/sav

Shellfish Demonstration Work in Delaware's Coastal Bays 1998-1999

John W. Ewart, DE Aquaculture Resource Center
Sea Grant Marine Advisory Service, College of Marine Studies
University of Delaware, 700 Pilottown Road, Lewes DE 19958
ph: 302-645-4060; fax: 302-645-4007;ewart@udel.edu; http://darc.cms.udel.edu/

Maintaining healthy populations of shellfish for their ecological, recreational and commercial contribution to the overall health and productivity of the estuary is a priority of the Center for the Inland Bay's Comprehensive Management Plan. Shellfish field demonstration work conducted during the initial 1998 season established a 5,600 square foot enclosure at the James Farm site in Indian River Bay for planting and evaluation of two species of commercially important bivalve molluscs. Two small scale bottom plantings of hard clams (Mercenaria mercenaria) simulating a pilot scale stock enhancement effort were established at the James Farm enclosure (3500 clams) and at Savage's Ditch in Rehoboth Bay (10,000 clams). Two size classes of native Delaware Bay oyster seed (Crassostrea virginica) were deployed in off-bottom "transient" culture gear at the James Farm site. Fish growth and survival was monitored at all sites summer and fall 1998.

Shoreline Changes - Maryland's Coastal Bays

Lamere Hennessee and Jennifer Stott
Maryland Geological Survey
2300 St. Paul Street, Baltimore MD 21218
ph: 410-554-5519; fax: 410-554-5502; lhennessee@mgs.md.gov

The Maryland Geological Survey is compiling digital and paper *Shoreline Changes* maps for the nine 7.5-minute quadrangles of the coastal bays in Maryland. Digital shoreline vectors, representing various shoreline positions between the years 1850 and 1989, are being digitized from MGS's *Historical Shorelines and Erosion Rates Atlas*, NOAA coastal survey maps, and a digital wetlands delineation based on 1988-1989 orthophotography. The six northern quads are complete; the three southern quads will be finished within a year. The digital shorelines are being used to calculate coastal land loss over time. Erosion studies, coupled with information about sea level rise, enable managers to plan more effectively for the effects of global warming on coastal communities and the related infrastructure. This information may also be used to address a variety of other coastal issues: (1) determining set-backs for flood insurance and other purposes, (2) determining the volume of sediment lost by erosion, a critical component in calculating a sediment budget for the coastal bays, (3) assessing the effects of shoreline erosion on bay water quality (e.g., turbidity, nutrient loading) and subaqueous habitats; and (4) understanding the processes responsible for shoreline erosion.

Survey Site Maps for EPA's 1998 "Condition of the Mid-Atlantic Estuaries" Report

Frederick W. (Rick) Kutz, US Environmental Protection Agency, Mid-Atlantic Assessment Team
701 Mapes Road, Fort Meade MD 20755
ph: 410-305-2742; fax: 410-305-3095; kutz.rick@epamail.epa.gov

The U.S. Environmental Protection Agency has led efforts to protect and restore the nation's estuaries by implementing such laws as the Clean Water Act and by participating in projects like National Estuary Programs. This display identifies survey sites in Sinepuxent, Chincoteague and the Virginia Coastal Bays on GIS map of the area that were used to compile data for the "Condition of the Mid-Atlantic Estuaries" report.

Virginia Institute of Marine Science Eastern Shore Laboratory - An Overview

Francis X. O'Beirn, PhD, Virginia Institute of Marine Science, Eastern Shore Lab
P. O. Box 350, Wachapreague VA 23480
ph: 575-787-5837; fax: 575-787-5831; francis@vims.edu; www.vims.edu

The Eastern Shore Laboratory of Virginia Institute of Marine Science was founded in the 60's and originally served as an outpost to monitor disease causing organisms of oysters. Since then, the scope of operations at the lab have greatly expanded. In addition to involvement in shellfish, aquaculture, research at the laboratory has focused on oyster reed restoration efforts and land use practices as they relate to water quality. In addition, the laboratory has an active education program which caters to students of all ages. The laboratory also caters to visiting scientists studying all aspects of the coastal bays and near shore waters.

Volunteering For The Coast - National Oceanic and Atmospheric Administration

Nina Petrovich, NOAA, Coastal Services Center
2234 S. Hobson Avenue, Charleston SC 29405
ph: 843-740-1203; fax: 843-740-1313; npetrovich@csc.noaa.gov

Learn about the public outreach efforts and ways to get information about NOAA and coastal initiatives.

Wetlands Restoration in the Coastal Bays

Susan Woods, Maryland Department of the Environment
2500 Broening Highway, Baltimore MD 21224
ph: 410-631-3172; fax: 410-631-3936; estierstorfer@mde.state.md.us; www.mde.state.md.us

MDE's display highlights restoring Maryland's wetlands and help our coastal bays. Become part of the solution, help restore Maryland's wetlands. Involve your business, school, community group or local government. Financial and technical assistance available.

APPENDIX D

CONFERENCE EVALUATION

1a. Did the Conference cover what you expected?

All those who responded said yes.
The respondents found the conference to be very valuable and praised the Assateague Coastal Trust (ACT) for doing an excellent job in organizing it.

1b. What were the coverage strengths?

Many of the respondents commented that the main coverage strength was the diversity of coverage, citing a diversity of lecture topics, representation from all three states, representation at different levels of organization, from local to statewide, and a good blend of science, management, and citizen interest. The specific topics that were named as coverage strengths were: natural resources overview, management issues, tristate program updates, and submerged aquatic vegetation (SAV).

1c. What other items would you like to have seen addressed?

- The role of education/outreach in providing for the long-term health of coastal bays.
- More specific details of existing programs -- what works, what didn't, and why - to inspire new initiatives.
- Need for adequate riparian buffers, public acquisition of sensitive areas and floodplains.
- More emphasis on developing solutions or recommendations about multi-use conflicts.
- Discussion of how much human impact is tolerable - where do we draw the line?
- More discussion of land use in the watershed. For example: sprawl development and impacts of sewage runoff, agriculture, monitoring of pesticide use in golf courses.
- More discussion of terrestrial animals in the watershed.
- More discussion of recreational interests such as fishing, boating, birdwatching.
- More balanced representation of Maryland, Delaware, and Virginia.
- More discussion of what measures can be taken to discourage developers and builders from developing wetlands.
- Review of the impact of the Route 50 bridge rock fill on flushing of northern bays - the rock fill has had more of an impact than most people realize.

2. What do you think are the most important issues associated with preserving the aquatic resources of the tristate region?

1. Education of all public in the coastal bays watershed about natural resources.
2. Habitat protection.
3. Preservation of water quality.
4. Reduction of human impacts.

3. What specific actions can be taken to address these issues?

- Education at all levels (e.g. signs at boat ramps, pamphlets at jet ski rentals, user-targeted mailings, boater education programs; school programs; education of politicians).
- Better coordination among the three states. Share data and expertise. Enforce equivalent fisheries restrictions across three states.
- Land use planning. Control growth in critical areas and expand buffers along waterways. Protect farmlands from development.
- Zone water ways. Ban hydraulic clamming. Zone SAV beds wider than present to allow expansion. Limit jet ski use areas. Establish no-take zones.
- Enforcement of regulations (at local or federal level; possibly funded by a small tourism tax). Publish a list of state and local contacts so that citizens may report violation.
- Determine actions that would protect bays against invasive species.
- Encourage nutrient management on farms; export manure.
- Encourage aquaculture.
- Research; we need more data to make informed, good management decisions.
- Political action to influence legislation.
- Continue communication among interest groups.

4. Other Comments:

- Many presentations were well organized and executed, but the communication of ideas would be improved if speakers would summarize the main ideas, not just the data.
- Next time, more representation of commercial fishing interests, especially hydraulic clam dredging; invite representation of commercial jet ski industry; encourage representation by local town councils.
- Time keeping was a problem, especially for panel discussions. Next time use a timer. Panelists should have a limited time to introduce their key ideas to enable more interaction among panelists and between panelists and audience.
- More time for questions and answers. This time would also allow time for citizens to present their views.
- Exhibits were excellent.
- Facilities; The seminar room was poorly designed for a large group; many people could not see the screen. Next time provide a wireless microphone and an adjustable podium for tall speakers. Next time have recycling bins available at meals.

Total attendance at the conference was 284. The summary above is based on 35 evaluation forms that were turned in after the conference, representing 12% of the conference participants.

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