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CHESAPEAKE BAY PROGRAM OYSTER RESTORATION

WORKSHOP PROCEEDINGS AND AGREEMENT STATEMENTS

Chesapeake Bay Program

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CHESAPEAKE BAY PROGRAM OYSTER RESTORATION: WORKSHOP PROCEEDINGS AND AGREEMENT STATEMENTS

INTRODUCTION

On January 13 and 14, 2000, the Chesapeake Bay Program cosponsored an Oyster Restoration Workshop in Waldorf, MD to enable scientists, managers, watermen and other members of the Chesapeake Bay community to exchange and review information that ultimately will lead to revisions of the Aquatic Reef Habitat Plan and the Oyster Management Plan. The workshop also was sponsored by members of the Chesapeake Bay Foundation, NOAA Chesapeake Bay Office, Maryland Sea Grant and the Virginia Sea Grant.

More than 100 people attended the workshop. Participants included scientists from universities and nonprofit organizations; managers from federal, state and local governments; watermen; and other members of the community interested in oyster restoration and management. On the first day, speakers gave presentations on oyster status and trends, restoration techniques, shell supply and hatchery function. During the second day participants discussed and came to consensus on several significant issues, components of reef design; the need for sanctuaries in restoration strategies (understanding that reserve areas are a necessary component of oyster restoration, and that reserve areas should include managed harvest); the importance of and strategies for minimizing the spread of oyster disease; research and monitoring priorities; the economic and ecological benefits of oyster restoration; and the need to conserve shell supply.

This workshop style–in which as many stakeholders and experts as possible were invited to address key questions over a two-day period–resulted in a very successful forum. The present model is offered as a tool to address additional complex management questions regarding the Chesapeake Bay.

This summary reverses the order of the proceedings by presenting the results of the two-day workshop first, then charting in greater detail the process that yielded those results. Therefore we begin with the consensus statements that evolved from the workshop presentations and discussions. These are followed by formal abstracts and editors' notes of the presentations that took place the previous day, which laid the groundwork for the consensus statements.

AGREEMENT STATEMENTS

JANUARY 14

The following statements were developed during discussions that took place on January 14, 2000, the second day of the workshop. These statements indicate the areas of strongest consensus and highest priority with respect to future achievements in oyster restoration.

OYSTER GOAL

The oyster goal in the most recent draft of the Chesapeake 2000 Agreement reads as follows: "By 2010, achieve, at a minimum, a tenfold increase in oysters in the Chesapeake Bay, based upon a 1994 baseline. By 2002, develop and implement a strategy to achieve this increase by using sanctuaries sufficient in size and distribution, aquaculture and other management approaches necessary to achieve this objective.

- Participants of this workshop agree that the oyster goal should emphasize oyster reef habitat as its focus and further recognize that the oyster goal should incorporate the ecological and economic benefits of oysters.

SANCTUARIES

- Sanctuaries are a necessary component of oyster restoration. Sanctuaries help ensure long-term growth and protection of the large oysters that provide increased fecundity and may lead to the development of more disease-tolerant oyster populations. Sanctuaries also provide stable habitat and the opportunity for complex biological structure development and will serve as a source of larvae for harvestable beds.

    - Ten percent of the historic productive oyster reef acreage should be placed in protected sanctuary areas. Historically productive areas should be identified using Winslow, Yates and Baylor surveys.

    - Sanctuary areas should be managed for maximum ecological benefit and for genetic health. They should be harvest-free areas and be closed to bottom-disturbing gear. The objective within sanctuaries should be to establish self-sustaining reefs.

    - Sanctuaries should exist as a network of sites. Larval dispersal should be a consideration when determining sites for sanctuaries.

    - Restoration in the form of reef construction should occur within sanctuaries.

    - Information on the existence and location of sanctuary areas should be publicized and given to the recreational and commercial fishing community. Sanctuary areas should be clearly marked.

- Sanctuaries should be placed in areas with high recruitment or should be stocked with hatchery seed in areas with good larval retention but low or infrequent recruitment.

- Sanctuaries should be located in diverse salinity zones. Different restoration strategies should be used in varying salinities.

REEF DESIGN

- The shape and design of a reef should meet what is called optimal relief criteria (ORC). ORC is a comprehensive and flexible definition that considers such issues as the efficient use of resources, water depth, available natural relief and habitat benefits. Reefs should have sufficient vertical relief so that oyster recruitment, growth and survival outpace local sedimentation. Relief should provide elevation above low oxygenated areas.

- The ORC and optimal size of a reef within a sanctuary will vary from site to site.

- The definition of ORC may vary among sanctuaries and harvest areas.

- Interstitial space is important for early survival of oysters and the development of benthic communities. The amount of interstitial space needed depends on the desired outcome of an individual reef. A minimal depth of 15 to 20 cm of interstitial space is recommended for maximum ecological benefit.

- Some sites may need replication to determine methods to improve restoration.

CONSTRUCTION

- Of the materials tested so far, oyster shell provides the best substrate.

- The amount of oyster fossil shell and fresh oyster shell (i.e. cultch) is limited and must be used as wisely as possible.

- Alternative materials, especially for the reef core, need to be further explored. Alternative non-toxic materials can be used in the core to provide vertical structure. The external layer of the reef must be a material that provides optimal substrate for oyster settlement and survival.

- Discretion must be used in the selection of alternative materials to avoid contamination of the Bay.

MONITORING

- A Baywide monitoring effort, including stock assessment, is necessary to track progress of the tenfold goal. The discussion of whether population estimates should be relative or absolute numbers remains unresolved.

    - Monitoring should be focused on the benefits or goals specific to each site.

    - Monitoring should be spatially explicit, quantitative and directed toward answering questions relevant for adaptive management, with an objective to improve restoration strategies.

    - Monitoring at some sites should include assessments of the ecological functioning of reefs.

DISEASE MANAGEMENT

- Oyster diseases, including MSX and Dermo, pose major obstacles to the success of restoration strategies.

    - The movement of disease should be minimized as much as possible.

    - Managers should adopt a policy to "know what you move"; the infection rate and location of transplanted oysters should be tracked.

    - In areas of low salinity and low recruitment only uninfected oysters should be seeded.

STOCKING

- Hatcheries and buy-back options can help supplement natural recruitment.

- Efforts should be made to maintain genetic diversity in hatchery and stocking efforts through multiple spawns or other guidelines.

- Wild strains should be used whenever possible during stocking.

- Managers should adopt a policy to keep track of "what goes where." Oyster location should be tracked from hatchery source to site planting.

- The role of hatcheries may include providing a "jumpstart" for restored reefs, providing disease-free stock, providing a means for experimentation, and assisting in increasing densities.

RESEARCH PRIORITIES

- Develop hydrodynamic models and other necessary means to further understand larval dispersal.

- Further develop an understanding of how reef structure and placement in the landscape affect reef function. Understand the issue of cost versus ecological benefits with respect to the different techniques of vertical relief utilization.

- Conduct research to support the development of components for optimal relief criteria.

- Develop an estimate of how much cultch is needed and how long the fossil shell supply will last.

- Develop alternative reef construction materials.

- Define low-level disease. Better understand the threshold between infection and mortality.

- Understand the relationship between oyster population density and biological function.

- Aim to understand the interaction potential between non-Chesapeake Bay stock and wild stock.

ABSTRACTS AND EDITORS' PRESENTATION NOTES

JANUARY 13

The following abstracts were provided to workshop participants. The presentation notes are based on the general discussion and comments that took place during and following each presentation, and do not exclusively reflect the recommendations of their respective presenters.

OYSTER STOCK ASSESSMENT IN VIRGINIA

Abstract:

Dr. Roger Mann (presenter), Virginia Institute of Marine Science (VIMS), Gloucester Point, VA; Dr. James Wesson, Virginia Marine Resources Commission (VMRC)

Prior to 1994 oyster management in Virginia was affected in the absence of data on standing stock of oysters on the public oyster (Baylor) grounds. Prior monitoring efforts by both VIMS and VMRC provided a broad spatial and temporal record of oyster stocks in the form of shellstring surveys (settlement) and dredge surveys (semi-quantitative studies expressing data on a per-bushel basis). These data were, however, of limited value in developing long-term restoration plans for the Virginia oyster resource where the foremost driving principle was to effect no net loss of standing stock over each annual cycle of restoration and fishing activity.

In the fall of 1993 a joint VIMS-VMRC effort was initiated to develop a standing stock estimate for the major oyster resources in Virginia waters. Known oyster resources were

identified. Stratified random surveys were effected for major oyster resources in the James River, and supplemented over time with similar surveys in the Rappahannock, Piankatank and Great Wicomico Rivers, Tangier Sound and other selected regions in the mainstem of the Chesapeake Bay. Hydraulically operated patent tongs were the sampling instrument of choice, providing a large (one-meter-square) sampling area per grab with adequate penetration of the substrate to include buried shell within the sample. Each sample provided information of absolute numbers of oysters per square meter, demographics of the population, quantitative information on recent mortality, and abundance data for shell substrate.

The fall 1999 continuance of the patent tong standing-stock survey represents the seventh year in an uninterrupted series of annual oyster surveys designed to estimate standing stock in absolute terms, and to provide for sensible management of the resource as a joint effort in both supporting the fishery and rebuilding the stock over a decade time period. The substantial database also provides, as will be illustrated in the presentation, signals that demonstrate the positive effects of shell supplementation on productive reefs, the impact of summer freshets, small-scale variability in both recruitment and growth along environmental clines, and interannual variability in non-fishing mortality. The database represents nearly 5,000 stations sampled over the seven-year time period, and can be used as an example of how effectively to optimize sampling design.

Presentation Notes:

- Speaker cautioned against placing oysters where they have not successfully grown or developed over time.

- Commented that we are trying to control harvest when that is a small part of variability, a small proportion of the signal–unfortunately, it is nearly the only variable we can control.

- Recommends focusing on numbers and size frequency distributions; and spending more time focusing on shell volume, because increases in clean shell yield record spat sets.

- To maintain oyster habitat, we must keep track of absolute numbers of oysters by size class, by region or reef system, over time–and the rest is a management decision. Data should be used to support management decisions.

- Must also consider population dynamics models to understand the relationship of the presence of oysters now to presence of oysters in subsequent years.

- Recommends building population dynamics model: numbers are what we need. If we’re going to set specific goals we must have accurate data.

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TRENDS IN ABUNDANCE, BIOMASS AND HEALTH OF MARYLAND'S OYSTER POPULATIONS, 1990-1999

Abstract:

Dr. Stephen J. Jordan
Maryland Department of Natural Resources

In 1990 Maryland initiated new protocols for monitoring oyster populations. The traditional Fall Oyster Survey, comprised of annual dredge samples from hundreds of oyster bars, was amended to include replicate sampling, size frequency and disease data from a fixed group of 43 oyster bars selected to be representative of all oyster-producing areas in Maryland's Chesapeake Bay. This enhanced survey provides consistent information on spatial patterns and trends in recruitment, pathology, mortality and population size structure. The data also support fishery-independent estimates of fishing mortality, and calculation of trends in relative biomass and abundance for the population. In the early 1990s, market-sized oysters were depleted by concurrent outbreaks of MSX and Dermo diseases. A heavy spat set in 1991 and moderate spat set in 1992 resulted in a modest recovery in the abundance of larger oysters by the mid-1990s. Near-record spat densities were observed in 1997, but in 1999 Dermo and MSX infections returned to the peak levels of 1992. Spat set in 1999 was moderate Baywide, but heavy in a few areas. Maryland oyster landings reached a historic low of about 70,000 bushels in the 1993-1994 season, then rebounded to more than 400,000 bushels in the 1998-1999 season. The status of the population and fishery landings over the next few years will depend on survival of the 1997 year class and subsequent recruitment.

Presentation Notes:

- Dredge data can provide most of the required information except absolute abundance.

- Argues that if we want tenfold increase, must reckon it on a biomass basis; can do it on a relative basis but not necessarily on absolute numbers–can follow trends based on historical data.

- Oysters showed a modest recovery between 1993 and 1998, but it's unclear whether the recovery will continue.

- MSX and Dermo were rampant in 1999–we expect to see this translate into a significant problem next year. Mortality will likely increase if the drought continues.

- When oysters are first exposed to disease, we see 80 percent to 90 percent mortality; this drops in subsequent years to between 40 percent and 60 percent. It is unknown whether this is tolerance or resistance.

- It was noted by the audience that the largest oysters are important for fecundity and disease resistance; a buy-back program was suggested as one management possibility.

- As shell decreases, the spat declines.

STATUS OF THE MAJOR OYSTER DISEASES IN CHESAPEAKE BAY IN 1999 AND CONSIDERATIONS FOR FUTURE RESTORATION EFFORTS

Abstract:

Dr. Eugene M. Burreson, VIMS

During the years 1996-98 significant declines in *Haplosporidium nelsoni* (MSX) and *Perkinsus marinus* (Dermo) prevalences were observed throughout the Chesapeake Bay, and important successes in oyster restoration efforts occurred. This reprieve from disease pressure was due to climatic fluctuations that resulted in high streamflows yielding low salinities and relatively cool temperatures. In 1999, we observed a dramatic resurgence of both diseases as environmental conditions once again promoted the proliferation and spread of the pathogens. Unusually warm temperatures were observed throughout the year. Weekly average water temperature recorded in the lower York River (YR) at VIMS exceeded long-term averages more than 80 percent of the time. Based on the long-term average, one would expect to see winter water temperatures remain below 5.0°C for a period of eight weeks; however, in 1999 weekly water temperature averages never went below 6.0°C. In addition to being warm, 1999 was extremely dry. Continuing a trend that began in the summer of 1998, estimated streamflow entering Chesapeake Bay in 1999 was below average for all months except September and October, and monthly streamflows for May and June were the lowest recorded during the 48-year monitoring period.

As a consequence of the relatively warm temperatures and high salinities, severe epizootics of both *H. nelsoni* and *P. marinus* occurred in most tributaries in Virginia and in several areas in Maryland. In the upper James River, Virginia, prevalences and intensities *of P. marinus* were the highest on record. The proportion of advanced infections (moderate and heavy intensity) in October was as high as 60 percent at Wreck Shoal and 48 percent at Horsehead Rock and significant mortalities occurred in these areas. Record high levels of *P. marinus* were also observed in Virginia's other major tributaries and prevalences exceeding 90 percent were observed in many areas in the upper Bay. *Haplosporidium nelsoni* was not nearly as widely distributed as *P. marinus*; however, it was observed at record high levels in many areas. Particularly hard-hit was the Great Wicomico River, where, in midsummer, MSX prevalences were as high as 64 percent, and extensive oyster mortalities occurred. Relatively high prevalences of *H. nelsoni* were also observed in the Rappahannock River. The parasite was found at lower prevalences in most other Virginia tributaries and in several upper Bay areas.

The resurgence of oyster disease in the Chesapeake Bay in 1999 underscores how quickly the diseases can intensify in the wake of favorable environmental conditions and how unlikely is disease eradication. Given the serious impact that oyster disease has on Chesapeake Bay oyster populations, it must remain a critical factor for consideration when developing oyster restoration

strategies. Especially important is the avoidance of the movement of infected seed or when movement of infected seed is unavoidable there should be an appreciation of the disease status in the transfer area and of the consequences of the transfer.

Presentation Notes:

- If we continue to consume all the large (potentially disease-resistant) oysters, we can not study them.
- Purpose should not be to eliminate disease but to restore population.
- Must not let setbacks deter overall efforts.
- Restoration strategies must take disease into account.
- It is not necessary to move seed in order to restore reefs.

USE OF HISTORICAL RECORDS AND CHARTS IN RESTORATION OF CHESAPEAKE OYSTER POPULATION

Abstract:

Dr. William Hargis, Jr. (Presenter), Sharon Dewing, Helen Woods, and Dexter S. Haven, Virginia Institute of Marine Science.

Colonists and colonial travelers reported emerging or up thrusting oyster "shoals" in the James River estuary (Wharton 1957). Apparently, the earliest chart showing such shoals was that of Robert Tindall (1607).

Following the lead of aborigines Europeans harvested oysters from those shoals with little impact on oyster populations or their favored micro- or macro-habitats – the shoals. As numbers of Europeans and their harvesting technologies improved adverse impacts began to appear.

Some 200n years after European settlement of the Chesapeake region Virginia (1811) and Maryland (1820) banned use of oyster dredges. Though dredging was later reinstated these actions are taken as a clear sign that both states recognized the fact of overharvesting. Their corrective responses were superficial. Market-oyster production continued to decline. The true causes of its decline were either not recognized or ignored.

Stevenson (1894) called the oyster bars, beds or rocks of the upper Chesapeake system reefs. Further, he recognized that destruction of those reefs by oyster-harvesting and shell-mining were predominant factors in reducing market-oyster production.

This finding was largely ignored by managers and scientists until recently. Today, the importance of the reefs and their structure and associated benefits tot he well-being of the oyster populations that established and maintained them seems widely recognized. Questions exist as to what should be done next.

To help resolve them we seek useful clues from historical records and charts. This report

describes our studies of the historical bottom features of the James, most productive and persistent of lower-Bay oyster-producing estuaries and other once-productive Bay tributaries.

Using accepted computer-imaging techniques employed in VIMS' GIS program we are construction 3-dimensional bathymetric maps of the James and other estuaries. Our objective is to learn what those bathymetric reconstruction can tell us about where and ho reef restoration – or – construction efforts should be conducted.

Presentation Notes:

- Speaker emphasized that "Disease is a red herring that nature has thrown at oyster scientists."
- Navigation charts are an essential tool for oyster restoration.
- The precarious state of the oyster resource showed that oysters declined before disease arrived. The year 1884 was peak production Baywide, 1904 was peak production in Virginia. MSX didn't show up in MD until the 1960s.
- Speaker reviewed the history of reefs in Maryland and Virginia according to maps ranging from Tindall's (1607) through the present.
- Since it's nearly impossible to shut down the commercial fishery, we must establish sanctuaries, broodstock reserves, spawning reefs. Hargis described a model with vertical sanctuary reefs in the middle, serving as a broodstock reserve, surrounded by harvestable areas.
- The oyster population has been reduced primarily due to harvesting and shell mining. Disease is a secondary cause for decline that has been accelerated by a reduced quality gene pool due to over-harvesting.
- Reef restoration is probably the only way to rebuild beds.
- Reefs provide important ecological habitat. Reef dimension is an essential component of restoration.

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OYSTER REEF HABITAT

Abstract:
Dr. Mark Luckenbach, VIMS

As efforts proceed to rehabilitate oyster reef habitat, it will be important to optimize the use of limited shell resources. Much of the discussion to date has focused on the efficacy of planting shells in two-dimensional (low relief) versus three-dimensional (high relief) configurations. I contend that this dichotomy is an oversimplification and that we need to begin to consider specific aspects of reef architecture that promote oyster survival and growth. In that regard, there is clear evidence that interstitial space, to a depth of at least 15 cm, is important in enhancing the survival of new oyster recruits. Evidence from experiments conducted on shell-based reefs and from experimental reefs that vary in construction material (and hence the amount of interstitial space) clearly demonstrates that adequate sub-surface space within the interstices of a reef is necessary to achieve even modest survival of new oyster recruits. Similarly, there is clear evidence from several environments that vertical relief of substrate, both in relation to the seabed and tidal elevation, can affect the growth, survival, disease dynamics and reproductive output of oysters. Some of the effects are likely habitat-specific, but all studies to date indicate enhanced performance with increased elevation above the seabed as a result of increased food flux, reduced sedimentation and/or reduced low oxygen stress. A review of oyster stock assessment data from Virginia reveals an order of magnitude greater number of oysters per unit area reaching market size on high-relief reefs (~ 2 – 4 m) than on low-relief reefs (~10 – 20 cm). However, the same data normalized to the volume of shell required to create the habitats reveal similar oyster abundances (< 1.0 market-sized oyster per bushel of shell) in each habitat type.

The take-home message is that if our goal is to maintain short-term fisheries production, it may be sufficient to spread shell resources thinly and harvest oysters as they reach market size. This approach may in fact be sustainable, but only with continued high inputs of resources (i.e., shell and oyster seed). Alternatively, if our goal is to rehabilitate reef habitats, restore self-supporting oyster populations and develop a cost-effective sustainable fishery, we will need to initiate habitat restoration with appropriately scaled, architecturally complex reef bases and manage oysters in a fashion which permits them to complete the process of building biogenic reefs.

Presentation Notes:

- Interstitial space is an important component in oyster reefs.

- An experiment comparing substrates of ash or clam found that more spat survive on oyster substrate.

- Elevation above seabed affects growth, survival and possibly disease dynamics. This may be because oysters can avoid hypoxia. Also, there is increased flow and flux of food and decreased sedimentation.

- Relief should be high enough to provide habitat and to outpace sedimentation.

- Speaker believes that the enhanced settlement, growth and survival of oysters on high-relief, structurally complex reefs compensates for the “wasted shell.”

- Harvest is one part of the system we can control, but is a small signal of variability.

- How frequently should shell be replaced is a question that remains unresolved; it depends on site-specific goal.

- Oyster reefs are biogenic (i.e., formed by organisms) structures. Ultimately, “construction” of reefs must be done by oysters; our role in this process is to provide some substrate–and sometimes oysters–to jump-start the process.

OYSTER REEF RESTORATION IN MARYLAND

Abstract:

Chris Judy, Maryland Department of Natural Resources (MD DNR)

Maryland’s historic oyster bars were once heavily populated by oysters, resulting in ecologically valuable reef communities. Over thousands of years these oyster populations had built up large-scale, three-dimensional underwater “hills”(reefs). Those hills mostly remain today, as confirmed by comparing pre-harvest nautical charts to current bathymetry, but the dense population of oysters is largely gone, the result of over 100 years of harvesting and disease mortality during the latter half of the 20^{th} century. The loss of this living veneer of oysters resulted in a loss of the textured three-dimensional surface produced by the oysters themselves, and helpful to the associated organisms. Oysters not only need 3-D habitat, they *are* 3-D habitat. Re-establishing dense populations of oysters to once again provide a highly textured habitat is considered important for the Bay.

Maryland restores reefs by a) constructing man-made shell piles and b) rehabilitating natural underwater hills by planting shell. Shell piles vary from 30 feet long to over 100 feet long and range in height from about 4 feet to over 8 feet. Shells, a valuable and finite resource, in the interior of the pile are unavailable to spat set. In response, Maryland has also restored reefs by spreading shell about 4 inches thick on natural reefs to restore more acres for a given budget. For the cost of about 1 acre of man-made piles, approximately 8 acres of natural bottom can be shelled. This natural bottom is three-dimensional on a large scale. Either spat set or seed plantings on 8 acres will yield more oyster biomass than on 1 acre.

Maryland will continue to monitor reef projects to biologically and economically evaluate man-made and natural reef restoration approaches.

Presentation Notes:

- The value of shell and its importance in reestablishing habitat is obvious. Shell supply is limited and must be conserved.

- Presented summaries of Maryland project in Severn River and the Corps of Engineers projects in the Chester, Severn, Patuxent, Choptank and Magothy rivers. Five sites with shell piles, and two flat areas with natural relief. Naturally existing hills (reefs) cost $2,700 per acre; shell piles are $27,000 per acre.

- Discussed older charts and pictures of Tangier Sound off Smith Island; 1870s chart. Seventeen-foot depth. Depths are the same in the new charts. Bottom has had the same basic contour–nature creates the same shape repeatedly.

THE IMPORTANCE OF THREE-DIMENSIONAL REEFS

Presentation given by Dr. Ken Paynter, University of Maryland (no abstract available).

Presentation Notes:

- Speaker presented results from an Army Corps of Engineers project.

- Three plots were created for each site, with shell bases. Site F1 received 2 million per acre hatchery seed and resulted in one hundred market size per meter square on F1 plot. Site F2 received 250,000 natural seed and resulted in 10 market size per meter square.

- As of May 1999 no Dermo or MSX were detected on sites.

- Speaker showed a video clip of F1 showed three-dimensional reef (which had high density of seed from hatchery) with rich diversity of aquatic life, including anemones, mud crabs, blue crabs, ctenophores, and pipe fish.

- Video clip of site F2 showed lower density of oysters but using the same shell; high sedimentation, very little relief; the scattered planting didn’t develop into a complex community.

NEW TECHNIQUES FOR OYSTER RESTORATION

Presentation by Gary Smith, Oxford Laboratory (no abstract available).

Presentation Notes:

- Speaker presented results from mapping and analysis project. Discussed using remote sensing techniques and acoustic sea floor classification systems (ASCS).

- ASCS is accurate and precise, statistically robust, scale relevant, cost-effective, with sub-surface capability. The process allows one to create cross-section image–beam the bottom with generic impulse. Backscatter goes to satellite with bottom characteristics.

- This technique may be applied to find shell resources in sediment.

- ASCS can be used to generate charts to determine shell density and depth; integration of many data types.

RELATIONSHIP BETWEEN RESTORATION METHODS AND THE USE OF REEFS BY FISH AND CRABS

Presentation by Dr. Denise Breitburg, Academy of Natural Sciences.

The ecological value of oyster reefs includes their function as feeding, shelter and refuge habitat for finfish and crabs. Studies conducted in Maryland, Virginia and North Carolina have shown that estuarine fish assemblages often are more diverse, and that some individual species are more abundant, on and adjacent to restored reefs than over unstructured soft bottom sediments. However, we do not currently have the information needed to predict which characteristics of reefs maximize their benefit to fish and crab populations in Chesapeake Bay. We also have little information to determine how the various reef restoration methods differ in value as fish and crab habitat. The value of constructed, restored and protected oyster reefs as fish and crab habitat should be an important consideration when choosing among the techniques that are beneficial to oysters, and may provide justification for restoration efforts that are more costly than those required for oysters alone.

Researchers in Maryland, Virginia and North Carolina have examined the effect of vertical relief, reef construction material and salinity on the use of reefs by fish and crabs. The effect of reef vertical relief on use by fish and crabs needs more study. There is little data on this issue, and the results vary somewhat with sampling gear (affecting which species are most easily caught and whether fish using the reefs in different ways are equally susceptible), and whether the upper parts of high-relief reefs can serve as a refuge from hypoxic waters. Small-scale vertical relief within reefs may also enhance their value as settlement habitat for resident reef fishes and as feeding habitat for fish such as juvenile striped bass that prey on these settling larvae, but there are no data to suggest how much relief is required to provide these benefits. Field studies in VA have found that the material used to construct reefs affects the use of those reefs by fish and decapod crustaceans. Nestlerode and colleagues at VIMS have found that clam shells, which provide little interstitial space, are not used as extensively by fish as are reefs made from other materials. Finally, the fish assemblages that use oyster reefs vary with salinity. Maximizing the benefit for fish assemblages will require the construction of reefs in a variety of salinity zones.

In addition to refining data on the issues above, a number of other questions should be addressed if the agreed-upon goal is to maximize the ecological value of restored, constructed and protected reefs as well as to enhance oyster populations. For example, we do not know how the placement of reefs within the landscape affects their use by fish and crabs. Structured habitat may provide important migration corridors for mobile animals that rely on them for food or shelter. The proximity to other structured habitat, which includes submerged aquatic vegetation as well as oyster reefs in Chesapeake Bay, may thus influence the value of reefs to fish and crab habitat. We do not know if the value of a reef is greatest if it lies near other structured habitat or whether it is more critical to construct reefs where no nearby structured habitat currently exists. Similarly, we do not know if the size of oyster reefs is consequential to fish. Most commercially and recreationally important fish and crabs have daily ranges many times the size of reefs currently constructed. If small size diminishes the value of reefs as fish and crab habitat, it may be more essential to restore a few large areas than many small areas. Finally, we need to consider that reefs affect fish populations through food web interactions even at a distance from the reefs themselves. If the Bay community proposes to move toward ecosystem management, it will be important to consider the whole suite of potential effects of oyster reefs on fish and crab populations–not just their role as habitat used by fish and crabs.

Presentation Notes:

- Some fish species show a higher abundance around reef habitat compared to soft bottom habitat.

- Reef construction material matters in the context of whether it creates efficient interstitial space.

- There are insufficient data to determine the importance of large-scale vertical relief to fish except where high relief provides a refuge from low oxygen in bottom waters. Small scale vertical relief within reefs may enhance the habitat value for settling fish larvae, and provide feeding sites for juvenile striped bass.

- Reefs should be placed within variety of salinity regimes.

HATCHERIES AND RESTORATION

Presentation by Dr. Ken Paynter, University of Maryland (no abstract available).

Presentation Notes:

- Some key questions overlay the role of hatcheries in ecological restoration. These include :

- If you build a structure "will they come"?
- Should you build it anyway? Is jump-starting a reef with hatchery seed productive?

- Hatcheries play an important role in providing disease-free seed, providing high density seed where recruitment is low, and providing an ability to control genetic stock.

GENETIC CONSIDERATIONS FOR HATCHERY-BASED RESTORATION EFFORTS

Abstract:

Dr. Standish K. Allen, Jr.
Aquaculture Genetics and Breeding Technology Center, VIMS

One of the far-reaching effects of commercial fisheries is a fundamental shift in the population genetics of a species. Numerous such cases have been documented in various fisheries around the world. For oysters of the Chesapeake Bay, there was likely little net effect on population genetics except to reduce overall population size until the advent of the diseases MSX and Dermo in the late 1950s. When diseases cropped the effective size of the breeding population in the Chesapeake Bay, the number of reproductively capable adults was probably low enough so that harvest from fisheries could make a significant impact, especially acting in concert with diseases.

Diseases act on less robust oysters in the population, leaving hardier, disease-resistant adults to survive. Normally these hearty adults would reproduce and drive the population to ever-increasing disease resistance over time, but instead, they are taken in the fisheries. In effect then, both small, susceptible oysters are removed from the population by diseases and large, resistant ones by fishing. This is called stabilizing selection and results in decreased genetic variation. In particular, it results in loss of alleles for disease resistance. Thus it might be argued that the current natural oyster populations have lost some of their capability to respond to disease challenges.

Might there be a role for artificially selected, disease-resistant stocks in oyster reef restoration? Perhaps if it could be shown that artificially derived strains provided a source of larvae to the restored reefs and their surroundings, and that the infusion of disease-resistant alleles was sufficiently large to bolster disease resistance among natural populations (by interbreeding), stocking hatchery seed onto reefs would make sense. And then there's the question of whether it would make sense or be economically feasible to stock reefs with resistant seed on a recurring basis.

Presentation Notes:

- Through artificial selection, disease resistant alleles can be enriched.

TOYS OR TOOLS: USING OYSTER HATCHERIES IN RESTORATION PROJECTS

Abstract:

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Oyster hatcheries have a long history in the Chesapeake Bay region and elsewhere. Until recently, hatcheries have not been looked upon as major tools in large scale oyster reef restoration projects due to a perception that they are cost prohibitive. Recent emphasis on utilizing hatchery technology has demonstrated their ability to produce significant quantities of oyster seed at costs that are similar to those for more traditional “natural” methods of spat production. Comparisons are made with cost estimates for natural seed and factors that may further demonstrate the advantages of hatchery produced seed are discussed. Improvements in hatchery methods, cultch handling, and transportation should further reduce the cost of hatchery production making hatchery seed competitive with natural seed in many instances.

Presentation Notes:

- Natural seed is most cost-effective when consistent, heavy natural sets occur.
- Hatchery seed is most cost-effective when sets are limited and not dense.
- Current plans to improve hatcheries will make them more cost-competitive.

STATUS OF SHELL SUPPLY FOR REEF RESTORATION AND ENVIRONMENTAL IMPACTS OF DREDGING

Abstract:

Chris Judy, MD DNR

Oyster shell is an essential component of oyster restoration. Two sources of oyster shell include a) ancient buried deposits from which shells are dredged, b) shucking houses, which supply shell as a result of oyster processing. Shucked shells are available in limited quantity (about 150,000 bushels in Maryland per year) compared to dredged shells which are very abundant (more than 2.5 million bushels in Maryland per year).

Shell dredging began in 1960 and has occurred primarily in Maryland’s upper Bay near Tolchester Pooles Island. Since 1960, Maryland has planted approximately 180 million bushels of

shells. The shell dredging areas are nearly exhausted after 40 years. To continue dredging shells, new areas need to be permitted and access to some old permitted areas needs to be opened. Permits are increasingly difficult to obtain due to environmental concerns raised by permit agencies and fishermen. In addition, shell deposits are large scale, natural three-dimensional structures and dredging them to build very small scale man-made three dimensional structures is problematic. Deposits to support future shell dredging exist in the upper Bay north of Pooles Island, in the upper Potomac River and some locations in Virginia. Acquiring permits will be difficult.

As an alternate to dredging ancient shell deposits, new approaches to supplying shell involve cleaning exposed shell on natural bars, extracting shallow buried shells from oyster bars and using alternate cultch material (non-shell material). Shell cleaning is done by vacuum technology in some northern states with success and shell extraction has been tested in Virginia with favorable results. Alternate cultch materials are usually limited in quantity. Any new approach will need to provide large scale results (thousands of acres), be economical and be "permittable" by regulatory agencies.

Presentation Notes:

- Presented data on shell plantings and costs from 1990-99: 22 million bushels planted over 4,000 acres, at a cost of $8 million.

- MD pays for the service: dredging, washing, transport and planting–but not for the shells themselves.

- MD dredges for shells in Upper Bay, where there is low salinity and few oysters.

- The dredging process is controversial. Dredging changes bottom topography, some worry about fishery impacts, and the affect of plumes on benthic organisms. In some cases more fish are found along the edge of dredged areas rather than in undredged areas. Benthic organisms are dramatically affected at first, but quickly recolonize.

- Alternative cultch materials are being considered.

<u>WHAT IS THE STATUS OF SHELL SUPPLY OR OTHER REEF CONSTRUCTION MATERIALS?</u>

Abstract:
Dr. Jim Wesson, VMRC

The availability of shell cultch or other suitable reef building materials will determine how fast reef restoration can occur. Shell cultch is available in both Maryland and Virginia from a number of sources. Fresh-shucked oyster shells currently provide a total Baywide of 600,000 to 800,000 thousand bushels (38,000-50,000 cu. yds.) of cultch. Fresh surf clam, conch and hard

clam shells are available in small quantities, but the availability varies with harvest amounts. Dredged fossil shells represent the largest potential for cultch and are in deposits throughout much of the Bay. If properly managed, 6 million to 8 million bushels (400-425 thousand cu. yds.) could be produced annually from these deposits for many years. The harvest of these shells requires an underwater dredging operation with associated environmental impacts that will have to be balanced with the benefits accrued from habitat improvement that resulting from restored oyster habitat.

There is the opportunity to recycle some shells and recapture shells buried a small distance in the sediment. The towing of crab or shellfish dredges without the harvesting mesh bag has been used for many years to turn over shells; however, most quantitative studies have been found little or no long-term benefit to this practice. Virginia has had some success in recent years with an hydraulic excavating apparatus that can harvest and relocate slightly buried shell, but this has mostly only been attempted in small projects.

All known sources of shell cultch are limited and may not be sufficient for large-scale, three-dimensional reef restoration. Shell cultch will remain a valuable resource and should be conserved and not wasted for either the core or underlayment of reef restoration projects if suitable alternatives can be found. Many biologically inert waste products may be available for these applications and should be tested. Broken concrete, stabilized coal ash, recycled glass, vitrious china, other building materials or dredge spoil may be useful as the core or underlayment for many projects. These materials may save valuable shell cultch, while at the same time reducing construction costs.

CONCLUSION

The January 2000 Oyster Restoration Workshop presented an opportunity for many Bay stakeholders–including scientists, watermen and managers–to discuss and begin to resolve the fundamental and pressing issues that pertain to oyster restoration, and to build consensus. The two-day meeting underscored the fact that we share the benefits and responsibilities generated by this important natural resource. The workshop process enabled participants to reach genuine consensus on several key issues, and allowed them to exchange information about mutual concerns and conflicting interests. Participants also began to identify directions for further research and to set explicit goals for action.

SUMMARY OF MAIN CONSENSUS POINTS

- Sanctuaries are an essential component of a successful oyster restoration strategy.
- Ten percent of the historic productive oyster reef acreage should be placed in protected sanctuary areas.
- Reefs are biogenic and should be managed for maximum ecological benefit.

NEXT STEPS

- To strengthen and add momentum to the progress the workshop generated, we recommend that additional workshops be scheduled and conducted to resolve remaining issues, such as stock assessment.
- The workshop yielded recommendations for revisions to the Aquatic Reef Habitat Plan and should supply additional support for revisions to the Oyster Management Plan.
- We hope that the present document can serve to educate and offer support to other oyster restoration initiatives.

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Cover illustration courtesy of Alice J. Lippson, from *Life in the Chesapeake Bay*.

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