VIRGINIA SEA GRANT

PROGRAM REPORT 1999-2000

Sea Grant
Virginia

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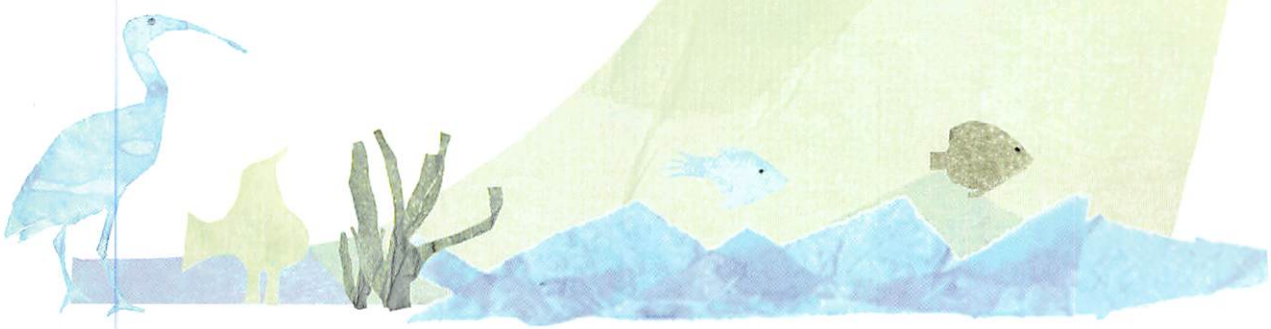

Virginia Sea Grant Program Report 1999-2000

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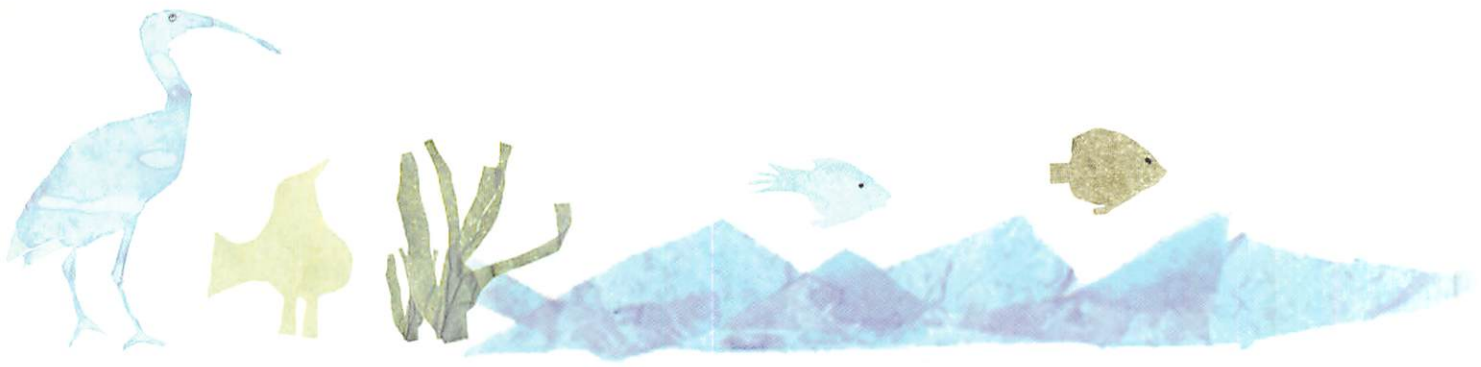

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letter from the director

The coastal lands and natural resources of Virginia provide us with many opportunities for making a living, enjoying various seafoods, recreational fishing, boating and swimming, sightseeing, and other activities that are part of our daily routines. For these lands and resources to remain available to ourselves and to the generations to come, those who make use of them must do so with knowledge of how to maintain these valuable assets into the future. The Virginia Sea Grant College Program is designed and managed to conduct research projects, educational activities and advisory services (i.e. outreach or technology transfer) that provide the information necessary for effective and sustained use and management of the Commonwealth's coastal and marine resources.

The report you are holding covers Virginia Sea Grant activities during 1999 and 2000. In this report, we have elected to highlight several projects that are representative of the program during these years. The program activities that we have included emphasize achievements of interest to the general public and serves as a summary record for individuals from government, industry and academia.

We could not possibly have produced a report that described every activity in which Sea Grant personnel are engaged without having it become unbearably burdensome for the general reader. Thus, as you read this report, please keep in mind that it is not a comprehensive documentation of the entire program – rather, it is a series of snapshots that give you an idea of the types of research, education and advisory activities that comprise the Virginia Sea Grant College Program and the impacts that these activities have had on the economy of Virginia and the management of its coastal and marine resources. You can get an idea of the extensive nature of Virginia Sea Grant by referring to the directory of projects that is provided toward the back of this document.

As you read the report, please take note of the many partnerships that have evolved within the projects, as well as the leveraging of resources that occurs to make many of them possible. Partnering and leveraging are of ever-increasing importance to a program like Sea Grant because of the added strengths of expertise and capability they bring to the projects or activities that are involved.

Finally, although this report covers 1999 and 2000 in the life of Virginia Sea Grant, I would encourage you to visit our website for additional information about projects and activities in our program, as well as linking you to the national network of Sea Grant programs throughout the United States.

William L. Richards

enhancing wild fish stocks through aquaculture

Wild finfish stocks are declining worldwide due to overfishing, habitat degradation and deteriorating environmental conditions. As these and other pressures take their toll on wild fish populations, the fishing community is increasingly looking to aquaculture to offset these threats to livelihoods and recreational pastimes. One fish garnering attention is the cobia, a mild tasting, flaky white fish prized recreationally as well as commercially.

Cobia grows very rapidly, can be trained to accept a prepared diet, is a highly popular recreational species, and offers expanding opportunities in the food market. Moreover, its ability to hatch millions of eggs in a short time, along with its high fillet yield, should enable production at a competitive price in global seafood markets, and may provide new economic opportunities in coastal areas for aquaculture and seafood processors.

A Virginia Sea Grant project took an important first step in the successful aquaculture production of cobia. Despite growing knowledge about cobia biology and culture, questions remained about successful spawning, egg production and viability, and larval maintenance – all issues demanding answers before industry might be willing to risk production on a commercial scale.

Researchers at the Virginia Institute of Marine Science set out to spawn healthy cobia eggs in captivity, followed by fertilization and grow-out of larval and juvenile stages. The researchers arranged for recreational cobia fishermen to capture wild broodstock fish in lower Chesapeake Bay in June 2000. Nine wild caught brood fish were selected for spawning at the marine finfish culture facilities at VIMS. Because no one in the U.S. had succeeded in naturally spawning cobia in tanks despite years of trying, the researchers implanted a spawning hormone in both male and female fish and placed them in a large recirculating water tank equipped with an egg collection device. Within 48 hours of the hormonal implants, the six females (several weighing close to 50 pounds) and three males began spawning. Of the millions of eggs collected, approximately 30 percent hatched. Although only a small number of animals matured through the larval stage to metamorphosis, the project still represented the first time in the U.S. that juvenile cobia were produced in captivity. Results clearly showed that animals could be grown to market size in less than eight months – demonstrating the feasibility of commercial production.

This project strengthened ties between Virginia Sea Grant and recreational fishing associations whose continued support ranges from scientist participation in fishing tournaments for brood stock acquisition, to conducting "fishing for science" tournaments with no-kill guidelines. Although the economic benefits from this project are not yet quantifiable in terms of dollars generated, early information predicts a ready market, with seafood dealers, restaurants, and the general public all favorably accepting cultured cobia during product trials.

Scientifically, the results are focusing more attention on the potential for cobia culture, and ongoing discussions with scientists and industry members have led to better use of scarce research funds. Moreover, the attention paid to cobia by the recreational fishing community has led to increased interest in better management of the natural stocks and in the potential for the use of cultured cobia in stock enhancement projects.

VA-T-99-3 Technology (Aquaculture): Develop Sustainable U.S. Aquaculture. Captive Spawning, Larval and Early Juvenile Culture of Cobia *(Rachycentron canadum).* Duration: 10.1.1999-9.30.2000. Principal investigator: Michael Oesterling (Virginia Institute of Marine Science). Associate investigator: Jeffrey Tellock (VIMS).

Ongoing discussions with scientists and industry members have led to better use of scarce research funds.

Cobia aquaculturist Mike Oesterling gets a friendly greeting from an 80-pound "pet" from the brood stock at VIMS.
Photo: Pauli Hayes

For further information, contact Mike Oesterling at mike@vims.edu

revitalizing the nation's commercial fisheries

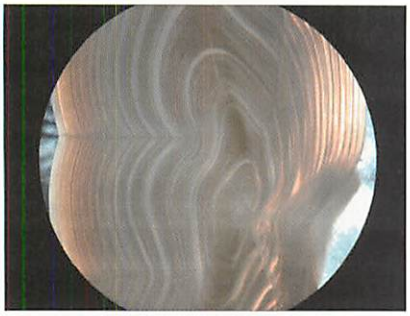
R/CF-36 Revitalizing the nation's commercial fisheries: Resolving stock structure and age-specific migrations of Atlantic coast weakfish (*Cynoscion regalis*) using chemical signatures in otoliths. Duration: 2.1.1999–1.31.2000. Principal investigators: Cynthia M. Jones (Old Dominion University); Simon R. Thorrold (Woods Hole Oceanographic Institute).

Weakfish *(Cynoscion regalis)* landings along the Atlantic coast of the U.S. have recently shown a significant decline, and efforts to manage this fishery are handicapped by an inability to determine the spatial extent of stocks. Adult weakfish follow a seasonal migration pattern, moving south and offshore during fall and winter, and returning northward during spring and summer. Younger weakfish stay inshore in more southern waters. The potential for stock mixing during the over-wintering period has led to concerns that catches off North Carolina bear some responsibility for the decline of the weakfish catch in northern waters, as does most of the South Atlantic shrimp trawl bycatch, largely composed of juvenile weakfish.

Judicious management of marine fishes depends on distinguishing among adjacent or mixed stocks. Unfortunately, there appeared to be few (if any) markers – genetic or morphological – that could reliably differentiate among all stocks of any marine fish species. Earlier Virginia Sea Grant-funded DNA analysis of juvenile weakfish confirmed little evidence of genetic variation along the Atlantic coast. Clearly, tools with greater temporal resolution were required for weakfish stock identification. While routinely used in age determination, previous studies provided encouraging signs that the chemical composition of otoliths (earbones) might prove the most powerful means to date of distinguishing among fish stocks.

Considerable potential benefits to fisheries management are possible now that geochemical signatures in otoliths are shown to be reliable natural tags of natal area.

To test this hypothesis, the researchers removed otoliths from weakfish along the Atlantic Coast and analyzed their geochemical signatures. Homing of spawning weakfish to their natal locations was high, from 56 percent to 79 percent, and strays were largely found close by. Contrary to results from genetic analyses, there is clearly considerable structure in weakfish populations throughout their range. Perhaps not surprisingly, Chesapeake Bay represented an area of considerable population mixing. The second striking pattern in these data was the high levels of spawning site fidelity, strongly suggesting that, at least in some conditions, adult weakfish can accurately navigate back to their natal estuaries to spawn.



Cross section of a fish otolith shows natural "tags" used to track fish migration patterns.
Photo copyright Kevin Telmer, University of Victoria. Used with permission.

Considerable potential benefits to fisheries management are possible now that geochemical signatures in otoliths are shown to be reliable natural tags of natal area. Although weakfish were chosen to test the approach due to life history characteristics including inshore spawning, the technique will be widely applicable to a number of marine species such as Atlantic bluefin tuna, Pacific salmon and Atlantic cod.

Although it is difficult to quantify the value of this research, the devastating impact of the collapse of the northern cod fishery on coastal communities is a stark reminder of the costs of improper fisheries management. More immediate financial benefits of this research will be seen if geochemical signatures in otoliths can be shown to augment conventional tagging approaches. Finally, there is a growing realization in fisheries management that spatial models, and spatial management practices such as marine protected areas, will be necessary for improved stewardship of marine resources. Data from geochemical signatures in otoliths will allow much more accurate models, as well as a means of documenting the success of marine protected areas. Improved stewardship of these resources *should provide* quantifiable benefits to society throughout the next century.

For further information, contact Cynthia Jones, cjones@.odu.edu

revitalizing the nation's commercial fisheries

Observers have long noted that oyster disease episodes tend to coincide with seasonal changes, indicating that climate variations can significantly impact the duration, severity and frequency of disease outbreak. These observations led a regional team of researchers to simulate climate variations as well as oyster disease in a pioneering model that may yield benefits for threatened marine species as well as the economic systems depending on them.

In earlier work, models were developed that accurately simulate annual cycles of intensity and prevalence of the parasitic diseases Dermo, caused by *Perkinsus marinus,* and MSX, caused by *Haplosporidium nelsoni,* in eastern oyster *(Crassostrea virginica)* populations. The host-parasite models show the growth and death of the parasites, as well as the growth and development of the oyster.

These oyster models provided insights into the environmental and biological processes underlying observed seasonal patterns in disease prevalence and intensity. Multi-year simulations of these host-parasite interactions show that Dermo and MSX outbreaks can be triggered by warm winters and high salinity (drought). Cold, wet winters can end an outbreak of Dermo, whereas cold winters alone can terminate an epizootic of MSX. The simulations further show that sensitive environmental periods affect the severity of the two diseases for months and sometimes years into the future.

Simulations show clearly the role of climate variations in controlling Dermo and MSX diseases.

This research project used Dermo and MSX oyster models to predict when and where these diseases might sicken large numbers of oysters. The study focused on how climate variations – even small ones – can initiate and control outbreaks of Dermo and MSX disease in oyster populations in Chesapeake and Delaware Bays. The researchers also looked at how the two diseases interact in oyster populations in both bays.

Simulations for the lower Chesapeake Bay show differences between simulated and observed MSX disease prevalences and intensities – arising from circulation variations in these areas. A result may be differences in MSX disease transmission rates in the upper and lower Bay. An additional result of the multi-year simulations of MSX disease in both bays shows an increase in MSX infective particle concentration over time. Extending the models to the full range of Chesapeake Bay will allow the implications of this result to be more fully explored.

Simulations show clearly the role of climate variations in controlling the two diseases. These results suggest that when carbon dioxide is increased, Dermo and MSX disease will decrease in prevalence and intensity throughout Chesapeake Bay. Moreover, the effect of decreased salinity, from increased precipitation as the climate warms, will reduce oyster populations in the northern portion of Chesapeake Bay. One implication of the future climate simulations is that survival of northern Bay oyster populations may depend on immigration of individuals from southern Chesapeake Bay populations.

Part of the project involved a model for the management of fished oyster populations in which disease mortality is a controlling factor. This model is general enough that it can be applied to any commercial shellfish species, and shows that appropriate timing of the fishing season with respect to the timing of disease mortality can more than double the yearly allocation to a fishery.

VA-OD-99-1 Oyster Disease Research Program: Revive the Nation's Commercial Fisheries – Modeling the effects of climate variability on the prevalence and intensity of Dermo and MSX diseases in the eastern oyster populations. Duration: 10.1.1999–9.30.2001. Principal investigator: Eileen Hofmann (Old Dominion University). Associate investigators: John Klinck (ODU), Gene Burreson (Virginia Institute of Marine Science). Other Co-Principal Investigators: E.N. Powell and S.E. Ford (Haskin Shellfish Research Laboratory) S.J. Jordan (Paul S. Sarbanes Cooperative Oxford Laboratory).

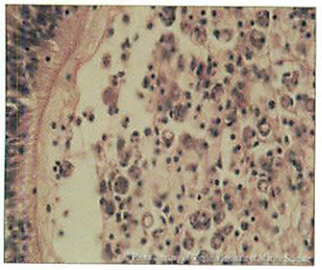
Healthy oyster beds such as this one are increasingly rare.
Photo courtesy NOAA.

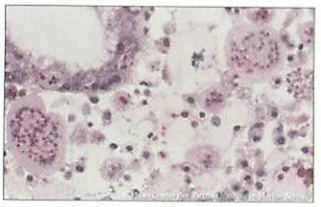
For further information, contact Eileen Hofmann
hofmann@ccpo.odu.edu

VA-OD-99-2 Revitalize the Nation's Commercial Fisheries: Cooperative Regional Oyster Selective Breeding (CROSBreed) Project: Potential of selected stocks for restoration and extensive planting (ODRP). Duration: 10.1.1999 – 9.30.2001. Principal investigator: Standish Allen, Virginia Institute of Marine Science. Associate investigators: Eugene Burreson and Mark Luckenbach (VIMS).

Despite the devastating impact of the parasitic diseases Dermo and MSX on oyster populations in Chesapeake Bay, some oysters survive because of natural resistance to infection. Scientists at Rutgers University have for 30 years bred MSX survivors to produce descendents resistant to the parasite. While these oysters could fight off MSX, native Virginia oysters (*C. virginica*) remained susceptible to Dermo. Scientists from four mid-Atlantic institutions embarked on an ambitious regional program to breed MSX-resistant oysters for resistance to Dermo as well. After MSX disease resistance developed over several generations, synthetic lines – CROSBreed (XB) – were bred from the resultant oysters in response to Dermo disease challenge.

Trials in Delaware and Chesapeake bays showed MSX levels that were lower in XB oysters than in the other lines. The most important attribute of XB, however, is that it grew and survived at least as well, if not better, than control stocks in all locations. In fact, it fared better than wild stocks overall and may be appropriate for restoration purposes, in which longevity and reproductive success are required.





Top: The parasites Dermo, (top) and MSX (bottom) infect oyster tissue.

Testing revealed that XB3, the third generation of CROSBreed oysters, is innately resistant to Dermo. Because field results of XB oysters indicate they are hardier than wild controls, investigation has begun into potential "genetic rehabilitation" using XB or other disease resistant stocks.

The researchers amassed a brood stock repository and also produced "generic" XB lines, intended for single use by hatcheries and not for line propagation. Brood stock were distributed to three mid-Atlantic hatcheries, where XB seed was propagated and then distributed to commercial buyers as well as public programs.

Historically, oyster restoration efforts in Virginia have focused on building reef sanctuaries. A collaborative effort among VIMS, the Virginia Marine Resources Commission, the Chesapeake Bay Foundation, a private oyster hatchery, citizen's groups and public schools has been growing hatchery-produced oyster seed to a plantable size and then placing them, along with wild-caught oysters, on three-dimensional sanctuary reefs built by the VMRC. Researchers are monitoring survival, growth, disease status and egg production by each stock type.

CROSBreed now is less about the strain of oyster than about regional collaboration to use XB and other resistant strains in aquaculture and restoration.

The CROSBreed project has generated numerous benefits in addition to its success with a disease resistant stock. XB stocks released to hatcheries have been distributed to oyster growers for public programs, private oyster gardening, and oyster repletion. The distribution of XB brood stock has helped increase awareness of the genetic origins of natural oyster stocks as well as artificial strains. XB oysters have become a favorite template for other research projects, especially those studying disease mechanisms, and XB strains are now highly visible among citizen gardeners and industry growers.

Photos courtesy VIMS

For further information, contact Stan Allen, ska@vims.edu

Probably the most profound effect of the CROSBreed project, however, is that it drew investigators together into a regional, mission oriented approach. Shared resources and a common breeding goal have been central to the collaboration in the CROSbreed project from its inception, and CROSBreed now is less about the strain of oyster itself than about regional collaboration to use XB and other resistant strains in aquaculture and restoration.

revitalizing the nation's commercial fisheries

Concern is growing over the imminent impact of the Asian veined rapa whelk, *Rapana venosa,* on both the ecology of local shellfish populations and the economy of the industry they support. Strong evidence suggests that the mollusk crossed oceans in the ballast water of ships sailing from Asia and the Mediterranean Sea and spread to the Black Sea. There, without major predators, the growing population has decimated native oyster, scallop and mussel populations.

The goal of this ongoing Virginia Sea Grant study is to suggest methods to control or eradicate this non-native nuisance species. With active collaboration from NOAA agencies as well as the shellfish industry, researchers at the Virginia Institute of Marine Science continue to document the local distribution of adult *Rapana* in Chesapeake Bay.

Based on thermal tolerances of native adult animals and temperature and salinity tolerances of larval forms, researchers used 3D circulation modeling capabilities to estimate dispersal of larval forms. Collections to date indicate that *Rapana* has successfully reproduced in local waters – an observation supported by field collection of viable egg cases as well as extensive studies of larval and post larval biology.

As part of the effort to document the spread of *Rapana venosa* in Chesapeake Bay, scientists at VIMS also maintain a bounty program for industry and private citizens. Three distinct size classes are a clear signature of establishment of the invading population. Collaboration continues with workers in Italy, Turkey, France, and Uruguay who are also investigating emerging invasions by *Rapana.*

Examining post settlement growth and predation as indicators of ecological impact, the researchers are refining their estimates of how the non-native whelk might be expanding its territory and competing with native species. They found that *Rapana* preys upon all native bivalve species – including oyster, hard and soft clams, and mussels. These data are now part of a study estimating available food resources in the invaded region. Predation studies on native shellfish suggest an increasing negative impact on local fisheries – for example the invaders have demonstrated a dietary preference for the commercially valuable hard clam (*Mercenaria*). *Rapana* shells also shelter the striped hermit crab, which preys on oyster spat and also is expanding its range.

Researchers and industry members are collaborating to prevent the reproduction of *Rapana* by controlling the mating piles of adult whelks. Related research with commercial fishermen where *Rapana* is collected as bycatch is in a second phase of counting and archiving species "signatures" for eventual GIS presentation on the web.

A VIMS program on molluscan biology has incorporated data from the project, providing a resource on shellfish management issues. The program has catalyzed an active collaboration with Virginia industry in ballast water control technology as well as providing Congressional briefings on Capitol Hill. A high public profile is maintained through the media in addition to educational programs in museums and schools.

The impact of this work is reflected in the engagement of commercial fishermen in both active research and control of non-indigenous species in U.S. coastal waters. The increasing awareness has contributed to a continuing focus on control. On the educational side *Rapana* has become a "poster child" for invasion biology in the Chesapeake Bay region as outreach efforts have carried information to museums and schools.

VA-NI-99-3 Aquatic Nuisance Species Research and Outreach: Current distribution, potential range expansion, ecological and commercial impact, and control of the non indigenous marine gastropod *Rapana venosa.* Principal investigators: Roger Mann, John Graves and Juliana Harding, Virginia Institute of Marine Science. Duration: 10.1999-9.2001.

Rapana preys upon all native bivalve species – including oyster, hard and soft clams, and mussels.

***VIMS maintains a bounty program for the distinctive* Rapana venosa.**

Photo copyright Juliana Harding, VIMS. Used with permission.

For further information, see http://www.vims.edu/mollusc or contact Roger Mann rmann@vims.edu or Juli Harding jharding@vims.edu

revitalizing the nation's commercial fisheries

Restoring healthy populations of the indigenous Eastern oyster *C. virginica* to Chesapeake Bay is a vital component in oyster regeneration goals important to the nation and the mid-Atlantic region. The native oyster, its once-abundant populations decimated by overfishing as well as the oyster diseases Dermo and MSX-disease, can no longer support the livelihoods of watermen. Crucial to the success of oyster aquaculture in the Chesapeake Bay and other areas of the eastern seaboard are continued development of strains of *C. virginica* that are resistant to the oyster disease Dermo, caused by the parasite *P. marinus*. Responding to these economic as well as environmental issues, oyster researchers are focusing on rebuilding a healthy native oyster.

Identifying biomarkers resistant to Dermo will enable researchers and aquaculturists to rapidly screen and select oysters for generating disease resistant brood stocks.

VA-OD-99-6 Revitalize the Nation's Commercial Fisheries: Oyster Disease Research Program - Comparative Examination of Biochemical Correlates of Disease Resistance in selectively bred *Crassostrea virginica* and in *Crassostrea ariakensis*. Duration: 10.1.1999-9.30.2001. Principal investigator: Gustavo Calvo (Virginia Institute of Marine Science); Associate investigator: Stephen Kaattari (VIMS).

Virginia Institute of Marine Science researchers are focusing on understanding precisely how disease-resistant oysters combat the pathogenic process – an important precursor to enhancing mechanisms for resisting disease. Specifically, identifying biomarkers resistant to Dermo will enable researchers and aquaculturists to rapidly screen and select oysters for generating disease resistant brood stocks.

***Stephen Kaattari of VIMS exposes selectively bred disease-resistant native oysters to the pathogen* P. marinus.**
Photo courtesy VIMS

This project focused on disease resistance in selectively bred native and non-native oysters, respectively *C. virginica* and *C. ariakensis*. The researchers exposed resistant and susceptible eastern oysters to endemic disease agents in the natural environment of the lower York River, then challenged them in a laboratory environment with *P. marinus*. The relationships among survival, disease status, and enzyme reaction activity were analyzed in terms of how they supported resistance to *P. marinus*.

Overall, the study found that oyster size and susceptibility to disease were strongly correlated – a finding that agrees with the accepted notion that larger animals tend to become more infected than smaller animals due to their higher filtration rate. Due to their faster growth, however, the oysters bred to be more MSX-resistant grew to market size well before the other strains and before high mortality rates exacted a toll in summer and fall 2001. These results suggest that artificially-bred disease-resistant strains may be appropriate for aquaculture and restoration efforts to minimize disease mortality and maximize oyster growth.

For further information, contact Stephen Kaattari, kaattari@vims.edu.

develop sustainable aquaculture

The possibility of a full-scale introduction into Chesapeake Bay of the Suminoe oyster, *Crassostrea ariakensis,* remains an issue of broad, contentious debate even as the need for oyster restoration efforts galvanizes industry and environmentalists alike. The plight of the east coast oyster fishery is well known. Chesapeake Bay's native oyster population has been decimated by overfishing and disease, and many of the Bay's surviving oysters are sick with the widespread parasitic diseases MSX or Dermo.

In 1995 the Virginia legislature funded initial evaluation of several oyster species to provide a science-based foundation for policy decisions about non-native species introduction. VIMS researchers since then have tested candidate species for suitability to local environments and to assess environmental risk associated with possible introduction.

An introduction of several hundred certified triploid *C. gigas* in Delaware and Chesapeake Bays provided insight into potential risks in introducing non-native species. In this introduced population, the scientists found a relatively high proportion of mosaics – oysters with both diploid and triploid cells. Subsequent research showed that individual triploid oysters changed from entirely triploid to mosaic. These findings propelled a team of researchers to test another, more promising non-native species, *C. ariakensis,* for its potential in supplementing the dwindling populations of the native *C. virginica* without having negative impacts on Chesapeake Bay.

Central to this research is *in situ* testing of non-natives in Chesapeake Bay, especially for resistance to MSX-disease. An early trial by VIMS staff of triploid *C. ariakensis* in the disease-laden York River generated excitement from legislators and industry when it revealed disease resistance and fast growth. In contrast to the higher reversion rates in *C. gigas,* the average reversion rate in *C. ariakensis* was 2.5 percent over an 18-month period.

This project assessed both risks and opportunities in the potential deployment of triploid *C. ariakensis* in Chesapeake Bay. Virginia Tech researchers modeled effects of variables — salinity, certainty of obtaining a desired harvest rate, etc. — on the probability of a Suminoe population becoming self-sustaining. In testing these and other potential risk factors, they found that decreased salinity resulted in diminished reproductive capability, thereby increasingly the likelihood of self-sustaining populations. As harvest rates rose, however, the probability of a self-sustaining population increased.

After the opportunity assessment reflected high industry interest for triploid *C. ariakensis* culture, VIMS marine advisory services staff examined suitability of the product to regional markets. Successfully introducing a new or substitute product into an established, highly valued market is difficult — more so if the market consists of a single, prized commodity such as Virginia's *C. virginica.* In a taste test, however, 64 volunteers who tasted both species had favorable responses to *C. ariakensis,* indicating potential consumer acceptance.

Summarizing the project results, the research data on rates of reversion in several different salinity regimes has enabled the quantification of risks associated with reversion in triploids. The model helped to define the limits of triploid *C. ariakensis* aquaculture. Product quality testing provided an important indication of how existing markets will accept *C. ariakensis.* The data developed here is now appropriate for a population-level model estimating the risk of using triploid *C. ariakensis* in aquaculture.

C. ariakensis is in the spotlight, and these studies contributed to a shift in thinking about its introduction. Industry has accelerated trials on triploid *C. ariakensis,* resource managers are taking it seriously as a viable candidate for introduction, and a National Academy of Sciences study is addressing triploid aquaculture as well as diploid introduction.

R/A–30 Develop Sustainable Aquaculture: Risk and Opportunity Assessment for *Crassostrea ariakensis* Aquaculture in Virginia. Duration: 2.1.1999 – 1.31.2000. Principal investigators: Standish K. Allen, Jr. (Virginia Institute of Marine Science), Eric M. Hallerman (Virginia Tech); Associate investigator: William D. DuPaul (VIMS).

The data developed here is now appropriate for a population-level model estimating the risk of using triploid C. ariakensis in aquaculture.

C. Ariakensis *has so far proved faster growing and more disease resistant than native species.*
Photo courtesy VIMS.

For further information, contact Stan Allen, ska@vims.edu or Eric Hallerman, ehallerm@vt.edu

advances in seafood technology: seafood safety

R/SP-14 Identification of *Listeria monocytogenes* serovars in blue crab *(Callinectes sapidus)* processing facilities and development of sanitary standard operating procedures for their control or elimination. Duration: 02.01.1999–01.31.2000. Principal Investigators: George Flick, Stephen Boyle, Michael Jahncke, Robert Croonenberghs (Virginia Tech).

As awareness grows of the effects of pathogens – both natural and manufactured – on human health, the U.S. government has stepped up its emphasis on food safety. In one example of this increased emphasis, the U.S. Food and Drug Administration (USDA) declared zero regulatory tolerance for the bacteria *Listeria monocytogenes* in any ready-to-eat food. The bacteria can cause gastrointestinal symptoms in susceptible individuals, or result in the more serious listeriosis, which in some cases leads to septicemia, meningitis, encephalitis, and uterine infections in pregnant women.

Because the *Listeria* microorganism is a ubiquitous part of the normal microflora in estuaries and food processing environments, however, meeting the zero defect standard is exceeding difficult. Legal action has already been taken against several crab processors when contamination was found in their plants. Although they were permitted to continue operating under Consent Decrees requiring them to amend their practices, the crab processors clearly need to know as much as possible about the *Listeria* strains present in their facilities so they can implement the most appropriate methods for sanitation and pathogen control.

To develop new Sanitary Standard Operating Procedures, Virginia Sea Grant funded a study to isolate *L. monocytogenes* from several locations within three different crab processing plants at various times during the operational year. Surveys of personnel, product, food and non-food contact surfaces and utensils were conducted in blue crab processing establishments for the presence of *L. monocytogenes*. The bacteria discovered were typed, and data was gathered to pinpoint where the microorganism entered, how it spread within the facility, and how it might wind up in the finished product.

Comparing Virginia Sea Grant studies in the early 1990s with current results, L. monocytogenes contamination in fresh crabmeat declined from roughly 10 percent to below 1 percent, if the pathogen is detected at all.

Comparing Virginia Sea Grant studies in the early 1990s with current results, *L. monocytogene* contamination in fresh crabmeat declined from roughly 10 percent to below 1 percent, if the pathogen is detected at all. This drop in contaminant levels illustrates the strides made in contolling *Listeria* in the past decade. Knowing the path that *Listeria* contamination takes within these three facilities will create a model for crab processors in general to control the pathogen, and to eliminate it from the finished product.

Since the project was initiated one of the facilities, operating under a Consent Decree because of a high incidence of *L. monocytogenes* in its packed product, was released from the Decree because of its current high sanitary standards and compliance with the aspects of the decree. The sanitation program established by the firm was modeled after the one recommended by this project. Further, a cooperative program has been developed with Sea Grant programs at Cornell University, University of Delaware, Virginia Tech, and Louisiana State University, adding smoked fish and crawfish to the studies on blue crab.

For further information, contact George Flick at flickg@vt.edu

advances in seafood technology: seafood safety

The aquaculture industry in the United States is maturing and under increased scrutiny and regulation. Aquaculture producers must be proactive and take the time to identify all potential risks associated with their operations. An integrated risk management and communication approach is necessary to minimize unintended consequences from aquaculture.

In this project, the preventive paradigm of Hazard Analysis and Critical Control Point (HACCP) was applied as a risk management tool in three different situations to reduce the potential for negative impacts on wild fish stocks and protected resources. HACCP is designed to first identify steps that carry a potential hazard (the Hazard Analysis), and then define precisely how those hazards could be mitigated (establishing the Critical Control Points).

This integrated risk management approach was the common theme in three situations analyzed by Virginia Sea Grant and associated researchers. The first was to control exotic shrimp viruses in ponds at a shrimp production facility to reduce potential negative impacts on wild stocks. The second was to control possible discharge of harmful exotic shrimp viruses from shrimp processing companies into the Gulf of Mexico. The third was to control potential human and animal disease in a marine Recirculating Aquaculture System.

Results indicate that HACCP principles can succeed as a risk management tool in all three situations. Needs were identified at all three facilities for employee training programs as well as written standard operating procedures for personnel, equipment and processes. Overlapping control procedures added the safeguards of record reviews, site evaluations, and periodic testing in conjunction with the new procedures.

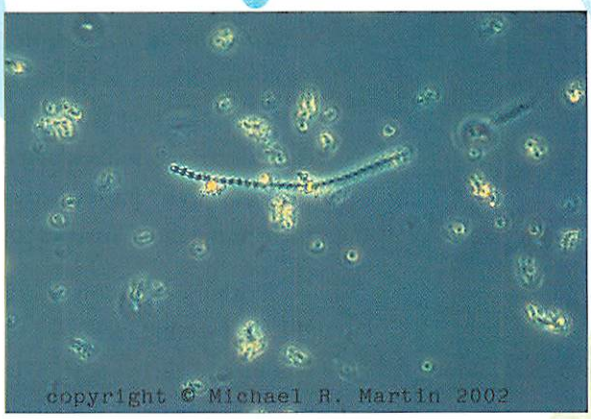
Information from this project is providing regulatory agencies, aquaculture producers, scientists, and seafood processing industries a recognized risk management approach to address pathogens in shrimp aquaculture and processing industries.

In addition, the plans can be easily adapted to address other diseases, escapement, water effluents, and other problem areas. It can also be used as a model for aquaculture, seafood processing industries, and environmental interests around the world.

Finally, it has great value in helping to reduce the frequency and use of chemotherapeutics and other chemicals currently in use in aquaculture to control diseases and pathogens, and to help protect our wild fishery stocks from diseases associated with aquaculture.

VA-T-99-1 Sea Grant Technology Program–Aquaculture: Application of Hazard Analysis and Critical Control Point (HACCP) Principles as a Risk Management Approach for Exotic Pathogen Control in Aquaculture. Duration: 10.1.999 – 9.30.2001. Principal investigators: Michael Jahncke, Michael Schwarz (Virginia Tech). Associate investigators: Craig Browdy (S.C. Dept. of Natural Resources, David Smith (Clemson University), and Juan Silva (Mississippi State University).

An integrated risk management and communication approach is necessary to minimize unintended consequences from aquaculture.



The presence of bacteria such as this one can be reduced or eliminated through the use of HACCP in processing plants.

Photo copyright Michael R. Martin, Cedar Eden Environmental, LLC. Used with permission.

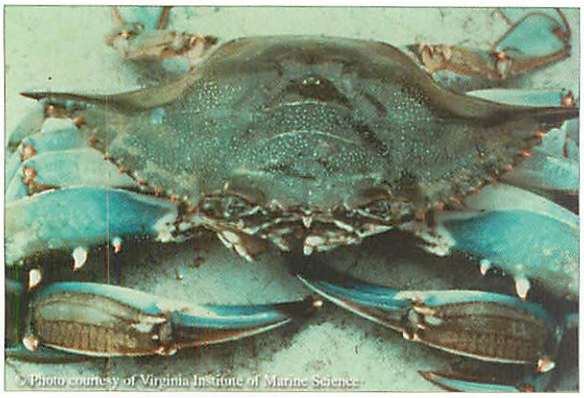
For further information, contact Michael Jahncke, mjahncke@vt.edu or Michael Schwarz, mschwarz@vt.edu

outreach and education

A-EP-2 Economic leadership. Education / Outreach: Bringing blue crab issues to the public. Duration: 9.1.2000–1.31.2001. Principal investigators: Jacques van Montfrans, Vicki Clark (Virginia Institute of Marine Science).

Conflicting reports on the decline of the blue crab fishery have resulted in media attention and public concern. Emotional responses to a dwindling resource and misconceptions about blue crab population dynamics have proliferated in the lack of solid, accessible information. In addition, many fisheries managers – though aware of broad scientific research on blue crab ecology – sometimes know little about specific ecology that might effect management decisions.

Responding to this lack of widespread public knowledge about blue crab population dynamics, researchers and educators at the Virginia Institute of Marine Science crafted a project to provide research-based information on blue crab ecology and related issues. This project also directly addressed Sea Grant's vision to develop environmentally and scientifically informed citizens and enhance public stewardship of marine resources.



The interactive CD provides research-based information on blue crab ecology.
Photograph courtesy VIMS

Resulting outreach activities and products include a slide program, fact sheet, and CD-ROM that are expected to greatly increase the number of individuals reached by the project. To date, 200 sets of these outreach products have been distributed and serve as a resource for educators, students, resource managers and anyone seeking basic background information on blue crabs. Slides and video footage produced by VIMS scientists and staff include images of blue crab behavior and commercial fishing activity. Additional footage is excerpted from outtakes of a natural history film produced by the British Broadcasting Company, recorded by with assistance from VIMS personnel, and reproduced at no charge.

Because this project enables students to use actual data from scientific studies on blue crab ecology, they gain a hands-on feel for how scientific investigations are conducted.

Overwhelming interest by educators and students was expressed during field testing, and interest from educators in activities based on actual scientific data continues to be very strong. Because this project enables students to use actual data from scientific studies on blue crab ecology, they gain a hands-on feel for how scientific investigations are conducted. Numerical data analysis makes this type of activity particularly useful to science teachers anxious to incorporate mathematics into their lessons

Written evaluations received from high school students involved in the field testing indicated that most of the information in the lesson was new to them – a surprising finding since all of the field test groups came from schools in coastal communities. Concepts most often mentioned as new ones to the students were life cycle, male/female differentiation in habitat preferences, and reproductive cycle. Many science educators also indicated that the blue crab habitat use and life cycle information was new to them. Public awareness of many of these issues has increased, and although difficult to quantify, input from participants indicates that the information has been enlightening for educators and the public.

For further information, contact Jacques van Montfrans, vanm@vims.edu or Vicki Clark, vclark@vims.edu

coastal ecosystem health

Sediment contamination is a widespread problem that poses a serious threat to aquatic ecosystems. It can harbor toxic pesticides, herbicides, polychlorinated biphenyls (PCBs) polycyclic aromatic hydrocarbons (PAHs), and heavy metals including lead, mercury and arsenic. Contaminated sediments may poison aquatic life directly or feed bioaccumulators – organisms that retain toxins which are then passed up the food chain.

Under the auspices of the Chesapeake Bay Environmental Effects Committee, Virginia and Maryland Sea Grants are conducting ongoing joint research to create a scientific context for managing living resources in Chesapeake Bay that are affected by toxic substances. This project will help resource managers understand ecosystem effects by showing how populations of target species respond to contaminated sediments in Baltimore Harbor, Md., and the Elizabeth River, Va. The Virginia portion of the grant seeks to understand how contaminated sediments impact living resources by using ecological and behavioral studies of the estuarine amphipod *Leptocheirus plumulosus* (a small crustacean similar to a beach flea).

In studying the burrowing behavior of "*Lepto,*" the researchers detected sublethal effects of contaminated sediments on amphipod burrowing behavior. Because amphipod mortality was high in both locations at full and 50 percent dilution treatments, they did not have enough surviving amphipods to estimate changes in burrowing behavior. In the 10 percent contaminated sediment treatments, mortality was lower and an increase in burrowing times was evident for both sites relative to the "clean" control sediments. These and previous experimental results increased confidence that changes in burrowing behavior are useful for detecting sublethal contaminant levels in sediments.

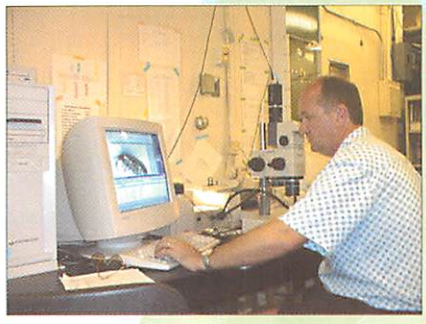
Contaminated sediments may poison aquatic life directly or feed bioaccumulators – organisms that retain toxins which are then passed up the food chain.

Calculations further indicated significant effects of sediment contaminants on the reproductive capabilities, or secondary production, of "*Lepto.*" The researchers estimated that during the first 45 days of the experiment, the secondary production of juveniles was reduced by roughly half in mesocosms with sediment from Baltimore Harbor compared to mesocosms with sediment from a control site. Initial results indicate that significant differences will be seen in secondary production in environments composed of 50 percent contaminants, 10 percent contaminants and controls.

Also, during this time span considerable effort was spent in developing methods to examine changes in the bioirrigation behavior of amphipods in contaminated versus clean sediments. Although the small size of the amphipods and high oxygen demand of the contaminated sediments created difficulties in experimental manipulations, the scientists continue to work to develop a system that will allow characterization of bioirrigation rates and other important behaviors *in situ*.

In sum, this research will aid in the understanding of the effects of sediment contamination on aquatic ecosystems and, hopefully, lead to strategies for better management of Chesapeake Bay living resources.

R/CBT-38 Chesapeake Bay Environmental Effects Committee: Quantifying Ecological Risks of Contaminated Sediments on Living Resources in Supporting Decisions on Habitat Restoration Strategies in the Chesapeake Bay (Virginia Portion). Duration: 1.1.2000–12.31.2000. Principal investigators: Kenneth Tenore (University of Maryland Center for Environmental Science); Eugene Burreson (Virginia Institute of Marine Science). Associate investigators: Pete Van Veld, Linda Schaffner, William DuPaul (VIMS); Joel E. Baker, Thomas Miller, Christopher Rowe, Guritno Roesijadi (Chesapeake Biological Laboratory); Merrill Leffler (Maryland Sea Grant).



Tom Miller of CBL takes measurements of a "lepto" specimen.

For further information, contact Gene Burreson, gene@vims.edu

program development mini-grants - fisheries

R/MG-00-5 Alternative Baits for the Whelk Fishery. Principal investigator: Robert Fisher (Virginia Institute of Marine Science, Marine Advisory Service).

One of earth's "living fossils," the prehistoric horseshoe crab (*Limulus polyphemus*) has survived for more than 250 million years. Still common along the coasts of Virginia, Maryland and Delaware, the horseshoe crab has evolved little in its millions of years on earth. This ancient creature, however, is in great demand among competing user groups — shorebirds and loggerhead turtles for food, conch fishermen for a livelihood and medical researchers for human health benefits.

At present, the conch fishery relies exclusively on horseshoe crabs as bait for conch traps, using the majority of crabs harvested on the entire East Coast, equal to nearly 1.5 million animals annually. To avert overfishing, the Atlantic States Marine Fisheries Commission in 2000 imposed a quota on horseshoe crabs for mid-Atlantic fishermen, with Virginia's quota set at 152,500 crabs per year. Virginia accepted the imposed limit, and joined 14 other Mid-Atlantic states to conserve the crab resource. While this was an important first step in preserving the resource, additional conservation measures were still needed.

Collaborating with a regional research and development group, Virginia Sea Grant marine advisory specialist Robert Fisher designed a gear innovation to reduce the number of crabs used by Virginia conch fishermen. This device, a plastic mesh bag to hold bait, prevents large scavenger animals from consuming the bait. As a result, less bait is needed per trap. Instead of using a whole crab per pot as in the past, a fisherman using a bait bag can reduce the amount of crabs used by at least half without significantly reducing catch.

Top: A mesh bait bag prevents whelk from consuming the horseshoe crab bait.
Photo by Sally Mills, VIMS

Bottom: At the turn of the 20th century horseshoe crabs were so abundant they were used for fertilizer.
Illustration courtesy NOAA Historical Collection.

Development of the bait bag in the conch pot fishery has reduced fishermen's bait costs without impacting their total catch, and has helped secure their bait needs in the shadow of increasing horseshoe crab harvesting restrictions. If other whelk harvesting states adopt bags, well over 1 million crabs could be conserved annually. Bait bags, made of durable plastic that will outlive most conch pots, cost only approximately $1 each, and given the high price of horseshoe crabs, can save fishermen thousands of dollars per year.

Instead of using a whole crab per pot as in the past, a fisherman using a bait bag can reduce the amount of crabs used by at least half without significantly reducing catch.

In the fall of 2000, as a result of this research, Virginia became the first state on the Atlantic seaboard to adopt bait bag regulations. The bags are currently being tested in Maryland, Delaware and New Jersey. Further, the annual Award of Excellence in Scientific, Technical and Advisory contributions to the conservation of Atlantic Coastal Fisheries was awarded for this research by the Atlantic States Marine Fisheries Commission in April 2001.

For further information, contact Bob Fisher, rfisher@vims.edu

program development mini-grants - fisheries

Significant changes have occurred over time in the contours of the oyster-producing bottoms of the lower Chesapeake Bay and its tributaries. These reductions are primarily related to over-harvesting of live oysters as well as shells. It took some 6,000 years for the native oyster *C. Virginica* to develop to the population levels available to Chesapeake oystermen when Europeans arrived in the region. It took only 300 years to reach the current low population levels. This project reinforced the obvious conclusions that oyster harvesting over time has severely reduced the once-productive oyster reefs.

Results from this project show the contribution of oyster reefs of the productivity of tributaries in terms of oyster yields in past years. In turn, this suggests that their return to former or near-former dimensions would do the same. Restoration or rehabilitation potential of Virginia's and Maryland's once highly productive oyster reefs depends upon several factors: state agency resolve, active harvesters, good water quality, maintenance of estuarine bottoms and reduction of disease and predation.

The project focused on constructing 3-D graphical presentations of the oyster (*C. virginica*) reefs of the lower Chesapeake Bay through a comparison of present conditions with topographic soundings of the Bay's bottom made by the U.S. Coast and Geodedic Survey in the 1930s.

This and associated research resulted in a recommendation that significant reductions should be made in the harvesting levels of live Chesapeake Bay oysters and mining of oyster shells, and that reef structures be restored through appropriate "shelling" programs to encourage recovery and bioproductivity of the Chesapeake's oyster populations.

R/MG-00-10. Oyster reef mapping. Principal investigator: William J. Hargis, Jr. (Emeritus, Virginia Institute of Marine Science).

Oyster restoration efforts such as this on Virginia's Eastern Shore are increasingly common in the Chesapeake Bay area.
Photo courtesy VIMS

For further information, contact Bill Hargis, (804) 684-7533.

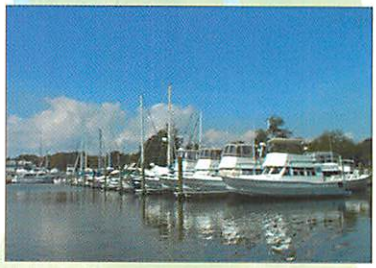
business

Parking problems plague boats as well as cars. As many boat-owners know, while there may be plenty of room to navigate at sea, finding an available space in which to park a watercraft may not be an easy task. The U.S. Fish and Wildlife Service addressed this need by proposing a National Boating Infrastructure Grant Program that provides $32 million to states over four years to install transient tie-up facilities for recreational boats 26 feet or more in length. Participating states are required to determine where public boat access facilities are currently available and where additional facilities are needed.

Because this information was not readily available for Virginia and most other states, the Sea Grant advisory program at VIMS conducted a survey to assess the needs of boaters before facilitating a state boating plan to provide better access. Approximately 500 boaters and marina operators provided responses detailing boating infrastructure needs. A subsequent final report assisted the Virginia Department of Health in complying with national guidelines related to the Boating Infrastructure Grants Program.

VIMS provided outreach to marinas and communities, assisting and advising on the preparation of local project proposals, and also provided VDOH reviews of the competitive proposals for final preparation of the boating infrastructure grants' overall proposal. The VDOH submitted these competitive proposals that led to funding of more than $1.3 million in federal infrastructure funding of 16 projects within Virginia, with one year left of potential funding.

R-MG-04 Recreational boating infrastructure survey. Principal Investigator: Tom Murray (VIMS). Duration: 4/1/2000-1.31.2001



A survey by the Marine Advisory Services at VIMS helped determine the needs for a boating infrastructure for recreational boaters.
Photo: Sally Mills, VIMS

For further information, contact Tom Murray, tjm@vims.edu

A/MG-00-9 Blue Crab Bowl. Principal investigator: Susan Haynes (Virginia Institute of Marine Science).

Virginia's Blue Crab Bowl, alternating between Old Dominion University and theVirginia Institute of Marine Science, is an academic tournament serving as the regional competition for the National Ocean Science Bowl. The event draws nearly 100 of Virginia's best high school science students, who compete in teams of four. The team capturing the regional title represents Virginia in the National Ocean Sciences Bowl, with all expenses paid.

The Blue Crab Bowl provides an opportunity for Virginia students who excel in math and science to receive national recognition for their work while broadening their awareness and understanding of the oceans. At the same time, gearing up for the competition helps teachers use the oceans as an interdisciplinary vehicle for teaching biology, chemistry, geology, physics and mathematics by giving them access to marine science educators and scientific professionals, who in turn develop new links with their local pre-college community and open students' eyes to ocean-related career options.

The Grafton High School 2000 Blue Crab Bowl winners, coached by science teacher Jane Butler, were invited to the White House to represent the National Ocean Sciences Bowl.

The winning team in the 2000 Blue Crab Bowl, from Grafton High School and coached by science teacher Jane Butler, was invited to the White House when administrators at the Consortium for Oceanographic Research and Education sought a team to represent the National Ocean Sciences Bowl during an event focused on oceanography and hosted by Hillary Rodham Clinton in Washington, D.C.

In contrast to many competitions, students don't need to be on the winning team to have a positive experience at the Bowl.

Team captain Kevin Ford followed up his stint as a BCB participant with a mentorship under the direction of Dr. John Graves at VIMS. Kevin's research revolved around a series of sophisticated molecular genetics techniques, including isolations of genomic DNA primarily in identification of tuna species. He is an undergraduate at the University of California San Diego and plans to pursue a master's degree in marine science.

In contrast to many competitions, students don't need to be on the winning team to have a positive experience at the Bowl. The event, said one coach, "enhanced the students' interest in the marine sciences and gave them a sense of achievement. It's a contest in which intellectual development is more important than winning. This is a rare achievement and one that has made my students want to do it again next year."

The Blue Crab Bowl is a cooperative effort between VIMS, the Sea Grant Marine Advisory Program, the College of William and Mary and the Department of Ocean, Earth, and Atmospheric Sciences and the Center for Coastal Physical Oceanography at Old Dominion University. Local sponsors of the regional Blue Crab Bowl include Virginia Sea Grant, ODU's Center for Coastal Physical Oceanography, the Mid Atlantic Marine Education Association and local businesses. Additionally, more than 40 faculty, staff and graduate students from both institutions donate many hours of their time each year to ensure the success of this event.

For further information, contact Susan Haynes, shaynes@vims.edu

marine advisory services accomplishments

virginia institute of marine science

In cooperation with industry and the NMFS, conducted two scallop resource surveys in the Hudson canyon and Virginia Beach closed areas to determine harvest levels for 2001.

In cooperation with industry, NMFS, and the NEFMC, initiated sea trials to evaluate the performance of a 4-inch ring sea scallop dredge for use in special management areas.

In partnership with public and private organizations, hosted a national symposium on the subject of catch and release in marine recreational fisheries.

In partnership with 2 state natural resource agencies, launched a Virginia clean marina program

Conducted a series of experiments on fishing vessels to determine the viability of a bait holding bag to reduce the amount of horseshoe crab bait used in the commercial whelk fishery.

Conducted a series of HACCP workshops throughout tidewater Virginia for commercial soft crab producers.

Collaborated with North Carolina Sea Grant and the North Carolina Aquarium to design and implement a 2-week oceanography course for science teachers as part of the national COAST/Pathfinder project.

In collaboration with VIMS molluscan ecologists, planned and implemented the Virginia Oyster Reef Teaching Experience (VORTEX) program.

Collaborated with North Carolina Sea Grant and the North Carolina Aquarium in designing and implementing a teacher course at East Carolina University. The course, entitled "Hurricane Floyd and the Flood," was part of the COAST/Pathfinder project, funded by the National Ocean Partnership Program.

Launched "Experimental Design in the Marine Science Laboratory," a new, semester-long graduate course for secondary science teachers to provide techniques and tools for implementing investigative marine science in their classrooms.

Coordinated in collaboration with Old Dominion University's Center for Coastal Physical Oceanography the Blue Crab Bowls in 1999 and 2000.

Worked with VIMS/W&M School of Marine Science to establish for the first time a catalog graduate level course for teachers.

Conceptualized and developed a proposal to the Chesapeake Bay Program for a web site serving as a communications hub for Chesapeake Bay Education.

The Bridge grew considerably in 1999-2000. During this time, visitation approached 100,000 annually, and represented visitors from more than 100 countries. Approximately 900 resources were organized and linked from the Bridge's topical pages. The TROLL (Teacher Reviewers of On-Line Learning) was established and began evaluating sites for their utility in classroom settings.

Educator Lee Larkin chaired the committee that developed the Virginia Naturally website. Virginia Naturally is a project of the Commonwealth of Virginia's Environmental Education Initiative, begun in 2000. The website is a key feature of the program, linking Virginia's agencies that are active in environmental education and providing Virginian's with improved access to information and services.

Conducted the first successful spawning of cobia *(Rachycentron canadum)* in captivity in the United States, and raised to juvenile stage in recirculating water system.

Initiated implementation of Virginia Fisheries Resource Grants. The program implemented 12 new industry research projects and developed a second request for proposals in its maiden year.

Provided leadership in the implementation of the Boating Infrastructure Grants Program in Virginia, which led to over $1 million in USFWS grant funds provided for public/private marine industry projects in the Commonwealth.

virginia tech

Hosted Third International Conference on Recirculating Aquaculture

Hosted Aquaculture Bio-Engineering Workshop

Hosted 2 Aquaculture Waste Management Conferences

Design and Operation of Aquaculture Facilities Workshop

Expansion of mariculture facilities VSAREC in Hampton

International Symposium on the presence and significance of histamine in fish

Medical Device HACCP curriculum and associated training materials developed

Established *International Journal of Recirculating Aquaculture*

Developed and constructed Southwest Virginia Aquaculture Research and Extension Center in Saltville, VA, a demonstration facility for recirculating aquaculture enterprise in the region. Established and funded new faculty position in Fish Nutrition

Received the USDA Group Honor Award for Seafood HACCP Alliance

Published 900+ page Marine and Freshwater Products Handbook, the preeminent text for commercial food and industrial aquatic products, and Improving the Performance of Full-service Retail Seafood Departments

Created Seafood Process Monitor, a system which integrated process monitoring tools (to monitor temperature, pressure, watts, etc.) with a user-friendly computer interface

Created extensive new databases on Seafood Reference works and Seafood Composition

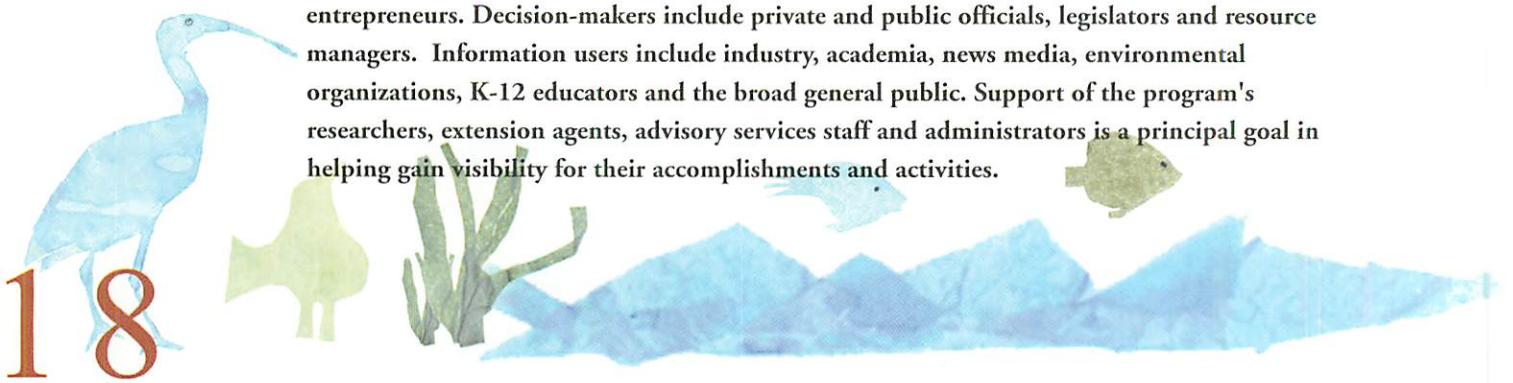
program elements

Program Administration: The administrative office at the University of Virginia in Charlottesville coordinates and develops project activities within Virginia Sea Grant, ensuring interdisciplinary and unified responses to coastal resource management problems. Through the Virginia Graduate Marine Science Consortium, the office helps bring together the resources of university, industry, private and government sectors to address coastal resource issues. The office also oversees fiscal management for all Sea Grant project activities in Virginia.

Project Development: One of the most valuable aspects of a Sea Grant program is its capability to bring university, governmental or private resources to bear upon various emerging problems or opportunities. Some of these cannot be predicted or anticipated far enough in advance to permit proposal preparation and review as it usually occurs. Providing the ability to initiate projects in mid-cycle allows for preliminary testing of new research concepts, supplementing existing projects to include relevant, but unanticipated elements, and the development of innovative ideas. Activity within this category may include small applied research efforts, workshops, conferences, special education efforts, publications, etc.

Marine Advisory Services: This component of Virginia Sea Grant is the interface between marine resource users, planners, researchers and educators. Educators inform the general public on marine-related matters. Professionals collect, analyze and transfer technical information in an understandable format to the users of marine resources and marine educators, and identify problems facing users of the marine environment and its resources. Then, an appropriate response can be undertaken by research, advisory or educational activities. The program also promotes understanding and cooperation among resource users and managers by serving as an identified clearinghouse of information and assistance. Business liaison staff members develop management and educational information on resource economics to industry managers and professionals concerned with the commercial fishing industry. Staff throughout the program develop scientific, technological and educational products for personnel in the harvesting, processing, distribution and preparation of marine food products.

Communications: The Virginia Sea Grant communicators convey science- and advisory-based information to audiences in Virginia, the Chesapeake Bay region and the nation. Their products are designed to help audiences understand the value of safeguarding the natural environment for future generations. In serving their client groups and stakeholders, they provide tools to inform those groups and promote marine science literacy as broadly as possible. The primary audiences are distinct yet overlapping. Resource users include the commercial and recreational fishing community, seafood processors, coastal residents and entrepreneurs. Decision-makers include private and public officials, legislators and resource managers. Information users include industry, academia, news media, environmental organizations, K-12 educators and the broad general public. Support of the program's researchers, extension agents, advisory services staff and administrators is a principal goal in helping gain visibility for their accomplishments and activities.



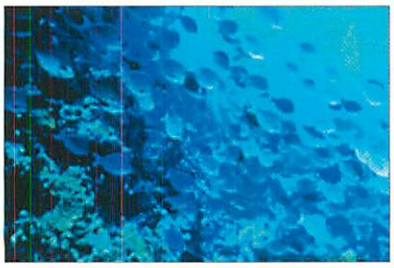
budget information

	1999		*2000*	
	NOAA	MATCH	NOAA	MATCH
I. CORE PROGRAM				
A. Research				
Commercial Fisheries	$ 144,126	$ 84,411	$ 158,236	$ 86,245
Sustainable Aquaculture	$ 104,783	$ 57,288	$ 141,841	$ 75,684
Seafood Technology and New Products	$ 86,900	$ 43,605	$ 49,040	$ 24,768
Environmental Research	$ 43,741	$ 21,871	$ 43,061	$ 21,531
TOTAL	**$ 379,550**	**$207,175**	**$392,178**	**$208,228**
B. Marine Advisory Service	$ 565,767	$ 427,090	$ 565,767	$ 427,090
TOTAL	**$ 565,767**	**$427,090**	**$565,767**	**$427,090**
C. Administration				
Program Administration	$ 218,757	$ 48,172	$ 218,757	$ 48,172
Program Development	$ 147,926	$ 0	$ 135,298	$ 0
TOTAL	**$ 366,683**	**$ 48,172**	**$354,055**	**$ 48,172**
II. NATIONAL STRATEGIC INITIATIVES				
Oyster Disease Research Program	$ 335,397	$ 211,790	$ 340,669	$ 138,462
Gulf Oyster Industry Program	$ 26,266	$ 5,331	$ 199,211	$ 100,633
Essential Fish Habitat	--	--	$ 438,221	$ 219,850
Aquaculture Development	--	--	$ 22,859	$ 12,079
Aquatic Nuisance Species / Ballast Water	$ 200,817	$ 94,123	$ 105,150	$ 83,408
Cobia Culture	--	--	$ 72,104	$ 36,791
TOTAL	**$ 562,480**	**$321,244**	**$1,178,214**	**$591,233**
III. OTHER ACTIVITIES				
Chesapeake Bay Toxics Research Program	$ 434,868	--	$ 208,000	--
John A. Knauss Fellowship Program	$ 38,000	--	$ 76,000	--
Histamine Conference	$ 25,000	--	--	--
TOTAL	**$ 497,868**	**--**	**$284,000**	**--**

directory of projects

CORE RESEARCH PROJECTS

R/CO-3 Lower Chesapeake Bay Initiative: Nutrient fluxes through the Chesapeake Bay mouth. Arnoldo Valle-Levinson, Larry Atkinson (Old Dominion University), and Louis Codispoti (University of Maryland).



A school of fish in Chesapeake Bay
Photo courtesy VIMS.

R/CF-36 Commercial Fisheries: Resolving stock structure and age-specific migrations of Atlantic Coast weakfish (*Cynoscion regalis*) using chemical signatures in otoliths. Simon Thorrold (Woods Hole Oceanographic Institute), Cynthia Jones (Old Dominion University).

R/A-30 Risk and opportunity assessment for *Crassostrea ariakensis* aquaculture in Virginia. Standish Allen, William DuPaul (Virginia Institute of Marine Science), and Eric Hallerman (Virginia Tech).

R/A-31 Development of DNA-based molecular techniques for the diagnosis of QPX, quahog parasite unknown, a pathogen of the hard clam *Mercenaria mercenaria.* Lisa Calvo, Nancy Stokes, Eugene Burreson (Virginia Institute of Marine Science).

R/SP-14 Identification of *Listeria monocytogenes* serovars in blue crab (*Callinectes sapidus*) processing facilities and development of sanitary standard operating procedures for their control or elimination. George Flick, Stephen Boyle, Michael Jahncke, (Virginia Tech), and Robert Croonenberghs (Virginia Department of Health).

R/SP-15 Effects of time/temperatures on bacteria and pathogen growth and survival in fresh crabmeat products. Michael Jahncke, George Flick, Robert Lane (Virginia Tech).

R/CM-26 Synergistic interactions between submerged aquatic vegetation and clam aquaculture. Kenneth Moore, Iris Anderson, Robert Neikirk (Virginia Institute of Marine Science).

NATIONAL STRATEGIC INVESTMENT PROJECTS

National Fisheries Habitat Program

VA-EFH-00-02 Identifying larval sources and essential fish habitat of juvenile snappers along the southeastern coast of the United States. Simon Thorrold (Woods Hole Oceanographic Institute) and Cynthia Jones (Old Dominion University), Luiz Barbieri, (Florida Fish and Wildlife Conservation Commission), Robert Cowen and Su Sponaugle (University of Miami), and Jonathan Hare, (NOAA/ NOS Beaufort Lab).

VA-EFH-00-01 Fisheries habitat: Spatial dynamics and the protection of critical habitats to conserve spawning stock and recruitment in exploited marine species with complex life cycles. Romuald Lipcius, Harry Ven-chieh Wang, Jacques van Montfrans, and Rochelle Seitz (Virginia Institute of Marine Science), Anson Hines (Smithsonian Environmental Research Center), Arnoldo Valle-Levinson (Old Dominion University), Thomas Miller (Chesapeake Biological Laboratory), Michael Fogarty (Northeast Fisheries Science Center), and Livingston Marshall, Jr. (Morgan State University).

Sea Grant Technology Program – Aquaculture

VA-T-99-1 Application of hazard analysis critical control point (HACCP) principles as a risk management approach for exotic pathogen control and exotic species control in aquaculture. Michael Jahncke and Michael Schwarz (Virginia Tech), Craig Browdy (South Carolina

directory of projects

Department of Natural Resources), David Smith (Clemson University), and Juan Silva (Mississippi State University).

VA-T-99-3 Captive spawning, larval and early juvenile culture of Cobia *(Rachycentron canadum).* Michael Oesterling and Jeffrey Tellock (Virginia Institute of Marine Science).

Rapana venosa
egg mass
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Aquatic Nuisance Species Research & Outreach and Improved Methods for Ballast Water Treatment and Management

VA-NI-99-3 Aquatic nuisance species research and outreach: Current distribution, potential range expansion, and ecological and commercial impact, and control of the nonindigenous marine gastropod *Rapana venosa.* Roger Mann, John Graves and Juliana Harding (Virginia Institute of Marine Science).

VA-NI-99-4 Ballast water treatment and management: Inactivation of human pathogens through photon engineering. Fred Dobbs and Mounir Laroussi (Old Dominion University).

Oyster Disease Research Program

VA-OD-99-1 Modeling the effects of climate variability on the prevalence and intensity of Dermo and MSX diseases in Eastern oyster populations. Eileen Hofmann and John Klinck (Old Dominion University), Eugene Burreson (Virginia Institute of Marine Science), Susan Ford and Eric Powell (Rutgers University) Stephen Jordan (Maryland Department of Natural Resources).

VA-OD-99-2 Cooperative Regional Oyster Selective Breeding (CROSBreed) Project: Potential of Selected Stocks for Restoration and Extensive Planting. Standish Allen, Jr., Eugene Burreson, Mark Luckenback (Virginia Institute of Marine Science) Ximing Guo, Susan E. Ford, and Greg DeBrosse (Rutgers University) Patrick Gaffney (University of Delaware) Kennedy Paynter (University of Maryland, College Park) and Donald Meritt (University of Maryland System).

VA-OD-99-3 Comparison of physiological condition and defense mechanisms among Eastern oyster populations with natural Dermo resistance. Fu-Lin Chu (Virginia Institute of Marine Science)

VA-OD-99-6 Comparative examination of biochemical correlates of disease resistance in selectively bred *(Crassostrea virginica)* and in *(Crassostrea ariakensis).* Gustavo Calvo and Stephen Kaattari (Virginia Institute of Marine Science).

VA-OD-99-x Development of a moderate density linkage map of the Eastern Oyster *(Crassostrea virginica):* Identification of disease-resistant genes. Patrick Gaffney (University of Delaware) Kimberly Reece (Virginia Institute of Marine Science).

The Eastern oyster,
Crassostrea virginica
Photo courtesy VIMS

Gulf Oyster Industry Program

VA-GI-99-1 Development of processing procedures for oyster products to inactivate *Vibrio vulnificus* and *Vibrio parahaemolyticus* in raw oysters. Kumar Mallikarjunan, Michael Jahncke and Susan Duncan (Virginia Tech) D.E. Farkas; R. Grodner; L. Andrews

R/GOIP-99-1 Natural Dermo Resistance and Role in Development of Hatcheries in Gulf of Mexico. Standish Allen (Virginia Institute of Marine Science) and J. LaPeyre

Chesapeake Bay Environmental Effects Committee (CBEEC) Toxics Research Program

R/CBT-38 Chesapeake Ecotox Research Project (CERP): Quantifying Ecological Risks of Contaminated Sediments on Living Resources in Supporting Decisions on Habitat Restoration Strategies in the Chesapeake Bay. Ken Tenore (University of Maryland) and Eugene Burreson (Virginia Institute of Marine Science).

R/CBT-35 Transport and fate of sediment-associated polycyclic aromatic hydrocarbons and trace elements in the Elizabeth River. Rebecca Dickhut (Virginia Institute of Marine Science), C. Friedrichs, S. Kuehl, J. Brubaker and C. Chisholm-Brause.

(R/CBT-34) Benthic community responses to multiple contaminants. Raymond W. Alden, Daniel Dauer and Alan W. Messing (Old Dominion University).

(R/CBT-36) (With Maryland Sea Grant) Bioaccumulation dynamics of hydrophobic organic contaminants in Anacostia River. David Velinsky and James McNair (Academy of Natural Sciences), Gregory Foster and D. Kelso (George Mason University).

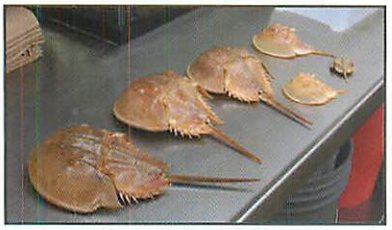
PROGRAM DEVELOPMENT RESEARCH MINI-GRANTS

R/MG-00-01 John McConaugha (Old Dominion University) Lipofuscin technique for aging horseshoe crabs.

R/MG-00-02 Fred C. Dobbs (Old Dominion University) Acoustic screen for control of non-indigenous species in ballast water.

R/MG-00-03 Michael Jahncke (Virginia Tech) Sensory studies for blue crab meat products.

R/MG-00-04 Tom Murray (Virginia Institute of Marine Science) Virginia recreational boating infrastructure survey.



Horseshoe crabs of various ages await testing in Steve Smith's lab at Virginia Tech.

Pauli Hayes photo.

R/MG-00-05 Robert Fisher (Virginia Institute of Marine Science) Extended research on alternative bait for whelk fishery.

R/MG-00-06 Cynthia Jones (Old Dominion University) and Simon Thorrold (Woods Hole Oceanographic Institute) Spatial framework for natural resource management

R/MG-00-07 Rich Collins (University of Virginia) Survey of stakeholder perceptions of blue crab fishery.

R/MG-00-08 Michael Jahncke (Virginia Tech) Safety of refrigerated raw and fully cooked batter and breaded fish portions.

R/MG-00-09 Steve Smith (Virginia Tech) Pharmacokinetics of oxytetracycline in cultured Summer flounder at different salinities.

R/MG-00-10 William Hargis (Virginia Institute of Marine Science) Oyster reef charting.

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☆ Faisal, Mohamed, Jerome F. La Peyre, Ehab Elsayed, and D. Craig Wright, Bacitracin Inhibits the Oyster Pathogen *Perkinsus marinus* In Vitro and In Vivo, Jrnl. of Aquatic Animal Health 11:130-138, 1999.

☆ Kotob, Shaban I., Shawn M. McLaughlin, Peter van Berkum and Mohamed Faisal, Characterization of Two *Perkinsus* spp. from the Softshell clam, *Mya arenaria* Using the Small Subunit Ribosomal RNA Gene, J. Eukaryot. Microbiol., 46(4), 1999 pp. 439-444.

☆ Gingerich, Todd M., Tatiana Lorca, George J. Flick, Merle D. Pierson and Harold M. McNair, Biogenic Amine Survey and Organoleptic Changes in Fresh, Stored, and Temperature-abused Bluefish (*Pomatomus saltatrix*). Jrnl. of Food Protection, Vol. 62, No. 9, pp. 1033-1037, 1999.

☆ Chu, Fu-Lin E. Effects of field-contaminated sediments and related water soluble components on haemocyte function and *Perkinsus marinus* susceptibility and expression in oysters. Biomarkers, Vol. 4, No. 6, pp. 537-548, 1999.

☆ Moore, Kenneth H. and Wetzel, Richard L., Seasonal variations in eelgrass (*Zostera marina L.*) responses to nutrient enrichment and reduced light availability in experimental ecosystems. Jrnl. Of Experimental Marine Buiology and Ecology, 244, pp. 1-28, 2000.

☆ Kotob, S.I., McLaughlin, S.M., Van Berkum, P., and Faisal, M. Discrimination between two *Perkinsus* spp. Isolated from the softshell clam, *Mya arenaria,* by sequence analysis of two internal transcibed spacer regions and the 5.8S ribosomal RNA gene. Parasitology, 199, pp. 363-368, 1999.

☆ Ford, Susan, Powell, Eric, Klinck, John, and Hofman, Eileen. Modeling the MSX parasite in Eastern oyster (*crassostrea virginica*) populations. I. Model development, implementation, and verification. Jrnl. of Shellfish Research, Vol. 18, No. 2, pp. 475-500, 1999.

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☆ Loftus, Andrew J., Waldron, Jeff, Fay, Virginia, Davy, Kay, and Lucy, Jon. Overview of angler-based tagging programs and management issues. Fisheries, Vol. 25, No. 4, 2000.

☆ Lucy, Jon and Davy, Kay. Benefits of angler-assisted tag and release programs. Fisheries, Vol. 25, No. 4, 2000.

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☆ Eric N. Powell, John M. Klinck, Susan E. Ford, Eileen E. Hofmann, and Stephen J. Jordan. Modeling the MSX parasite in eastern oyster *(Crassostrea Virginica)* Populations. Part III. Regional application and the problem of transmission. Journal of Shellfish Research, Vol. 18, No. 2, pp 517-537, 1999.

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☆ M.B. Lowit, L.K. Blum, A.L. Mills. Determining replication for discrimination among microbial communities in environmental samples using community-level physiological profiles. FEMS Microbiology Ecology 32, 2000, pp. 97-102.

☆ Roger Mann & Juliana M. Harding. Invasion of the North American Atlantic coast by a large predatory Asian mollusk. Biologic Invasions 2: pp. 7-22, 2000.

☆ C.D. Harvell, K. Kim, J.M. Burkholder, R.R. Colwell, P.R. Epstein, D.J. Grimes, E. E. Hofmann, E.K. Lipp, A.D.M.E. Osterhaus, R. M. Overstreet, J.W. Porter, G.W. Smith, and G.R. Vasta . Emerging marine diseases – Climate links and anthropogenic factors. Science, 3 Sept. 1999, Vol. 285, pp. 1505-1510.

The cownose ray contributes to the destruction of seagrass beds in Chesapeake Bay.
Photo courtesy Jack Musick, VIMS

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☆ How to Handle an FDA Inspection. Stephen Mcnamara, VT.

☆ A Plan to Improve the Competitiveness of the Blue Crab Processing Industry and the Quality of Crab Meat Products in the U.S. Marketplace. Jahncke & Sensory working group, VT.

☆ Intensive Yellow Perch Hatchery fact sheet. Keith Tompkins, George Libey, VT.

☆ The Status of Virginia's Public Oyster Resource 1999. Melissa Southworth, Juliana M. Harding and Roger Mann, VIMS.

☆ Seasonal Residence, Movement, and Activity of Adult Tautog, *Tautoga onitis*". Jon A. Lucy, Claude M Bain, III, and Michael D. Arendt, VIMS.

Bay scallops
Photo courtesy VIMS

☆ Virginia Game Fish Tagging Program - Annual Report 1999. Jon A. Lucy, Claude M. Bain, III and Michael D. Arendt, VIMS.

☆ Economic Aspects of Allocating Striped Bass Among Competing User Groups in Virginia. James E. Kirkley, Kenneth E. McConnell, Winnie Ryan, VIMS.

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☆ Clam Strain Registry. Tom Gallivan and Stan Allen, VIMS.

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☆ Lacey, Patricia F., Aquaculture Marketing: Exploring Opportunities for the Small Producer. VT.

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☆ Harding, J.M., Mann, R., and V.P. Clark. 1999. Shell Games. VIMS.

☆ Lucy, Jon A., and Michael D. Arendt (graduate assist.) Exploratory field Evaluation of Hook-Release Mortality in Tautog. VIMS.

☆ Tompkins, Keith, and George Libey.1999. Spawning Yellow Perch Throughout the Year. VT.

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