

Testimony submitted to  
U.S. House of Representatives  
Committee on Resources  
Subcommittee on Fisheries Conservation, Wildlife and Oceans.

Thursday November 14, 2002

by

Professor Roger Mann  
School of Marine Science  
Virginia Institute of Marine Science  
College of William and Mary  
Gloucester Point, VA 23062

Subject: Ballast water management

## Testimony

Mr. Chairman, Members of the Committee, it is a pleasure to be here today and accept your invitation to provide testimony to the Committee on H.R. 5395 and H.R. 5396.

My name is Roger Mann. I am a Professor of Marine Science at the School of Marine Science, Virginia Institute of Marine Science, College of William and Mary. I have been a researcher in the field of marine science for over twenty-five years. Throughout that period I have maintained an active interest in the biology of introduced (non-native) aquatic species. I have edited two major volumes on this subject, maintained an interaction with other researchers in this field including those appointed to the International Council for the Exploration of the Seas Committee on Introductions, was a member of the US Department of Agriculture Working Group on Biotechnology tasked with developing guidelines for research involving genetically modified organisms, and am currently the Principal Investigator on a federally funded research project examining impacts of a remarkable invading predatory marine snail in the Chesapeake Bay. The fact that this recent invader arrived on our shores through ballast water vectors makes my interest in today's subject of discussion even more pointed. The arrival of non-native species into the waters of the United States through ballast water and other vectors remains a significant threat to the integrity of native ecosystems, and through this to their value as both sources of direct economic benefit and as recreational and aesthetic resources. I complement the authors and sponsors of these bills for their timely and focused attention to these important issues.

In the limited time I have available I will focus my remarks on proposed modifications in ballast water management, specifically their feasibility in implementation and prospects for their effectiveness in controlling aquatic invasions. Further, I will briefly comment on the prospects for the proposed new programs and research priorities to provide new and improved tools in detection, control and eradication of invasive species.

Section 104 of HR 5396 addresses "Prevention of introduction of aquatic invasive species into the waters of the United States by vessels." A significant portion of this section focuses on ballast water management and treatment systems for control of potentially harmful organisms within ballast water. Subsection (e)(1)(B) addresses BALLAST WATER MANAGEMENT STANDARDS AND CERTIFICATION PROCEDURES – INTERIM STANDARDS. Two options are proffered for ballast water exchange, either (1) at least one empty and refill on the high sea or in an alternate exchange area, or (2) sufficient flow through exchange to achieve 95% ballast replacement. These are admirable goals for reduction of organisms from distant source(s) that are subject to discharge in United States waters. I support these targets, although I am cognizant of the logistical difficulties that accompanying compliance with such standards by a ship's Master under challenging sea states, and the fact that a simple dilution approach may not reduce the numbers of potential invaders in any one ballast tank below a critical level that may sustain the initial stages of an invasion in a receiving port. A dilution standard is a practical method in implementation and enforcement for ballast water exchange, although it is in contrast to long standing approaches to regulations affecting drinking water,

shellfish growing and harvest regions, and effluent standards for such commercial enterprises as seafood processing plants that employ absolute values rather than percentage reductions. Finally, at the individual vessel level, compliance with flow through ballast replacement may be difficult depending on vessel configuration. However, none of these qualifications should deter the goal of compliance with ballast water exchange or dilution where operating conditions allow.

The alternate approach to ballast water exchange, and one that I strongly support, is the development and employment of ballast water treatment systems designed specifically to reduce the number of included potentially harmful organisms. In developing the text of subsections (e)(1)(B)(ii) and (e)(3)(A)(ii) the authors have sought to provide parity with a 95% replacement approach by inclusion of the requirement that treatment systems kill or remove “at least 95% of each of the live aquatic vertebrates, invertebrates, phytoplankton and macroalgae.” Again, these are admirable goals that would reduce the numbers of potentially harmful organisms discharged at receiving ports; however, I believe this section of the text could be improved to encourage both the development of appropriate technologies and facilitate their testing prior to approval. A number of innovative technologies are currently under development in the private sector for application in ballast water control. These reflect the continuing diversity and depth of talent that has made American industry a world leader in mitigating adverse environmental problems. As examples researchers are investigating ballast water treatment technologies using ultraviolet radiation, ozone disinfecting, mechanical filtration, and deoxygenation using nitrogen gas purging or vacuum degassing. Each of these technologies has its strengths and promises with respect to control of ballast water communities. The interim standard set by this bill must provide specific targets, not percentage reductions. Without these the developers cannot progress with system design for eventual application in the shipping industry. Depending on the technology employed, control of the identified groups- live aquatic vertebrates, invertebrates, phytoplankton and macroalgae - is not attained with uniformity, just as the threat from these groups may also not be uniform. The ability to control a significant threat from the majority of these groups should not disqualify or discourage the continuing development of a technology that does not control all of the groups. For example, mechanical filtration in very large scale practical application is a compromise between volume treated and size retention of particles. In the current context a 50-micron retention standard might be attainable for very large volumes and be successful in retaining all the life history stages, including eggs, of the vast majority of aquatic vertebrates, invertebrates and macroalgae. This list would include a very substantial number of notorious invaders that are currently creating ecological and economic problems in many locations distant from their home ranges. By contrast a 50-micron filter would do little to retain most phytoplankton simply because this group contains many representatives with individual sizes well below 50-microns. Although they are undoubtedly widely distributed by ballast water transport, phytoplankton as a group have a proportionately lesser history as deleterious environmental agents when established in regions beyond their native ranges. A notable absentee from the text of the bill are the toxic dinoflagellates that cause red tide blooms – a group that may well represent a very serious challenge to any and all of the currently researched control technologies.

I respectfully offer the following two suggestions for consideration in minor text revisions for the bill. First, definitions for phytoplankton and macroalgae should be included that describe inclusive size ranges for both categories. Second, interim standards should be considered in terms of reduction in absolute numbers in defined size ranges, for example 100% kill of all organisms in excess of 50 microns maximum dimension, in order to make them independent of variation in source of the ballast water. Both will, I believe, assist the developers of treatment technologies and expedite the approval process for technologies as they reach maturity.

In closing I wish to add two comments. I offer my compliments on the details in HR 5396 addressing continual review and provision for improvement in standards as technology improves. We should not be handcuffed by the search for ultimate control tools while good, although perhaps not perfect technology is within our grasp to address the ecological problem at hand. Incremental common sense dictates employment of the best available tools now, and better tools in due course. Finally, both HR 5395 and HR 5396 provide a sound basis for new and continuing research priorities on a broad range of invasive species issues, and conduits to deliver the associated results to the regulatory process. Knowledge is a powerful tool that we must pursue and share to detect, control and, where possible eradicate, invading unwanted non-native species from the waters of the United States.

This concludes my testimony.

Follow up address and summary of testimony.

Name: Roger Mann

Address: School of Marine Science,  
Virginia Institute of Marine Science,  
College of William and Mary,  
Gloucester Point, VA 23062  
Phone: 804/684-7360  
FAX: 804/684-7045  
e-mail: rmann@vims.edu

Summary.

My remarks focus on (1) proposed modifications in ballast water management, specifically their feasibility in implementation and prospects for their effectiveness in controlling aquatic invasions, and (2) proposed new programs and research priorities to provide new and improved tools in detection, control and eradication of invasive species. Section 104 of HR 5396 addresses "Prevention of introduction of aquatic invasive species into the waters of the United States by vessels." Two options are proffered for ballast water exchange as management tools, either (1) at least one empty and refill on the high sea or in an alternate exchange area, or (2) sufficient flow through exchange to achieve 95% ballast replacement. I support these targets, although practical implementation by a ship's Master under challenging sea states may be difficult. A dilution standard is a practical method in implementation and enforcement for ballast water exchange, although it is in contrast to regulations that employ absolute values rather than percentage reductions. I strongly support the development and employment of ballast water treatment systems designed specifically to reduce the number of included potentially harmful organisms. Interim standards for such systems are addressed in subsections (e)(1)(B)(ii) and (e)(3)(A)(ii) of HR 5396 and require that treatment systems kill or remove "at least 95% of each of the live aquatic vertebrates, invertebrates, phytoplankton and macroalgae." I suggest these sections of the bill be revised to accommodate the following points: (1) definitions for phytoplankton and macroalgae should be included that describe inclusive size ranges for both categories, and (2) interim standards should be considered in terms of reduction in absolute numbers in defined size ranges, for example 100% kill of all organisms in excess of 50 microns maximum dimension, in order to make them independent of variation in source of the ballast water. Both will, I believe, assist the developers of treatment technologies and expedite the approval process for technologies as they reach maturity. Finally, I compliment both HR 5395 and HR 5396 as tools provide a sound basis for new and continuing research priorities on a broad range of invasive species issues, and conduits to deliver the associated results to the regulatory process. Knowledge is a powerful tool that we must pursue and share to detect, control and, where possible eradicate, invading unwanted non-native species from the waters of the United States.

## **DISCLOSURE REQUIREMENT**

### **Required by House Rule XI, clause 2(g)**

#### **A. To be completed by all witnesses.**

**1. Name:** Roger Mann

**2. Business Address:** School of Marine Science, Virginia Institute of Marine Science,  
College of William and Mary, Gloucester Point, VA 23062

**3. Business Phone Number:** 804/684-736-

**4. Organization you are representing:** Virginia Institute of Marine Science, College of  
William and Mary, Gloucester Point, VA 23062

#### **5. Training or educational certificates and experiences:**

B.S.1972. University of East Anglia, Norwich, U.K.

Ph.D.1976. University College of North Wales, Bangor, Marine Science Laboratories,  
Menai Bridge, Wales

Chesapeake Bay Commission Tribute to Excellence, 1994, for "...official recognition of  
significant contributions to the management and protection of the Chesapeake Bay." For  
work on the Chesapeake Bay Commission working group on Ballast Water Impacts in  
the Chesapeake Bay

**6. Professional licenses:** none

**7. Work related experiences** – see item 5 above.

**8. Representational capacity in organization:** Professor of Marine Science.

#### **B. Non governmental witnesses.**

**1. Federal grants to the witness** – see list attached

**2. Federal grants to the parent organization of the witness** – see list attached

**3. Other information:** none.

Dr. Roger L. Mann  
Professor, Marine Science  
Virginia Institute of Marine Science

Awards from Department of Commerce since October 1, 1999

Mann, Roger, "Fishery Independent Standing Stock Surveys of Hard Clam Populations in the Chesapeake Bay and a Comparison with Continuing Estimates from Fishery Dependent Data," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$70,163

Mann, Roger, "Oyster Advisory Report for NOAA/NMFS Chesapeake Bay Office," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$5,380

Mann, Roger, "Oyster Heritage Program: Fall 1999," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality, \$10,000

Mann, Roger, "Oyster Larvae and Recruitment: The Paradox of Turbidity, Salinity and Larval Feeding Conditions," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$118,396

Mann, Roger, "Oyster Population Estimation in Support of the Ten-Year Goal for Oyster Restoration in the Chesapeake Bay Fishery," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$56,039

Mann, Roger and Juliana M. Harding, "Aquatic Nuisance Species Research: Current Distribution, Potential Range Expansion, Ecological and Commercial Impact, and Control of the Non-Indigenous Marine Gastropod, *Rapana venosa*," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$206,179

Mann, Roger and Mark W. Luckenbach, "Restoring an Oyster Reef for Mitigation of Estuarine Water Quality," National Oceanic and Atmospheric Administration/Cooperative Institute of Coastal and Estuarine Environmental Technology, \$29,403

GRANT AND CONTRACT AWARDS  
RECEIVED BY THE VIRGINIA INSTITUTE OF MARINE SCIENCE  
FROM  
DEPARTMENT OF COMMERCE AND DEPARTMENT OF THE INTERIOR  
SINCE OCTOBER 1, 1999

**DEPARTMENT OF COMMERCE**

Allen, Standish K., "NOAA: Travel Grant for Research Visits to France," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$6,000

Allen, Standish K., Eugene M. Burreson, Mark W. Luckenbach, and Francis X. O'Beirn, "Cooperative Regional Oyster Selective Breeding (CROSBreed) Project: Potential of selected stocks for restoration and extensive planting," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$202,737

Allen, Standish K., and Kimberly S. Reece, "Oyster Genetic Enhancement in the Natural Environment: Pilot Studies," National Oceanic and Atmospheric Administration/Sea Grant Virginia Graduate Marine Science Consortium, \$29,477

Allen, Standish K., Mark W. Luckenbach, Kimberly S. Reece and Mark D. Camara, "A Consortium-Based Approach for Genetic Rehabilitation of Oysters in the Mid-Atlantic," National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$299,976

Allen, Standish K., and Shawn M. Stickler, "Natural Dermo Resistance and its Role in the Development of Hatcheries for the Gulf of New Mexico," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$3,423

Allen, Standish K., and William D. DuPaul, "Risk and Opportunity Assessment for *Crassostrea ariakensis* Aquaculture in Virginia," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$47,047

Anderson, Iris C., Kenneth A. Moore, Richard A. Wetzel, and William G. Reay, "Assessment of Pulse Amplitude Modulated Fluorescence Technology for Rapid Determination of Stress in Natural and Transplanted Seagrass Beds at CBNERRA-VA," Cooperative Institute for Coastal and Estuarine Environmental Technology, \$189,896

Berman Marcia R., "Development of a GIS Database in Support of Virginia's Shellfish Sanitation Program," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Health, \$100,000



Berman, Marcia R., "Development of Shoreline Situation Reports for Tidewater Localities," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$100,000

Berman, Marcia R., "Educational/Informational Materials for Virginia Oyster," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$7,816

Bonzek, Christopher F., "Preparation of 2002 Chesapeake Bay Blue Crab Advisory Report " National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$8,688

Bonzek, Christopher F., David A. Hata, John M. Hoenig, "Design and Pilot Implementation of a Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$115,000

Bronk, Deborah A., "Coastal Eutrophication in the Southeastern United States: Nitrogen versus Phosphorus Limitation and the Contribution of Organic Nitrogen," National Oceanic and Atmospheric Administration/Sea Grant/Georgia Sea Grant Program, \$58,845

Burreson, Eugene M., "Effects of Climate Variability on the Prevalence and Intensity of Dermo and MSX Diseases in Eastern Oyster Populations," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$65,130

Burreson, Eugene M., "Elucidating the Life Cycle of the *Haplosporidium nelsoni* (MSX) Using an Experimental Approach and Molecular Diagnostics," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$79,797

Burreson, Eugene M., "FY 2000 Virginia Cooperative Marine Education and Research Program- Support for Hampton University," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$60,000

Burreson, Eugene M., Howard I. Kator, "Parasites and Pathogens of *Crassostrea ariakensis* Held in Chesapeake Bay and Comparative Elimination Kinetics of Fecal Coliforms," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$34,834

Burreson, Eugene M., Kimberly S. Reece and Nancy A. Stokes, "Infectivity, Pathogenicity, and Epizootiology of the Clam Parasites *Perkinsus Chesapeaki* and *Perkinsus andrewsi* in the Chesapeake Bay Oysters: Have We Been Misinterpreting the *Perkinsus marinus* Epizootiology," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$154,603

Burreson, Eugene M., Kimberly S. Reece, "Oyster Herpes Virus Threat to U.S. Oyster Producers," National Oceanic and Atmospheric Administration/Sea Grant/Pacific Shellfish Institute, \$27,266

Burreson, Eugene M., Kimberly S. Reece, and Standish K. Allen, "Potential Pathogens of *Crassostrea ariakensis* in its Native Range in China and in Established Populations in Washington, US," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$77,187

Burreson, Eugene M., and Lisa Ragone Calvo, "Flagellate infecting hard clam larvae," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$6,985

Burreson, Eugene M., Lisa Ragone Calvo and Kimberly S. Reece "In Situ Determination of *Perkinsus marinus* Transmission Dynamics in Low Salinity Habitats: Implications for Disease Avoidance Management Strategies and Oyster Restoration," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$75,600

Burreson, Eugene M. and Nancy A. Stokes, "Investigations into the Prevalence and Mortality Associated with SSO and SSO-like Infections of *Crassostrea virginica* in the Eastern U. S.," National Oceanic and Atmospheric Administration/Sea Grant/Marine Biological Laboratory, \$82,363

Burreson, Eugene M., William D. DuPaul, Linda C. Schaffner, Peter A. VanVeld, "Chesapeake Ecotox Research Project: Quantifying Ecological Risks of Contaminated Sediments on Living Resources in Decisions on Habitat Restoration Strategies in the Chesapeake Bay," National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$335,796

Calvo, Gustavo W., and Stephen L. Kaattari, "Comparative Examination of Biochemical Correlates of Disease Resistance in Selectively Bred *Crassostrea virginica* and *Crassostrea ariakensis*," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$289,687

Calvo, Lisa Ragone, and Nancy A. Stokes, "Development of DNA-Based Molecular Techniques for the Diagnosis of QPX, Quahog Parasite Unknown, a Pathogen of the Hard Clam *Mercenaria mercenaria*" National Oceanic and Atmospheric Administration/ Sea Grant Virginia Graduate Marine Science Consortium, \$50,174

Calvo, Lisa Ragone, and Eugene M. Burreson, "Influence of Host Genetic Origin and Geographic Location on QPX Disease in Hard Clams, *Mercenaria mercenaria*," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$212,998

Canuel, Elizabeth A., Robert J. Orth, "Foodweb analysis of Seagrass Beds," National Oceanic and Atmospheric Administration/Coastal Zone Management/Virginia Department of Environmental Quality, \$10,000

Chu, Fu-Lin, "Comparison of Physiological Condition and Defense Mechanisms Among Eastern Oyster Populations with Natural Dermo Resistance," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$141,389

Chu, Fu-Lin, "Enhanced Tautog (*Tautoga onitis*) Survival via Essential Fatty Acid Enrichment of Larval Feed," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$26,586

Chu, Fu-Lin, "Evaluation of Inherent and Induced Thermal-Tolerance in Protection of Oyster Populations from Summer Mortality Caused by Dermo and MSX Parasitism and Thermal Stress," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$62,328

Chuenpagdee, Ratana, "Assessing Stakeholder Preferences for Ecosystem Management Options for the Chesapeake Bay," National Oceanic and Atmospheric Administration/National Marine Fisheries Service \$59,260

Chuenpagdee, Ratana, "A Dynamic Mass Balance Model of the Chesapeake Bay Ecosystem," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$8,504

Chuenpagdee, Ratana, "Coastal Zone Management in Asia-Pacific: The State of the Art Database," National Oceanic and Atmospheric Administration, \$15,000

Diaz, Robert J., "Essential Fish Habitat on the Inner Continental Shelf," National Oceanic and Atmospheric Administration/New Jersey Sea Grant, \$34,769

Diaz, Robert J., "Mapping Benthic Habitats in the York River, VA," National Oceanic and Atmospheric Administration, \$99,500

Dickhut, Rebecca M., Chisholm-Brause, Catherine J., and Carl T. Friedrichs, "Transport and Fate of Sediment-Associated Polycyclic Aromatic Hydrocarbons and Trace Elements in the Elizabeth River," National Oceanic and Atmospheric Administration/Sea Grant Virginia Graduate Marine Science Consortium, \$81,000

DuPaul, William D., "Evaluation of Bycatch Reduction Devices to Facilitate Summer Flounder (*Paralichthys dentatus*) Escapement from Sea Scallop Trawls," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$10,530

DuPaul, William D, "Marina Technical Assistance Program," National Oceanic and Atmospheric Administration/Coastal Resource Management/Virginia Department of Conservation and Recreation, \$202,505

DuPaul, William D., "Performance Evaluation of a 4.0" Ring Scallop Dredge in the Context of Area Management Strategy for Sea Scallops," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$9,187

DuPaul, William D., "Performance Evaluation of a 4.0" Ring Scallop Dredge in the Context of Area Management Strategy for Sea Scallops," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$24,937

DuPaul, William D., "Performance Evaluation of a 4.0" Ring Scallop Dredge in the Context of Area Management Strategy for Sea Scallops," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$11,970

DuPaul, William D., "Program Assessment Team Visit for Material Development," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$1,000

DuPaul, William D., "Sea Scallop Survey Mid-Atlantic Closed Areas, Participation in Research TAC Set-Aside Georges Bank," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$6,300

DuPaul, William D., "Virginia Graduate Marine Science Consortium Marine Advisory Services," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$1,474,010

DuPaul, William D., David B. Rudders, "Evaluation of Gear Modifications to Reduce the Bycatch of Summer Flounder (*Paralichthys dentatus*) in Sea Scallop Dredges," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$119,002

DuPaul, William D., Fu-Lin Chu, and Michael J. Oesterling, "An Integrated Approach to the Development of Cobia (*Rachycentron canadum*) Culture in the United States," National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$171,355

DuPaul, William D., Thomas J. Murray, "Coastal Community Development Initiative," National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$50,000

DuPaul, William D., Thomas J. Murray, "Conference Support: Development of a Work Plan for Measuring Activity and Economic Impact of the Atlantic Intracoastal Waterway (AIWW)," National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$17,355

Fisher, Robert A., "The Effect of Circle Square Vents on Discard Reduction in the Black Sea Bass, *Centropristis striata*, Trap Fishery," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$57,098

Fisher, Robert A., "Enhancement of the Value and Product Quality of Commercially Caught Striped Bass," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium \$7,519

Fisher, Robert A., "Funding for Research on Alternative Baits for the Whelk Fishery Using Underutilized Species and Processing Waste Material," National Oceanic and Atmospheric Administration /Sea Grant/Virginia Graduate Marine Science Consortium, \$5,838

Graves, John E., "Administrative and Travel Management Support for the United States Section of the International Conference for the Conservation of Atlantic Tuna," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$300,000

Graves, John E., "Analysis of Mortality for Pelagic Fishes Caught in the Long-Line Fishery," National Oceanic and Atmospheric Administration /National Marine Fisheries Service, \$5,000

Graves, John E., "Comparison of Closed-area Management Regimes in the Gulf of Mexico, North Atlantic and Central Pacific Highly Migratory Species Longline Fisheries," National Oceanic and Atmospheric Administration/Sea Grant/Hawaii, \$19,950

Graves, John E., "Cooperative Marine Education and Research Program: Special Student Support," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$14,685

Graves, John E., "Development of Hypervariable, Nuclear-DNA Markers for Population Structure Analysis of Atlantic Bluefin Tuna," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$125,866

Graves, John E., "Development of a Molecular Marker to Discriminate between Atlantic and Indo-Pacific Sailfish," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$79,674

Graves, John E., "Population Structure Analysis of Atlantic Bluefin Tuna Using Hypervariable, Nuclear DNA Markers," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$126,793

Graves, John E., "Population Structure Analysis of Atlantic Bluefin Tuna Using Hypervariable, Nuclear DNA Markers," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$65,157

Graves, John E., "Population Structuring of Western Atlantic Fishes: The Relative Genetic Isolation of Bermudian Populations," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$69,511

Graves, John E., "Post-Release Survival of Atlantic Blue and White Marlin Using Pop-up Satellite Archival Tag Technology," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$20,000

Graves, John E., "Student Research Support: Billfish Population Assessment," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$59,372

Haas, Leonard W., "Water Quality Monitoring in the Great Wicomico River," National Oceanic and Atmospheric Administration/Coastal America, \$20,000

Hardaway, C. Scott, Lyle M. Varnell, William G. Reay, "Chesapeake Bay Dune Systems: Evolution and Status," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$323,181

Hargis, William J., "Oyster Heritage Program," National Oceanic and Atmospheric Administration/National Oceanic and Atmospheric Administration/ Sea Grant/Virginia Graduate Marine Science Consortium, \$5,000

Hargis, William J., "Oyster Reef Charting," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$8,000

Havens, Kirk J., "Marina Siting Suitability Index and Map Portfolio," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Conservation and Recreation, \$57,294

Hershner, Carl H., "Enhancement of Aquaculture Management," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality, \$220,275

Hershner, Carl H., "Enhancement of Wetlands Regulatory Program: Compensation Review and Draft Monitoring Protocol," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality , \$175,500

Hershner, Carlton H., "Shallow Water Resource Use Conflicts: Use Suitability and Spatial Model Development," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$63,000

Hershner, Carlton H., and Pamela A. Mason, "Update of Section 309 Coastal Needs Assessment and Strategy," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$15,000

Hershner, Carlton H., Thomas A. Barnard Jr., and Pamela A. Mason, "Tidal Wetlands Management Technical Support," NOAA Coastal Resource Management/Virginia Department of Environmental Quality, \$120,000

Hoenig, John M., "Contributions to the Biology of the Red Drum, *Sciaenops ocellatus*, in South Carolina," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$14,340

Hoenig, John M., "Development of Software for Length-based Stock Assessments," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$30,882

Hoenig, John M., "Developing, Assessing, and Managing a Fishery for Cownose Ray, *Rhinoptera bonasus* in Chesapeake Bay," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$95,191

Hoenig, John M., "A Field Study of the Population Dynamics of the Blue Crab in Chesapeake Bay," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$39,743

Hoenig, John M., Daniel A. Hepworth, "Adding Methods to the FACT Software Package," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$56,572

Hoenig, John M., and John E. Olney, Sr., "A Study of the River Origin of American Shad Captured in the Atlantic Ocean Intercept Fishery in Virginia," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$45,328

Hoenig, John M., Daniel A. Hepworth and Romuald N. Lipcius, "Tagging Studies of the Blue Crabs in Chesapeake Bay," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$270,825

Hoenig, John M., William D. DuPaul and Daniel A. Hepworth, "Evaluating Three Models for Estimating Gear Efficiency of Towed Dredges: When Do the Patch, Criss-Cross, and Zipper Methods Work?" National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$35, 998

Kaattari, Stephen L., "Induction of Potential Pathological State in *Perkinsus marinus* by Exposure to Oyster Tissue Extracts: Modulation of Cell Morphology and Protease/Antigen Production," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$112,855

Kirkley, James E., "Community Impact Assessments for Fisheries Management: Impact Assessment of Highly Migratory Species Management and Regulation," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$98,418

Kirkley, James E., "The Economic Effects of *Pfiesteria* in the Mid-Atlantic Region," National Oceanic and Atmospheric Administration/National Marine Fisheries Service \$14,546

Kirkley, James E., Ratana Chuenpagdee and Robert L. Hicks, "Assessing the Economic Impacts of Regulating and Managing Northwest Atlantic Fisheries: An Input/Output Framework for Estimating Economic Impacts in the Mid-Atlantic Region," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$120,000

Kirkley, James E., and William D. DuPaul, "Community Based Area Management Strategies and Capacity Reduction Programs for the Sea Scallop Industry," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$179,565

Larkin, Frances Lee, "Blue Crab Bowl Participation" National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$7,326

Larkin, F. Lee, "2001 National Marine Educators Association, Conference Support," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$6,300

Lipcius, Romuald N., "The Blue Crab, *Callinectes sapidus*: An Integrated Research of Basic Biology, Hatchery Technologies and the Potential for Replenishing Stocks," National Oceanic and Atmospheric Administration /National Marine Fisheries Service, \$225,000

Lipcius, Romuald N., Jacques van Montfrans, Rochelle D. Seitz, and Harry V. Wang, "Fisheries Habitat: Spatial Dynamics and Protection of Critical Habitats to Conserve Spawning Stock and Recruitment in Exploited Marine Species with Complex Life Cycles," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$445,547

Lipcius, Romuald N., and Marcel M. Montane, "A Field Study of the Population Dynamics of the Blue Crab in the Chesapeake Bay," National Oceanic and Atmospheric Administration /National Marine Fisheries Service, \$254,393

Lipcius, Romuald N., and William T. Stockhausen Jr., "Impact of Physical Transport, Habitat Quality and Adult Abundance upon Recruitment Dynamics of the Caribbean Spiny Lobster," National Oceanic and Atmospheric Administration/National Undersea Research Program, \$30,013



Luckenbach, Mark W., "An Experimental Evaluation of the Effect of Scale on Oyster Reef Restoration," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$187,509

Lynch, Maurice P., and William G. Reay, "Chesapeake Bay National Estuarine Research Virginia: Acquisition and Development Award for Education Center/Taskinas Creek," National Oceanic and Atmospheric Administration/National Estuarine Research Reserve System, \$750,000

Lynch, Maurice P., "System-Wide Monitoring Program Training for Minority Undergraduate and Graduate Students," National Oceanic and Atmospheric Administration /National Estuarine Research Reserve, \$35,175

Maa, Jerome P. Y., "Field Deployment of VIMS Sea Carousel: Study of Bottom Sediment Erodibility Study in Northern Chesapeake Bay," National Oceanic and Atmospheric Administration/Maryland Sea Grant Consortium, \$40,914

Mann, Roger, "Aquatic Nuisance Species Invasions: Ecological and Commercial Impact, and Control of the Marine Gastropod *Rapana venosa*," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$103,311

Mann, Roger, "Fishery Independent Standing Stock Surveys of Hard Clam Populations in the Chesapeake Bay and a Comparison with Continuing Estimates from Fishery Dependent Data," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$70,163

Mann, Roger L., "Oyster Advisory Report for NOAA/NMFS Chesapeake Bay Office," National Oceanic and Atmospheric Administration/ National Marine Fisheries Service, \$5,380

Mann, Roger L., "Oyster Heritage Program: Fall 1999," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality, \$10,000

Mann, Roger, "Oyster Larvae and Recruitment: The Paradox of Turbidity, Salinity and Larval Feeding Conditions," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$118,396

Mann, Roger, "Oyster Population Estimation in Support of the Ten-Year Goal for Oyster Restoration in the Chesapeake Bay Fishery," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$56,039

Mann, Roger and Juliana N. Harding, "Aquatic Nuisance Species Research: Current Distribution, Potential Range Expansion, Ecological and Commercial Impact, and Control of the Non-Indigenous Marine Gastropod, *Rapana venosa*," National Oceanic

and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$206,179

Mann, Roger L., and Mark W. Luckenbach, "Restoring an Oyster Reef for Mitigation of Estuarine Water Quality," National Oceanic and Atmospheric Administration/Cooperative Institute of Coastal and Estuarine Environmental Technology, \$29,403

Mason, Pamela A., and Carlton H. Hershner, "Evaluation and Review of Virginia's Coastal Resources Management Program: A Continuation," National Oceanic and Atmospheric Administration /Coastal Resource Management/Virginia Department of Environmental Quality, \$60,000

Mills, Sally H., "Regional Web Site on the Horseshoe Crab: Cupporting Fisheries conservation and Management Through Public Education," National Oceanic and Atmospheric Administration /Sea Grant/Virginia Graduate Marine Science Consortium, \$1,001

Mills, Sally H., "Science Writing Workshop," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$3,000

Moore, Kennneth A., and Iris C. Anderson, "Synergistic Interactions between Submerged Aquatic Vegetation and Clam Aquaculture," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$43,061

Moore, Kenneth A., and Robert J. Orth, "Seagrass Eutrophication Interactions: Role of Spatial Patterns," National Oceanic and Atmospheric Administration/National Marine Fisheries Service /Sea Grant/Virginia Graduate Marine Science Consortium, \$7,000

Murray, Thomas J., "Analysis of Marine Recreational Fisheries Statistics Survey Data on Subsistence Fisheries in the NE Region," National Oceanic and Atmospheric Administration/National Marine Fisheries Service/National Marine Fisheries Service, \$28,437

Murray, Thomas J., "Meeting to Evaluate the Status of the Hard Clam Market," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$5,906

Murray, Thomas J., "Plan to enhance Education and Outreach to the Mid-Atlantic Charter Boat Fisheries," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$35,586

Murray, Thomas J., "Virginia Recreational Boating Infrastructure Survey," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$6,996

Musick, John A., “An Analysis of the Status and Ecology of the Dusky Shark, *Carcharhinus obscurus*, in the Western Atlantic,” National Marine Fisheries Service, \$29,527

Musick, John A., “An Assessment of Abundance of Shark Stocks in the Chesapeake Bight and a Delineation of Shark Nursery Grounds in Chesapeake Bay,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$124,663

Musick, John A., “Evaluation of Sea Turtle and Fisheries Interactions in the Chesapeake Bay,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$53,000

Musick, John A., “Loggerhead (*Caretta caretta*) Sea Turtle Behavior and Population Estimates in Virginia,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$28,803

Musick, John A., “Review, Synthesis and Summarization of Existing Shark Nursery Grounds Information in Virginia Waters,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$4,000

Musick, John A., “Stranding Patterns and Sources of Mortality of Sea Turtle Populations in Virginia,” National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$8,500

Musick, John A., Christina L. Conrath, “A Delineation of Winter Nursery Grounds, Migratory Patterns, and Critical Habitat of Juvenile Sandbar Sharks, *Carcharhinus plumbeus* in the Western Atlantic Ocean,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$186,939

Musick, John A., Daniel S. Ha, “Essential Fish Habitat of Juvenile Atlantic Sturgeon *Acipenser oxyrinchus* in Virginia,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$60,738

Musick, John A., Katherine L. Mansfield, “Evaluation of Interactions Between Sea Turtles and Pound Net Leaders in the VA Chesapeake Bay (PRESOL),” National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$35,000

Musick, John A., and Katherine L. Mansfield, “Sea Turtle and Fisheries Interactions in the Chesapeake Bay,” National Oceanic and Atmospheric Administration/National Marine Fisheries Service/National Marine Fisheries Service, \$37,500

Musick, John A., Roy Pemberton, “Black Sea Bass *Centropristis striata* Biology and Population Dynamics,” National Oceanic and Atmospheric Administration National Marine Fisheries Service, \$23,731

Niebuhr, David, "Support for NERRS 2001 Workshops," National Oceanic and Atmospheric Administration, \$3,300

Oesterling, Michael J., "Captive Spawning Larval and Early Juvenile Culture of Cobia, *Rachycentron Canadum*," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$72,104

Oesterling, Michael J., "Exploring the Collaborative Learning Process for Management of Mid-Atlantic Fisheries," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$1,751

Olney, Sr., John E., "Natal Tributary Origin of Mature American Shad Captured in the York River, Virginia," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$46,373

Olney, Sr., John E., "Validating New Stock Assessment Methods for American in the York River, Virginia," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$46,193

Olney, John E., and John M. Hoenig, "Calibrating Historic Catch Rates to Determine Restoration Targets for American Shad in the James and York Rivers, Virginia," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$39,000

Olney, John E., Sr., and John M Hoenig, "Estimating Population Parameters of American Shad in the York River, Virginia: Change-in-ratio and Index Removal Methods," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$48,770

Olney, John E., Sr., and John M. Hoenig, "Evaluating Methods for Estimating Population Parameters of American Shad in the York River, Virginia: Change-in-ratio and Index Removal," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$51,500

Orth, Robert J., "Development of a Bay Grasses (SAV) Volunteer Monitoring Web Site," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality, \$15,000

Orth, Robert J., "Distribution and Abundance of Submerged Aquatic Vegetation in the Chesapeake Bay and its Tidal Tributaries and the Coastal Bays of Virginia and Maryland," National Oceanic and Atmospheric Administration/Maryland Department of Natural Resources, Coastal Zone Management Division, \$98,046

Orth, Robert J., "Submerged Aquatic Vegetation: Distribution and Abundance of Chesapeake Bay, Tributaries, and Delmarva Coastal Bays," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$240,071

Orth, Robert J., "Virginia Oyster Heritage Program- Seagrass Habitat Restoration in Virginia Seaside Lagoons," National Oceanic and Atmospheric Administration/ Virginia Marine Resources Commission/Coastal Zone Management, \$30,000

Patterson, Mark R., "Flow Modulated Metabolism: Connection with Coral Bleaching and Reef Oxygen Crises," National Oceanic and Atmospheric Administration/National Undersea Research Center, Wilmington, \$46,577

Patterson, Mark R., "Sea Grant Technology Program: Development of Image Processing Algorithms for Identification and Quantification of Biological Targets Detected by Side Scan Sonar: Application to Fisheries Stock Assessments from Robotic Platforms," National Oceanic and Atmospheric Administration/Virginia Graduate Marine Science Consortium, \$89,675

Perry, James E., "Development and Presentation of Pilot Curriculum for Virginia Eco-tour Guide Certification Program," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$10,188

Reay, William C., "Operations, Education and Monitoring Grant 2001-2002, CBNERRVA," National Oceanic and Atmospheric Administration/National Estuarine Research Reserve, \$502,750

Reay, William C., "Property Acquisition, Chesapeake Bay National Research Reserve in Virginia: Catlett Islands," National Oceanic and Atmospheric Administration/National Estuarine Research Reserve, \$105,000

Reay, William C., "Property Acquisition, Chesapeake Bay National Research Reserve in Virginia: Dragon Run Preserve," National Oceanic and Atmospheric Administration/Office of Coastal Resource Management/Virginia Department of Environmental Quality, \$90,000

Reay, William C., "Property Acquisition, Chesapeake Bay National Research Reserve in Virginia: Harrison Track, Taskinas State Park," National Oceanic and Atmospheric Administration/National Estuarine Research Reserve, \$273,900

Reay, William G., "Support for Coastal Management Program, 2001," National Oceanic and Atmospheric Administration/Office for Coastal Resource Management/Virginia Department of Environmental Quality, \$1,555,110

Reay, William C., Robert Carroll, "Investigating Current Chesapeake Bay Fisheries Issues: A Field-Based Education Program," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$10,636

Reece, Kimberly S., "Development of a Moderate Density Linkage Map of the Eastern Oyster, *Crassostrea virginica*: Identification of Disease Resistant Genes," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$127,849

Reece, Kimberly S., and Standish K. Allen, "Analysis of Genetic Variation in *Crassostrea ariakensis*: Evaluation of Germplasm Resources for Broodstock Development," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$86,186

Shields, Jeffrey D., "Epidemiological Studies on Spiny Lobsters, *Panulirus argus*, Infected with a Pathogenic Herpes-like Virus," National Oceanic and Atmospheric Administration/National Marine Fisheries Service, \$142,474

Unger, Michael A., "Sea Grant Technology Program: Enhancing the Remediation of TBT Contaminated Wastewaters Through Mechanistic Investigations and Treatment Development," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$150,000

Van Montfrans, Jacques and Vicki P. Clark, "Bringing Blue Crab Issues to the Public," National Oceanic and Atmospheric Administration/Sea Grant/Virginia Graduate Marine Science Consortium, \$16,200

VanVeld, Peter A., "Development and Application of Biomarkers to Evaluate Endocrine Disruption in Fish as a Result of Chicken Manure Application on the Delmarva Peninsula," National Oceanic and Atmospheric Administration/Sea Grant/Maryland, \$20,000

Wang, Harry V., "Near Real Time Hydrographic Modeling," National Oceanic and Atmospheric Administration, \$5,000

Wang, Harry V., "Predicting the Distribution Pattern of Sea Nettles (*Chrysaota Quinguecirrha*) in the Chesapeake Bay," National Oceanic and Atmospheric Administration, \$5,000

## **DEPARTMENT OF THE INTERIOR**

Austin, Herbert M., and Patrick J. Geer, "Estimation of Juvenile Abundance of Recreationally Important Finfish in the Virginia Portion of the Chesapeake Bay," U.S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$342,718

Austin, Herbert M., A. Deane Estes, and Donald M. Seaver, "Estimation of Juvenile Striped Bass Relative Abundance in the Virginia Portion of the Chesapeake Bay," U. S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$275,503

Chittenden, Mark E., "Study of Important Recreational Fishes of the Chesapeake Bay Region to Develop Basic Biological Information and SPR/YPR Modeling to Provide Management Advice," U. S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$420,784

Diaz, Robert J., "Bottom Imaging and Habitat Characterization of Potential Sand Borrow Areas Offshore Delaware and Maryland (Fenwick Survey)", Minerals Management Service/Versar Inc., \$52,000

Diaz, Robert J., "Technical Support to SAIC for the Development of a NOAA Website on the Topic of Benthic Habitat Mapping," National Oceanic and Atmospheric Administration/Scientific Applications International, \$15,000

Diaz, Robert J., "Minerals Management Service Deepwater Program: Effects of Oil and Gas Exploration and Development," Minerals Management Service/Continental Shelf Associates, \$129,757

Hardaway Jr., C. Scott, "Evaluation of Shore Line Protection," National Park Service/Colonial National Historical Park, \$13,766

Harris, Courtney K., "Quantitative Shelf Sediment Transport," United States Geological Survey, \$65,650

Hobbs, Carl H., Robert J. Diaz, Jerome P. Y. Maa and Jesse E. McNinch, "Field Testing of a Physical/Biological Monitoring Methodology for Offshore Dredging and Mining Operations," Minerals Management Service, \$452,000

Hobbs, Carl H., and C. Scott Hardaway Jr., "Continuing Studies: Southeastern Virginia's Inner Continental Shelf Including Studies Related to Beach Nourishment," Mineral Management Service, \$45,964

Hoenig, John M., "Development of an Improved Assessment Method for Determining Relative Abundance of American Shad in Virginia Waters," U. S. Fish and Wildlife Service, \$22,408

Kator, Howard I., "Striped Bass Spleen Samples for Enumeration and Identification," U.S. Geological Survey, \$2,500

Kator, Howard I., "Evaluation of rep-PCR for Determination of Sources of Fecal Contamination in Watersheds," U. S. Geological Survey/Virginia Department of Environmental Quality, \$54,677

Lucy, Jon, "Conference Support: Catch & Release Symposium," U. S. Fish and Wildlife Service, \$2,500

McNinch, Jesse E., "Assessing the Spatial Correlation of Underlying Geology in the Nearshore with Shoreline and Bar Behavior: Outer Banks, North Carolina," United States Geological Survey, \$54,984

Musick, John A., "A Delineation of Shark Nursery Grounds in Chesapeake Bay and an Assessment of Abundance of Shark Stocks," U.S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$220,707

Olney, John E., "Evaluation of Striped Bass Stocks in Virginia: Tagging and Monitoring Studies," U.S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$690,127

Olney, John E., and John M. Hoenig, "Monitoring Relative Abundance of American Shad in Virginia's Rivers," U.S. Fish and Wildlife Service/Virginia Marine Resources Commission, \$596,310

Orth, Robert J., Judith F. Nowak, and David J. Wilcox, "Submerged Aquatic Vegetation Distribution and Abundance Survey of the Chesapeake Bay, its Tributaries and the Coastal Bays of the Delmarva Peninsula," U. S. Fish and Wildlife Service, \$95,000

Perry, James E., "Determination of Management Practices for Control of *Phragmites australis* within the Colonial National Historical Park, Virginia," National Park Service, \$5,000

Perry, James E., "Determination of Status of Existing Natural Resource from Recreational Use of Cape Hatteras National Seashore: Literature Review and Ecological Assessment," National Park Service, \$55,000

Vogelbein, Wolfgang K., Howard I. Kator, "Mycobacteriosis in Striped Bass: Laboratory Studies," U. S. Geological Survey, \$122,569

Vogelbein, Wolfgang K., "Studies on the Etiologies and Predisposing Factors of Skin Lesions of Menhaden in Chesapeake Bay Tributaries," U. S. Geological Survey, \$120,350