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Center for Coastal Physical Oceanography, Old Dominion University

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OYSTERS: Steamed, Fried, or Simulated

The Eastern oyster (Figure 1), Crassostrea virginica, has existed in the bays and estuaries along the Gulf of Mexico and southeastern United States coast for millions of years. Archaeological excavations of shell middens remaining from the first settlements of these regions indicate that the oyster was an important food source for the early inhabitants. Records surviving from the Jamestown settlement in 1607 show that the early English settlers learned about the culinary delights of oysters from the Powhatan Indians. Now oysters on the half shell, oyster chowder, and other oyster dishes are familiar items on menus and are often served as delicacies at special functions. However, the influence of the oyster extends beyond a culinary effect. In many Gulf and southeastern U.S. coastal regions oyster fishing has been a way of life for generations and has produced an unique culture.

Therefore, the decline in the oyster fishery in many regions has implications far beyond simply resulting in higher prices for the oyster consumer. The decline in oyster numbers has been most noticeable in Chesapeake Bay and the subsequent impact on the oyster fishery has been dramatic, as evidenced by recent articles in local newspapers. In effect, the Chesapeake Bay oyster fishery has gone from about 1.5 million bushels harvested in the early 1960s to less than a few hundred thousand harvested in the 1990s. Many factors, such as disease and overfishing, have been put forward as the causes underlying this drastic decline in oysters.

During the past four to five years, CCPO scientists, EILEEN HOFMANN, JOHN KLINCK, and MARGARET DEKSHENIEKS, have been working with ERIC POWELL, of the Haskin Shellfish Research Laboratory of Rutgers University, to develop a series of mathematical models that can be used to examine various environmental, physiological, and ecological processes that affect the growth and production of the Eastern oyster. Development of these models has followed a holistic approach in which interactions between the oyster and its environment have been explicitly included (Figure 2). This differs from other approaches that have been used to construct mathematical models of oysters, in particular, and bivalves in general.

The first of their oyster models was designed to simulate the growth of the oyster from settlement as spat to an adult. The model includes formulations that allow the growth and reproductive potential of the post-settlement oyster populations to be affected by ambient salinity, temperature, turbidity and food concentrations, and flow velocity. Biological controls on the growth of oysters are from competing effects of mussel filtration, which reduces the food available for the oyster and predation by crabs and oyster drills (Thais).

The post-settlement population model was used to simulate the population dynamics of oysters using environmental conditions that are representative of bays and estuaries, ranging from Laguna Madre, Texas to Chesapeake Bay. These simulations show marked differences in the rate of growth, spawning frequency, and reproductive potential in oyster populations over this latitudinal range (Hofmann et al. 1992; 1994). Oysters in the more southern latitudes tend to spawn more frequently and tend to be smaller than those in Chesapeake Bay. This difference in population characteristics results primarily from the effect of temperature on the apportionment of food resources by the oyster to growth and reproduction. Moreover, the simulations show clearly that the timing and magnitude of the spring and fall phytoplankton blooms have a pronounced effect on the reproductive potential of the post-settlement oyster population.

When oysters spawn, their eggs and sperm are released into the water column where fertilization takes place. It is here that oyster larvae develop until reaching settlement size. Thus, the second model developed focused on simulating the planktonic phase of the oyster life history. This model also explicitly includes environmental effects on the growth and development of the oyster larvae. Simulations with this model show that temperature is the primary factor controlling the larval planktonic time, with warm temperatures resulting in the shortest times (Dekshenieks et al. 1993). Application of this model over the latitudinal range used for the post-settlement model showed that oysters in the southern Gulf coast regions can spawn late into the fall and still produce larvae that are capable of completing their planktonic phase. However, spawns in Chesapeake Bay much later than early October result in unsuccessful larvae because the Bay waters cool down sooner in the fall than those at the more southern latitudes. More recent work with the model has shown that oyster larvae have a pronounced behavioral response to salinity changes that may enhance their retention in estuaries.

The most recent addition to the oyster post-settlement model has been a submodel that simulates the effect of the endoparasite, Perkinsus marinus, the causative agent of the disease Dermo, which ultimately results in oyster death. The simulations with the combined oyster-Dermo model have shown that environmental conditions have a major control on the disease organism and therefore on the oyster growth (Hofmann et al. 1995). One set of simulations with this model showed that climatic cycles, such as those associated with El Nino events, may exert a major control on the prevalence and intensity of this disease in oyster populations. If correct, this has considerable implications for the way in which management strategies for oyster populations are developed (Powell et al. 1994; in press).

In addition to using the oyster models to understand basic biological processes, the models have also been used in an applied mode. The oyster-Perkinsus marinus and oyster larvae models were combined with a circulation model developed for Galveston Bay, Texas by the U. S. Army Corps of Engineers, Waterways Experiment Station. The oyster-circulation model was then used to estimate the impact of deepening and widening the Houston Ship Channel on the oyster populations in Galveston Bay. A primary effect of the Houston Ship Channel is to provide a conduit for movement of higher salinity Gulf of Mexico water into Galveston Bay. Since some factors that affect oyster growth and reproduction, notably the prevalence and intensity of the disease, Perkinsus marinus, become more pronounced at high salinity, the concern was that an enlarged ship channel would have deleterious effects on the Galveston Bay oyster population. Moreover, the effect of the ship channel could be altered, favorably or unfavorable for the oyster populations, by the approach taken by the state of Texas in freshwater management over the next 50 years (1999-2049). Therefore, a series of simulations were undertaken that used the present and proposed new channel configurations with three freshwater inflow regimes: mean, low, and high river inflow conditions.

The simulations with the oyster-circulation model showed that freshwater management practices had more of an effect on the vitality of the Galveston Bay oyster populations than did the proposed changes in the Houston Ship Channel. These results have implications for setting long-term water usage policies for Texas, as well as for other similar systems. Additional simulations with the oyster-circulation model, which have formed the basis for a Ph.D. dissertation for CCPO student, MARGARET DEKSHENIEKS, show clearly that the physical environment exerts a strong control on structuring oyster populations in Galveston Bay. Hence, man-induced or natural changes that alter the present environment in Galveston Bay can have a large impact on the oyster fishery in this region.

The development of their oyster models is continuing. CCPO scientists recently had the pleasure of having Masato Kobayashi from the Yokohama College of Commerce, Yokohama, Japan, spend his sabbatical leave at CCPO. While at CCPO, Masato converted the Eastern oyster post-settlement model to one for the Japanese oyster, Crassostrea gigas. The Japanese oyster has been suggested as a replacement species for the Eastern oyster in Chesapeake Bay. The first series of simulations with the Japanese oyster model have focused on defining the differences between it and the Eastern oyster (Kobayashi et al. submitted). These have shown that the Japanese oyster differs in some of its physiological responses, as well as in its interaction with the environment.

This fall the CCPO scientists received funding from the National Oceanic and Atmospheric Administration, Sea Grant Program to extend their oyster-*Perkinsus marinus* model to include the effects of a second disease, MSX, which also infects oysters in Chesapeake Bay. This new modeling effort is joint with Steve Jordan from the Cooperative Oxford Laboratory, Oxford, Maryland and Susan Ford from the Haskin Shellfish Research Laboratory. Also involved is MICHELE PARASO, a first-year M.S. student at CCPO. The focus of this modeling effort will be on understanding the interaction of competing parasites in a single host, quantifying the processes that result in outbreaks of the the two diseases, and on identifying management strategies that could potentially lessen impact of these diseases on oyster populations.

Once the various oyster models are developed and tested, it is straightforward to apply them to other regions. For example, the scientists are now adapting the post-settlement oyster model for Delaware Bay so that it can be used to assess the effects of dredge spoil disposal resulting from deepening the Delaware Bay Ship Channel on local oyster populations. Also, this model is being restructured so that it can be interfaced with the water quality and circulation models developed for Chesapeake Bay by the Environmental Protection Agency. Thus, there are numerous opportunities to continue using our various models to study oysters and their interactions with the environment. The many scenarios that are tested with the oyster models will provide insight into the factors controlling these populations.

References

Dekshenieks, M. M., E. E. Hofmann and E. N. Powell, 1993, ``Environmental Effects on the Development of Eastern Oyster, *Crassostrea virginica*, (Gmelin, 1791), Larvae: A Modeling Study," *Journal of Shellfish Research*, 12(2), 241-254.

Hofmann, E. E., J. M. Klinck, E. N. Powell, S. Boyles and M. Ellis, 1994, ``Modeling Oyster Populations. II. Adult Size and Reproductive Effort," *Journal of Shellfish Research*, 13(1), 165-182.

Hofmann, E. E., E. N. Powell, J. M. Klinck and G. Saunders, 1995, ``Modeling Diseased Oyster Populations I. Modeling *Perkinsus marinus* Infections in Oysters," *Journal of Shellfish Research*, 14(1), 121-151.

Hofmann, E. E., E. N. Powell, J. M. Klinck and E. A. Wilson, 1992, ``Modeling Oyster Populations. III. Critical Feeding Periods, Growth and Reproduction," *Journal of Shellfish Research*, 11(2), 399-416.

Kobayashi, M., E. E. Hofmann, E. N. Powell, J. M. Klinck and K. Kusaka, submitted, ``A Population Dynamics Model for the Japanese Oyster, Crassostrea gigas," *Aquaculture*.

Powell, E. N., E. E. Hofmann, J. M. Klinck, E. A. Wilson-Ormond and M. S. Ellis, 1994, ``Modeling Oyster Populations V. Declining Phytoplankton Stocks and the Population Dynamics of American Oyster (*Crassostrea virginica*) Populations," *Fisheries Research*, in press.

Powell, E. N., J. M. Klinck, E. E. Hofmann and S. M. Ray, 1994, ``Modeling Oyster Populations IV: Rates of Mortality, Population Crashes and Management," *Fishery Bulletin*, 92, 347-373.

A NEW FACE AT CCPO: LINDA F. PROSPERIE

CCPO is pleased to welcome LINDA F. PROSPERIE to its family. As an Oceanographic Data Technician, she works under the direction of Lou Codispoti, research professor at CCPO. To be so young, Linda comes to CCPO with an already impressive career. She received a B.S. in Mathematical Science with a minor in Computer Science from Lamar University, Beaumont, Texas in 1982. After graduation, Linda went to work for Texas Instruments in a research and development environment, performing image processing and data and algorithm analysis. For two years, she was involved in developing radar scan software and maintaining a pulse processing system for the Navy in California. She then moved on to Litton Data Systems Division in Mississippi, where she developed and maintained a Navy communications system currently used on the LHD Wasp class of ships.

At CCPO, Linda will process hydrographic data sets collected on research cruises in support of the Joint Global Ocean Flux Study (JGOFS) Arabian Sea process study. This will include the development and execution of software tools for data manipulation, representation, and analysis. Linda expects that these hydrographic data sets will contribute to the understanding of the processes of nutrient fluctuations between atmosphere and the upper and deep ocean.

Throughout her career travels, Linda has been an avid bicycle tourer. Her major adventures include Grand Canyon/Bryce/Zion, the Canadian Rockies, the northern California coast, New England, Alaska, and cross-country from Seattle to Boston. She also enjoys backpacking and volleyball.

To top this all off, Linda is continuing graduate studies this fall at Old Dominion University. She is interested in geographic information systems and will be taking various classes in preparation for a degree in this area.

EFFECTS OF HURRICANE FELIX ON THE HYDROGRAPHY OF THE LOWER CHESAPEAKE BAY

Hurricane Felix moved westward across the tropical Atlantic during the second week of August 1995 and was forecast to reach land by August 16, 1995. The span of coast likely to be most affected by Felix extended from Cape Hatteras, North Carolina to Chincoteague on Virginia's Atlantic Coast. The lower Chesapeake Bay was expected to be influenced by winds of approximately 140 km/h (40 m/s) combined with low atmospheric pressures that were to cause storm surges of 2-3 m. While the residents of North Carolina and Virginia were evacuating the coastal areas and preparing for the worst, CCPO researchers, ARNOLDO VALLE-LEVINSON, JERRY MILLER, and GLEN WHELESS saw this as a research opportunity, as most oceanographers would. On August 16, however, Felix stalled near the western edge of the Gulf Stream, some 150 km ENE of Cape Hatteras and slowly moved northeastward.

The winds related to Felix during its passage off the mouth of the Chesapeake Bay prolonged to August 19 a period of predominantly northeasterly to northerly winds that began in early August 1995. The northeasterly winds, which drive a net barotropic inflow into the Bay due to its orientation, caused a storm surge during the passage of Felix that was similar to that of early August (approximately 0.7 m). The winds peaked at 15 m/s on late August 16 and remained above 10 m/s until August 19, thus maintaining the storm surge for four days.

Hydrographic data had been obtained at a transect across the lower Chesapeake Bay (Figure 1) on August 11, 1995, before the passage of Felix. This hydrographic transect is part of a CCPO-financed program of monthly spring-tide cruises that monitor the lower Bay hydrography. The hydrographic transect was repeated on August 21, two days after the weakening of the strong northeasterlies. The hydrography before the passage of Felix suggested encroachment of coastal waters into the estuary as reflected by high salinities and nearly-homogeneous vertical distributions over the shoals of the transect (Figure 2a). The suggested encroachment was consistent with the wind forcing (northeasterlies) in the area and with the very low river discharges of the Chesapeake Bay tributaries during July and August. Two days after the weakening of the winds related to Felix, the hydrographic distribution across the transect suggested drainage of the volume gained by the Chesapeake Bay during the period of northeasterly winds. Near-surface salinities were typically three units lower than those observed before Felix, and near-bottom salinities were comparable (Figure 2b). The water column showed strongly stratified conditions. This behavior suggests that the net inflow of coastal water into the lower Bay and the wind forcing related to Felix produced a vertically uniform along-estuary density gradient that relaxed after the winds weakened. The weakening of the winds coincided with neap tides, which also must have allowed the self-adjustment of the density gradient and the seaward advection of relatively buoyant waters near the surface. The hydrography observed in early August (Figure 2a) reflects conditions soon after relaxation of a net barotropic inflow event similar to that caused by Felix. However, in early August, the transect was occupied during spring tides and tidal mixing must have hindered the development of stratified conditions over the shallow regions of the lower Bay.

The self-adjustment of the density gradient after wind-forcing relaxation was studied with simplified (two-dimensional) numerical simulations (not shown). An initial along-estuary salinity gradient (vertically uniform) was allowed to self-adjust for one day, after which, an up-estuary wind stress pulse with maximum amplitude of 0.1 Pascals and period of three days was prescribed. Flow and salinity structures soon after wind relaxation were compared to those developed three days after wind relaxation. A few hours after relaxation of the prescribed up-estuary wind pulse, the flow was into the estuary and the salinity was vertically-homogeneous. This picture must have prevailed during the hurricane passage. Three days after wind relaxation, stratification was strong and flow was two-layered (outflow near the surface, inflow near the bottom), as a consequence of the self-adjustment of the vertically homogeneous density gradient. Therefore, it is concluded that the passage of Felix off the mouth of Chesapeake Bay enhanced the flushing of the Bay. This could be a general response of the Bay after strong northeasterly winds (10 m/s), provided that the wind forcing is followed by a period of weak tidal mixing (neap tides).

STUDENT PROFILES

SANG-KI LEE graduated from Inha University, Incheon, Korea in the spring of 1991 with a B.S. degree in oceanography. He then studied for one year as a M.S. student in the same institute. During this period, he worked on developing a multi-layer circulation model of the East Sea (Japan Sea). In the fall of 1991, he joined the M.S. program at ODU under the direction of Chester E. Grosch.

His M.S. thesis work focused on the instability of the Gulf Stream front. A linear instability model was used to comprehend the interaction of the Gulf Stream subsurface waters with the slope waters shoreward of the Gulf Stream front. After completing his M.S. degree, he entered the Ph.D. program in the spring of 1994 under the direction of G. T. Csanady. Sang-Ki's dissertation is entitled, ``Seasonal Variability of Heat and Mass Transport Process in the Upper Tropical Atlantic Ocean: A Numerical Model Study." This research involves the development of an isopycnal multi-layer numerical model including thermodynamics in the surface mixed layer. The model allows a vanishing layer depth through Flux Corrected Transport algorithm. Real wind and heat flux were used to force the model in a realistic geometry.

After graduation, Sang-Ki intends to obtain a teaching or research position in Korea.

JAMES KOZIANA received his undergraduate degree in physical sciences (concentration in meteorology) in 1979 and his M.Sc in atmospheric and earth sciences in 1982, both from Old Dominion University (ODU). After graduation, James (also known as Kozy) worked as a staff scientist for several private contractors for three years in support of flight projects, such as the Halogen Occulation Experiment (HALOE) and Measurement of Air Pollution from Satellites (MAPS) at NASA Langley Research Center, Hampton, VA. In 1985, he shifted his career track to space technology and took a position as space technologist/project leader for Technology Applications, Inc. (TAI), in which he was responsible for the progress of work on flight experiment projects. James's progressing career lead him to SpaceTec Ventures, Inc., in a manager/scientist position where he was responsible for the integration, testing, and mission operations of the MAPS and Lidar-InSpace Technology Experiment (LITE) Space Shuttle experiments.

In 1991, James began his association with oceanography at ODU as a part-time student, and in January 1994, he became a full-time graduate student in the physical oceanography program under the direction of Eileen Hofmann. James's dissertation is entitled, ``Air-Sea Exchanges and Coupling to a Mixed Layer-Biological Model of the Pacific Ocean." After graduation, he plans to pursue his research interests in a postdoctoral position in physical oceanography.

WHAT I DID ON MY SUMMER VACATION: A Visit to Cambridge by Chester E. Grosch, Professor of Oceanography

During the past July and August I spent five weeks visiting the University of Cambridge. My host was Michael Gaster FRS, the Francis Mond Professor of Aeronautical Engineering. This visit was the latest in a series of almost yearly visits dating back to 1983. In the early and middle 80's, I visited Mike at the National Physical Laboratory and since '86 at Cambridge, and during this period, Mike has also visited ODU and ICASE at NASA Langley.

The typical length of my visits with Mike has been four to eight weeks, long enough for my wife, Joan, and me to rent a flat. The one longer trip occurred in 1989 when I had a leave of absence, a Royal Society fellowship, and spent six months in Cambridge. Our visits have all been both pleasant and rewarding. One of the most notable features of this visit was the awful weather. Usually the English summer is lovely, cool, and partly cloudy with some rain. This past summer was the hottest and driest on record, and on record means a long time. Weather records in England begin, I believe, in 1659. It is rather unpleasant to have 90 degree temperatures and high humidity in a country where there are no fan and no air conditioning and where cross ventilation is thought to be unhealthy.

In the 80's, Mike and I collaborated on using the techniques of parallel computing in the study of hydrodynamic stability and transition. In more recent times we have been trying to understand how external forcing, both from the free stream and boundaries, induces instability modes in shear layers. We have carried out various theoretical calculations and, most recently, have been doing wind tunnel experiments. In these experiments, we measured the flow field generated inside a boundary layer by a bump on the boundary. The bump is very small on the boundary layer scale, being about 1/10 of a displacement thickness in height. These experiments yielded some surprising results; the interested reader may refer to Physics of Fluids, 6, 3079, 1994 for details. Results of a direct numerical simulation of this experiment, done in collaboration with another coworker at NASA Langley, will appear in Physics of Fluids at the end of this year. This summer Mike and I tried to extend the measurements by examining the scale effects of the bump size but with little success due to the appearance of substantial flow noise (0.05) of unknown origin in the tunnel. I am hoping to be able to have a longer visit in the near future in order to pursue these experiments. Beyond this, we hope to examine, both in experiments and with calculations, the interaction of stability modes with the flow field of the bump.

Cambridge University is an interesting place to visit. Along with Oxford, Cambridge retains some of the structure of its medieval heritage, most notably the 34 independent colleges. The University is responsible for lectures, libraries, laboratories, examinations, and the conferring of degrees. The colleges admit students (there is no University admissions office in the form familiar to people in U.S. universities), serve as boarding houses providing meals, and provide weekly tutoring for each student. The colleges tend to specialize in subjects in which they can tutor, depending on the expertise of their fellows. For example, one college has many engineers and historians as fellows. Another holdover is the names of the three terms, Michaelmas, Lent, and Easter.

Cambridge has about 12,000 students and is a large university by British standards. The average British University is about half the size of Cambridge. At Cambridge there are only two engineering departments: one is the Department of Chemical Engineering and the other is the Department of Engineering. The latter is very diverse and contains all of engineering outside chemical engineering. This department has around 1,200 undergraduates and a hundred or so post-graduate students. The faculty numbers about 120 with about 30 of them being Readers and Professors. The length of the undergraduate Engineering program is just now changing from three years to four years so enrollment will increase by about 25 percent over the next years.

Although Cambridge is, in many ways, very different from American universities, it shares, to a remarkable degree, the problems of American universities. Just after I arrived, Mike gave me a memorandum which summarized for the faculty the results of a University Senate study of the state of and major problems of Cambridge. In addition to the problems particular to Cambridge, such as strains between colleges and the university, their problems were too familiar. Faculty raises have been below inflation for a number of years (as I recall, Cambridge's raise last year was less than 1 percent). Government financial support for students is frozen and students are being pushed to work during vacations and take out ever larger loans. The government is reducing basic support for the universities and is demanding a large increase in the number of students ``processed" and in the ``productivity" of the faculty. Every university is being rated every three years by a government-sponsored group. This is supposed to foster competition for resources (read money) among the universities. Tenure has been abolished; faculty get five-year contracts and have no right to reappointment (this yields flexibility according to the government). Research must be directed toward the needs of industry. In particular, industries generate the equivalent of requests for proposals and faculty propose research in reply with the money coming from the government. Cambridge has survived, with change, for nearly 800 years and I expect will outlive current fashions.

A FEW WORDS FROM THE EDITOR

This issue of CCPO Circulation celebrates our second anniversary. Two years and eight issues is another example of ``how time flies when you are having fun." Publishing a newsletter every four months takes a lot of hard work not only by the editorial staff, but also by the article contributors. I want to take this opportunity to thank JULIE MORGAN, technical editor; BEVERLY SCOTT, distribution manager; A. D. KIRWAN, JR., for providing his ``words of wisdom" every issue (we can't live without them); and all the faculty, researchers, staff, and students at CCPO who have endlessly provided me with article contributions. Without you, my job as editor couldn't have been easier. Most importantly, I want to thank LARRY P. ATKINSON for giving me the opportunity to serve as editor of CCPO Circulation, a challenging project that he trusted me with completely. Lastly, I want to thank our faithful readers. I see your dedication to our newsletter everytime I receive kind and encouraging words about it or receive an address change request so that you are not overlooked on the mailing list. I toast you all! Here's to many, many more issues of CCPO Circulation.

Carole E. Blett Editor, CCPO Circulation

Picture Caption: Pictured is the editorial staff of CCPO Circulation: (l-r) Carole Blett, Julie Morgan, and Beverly Scott.

COMMUNITY INTERACTIONS

Seashore Walking Tours

MARGARET DEKSHENIEKS, a graduate student at CCPO, gave walking tours of the seashore to interested Hampton Roads residents and many tourists vacationing in Virginia Beach on every Wednesday evening during the summer months. Margaret is an interpreter of marine and beach ecology at First Landing/Seashore State Park, Virginia Beach, VA, and she has been giving beach walks at the park for two years. The park service has even asked Margaret to train other park volunteers.

As an interpreter, Margaret's responsibility was to describe what the visitors were seeing in the dunes and along the beach. The walks began with a brief overview of the Chesapeake Bay, including its circulation and the importance of the estuary to many of the local fisheries. During the walks, Margaret suggested to visitors that they look for pieces of shells, crabs, and other interesting things they can find along the shore, and then she held discussions on what was found. Margaret found that each walk was different due to the different organisms that both wash up on the beach and swim nearby at different times of the year. The walks were also varied depending on the interests of visitors. The visitors actually ``guide'' the walks based on their interests and questions. The goal of the walks was to give visitors a better understanding of the natural environment near the seashore. Interpreting these walks has been a very positive experience for Margaret, as well as for the visitors.

Due to the approaching cold weather, this past season's walks ended in mid-September. You can contact First Landing/Seashore State Park for more information on the beach walks that will start up again in the spring and for other educational tours offered year-round.

Elizabeth River Project

During the summer months, CCPO has had the pleasure to host the Elizabeth River Project (ERP) Subcommittee of the Water Quality Task Force. The ERP is a grassroots organization dedicated to improving the Elizabeth River. The Elizabeth River is a major commercial and military resource to the Commonwealth of Virginia, as well as to the nation. It represents a resource to commercial fisheries, recreational activities, tourism, and living resources of the region, and ultimately, the Elizabeth River runs into the Chesapeake Bay estuary.

The Subcommittee of the Water Quality Task Force of the ERP, known as the Watershed Action Team, is preparing a report on point sources of pollution. The preparation of this report and other reports will form an action plan that will be developed over the next couple of years to improve the Elizabeth River. The report will address and discuss sufficient ways to protect water quality from ``the stressors'' to the Elizabeth River. These stressors include dissolved oxygen depletion, nutrients, particulates, pathogens, organics, and metals. David Sump of Crenshaw, Ware Martin and Kim Coble of the Chesapeake Bay Foundation are the co-chairs of the Watershed Action Team. Other members of the team include: LARRY ATKINSON, Center for Coastal Physical Oceanography; Mark Stafford, U.S. Coast Guard; JoAnne Berkley, Chesapeake Bay Foundation; Pam Ferguson, Norfolk Naval Base; William Hunley, Hampton Roads Sanitation District; Jack Miles, JH Miles Co., Inc.; John Hanscom, Hutcher Sayer; Albert Kuo, Virginina Institute of Marine Science; Richard Ayers, Department of Environmental Quality; Linda Cole, Norfolk Naval Shipyard; David Weiss, Center for Innovative Technology; and Michelle Long and Derek Speetles, Texaco Lubricants.

ADK'S WORDS OF WISDOM

``A blind hog will always find an acorn.''

Pictured is A. D. Kirwan, Jr. (Denny). This photo indicates the seriousness involved in Denny's pondering of his words of wisdom for CCPO Circulation.

JUST THE FACTS...

Grants/Contracts Awarded

E. E. HOFMANN and J. M. KLINCK, ``Modeling and Transport and Exchange of Krill Between the Antarctic Peninsula and South Georgia," 212,149, NSF.

E. E. HOFMANN, ``Assimilation of Ocean Color Measurements into Physical-Biological Models," 140,000, NASA.

E. E. HOFMANN and T. D. CLAYTON, ``Global Change Fellowship Award," 66,000, NASA.

G. H. WHELESS, ``The Effects of Variable Environmental Forcing on Inlet Flow and Larval Transport," 32,320, Virginia Graduate Marine Science Consortium.

Presentations

M. Kobayashi, Yokohama College of Commerce, Yokohama, Japan; E. E. HOFMANN; E. N. Powell, Rutgers University; J. M. KLINCK; and K. Kusaka, Okayama Prefectural Institute of Fisheries, Okayama, Japan, ``A Population Dynamics Model for the Japanese Oyster, Crassostrea gigas, Based on Mariculture Data," The Fourth Asian Fisheries Forum, Beijing, China, October 16-20, 1995.

E. A. SMITH and J. Vazquez, A. Tran, and R. Sumagaysay, all three of NASA/Jet Propulsion Laboratory, ``The NOAA/NASA AVHRR Pathfinder Sea Surface Temperature Project and Data Validation," the Third Thematic Conference on Remote Sensing of Marine and Coastal Environments, Seattle, WA, September 18, 1995. This presentation was awarded one of two Honrorable Mention awards which were given out within the session consisting of 22 contributed posters.

Publications

L. A. CODISPOTI, ``Is the Ocean Losting Nitrate?" *Nature*, Vol. 376, August 31, 1995.

J. J. HOLDZKOM II, S. B. Hooker, NASA Goddard Space Flight Center, and A. D. KIRWAN, JR., ``A Comparison of a Hydrodynamic Lens Model to Observations of a Warm Core Ring," *Journal of Geophysical Research*, Vol. 100(C8), 15,889-15,897, August 15, 1995.

V. N. Eremeev and L. M. Ivanov, both of Marine Hydrophysical Institute of the Ukrainian Academy of Sciences, Sevastopol, Ukraine; A. D. KIRWAN, JR.; and T. M. Margolina, Marine Hydrophysical Institute of the Ukrainian Academy of Sciences, Sevastopol, Ukraine, ``Analysis of Caesium Pollution in the Black Sea by Regularization Methods," *Marine Pollution Bulletin*, Vol. 30(7), 460-462, 1995.

E. A. SMITH, ``Oceanographic CD-ROMS for Research and Education," *Oceanography*, Vol. 8(2), 1995.

A. VALLE-LEVINSON, ``Observations of Barotropic and Baroclinic Exchanges in the Lower Chesapeake Bay," *Continental Shelf Research*, Vol. 15(13), 1,631-1,647, 1995.

A. VALLE-LEVINSON, R. E. Wilson and R. L. Swanson, both of State University of New York, ``Physical Mechanisms Leading to Hypoxia and Anoxia in Western Long Island Sound," *Environment International*, Vol. 21(5), 657-666, 1995.

A. VALLE-LEVINSON and K. M. M. Lwiza, State University of New York, ``The Effects of Channels and Shoals on Exchange Between the Chesapeake Bay and the Adjacent Ocean," *Journal of Geophysical Research*, Vol. 100(C9), 18,551-18,563, September 15, 1995.

G. H. WHELESS, A. VALLE-LEVINSON, and W. Sherman, National Center for Supercomputing Applications, Urbana, IL, ``Virtual Reality in Oceanography," *Oceanography*, Vol. 8(2), 1995.

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