Marine Resource Bulletin
Vol. 18, No. 4 Winter 1987

Virginia Sea Grant College Program-Virginia Institute of Marine Science-College of William and Mary

Virginia Sea Grant College Program

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Bulletin

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The Marine Resource Bulletin is a quarterly publication of Marine Advisory Services of the Virginia Sea Grant College Program which is administered by the Virginia Graduate Marine Science Consortium with members at **The College of William and Mary, Old Dominion University, University of Virginia and Virginia Polytechnic Institute and State University**. Subscriptions are available without charge upon written request.

Sea Grant is a partnership of university, government and industry focusing on marine research, education and advisory service. Nationally, Sea Grant began in 1966 with passage of the Sea Grant Program and College Act.

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Deboroh M. Dowd is a student intern from Christopher Newport College.

Cover: Photo by Dick Cook, VIMS photo file. Work boat surrounded by ice.

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Oceanography for Landlubbers

The Virginia Institute of Marine Science (VIMS) presents a series of informal programs of general interest about the marine environment each year. VIMS' scientists, staff and guest speakers offer insights about the issues, events, habits and habitats which affect Virginia's marine environment and ultimately the lives of Virginia's citizens.

Programs are held in the Watermen's Hall Auditorium on the first Wednesday of each month at 7:30 p.m. Advance registration is not necessary.

Upcoming programs:

March 4: **Cornwallis' Sunken Fleet.** Dr. John Broadwater, Senior Underwater Archaeologist with the Virginia Division of Historic Landmarks, will present a program on the underwater archaeological research being conducted on the fleet of ships sunk during the Battle of Yorktown, 1781. The focus of the slide-illustrated talk will be the excavation within the cofferdam at Yorktown.

April 1: **Coastal Processes and Man.** Mr. Gary Anderson, Senior Geologist of Espey, Huston and Associates, Inc. will present a slide illustrated program on how coastal processes can create problems in balancing natural resources and developmental needs.

May 6: **Regulations for Growth and Preservation**. Mike Kelly, marine scientist with Espey, Huston and Associates, Inc. will explain the background and purpose of coastal regulations and how they work to protect homeowners, businesses and the coastal resources.

For more information, call Joe Choromanski, 642-7174.

Third Seafood Seminar Series Scheduled

The third Seafood Education Seminar series sponsored by Sea Grant at the Virginia Institute of Marine Science is titled "Seafood International." According to Sue Gammisch, seminar coordinator, Virginia chefs will prepare locally available seafoods in an international style.

The series seminars are scheduled for March 4, 11 and 18 and April 1, 8 and 15. As in the previous seminars, prominent chefs will prepare the seafood dinners in the VIMS' demonstration kitchen, explaining their techniques and answering questions. Representatives of Virginia wineries will choose and explain wine selections which complement the meal.

The twenty-five participants then sit down to dinner by candle light in front of the VIMS' aquaria. Each of the previous seminar series has been a sell-out. Persons interested in attending the upcoming series should contact Sue Gammisch at 642-7169 or Donna Soul at 247-2061.

ODU Oceanography Receives Endowment

The Old Dominion University Oceanography program received an $8.4 million grant from the estate of Fay M. Slover. This generous gift will be used to build the Oceanography Department, specifically in the area of physical oceanography, into a program with the potential to make major contributions within that field.

Plans include the recruitment of two faculty members with expertise in acoustics, satellite oceanography, and ocean models. The search for these scientists is already underway, and the Department hopes to have at least one onboard by 1987. In addition, funds will be used to buy equipment to support research in the field of physical oceanography as well as to provide money for graduate students and their related research.

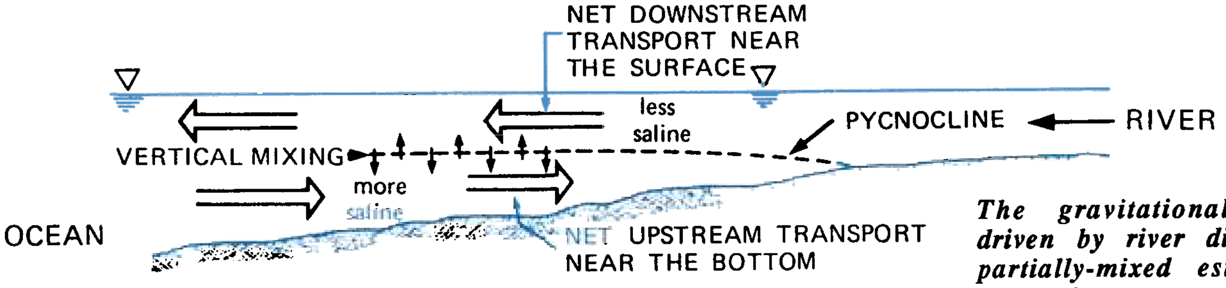
The Slover endowment will also support a distinguished visiting scholar program to attract world-class oceanographers to ODU on a yearly basis to lecture and conduct seminars.

Continued page 16

A scientist describes the mechanics of circulation in the Chesapeake Bay's tributary rivers. Understanding how water moves in the estuaries provides the basis for understanding many of the biological systems whose life cycles rely, in part, on these patterns of circulation.

Estuarine Circulation

by Dr. Linda Huzzey
Division of Physical Oceanography



The gravitational circulation driven by river discharge in a partially-mixed estuary. Currents shown are after averaging over the tidal cycle, and are superimposed on the back-and-forth tidal flow. (This is a vertical section along the estuary axis.)

An estuary is usually defined as a semi-enclosed body of water where seawater is mixed with freshwater. The freshwater comes from land drainage. The circulation, or patterns of water movement, and the mixing of water masses within an estuary are determined primarily by freshwater inflow, tides, winds and the river's topography.

The Chesapeake Bay and its tributaries are termed "partially mixed" estuaries. In such estuaries the salinity increases from the head of the river to the ocean at all depths. The water is essentially in two layers. The upper layer is a little less saline than the deeper one. Between them is a transitional layer which is called the pycnocline.

This layering of water masses is due to differences in density, just as a lighter layer of oil will float on denser water, less saline water is lighter than more saline water. In deep ocean waters where salinity is fairly uniform, differences in density arise predominantly from temperature differences. Warmer water in the upper layers and colder water in the depths constitute separate water masses. In estuaries, density variations arise because the salinity varies.

Thus, the change in salinity from the head of the river to the mouth produces layers of varying density along the length of the river. This density layering or "density gradients" causes a movement or circulation within the river driven by gravity. The result is a net seaward flow of the upper layer and a net up-river flow in the lower layer. The amount of freshwater (less saline, lighter water) flowing into the river determines the strength of this part of estuarine circulation.

The most obvious aspect of estuarine circulation is the ebbing and flooding of tidal currents. The magnitude of these tidal currents varies with the tidal range. The tidal range decreases with the distance up the estuary, resulting in a similar reduction of tidal highs and lows. Local bottom shape may modify this trend. The magnitude of the tidal current at any one place will vary semi-monthly with the neap-spring tidal cycle. The greatest currents will occur, therefore, at spring tides (full and new moons).

Wind affects both the circulation and salinity distribution of an estuary. Turbulence, generated by the wind flowing over the surface, moves down through the water column mixing the more dense water from the bottom upwards, and the relatively fresher surface waters downward. This results in a more uniform vertical density distribution. In addition to mixing, the frictional drag of the wind will induce a windward current at the surface and a return flow underneath. Therefore, a wind flowing up- estuary will tend to oppose the gravitational circulation, and thus reduce stratification, and a wind blowing down-estuary will have the opposite effect.

(continued)

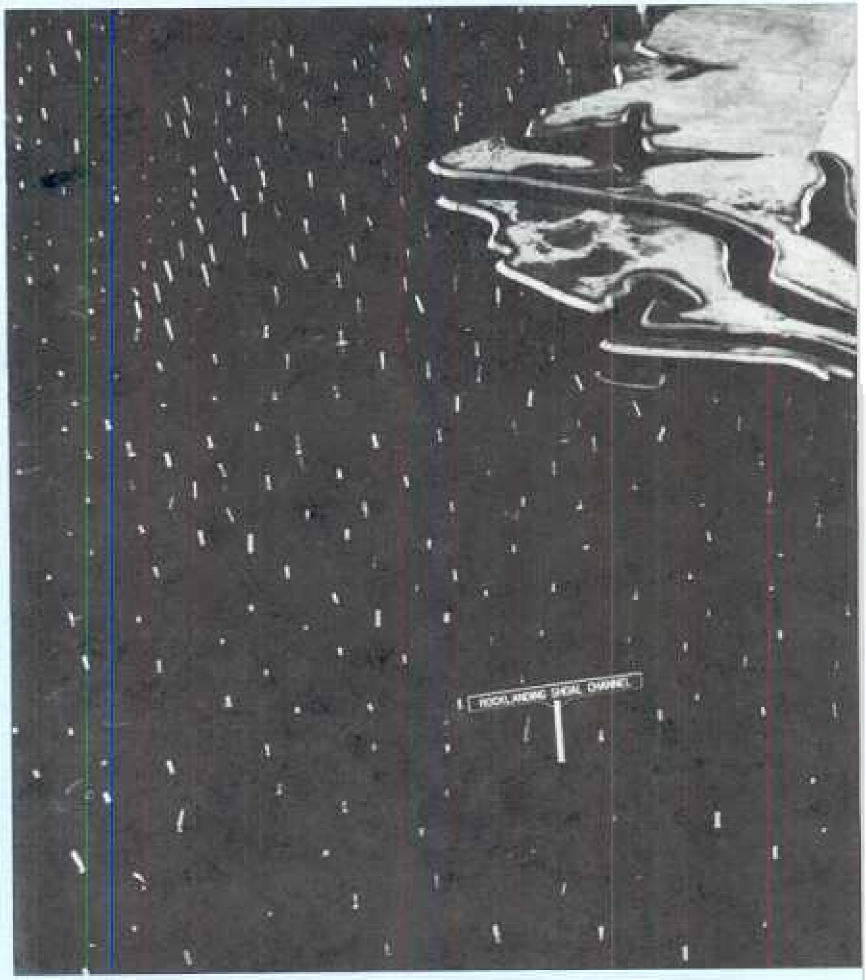
Winter mixing in the estuary, combined with the increased oxygen retention of cold water and lowered metabollic rate of organisms in the sediment, restores oxygen throughout the system. By spring, high levels of oxygen will support the burgeoning plants and animals in the river.

Seasonal variations in the circulation and mixing of the Chesapeake Bay can be attributed to seasonal variations in the driving forces. During the winter months, the water becomes much colder due to surface cooling, and there is also an increased incidence of strong winds. This will modify the stratification.

Although the stratification characteristic of partially-mixed estuaries is controlled primarily by salinity, temperature does play a role. During the summer, surface warming will reinforce the vertical density gradient. In the winter the opposite occurs; the layers reverse so that the surface waters are generally colder than those near the bed. This will significantly reduce the stratification. Moreover, the amount of freshwater runoff which enters the Chesapeake Bay is generally low throughout the winter season. As it is this runoff which provides the major source of bouyant energy to drive gravitational circulation, the strength of the gravitational circulation is reduced during the winter. Thus, due to the reduction in both the gravitational circulation and the surface water temperatures, the winter is a time of greatly reduced stratification.

Strong wind events occur more frequently during the fall and winter. Studies have shown that a wind of sufficient strength blowing along the axis of the Chesapeake Bay can induce mixing to depths of at least 22 meters. As the vertical stratification is generally weaker during the winter months, further vertical mixing by the wind is more effective at this time. Complete mixing of the layers may result, and can be observed to persist for several days before the more usual estuarine circulation and stratification is re-established.

With the onset of spring, high levels of runoff strengthen the stratification allowing the formation of a well-defined pycnocline, and the return of what is regarded as typical estuarine circulation patterns.



A Layman's

By Dr. Bruce J. Neilson
Head, Division of Physical Oceanography
Virginia Institute of Marine Science

Excerpted from: A Report to the Hampton Roads Water Quality Agency

In recent years, modelling studies have become a common component of engineering projects, especially environmental assessment and impact studies. Although there are many kinds of models which perform a myriad of tasks, the type of model, its capabilities, and often more importantly its limitations, are left unstated during typical modelling discussions.

What is a Model?

A model can be many different things - a mannequin, a pattern, an imitation, an analogy or a mathematical description, to list a few. Most of these definitions, however, are not appropriate for biological and physical systems such as exist in an estuary. A general definition for the kinds of models we

Portion of the James River model at the U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi. This 1965 photograph shows the Rocklanding Shoal Channel. Salinities are reproduced to scale by operating the model with salt water in the downstream portions and introducing fresh water upstream to simulate upland runoff. (Courtesy Corps of Engineers)

Guide to Models

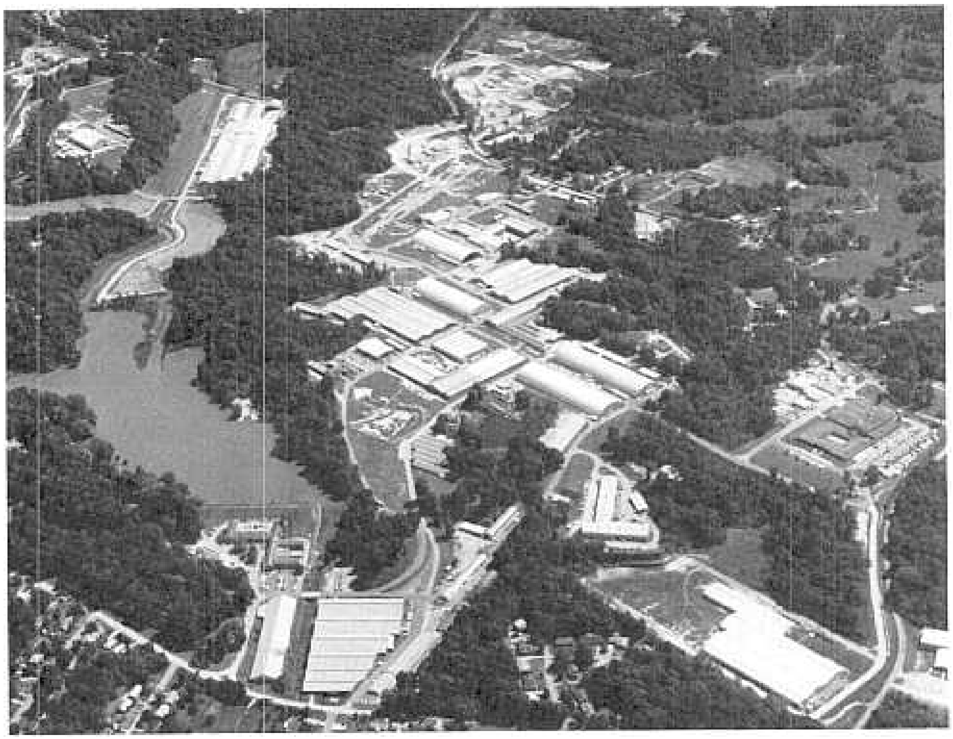
will be discussing is simply "an accounting system for events which take place". There is very little difference between these models and the way we keep track of our checking account.

The first requirement, no matter whether we are looking at our checking account or some highly complicated environmental system, is a general understanding of the events which take place and how they are inter-related. This understanding, which we will call the "conceptual model", helps us to visualize the system we are studying. For example, we intuitively understand a checking account to be a sum of money that increases when we make a deposit and decreases when we write a check. We might have a visual image of a piggy bank being filled and emptied. The point is that each of us has an idea of how a checking account works. This conceptualization is very important since it provides an ordered way of thinking, and allows us to watch the flow of money into and out of our account. After we observe the system for some time, we also gain a feeling for those items which impact our account most (our paycheck, for example) and those which are less significant (expenses for small items such as the daily newspaper). We can also see ways that events are inter-related. For example, often there will be a charge for writing a check, so that our balance goes down not only by the amount of the check, but also by the extra charge for writing a check.

Knowing the major impacts, however, will not be enough to give us a qualitative feeling for where the money goes. Although it is useful to know that more money is spent on the house than the car, we still want to know if there is any money left for entertainment. If, for some reason, we are certain that we can never do math, we might use beans or poker chips to keep track of our money. That is, we would have a bag of beans and a pot. Each time we made a deposit, an appropriate number of beans would be added to the pot, and each time we wrote a check, some beans would be taken from the pot and put back in the bag. Thus, we would know approximately how many dollars were in the checking account by counting the number of beans in the pot. The point that we are trying to make is that you don't have to use mathematics to keep track of your money, but rather you can see an "analog", which behaves just like your account. One special kind of analog model is the "scale model" or reduced version of the real system. For the case of the checking account, a scale model would use pennies to represent dollars.

In the end, it is very likely that we will need to use mathematics to keep track of things, no matter how difficult balancing the checkbook may be. In fact, the running tally of the balance in your account is a simple mathematical model. We could write equations to represent our entries, which would say something to the effect that the new balance equals the old balance, plus deposits, and minus checks and other charges. The problem we all encounter when the bank statement arrives is that some checks get cashed very quickly while others take months, and there is a devil of a time figuring out which is which. In other words, a checking account is a dynamic system and it is hard to capture or picture the entire system at any single moment. Similar difficulties occur with real world systems since substances are added by effluent discharges, overland runoff, and brought in from upstream while at the same time some substances are leaving the system by flowing downstream.

The first step in the modelling process is to organize our thoughts into a conceptual model of the way things behave. After that we can simulate or reproduce the behavior using either an analog, or a mathematical representation of the real world system.



The U.S. Army Waterways Experiment Station (WES) is the principal research, testing and development facility of the Corps of Engineers. The facility covers 700 acres and includes hydraulic models as well as other test facilities and laboratories. (Courtesy Corps of Engineers)

ANALOG AND SCALE MODELS

An analog model behaves like the real world, responding to changes in the same way as the prototype system. Usually an analog model is chosen because measurements are simple and cheap to make, whereas in the real world, measurements are very difficult or costly to obtain. Certain types of analog models have been built to simulate the behavior of rivers and other systems, but in general, they have not been especially useful since they cannot efficiently reproduce the many facets of real world systems. One special type of analog which has been used extensively is a scale model, or reduced version. A scale model is to a river as a doll house is to our home. In both cases, the degree of similarity built into the miniature is dependent primarily on the time and money we are willing to invest in creating it.

It should be noted that problems often arise when discussing models because a word means different things to different people. The models we will be discussing in this chapter are called scale models because the features of the real world are scaled down. Many people refer to these models as "physical models" since they are real, physical things which we can touch, walk around and see, as opposed to abstract or mathematical models. Others, unfortunately, use that term to mean any kind of model that simulates physical systems, as opposed to economics, animals and so on. Scale models are sometimes called "hydraulic models" because the main purpose is to simulate the flow of water. (This should not be confused with "hydrodynamic models" which are mathematical representations of the water flow.) The Corps of Engineers, which is probably the biggest builder of scale models in the country, uses the term hydraulic model. Scale, model, hydraulic model and physical model all refer to small replicas of rivers or estuaries.

MATHEMATICAL MODELS

A math model uses mathematical expressions and equations to represent the actions and processes which occur in a real world system. In this section, some of the more important differences will be presented so that the reader can differentiate between models and the capabilities and limitations inherent in each. The discussion will focus on numerical, as opposed to analytical, solutions. An analytical solution is one which is achieved by rigorous manipulations of the equations. It involves no approximation, but rather is exact. As a general rule, only simple problems or slightly more complex problems with very simple geometry will have analytical solutions. The estuarine environment tends to be extremely complex in its relationships and geometry, and there is a great deal of natural variability. Analytical solutions for estuaries are virtually unknown or else are achieved only by utilizing a long list of simplifying assumptions, so that the mathematics bears only a faint resemblance to the true situation. Numerical techniques, on the other hand, are approximate* and not exact, but they can be utilized to resolve complex systems of equations. Modern digital computers are able to make the calculations required for these numerical techniques in very small fractions of a second, duplicating many man-years of labor in a short span of time. As computer technology advances, our capability to model increasingly complex systems also grows.

**The word "approximate" may imply inaccurate to some persons, although this is not necessarily the case. The word is used here from a mathematical point of view to define methods which include some small amount of error, but otherwise give reliable and accurate results. To illustrate this approach to exactness, the following story is given: A boy and girl are seated at opposite ends of a sofa. As the boy becomes more certain of his desires, he moves one half the distance toward the girl. This process is repeated several times. From a mathematical point of view, the boy will never reach the girl no matter how many times he reduces the remaining distance by a half. In fact, however, he quickly gets close enough for all practical purposes. Similarly approximate solutions are not precise but are good enough for most practical needs.*

The vast majority of environmental models are deterministic, meaning that they are based on physical, chemical and biological laws and principles. One result of this approach is that the model responses are consistent. If the same input conditions are used, the resulting predictions will always be the same. Stochastic models, on the other hand, employ statistical relationships of one type or another. Some of these models are quite similar to the deterministic models but include estimates of the anticipated variability of the predictions. Other stochastic models achieve predictions through a series of "random events" that are appropriately structured. For the most part, the remaining discussion will deal with deterministic, numerical models only.

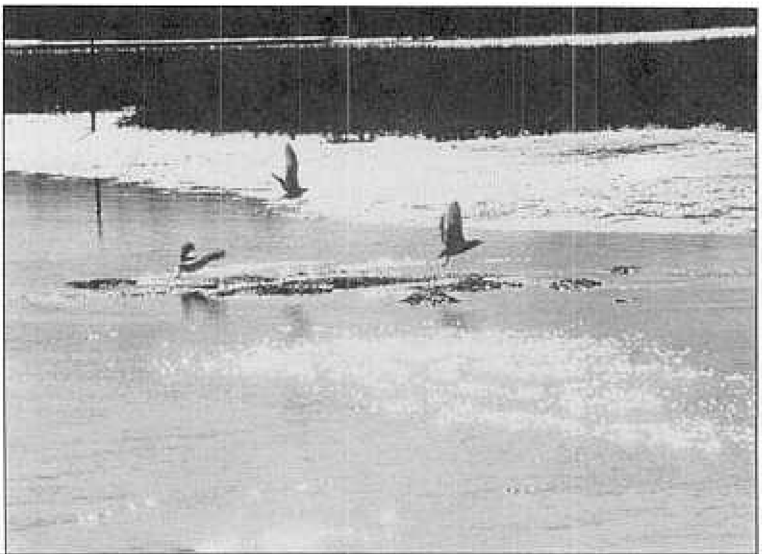
Dimensions of Space and Time, and Mathematical Approaches

The estuaries of the Chesapeake Bay system are variable both in space and in time. For example, if we began taking water samples from one end of the James River Bridge and proceeded to the opposite shore, one would observe that the characteristics of the water varied considerably over that distance. In addition, there would be differences with depth and time of the tidal cycle, as well as day-to-day variations. These variations can be observed throughout the tidal portions of the rivers, although the differences are usually most pronounced in the saline reaches. If we desire to characterize the river, either for our own understanding or for modelling purposes, it is necessary to observe the variations which occur in the three dimensions of space and over time. Over the years, our understanding of estuarine circulation has been developed by examining first those cases which are somewhat simpler. During late summer and early fall, the freshwater river flow is often quite small and constant, and as a result tidal mixing reduces vertical stratification and lateral variations. For this case, a steady state (does not change with time), one- dimensional model of the river may be justified. The dimension that is modelled is the longitudinal one, since salinity, for example, will still vary from something close to seawater near the mouth to freshwater in the uppermost reaches. Lateral and vertical variations are not directly included, since the average values for the cross-section will be used. Early models of estuaries were of this type. At a later date, it was possible to include more dimensions. Some scientists chose to have two-dimensional, steady state models while others chose one-dimensional, time-varying models. The important point to note is that the added dimension could be either time or space, but the increase in complexity of the mathematics and the added computer time were roughly equal. With the advent of sophisticated computers, three-dimensional, time-varying models provide the most precise and comprehensive modelling available today.

HYDRODYNAMIC MODELS

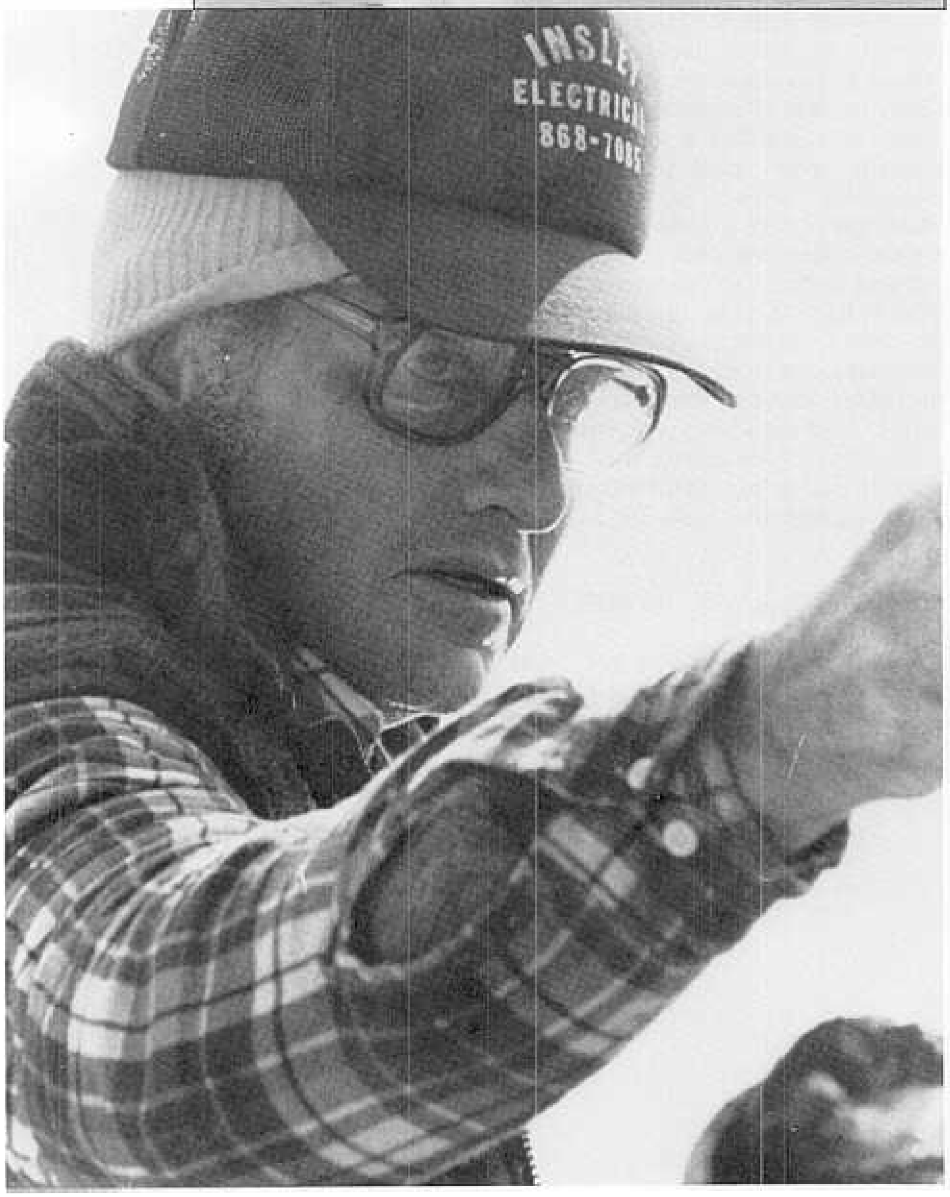
Hydrodynamic models are those which use the equations describing the forces acting on water parcels to predict the water movement. These models are useful for studies of circulation, sediment transport, erosion, and water quality. In particular, hydrodynamic models have been developed to provide input data to math models of water quality, since the current patterns determine how wastewaters and other substances are transported and dispersed through an estuary. The alternate route is simply to measure water currents at the same time that water quality is determined, but the resultant description of circulation is applicable only to those hydrological and meteorological conditions which existed during the field study. If, on the other hand, the data are used to calibrate a hydrodynamic model, the model can be used to predict currents for other freshwater flows.

People on the water



Winter

Photos and story by Nan Brown



Winters can be bitterly cold on Virginia waterways - it's usually at its blustery, bone-chilling worst in January and February.

On a deceptively calm late-December afternoon at the Menchville Marina, Poquoson waterman Ned Winder "remembers the future," knowing that this winter will likely be as cold as last year and the year before that and the year before that.

"It'll be so cold that icicles will be making from the culling boards," he says. He's watched the water dripping from his oyster tongs freeze into a long taper. Twenty-five degrees, not including wind-chill, is not uncommon out in the middle of the James River.

He looks out over Deep Creek and remembers the times he could throw a brick across the expanse of ice that covered the water from one side to the other. "It would stay froze for two weeks at a time," he says. "We can't (take the boats) out when it's like that!" Those are the days Winder spends making crab pots for the coming crabbing season that starts in April.

After 40 years of working Peninsula waters, Winder's come up with his theory as to why the James is so much colder than, say the York or the Poquoson River. The James flows in an almost direct line from the northwest, from whence come the prevailing winter blasts. The river is a natural funnel for the cold air pouring down from Richmond and the cold mountains beyond. "The river picks up the cold air and it comes right down on top of you," he says.

The oystermen (most of them are crabbers and fishermen in milder months) have to bundle up against the cold, and often water-laden, winds. They put on layers and layers of clothing - insulated unders, flannel shirts and jeans. As they work up warmth with the effort of tonging, they can peel off a layer or two till they're comfortable. An indispensible garment is raingear, or oilskins, to protect against the frigid water. Heads are wrapped in stocking caps and ski hoods, often topped off with a baseball cap. Rubber gloves over fabric ones provide protection for tong-wielding hands.

Winder's just brought a haul of oysters from the river's oyster beds to the marina. He's selling to poquoson wholesaler Bill Forrest.

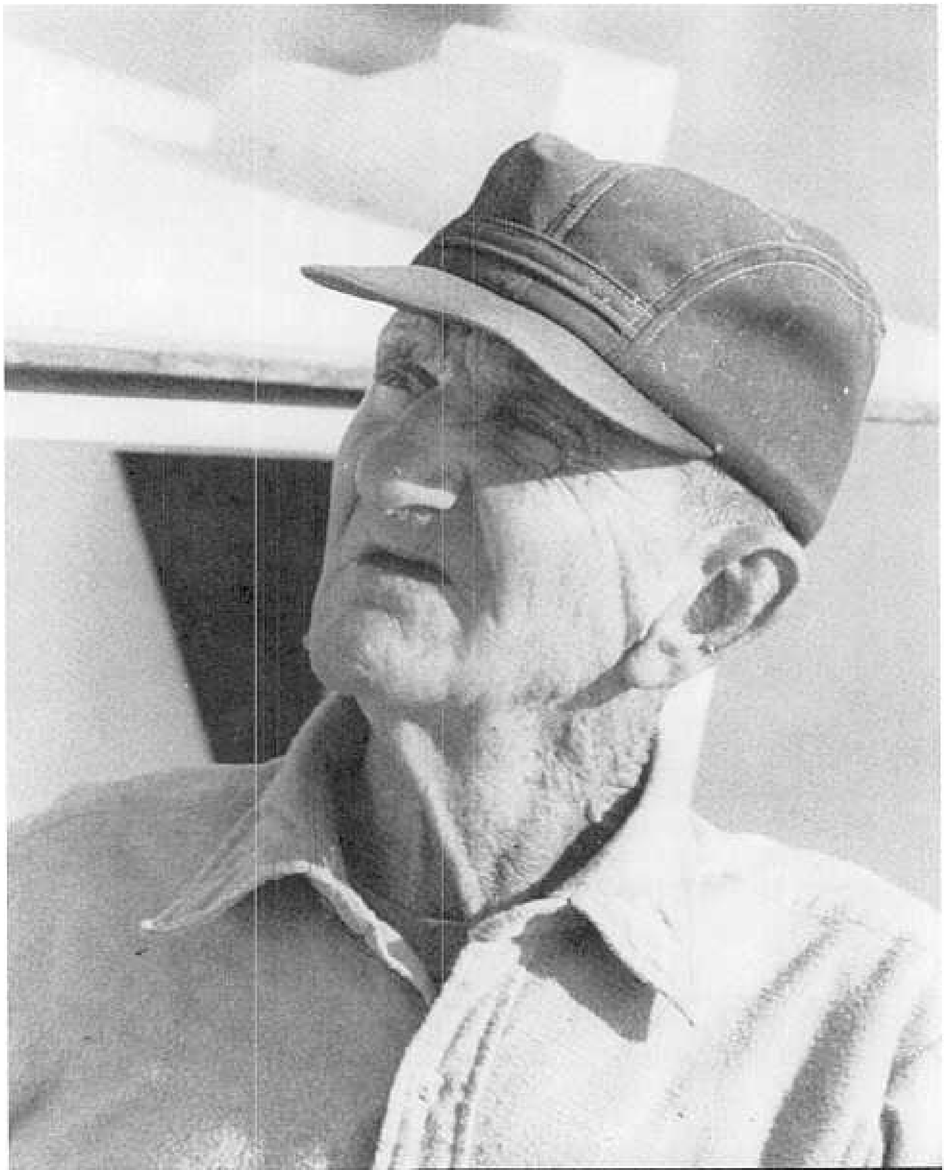
On the dock Forrest awaits the arrival of the next oyster boats. He unloads about ten boats a day, five days a week. He'd do it every day, but "Virginia state laws won't let us work the river on weekends," he says.

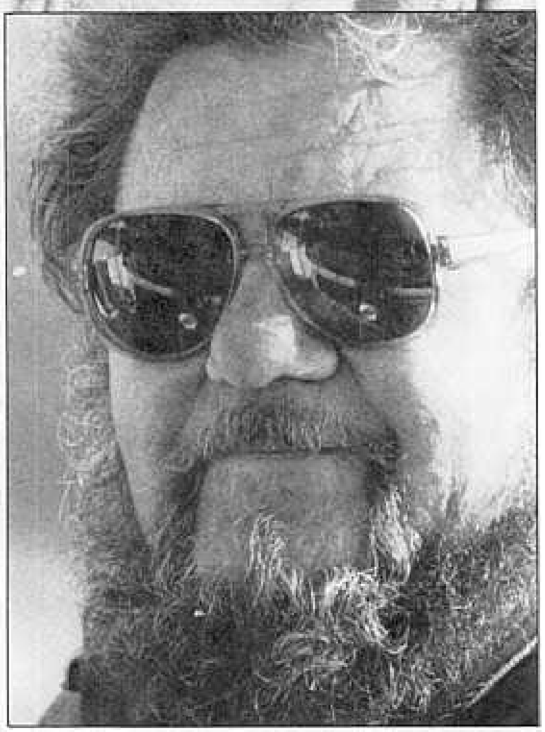
Forrest stands out in the cold for hours at a time. "We're here till all the boats have come in," he says. He watches and counts as the oysters are scooped into bushel containers and dumped into his trucks. This is the time of year when his own pier in Poquoson is not used. Oysters out of the Poquoson River are not plentiful. During the rest of the year his pier is used to unload boats bringing in crabs and fish.

It's going to be a cold and miserable winter out there on the James, but with oysters in demand, and the price right, it'll be profitable for Winder and the others - worth facing the blustery winds and frigid water.

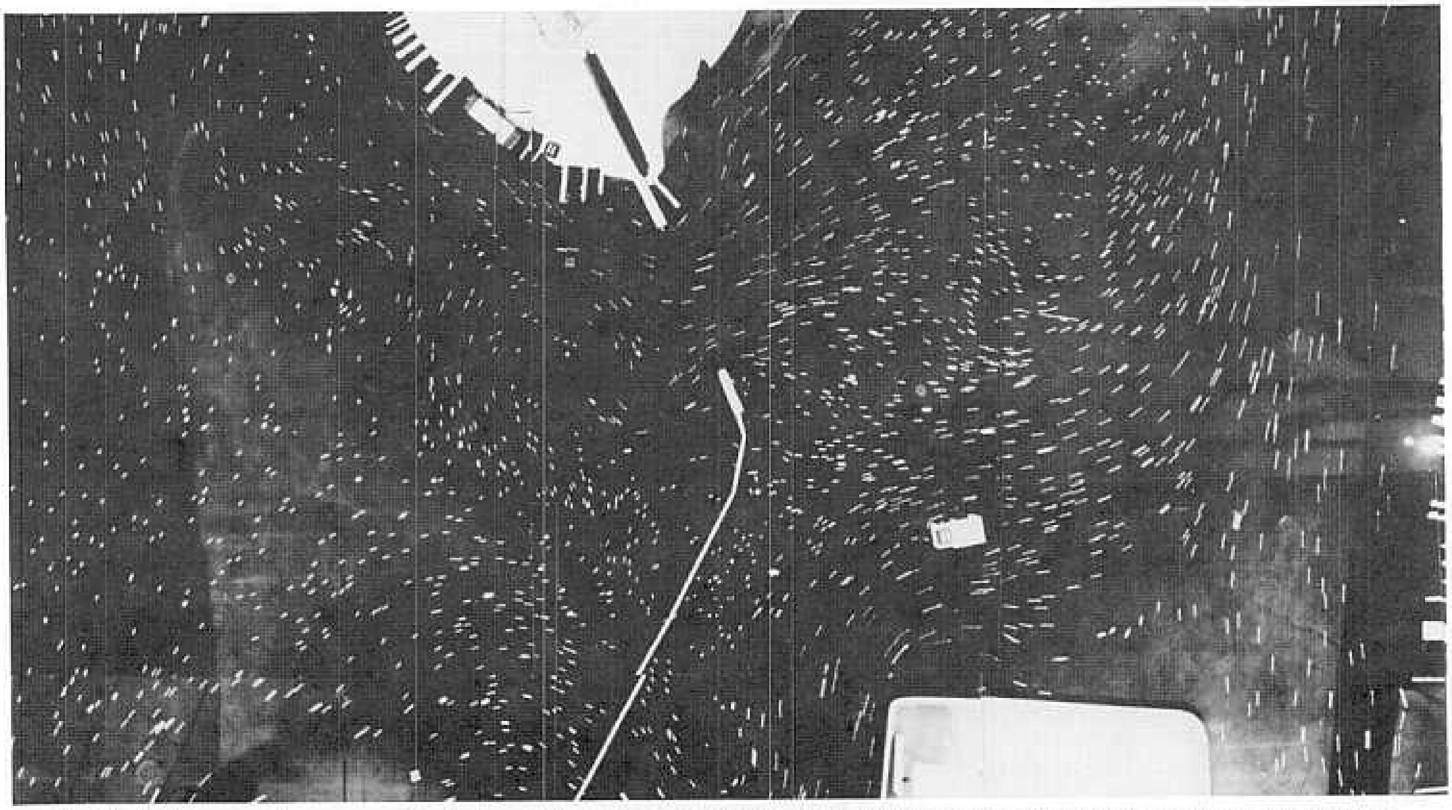
Ned Winder docks his boat and heads home. He knows he'll be back tomorrow to reap the river's rich harvest.

But he's thinking about April, one of his favorite months.





(Clockwise from bottom left). Ned Winder, winter scene on the York River, Lewis Insley and Bill Forrest.



"Confetti" photographs were used to further study surface circulation. In these photographs time-lapse exposures are made of material floating on the surface of the hydraulic model every prototype hour (5 minutes). Each streak in the photorepresents the movement of an object over a period of five minutes.

JAMES RIVER MODELS

Deborah M. Dowd

Two decades of research reveal some answers and more questions.

In 1985, the Virginia General Assembly mandated a study of circulation in the James River in order to determine environmental impacts of proposed port development. Data and information were taken from research begun over twenty years ago. A team of scientists with diverse specialties at the Virginia Institute of Marine Science worked together to accumulate a body of scientific knowledge that answered some questions and raised others.

"It was a wonderful opportunity to work on a project that involved so many talented people," said Dr. Robert Byrne, Associate Director for Research, who headed the research team. "I have a great deal of respect for everyone who worked on this project."

Interest in the James River and its seed oyster beds began as far back as the 1950's. "In the 50's the Virginia Fisheries Laboratory, which was the precursor of VIMS, and the Chesapeake Bay Laboratory in Maryland recognized the need for an understanding of the circulation in estuaries. The two states obtained additional funding from the Office of Naval Research to establish the Chesapeake Bay Institute of The Johns Hopkins University," Dr. Byrne explains. It was under the auspices of the Chesapeake Bay Institute that the earliest work in this field was done by Dr. Don Pritchard.

In 1964 the Commonwealth of Virginia funded a hydraulic model built at the Army Corps of Engineers Waterways Experiment Station at Vicksburg, Mississippi, in order to determine possible effects of dredging the James to make Richmond a port for major ocean-going vessels. This hydraulic model was built to a scale of 1,000 ft to 1 ft. in width and 100 ft. to 1 ft. in depth.

"There is a built in distortion in the model that is unavoidable because of the dimensions of the river itself," explains Dr. John Ruzecki, who conducted experiments in the model, "If you made the model exactly to scale, there would be areas in the model that would be an inch or less deep. This wouldn't be workable because the water would either evaporate too fast to conduct experiments or the surface tension would distort the circulation of water in the model." Because the model is scaled in size, time is scaled accordingly so that 1 minute in the model is equal to 1 hour of real time.

Once the model was built, field data were collected to "calibrate" or validate the hydraulic model. This was done by VIMS personnel who measured temperature, salinity, and tides from May through October. To approximate turbulent mixing, strips of metal protruded from the bottom. These strips were bent and the model run until the currents and salinity were close to the circulation of the river itself.

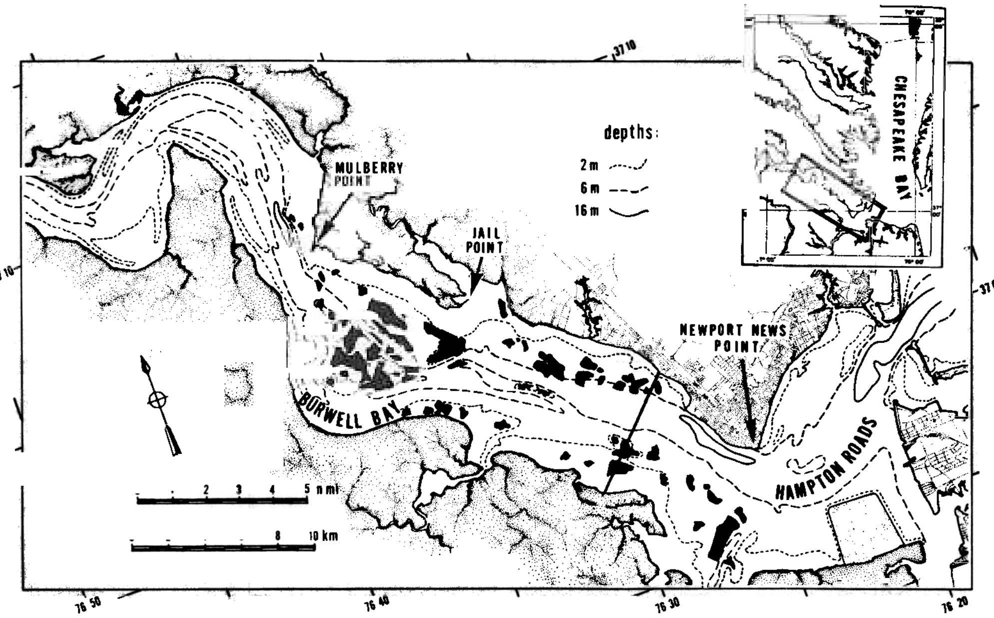
Hydraulic models were at that time the best technology had to offer. Many proposed projects such as dredging, placement of sewage treatment plants and other man-made changes were first tested in hydraulic models to evaluate their effects on the gross circulation. Some of these projects such as the 1968 proposal to extend Newport News Point were abandoned due to prohibitive cost. Others, such as effluent discharge facilities and the Yorktown Power Plant, got the green light and were built.

In 1968 many oyster beds had been diminished by disease. Scientists began looking for sites to place disease resistant oysters to help rejuvenate oyster production. A team from VIMS, including Dr. Ruzecki, went to Vicksburg to run experiments on the model. The studies included dye injection and measurement to determine water movement. Dr. Ruzecki's experiments involved injecting dye into the model at six intervals and then measuring the concentrations at 108 points throughout the model. There were seven hours of sampling and then the analysis was done.

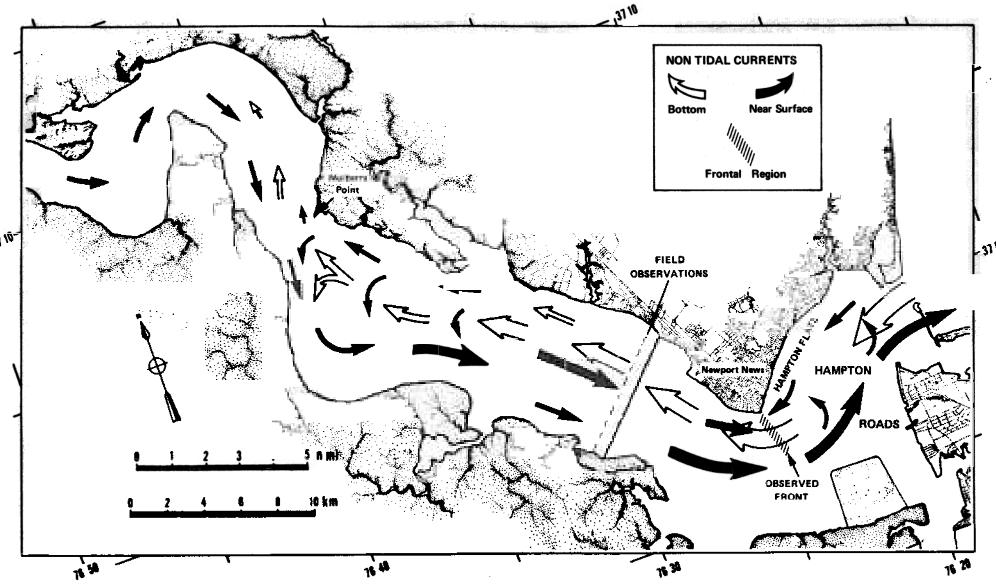
"There were catwalks over the model and samples were taken by pipet," Dr. Ruzecki remembers, "Graduate students were playing leapfrog on these catwalks to take samples and then get set for the next round." There were 112 sample sites at fourteen different levels and each sample had to be analyzed at least twice adding up to over 2,000 separate analyses! The data gathered from these dye studies were used to map the circulation pattern of the James.

In response to a request by the Peninsula Port Authority of Virginia to allow conveyance of state bottoms for construction of an island port facility,

This photograph shows the James River Hydraulic Model. The catwalks allowed sampling for dye at points throughout the model, but required some gymnastic ability on the part of graduate students.



Seed oyster beds in the James are marked here by irregularly-shaped dark areas. By looking at the hypothesized circulation diagram you can see that water from the mouth is circulated back to the location of these beds which are upstream.



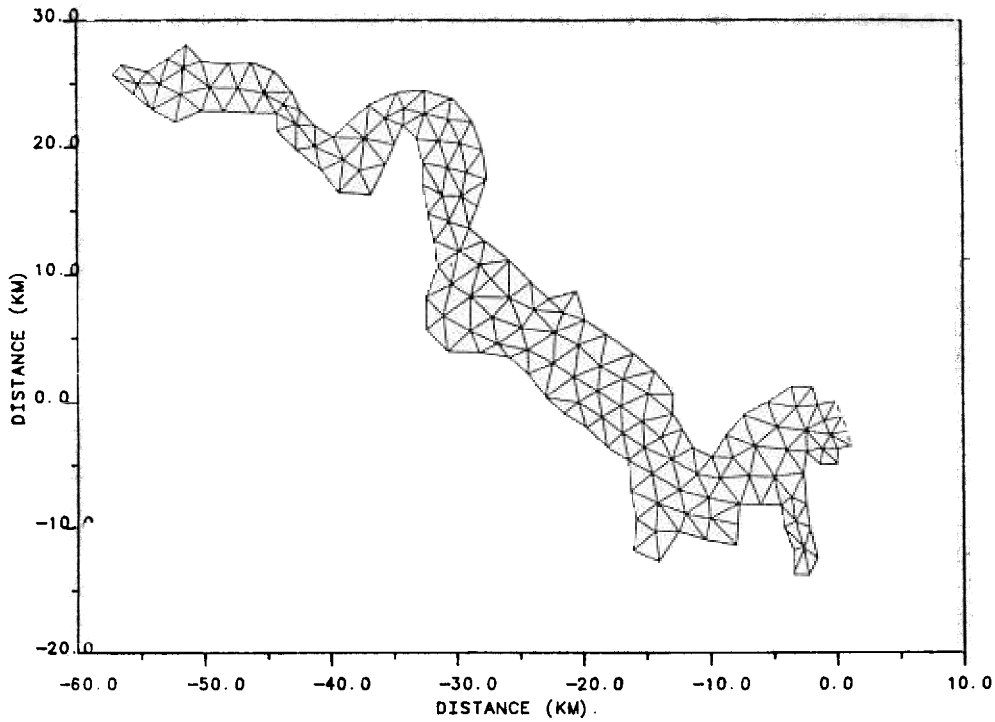
Evaluation and interpretation of dye studies conducted in the hydraulic model led to this hypothesized non-tidal circulation diagram of the James River.

Governor Charles Robb and the Assembly mandated a study of the possible effects on the environment. This study was to be done by the Virginia Institute of Marine Science. "We were to analyze the possible effects and present our findings," said Dr. Byrne, "and determine if there was a material probability of an adverse impact on the seed oyster beds of the James River."

With this mandate a great deal of data was re- examined and analyzed, including the dye studies done by Dr. Ruzecki. The analysis of this data gave a rough picture of what non-tidal circulation in the James is like. These findings were further validated by current measurement experiments which were carried out in the summer of 1985 off the James River Bridge. The results of these measurements were then compared to the hydraulic model. The disparities in the two sets of results were quite small, especially when the difference in conditions was taken into account.

Another tool that proved of great value in understanding circulation patterns was "confetti photographs." These are made by floating material on the surface of the hydraulic model, then using time exposure photography of the model. The result is a set of photographs showing a series of streaks corresponding to the surface water movement over a scaled time period. The information gleaned from these photographs was then translated to a grid to examine surface water movement throughout the passing of tidal cycles. This gridded data was then augmented by arrows to show the movement of an object on the surface over a full hour. When these photographs were analyzed they provided further information about circulation patterns including a little-understood feature called an estuarine front. Off of Newport News Point the surface water is injected to depths where the net movement is upstream. "This type of circulation feature is poorly understood," explains Dr. Byrne, "The body of theory on this is very fragile. We had to do a good deal of basic science. This included intensive observations and extension of the theoretical framework." Fronts have only been identified in the recent past and so the study team wanted to find out more about how this type of front figures in the overall circulation and mixing of water in the James. Specifically, they were interested in the role this front might play in the setting of oyster larvae. "Oyster larvae can only swim in the vertical plane in a corkscrew- type fashion," says Dr. Byrne, "To move in the horizontal plane they are dependent on circulation patterns." The significance of these seed oyster beds goes beyond their importance to the James River harvest. "The seed beds in the James are the source of seed oysters that are taken to other locations such as the Rappahannock," explains Dr. Byrne, "If we were to lose our seed beds in the James, it could sound the death knell for oystering in Virginia."

After careful analysis of the data acquired from the hydraulic model and field experiments, it was time to take the next step - that of predicting the effect of the proposed island on the circulation of the James and its effect on the seed oyster beds as well. The hydraulic model had been a wonderful tool in the past, but its technology was old and the model itself was in need of repairs. This brought the VIMS team to their next challenge - the formation of a mathematical model of the James River. "The formation of a mathematical model involves solving equations of fluid physics at points in the field of interest," explains Dr. Byrne. There are several types of mathematical models, each more complex. The simplest is a one-dimensional model. The best model and the most complex is a three-dimensional model but the capability to develop one did not exist at VIMS. "Dr. Paul Hyer recast an existing two-dimensional model," explains Dr. Ruzecki. "To do this the river is broken into chunks and values are calculated for each chunk. The size of the chunks governs the amount of detail that will appear in your model. "In order to examine specific details, you can then take a section and break it down further into smaller and smaller units to examine fine details such as the estuarine fronts. Using the math model, different variables can be introduced in order to assess the effects. This was done in the case of proposed sites for New Port Island, and it was decided that a material probability existed for a negative impact on the oyster beds of the James.



A fine grid "nested" two-dimensional model was generated for the New Port Island study. This involved a grid of triangles which allowed the shoreline to be matched in greater detail. The vertices of each triangle are called nodes and the relevant equations are solved for variables at each node.

Dr. Robert Byrne then fed an alternate site into the model. "One Sunday we were sitting around working on the analysis and decided to choose an alternate site for the island based on what we had learned about circulation patterns," Dr. Byrne explains, "When we ran the model with this new site, the disturbances were negligible." There are logistical problems, however, with the new, more easterly site, and it would be more expensive to build.

Though VIMS has turned over their report to the Peninsula Port Authority, their work in the area of estuarine circulation is only beginning. "We are very excited because the General Assembly has appropriated the funds for us to acquire the capability to formulate a three-dimensional model." Dr. Byrne continues, "We have already contracted with Dr. Peter Sheng from the University of Florida to bring this capability here." The three-dimensional model will put VIMS in the company of only a few other facilities with this type of capability.

The three-dimensional model will be used to carry on further studies of the estuarine fronts that have only begun to be understood. Also, important work will be done with the model to simulate actual paths of larvae in the water. Understanding larval transport can ultimately lead to enhancement of the fragile resource of our oyster beds and hard clam beds as well. The capability of this new model will be such that more can be learned about circulation and oysters in the James and their relationship with one another.

The future for the Virginia Institute of Marine Science will include research in areas of applied as well as pure science. The body of knowledge concerning the James River and its circulation already has many applications. Besides the ability to use the model to determine environmental impact of man-made changes along the river, the circulation information could be used in case of an oil or chemical spill. "With the capability we have now we could predict the concentrations of a substance spilled into the River," says Dr. Byrne. By moving along on the tide of technology, VIMS is increasing its capability to help us understand the natural processes of the waters that surround us so that we can better use and protect our priceless natural resources.

Dr. Robert Byrne, Associate Director for Research, headed the Newport Island research team.

ODU's Sailor/Scientists

by Deborah M. Dowd

Greg Williams received his undergraduate education at the United States Naval Academy. He served as a submariner, specializing in nuclear power. Tom Berger spent most of his Navy career looking for submarines as a surface warfare officer. During his Navy career he attended post-graduate school in the field of physical oceanography.

Today both retired Naval officers are graduate students at Old Dominion University's School of Oceanography. "Actually my decision to finally return to school had to do with the fact that I didn't want to waste my V.A. benefits," Williams laughed. "I tried to get into post-graduate school in the Navy but it never worked out. I had taken classes in oceanography here so when I decided to return to school, ODU seemed the logical choice."

CDR Greg Williams, USN (Ret.), now a graduate student at ODU.

Tom Berger tried working as a consultant after his retirement, using the expertise he gained in Navy post-graduate school, but he really wasn't satisfied. "I missed the challenge of scientific research and so I decided to pursue my doctorate," he said.

The ODU Oceanography Department has always had a special relationship with the Navy. The ODU campus and the world's largest Naval Base (Norfolk) are next-door neighbors. This proximity has spawned a tradition of cooperative programs. In addition, Dr. Carvel Blair, Assistant Director of the Department, is a retired Naval officer. "A number of our faculty are retired or ex-Navy personnel, as are several of our graduate students, as well as some on active duty who take courses in our department." Dr. Blair encourages a spirit of camaraderie reminiscent of that found on-board ship. He takes special pride in Greg Williams and Tom Berger.

Williams is presently doing a teaching assistantship while pursuing his master's degree. "Right now I'm teaching a basic oceanography lab," he said, "and I've really enjoyed that a great deal." Williams and Dr. Blair are working on ideas for a research project. "It will probably be something related to tides in the Chesapeake Bay but it's only in the planning stages," Williams explained.

Tom Berger has been at ODU since September of 1983. His interests are in the field of mathematical modeling of estuarine circulation, a project he has been working on with Dr. Larry Atkinson. "What I do is mostly 'number crunching,'" Berger explains, "I have spent almost 500 hours on the computer this year alone." Tom took some time away from his terminal last winter when he served as chief scientist on the research vessel "Endeavor" participating in GALE - Genesis of Atlantic Lows Experiment. "We went out to study what meteorologists call explosive winter storms," Berger said.

"Anyone who has lived in this area can remember a storm when we received large amounts of snow. This is the type of storm we were studying." The research vessel, which belongs to the University of Rhode Island, spent from the 10th of January to February 1986 off the coast from Cape Hatteras northward studying the formation of these fronts.

"We were hoping to learn something about how and why these storms form," Tom explains, "They are characterized by a sharp drop in pressure and are extremely unpredictable." Since fronts of this type often drop many inches of snow on an area ill prepared for that type of weather, a better understanding of their formation could help meteorologists predict these winter storms. "While we were out we actually encountered two such fronts," Berger said, "One proved inconsequential while the other became a full-fledged storm, but was too far out to sea to cause much precipitation on land.

In 1970, Dr. Carvel Blair of ODU's Oceanography Department, was Commander Flotilla One, in charge of assault boats in the Mekong Delta.

Both Williams and Berger have found Old Dominion a challenging academic and scientific environment. The skills and knowledge that they have acquired during both their naval and academic careers will serve them well in the future.

Since its inception, Old Dominion and the Navy have fostered a relationship between sailor and marine scientist. Greg Williams and Tom Berger have enhanced that relationship and continue the tradition.

Fish house kitchen

HEARTY SEAFOOD TO WARM WINTER MENUS

Donna Soul
Extension Specialist
Seafood Utilization

Now that winter is upon us it's time to get out the sweaters and wool socks and "cook up" a pot of hearty (heart-healthy) seafood chowder.

Seafood chowders offer a wide variety of menu ideas and nutritious one-dish meals. If terms like soup, stew, bouillabaise and chowder confuse you, you're not alone! A soup is simply a cooked, flavored, seasoned liquid which may be clear (not thickened), naturally thickened (a puree of its own ingredients) or cream based (thickened with a thickening agent).

A stew is made of meat, poultry or fish simmered or braised with other ingredients at low temperatures and served with the cooking liquid. The cooking liquid is usually thickened with a thickening agent.

A chowder, on the other hand, is a hearty soup made of fish or vegetables with a large portion of solid ingredients served in their own liquid.

Bouillabaise (boo-yah-bess), a true Fisherman's stew, is a fish soup or stew made of several kinds of fish and shellfish cooked together with olive oil, flavor builders, water and sometimes white wine.

Any of these one-dish meals provides a well-balanced way to warm up a cold day. Seafood has a high nutrient density which refers to the amount and variety of nutrients in 100 calories of the food. Seafood is packed with high quality protein, many essential vitamins and minerals, water and some essential polyunsaturated fatty acids.

Finfish provide between 15 and 24% protein while shellfish provide 8-24% protein. Protein content depends largely on the species of finfish or shellfish. Oysters contain about 8% high quality protein and scallops may contain as much as 24 or 25% high quality protein.

Seafood is a good source of vitamins B6, B12, biotin, thiamin, riboflavin and folic acid. Some important minerals that are needed by the body in trace amounts are present in seafoods. Some of these trace minerals include zinc, copper, iodine, manganese, cobalt, molybdenum and selenium.

In general, most seafoods are low in fat; shellfish usually contain less than 2% fat, whereas finfish range from less than 1% in very lean fish to greater than 10% in fattier fish. Something just as important as the fat content itself is the type of fat present in foods. Seafoods contain polyunsaturated fats, more specifically omega 3 fatty acids. Omega 3 refers to a type of polyunsaturated fat which has been shown to reduce the risk of coronary heart disease. This type of fat is found only in marine life (plants, fish and shellfish).

Seafood chowders, soups or stews can warm some of those cold winter days. For a heart-healthy, winter-warmer try this bouillabaise recipe served with some crusty French bread.

BOUILLABAISE

3 garlic cloves, crushed
1/2 cup each, chopped green onion, celery and green pepper
1/4 cup olive oil
2 bay leaves
1/2 tablespoon oregano
1/4 cup chopped fresh parsely
1 teaspoon salt
1/2 teaspoon saffron
1 large can (28 oz) whole tomatoes, chopped
8 ounces clam juice
2-1/2 cups water
1/2 cup dry sherry
1/2 pound medium shrimp, cleaned
1 pint standard oysters, shucked
1 pound fish fillets cut in chunks (halibut, flounder, seatrout, black seabass, snapper, whiting)
1/2 pound regular crabmeat
8 Littleneck clams, scrubbed
8 mussels, scrubbed

In a 4-quart pot saute garlic, celery, onion and green pepper in olive oil until tender. Add spices and tomatoes. Simmer for 1 hour. Add clam juice, water and sherry and simmer for 10 minutes. Add shrimp, oysters and fish and simmer for about 3 minutes. Add crabmeat, clams and mussels open. Serve immediately.

Makes 6 to 8 servings.

Donna Soul works at the Virginia Cooperative Extension Service's Virginia Seafood Laboratory in Hampton. The Laboratory was developed by Virginia Tech to serve both seafood professionals and the public. Donna tests and develops seafood recipes, designs training programs for consumers, extension agents, retailers, processors, restaurateurs and other professionals. Her work is funded by Sea Grant. For more information about the VPI extension programs call 804/247-2061.

Harborfest Report

A study of one of Hampton Roads' most popular waterfront festivals, Norfolk's Harborfest, was prepared by VIMS Sea Grant Marine Advisory Services Program to assist festival organizers in evaluating the progress and problems of the celebration. Results of the 1986 festival analysis were compared to a 1979 study of the same but considerably smaller, less complex event. Results of the study indicate that the festival, while drawing a greater proportion of local attendees than in 1979, still attracts a significant number of patrons from beyond the boundaries of Greater Hampton Roads and from outside Virginia.

The majority of the crowd attends with family and friends and feel that the overall quality of the festival has improved. Festival ferry and bus shuttle services, while not without problems, helped keep approximately 25,000 cars out of the downtown waterfront area. Festival problems of greatest concern to patrons involved high prices and commercialization of the event along with crowd congestion issues. Water events, although presently comprising a smaller proportion of the festival programming than in 1979, are the most popular events for patrons. If development forces the festival off of the waterfront into downtown streets, over 80% of the patrons indicated they would be unlikely to return to the event. Attendance for the 1986 celebration was estimated to be 385,700; more than double that of 1979. Patrons spent $9.7 million during the three-day festival. Copies of the report are available for $3.00. Write Publications Request, Marine Advisory Services, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.

Fishing Tournament Workshop Announced

Jon Lucy, Marine Recreation Specialist at the Virginia Institute of Marine Science, announced that Sea Grant will co-sponsor a Marine Recreational Fishing Tournament Workshop on Saturday, March 21, 1987. The workshop is intended to assist groups who organize the growing number of tournaments in Virginia. The Deltaville Fishing and Conservation Club is co-sponsoring the program.

Topics will include: Expanding tournament circuit - problems ahead?; How to organize successful tournaments; Liability-legal issues; Use of Torsey Meters; Approaching sponsors; Tournaments, conservation issues and fisheries management; Tournaments as tourist attractions for communities.

The workshop will be held from 9-5 in Watermen's Hall at VIMS, Gloucester Point. For more information, contact Jon Lucy, 642-7166.

Sea Grant Communications
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Gloucester Point, Virginia

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