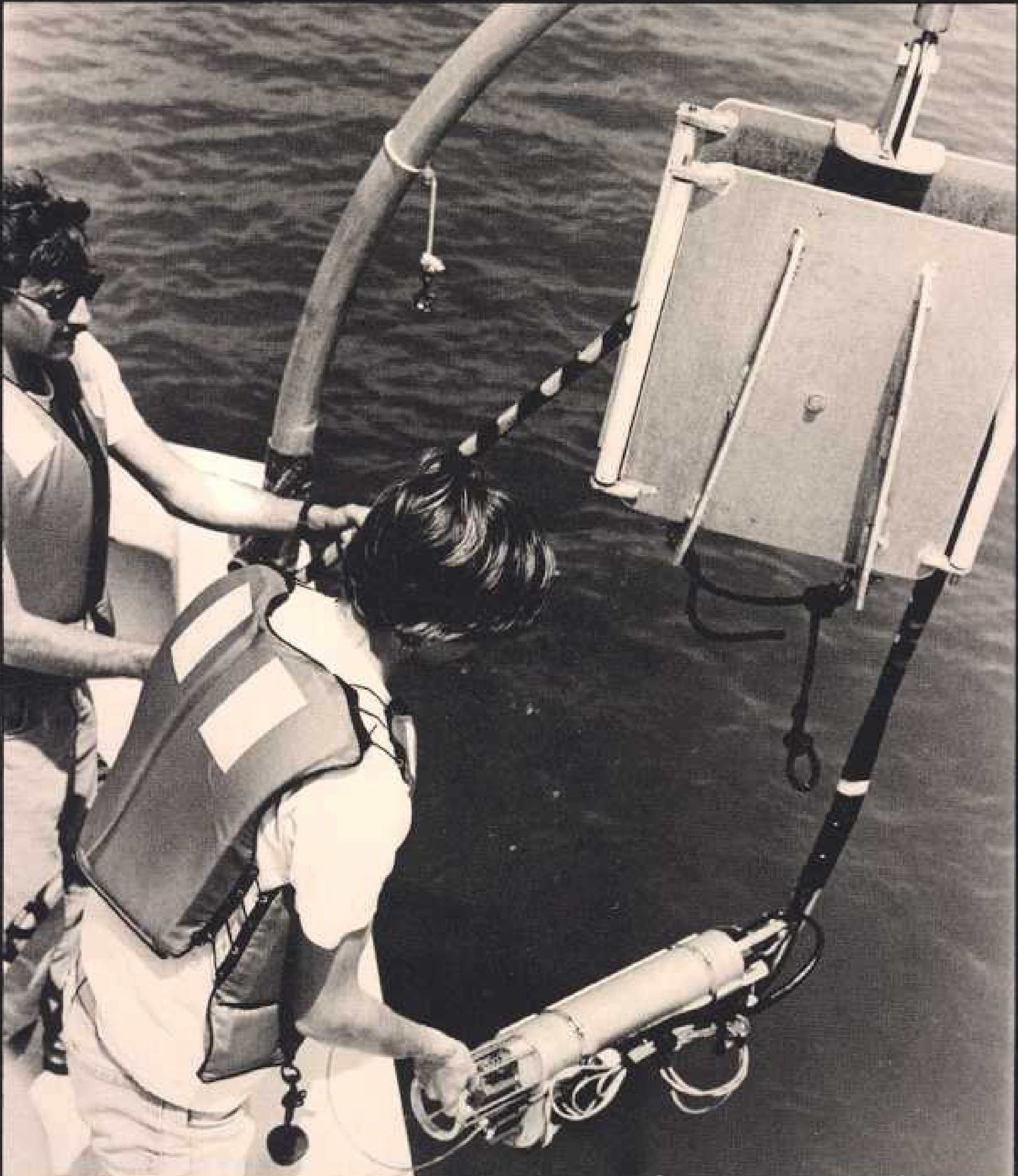
Virginia MARINE RESOURCE BULLETIN

Vol. 20, No. 1 Spring 1988



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

Virginia
MARINE RESOURCE
BULLETIN

DR. FRANK O. PERKINS
Dean/Director
Virginia Institute of Marine Science

DR. WILLIAM RICKARDS
Director
Virginia Sea Grant College Program

DR. WILLIAM D. DUPAUL
Director
Marine Advisory Services

Vol. 20, No. 1 Spring 1988

Contents

Virginia Sea Grant College Program

C. M. Plummer, Editor
Nancy J. Chartier, Writer
Kay B. Stubblefield, Graphics
Harold Burrell, Photo Editor
Janet Walker, Typesetting

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.

Glistening in the sun, the salinity, temperature, depth probe (STD), hangs from its pulley at the completion of a sampling station.

Chesapeake Bay Agreement
Water Quality Goals

The proposed 1987 Chesapeake Bay Agreement, drafted August 5-6, 1987, in Norfolk by the Governors of three states surrounding the Bay, the Mayor of the District of Columbia, the EPA Administrator, and the Chesapeake Bay Commission Chairman, contains goals and priority commitments to achieve them in six areas of concern.

GOAL: Reduce or control point and nonpoint sources of pollution to attain a water quality condition necessary to support the living resources of the Bay.

COMMITMENT:

- By July 1988, adopt and begin implementing a plan to achieve 40% reduction of nutrients entering the Bay by the year 2000. By December 1991, reevaluate the 40% reduction target based on results of modeling, research monitoring, and progress to date.
- By December 1988, adopt an implementation plan for reduction and control of toxic materials from point and nonpoint sources and from bottom sediments.
- By July 1988, adopt an implementation plan for management and control of conventional pollutants.
- By July 1988, the EPA will develop and adopt a plan for control and reduction of point and nonpoint sources of nutrient, toxic, and conventional pollution from all federal agencies and installations.

What are

HAZARDOUS AND TOXIC WASTES . . .

(and what are we doing about them?)

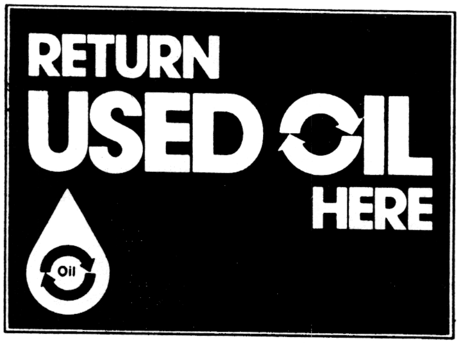
Robert Huggett, Professor and Head of the Division of Chemistry and Toxicology

The world we live in is a closed system. That means that with the exception of a few satellites and a few air molecules which escape the gravity of the earth, nothing with mass leaves the system. This in turn means that every ton of raw materials taken from the earth, be it coal, crude oil or copper ore, will, at some point in the future, become an equal amount of waste. All wastes are not hazardous, however.

Whether something is hazardous or not depends on the chemistry and biochemistry of the substance itself. From a scientific standpoint, if a substance can chemically react with an organism in such a way that the organism dies within a short period of time or some essential physiological function is impaired, then the substance has the potential to be hazardous. To differentiate, we use the term "acute toxicity" when death results fairly quickly, and "chronic toxicity" when essential functions are impaired. For instance, a substance that caused the inability to reproduce would be considered "chronic."

All wastes are not hazardous and we can certainly be thankful for that, but we still generate quite a bit. It is estimated that approximately 150 million metric tons of hazardous wastes are produced in this country each year. That's roughly half a ton of hazardous waste being generated for each man, woman and child in this country per year.

The next question which comes to mind is, where does it all come from? Well the answer is either directly or indirectly, from all of us. It is somewhat unfair to blame just one segment of our economy for all our problems. Obviously, many of our chemical industries generate hazardous wastes as they produce the commodities that we require or demand, but so do hospitals from their laboratories, and so do high schools, colleges and universities from their teaching and research laboratories. While individually the quantities generated may be small, they add up to sizeable amounts. Indeed, each of us generates a certain amount of hazardous wastes.



This is the sign which is used to show people where to bring the used crankcase oil that they have collected when they changed the oil in their automobiles. This collection is the result of the State realizing that during the combustion process occurring in our cars, a number of toxic and hence hazardous compounds are produced. They are called polynuclear aromatic hydrocarbons (PAH for short). These get into the crankcase oil and, if the oil is not properly disposed, can contaminate the environment. When you think of the number of automobiles in this country you can imagine the magnitude of this source which we, as individuals, generate. Then there are the emissions from home furnaces or stoves, the pesticides we use around the yard or house, the various solvents used, etc.; all in all, there's quite a bit. Where does it go?

Initially, to a variety of places. In the past and at present for those who don't use the provided waste oil receptacles, the used crankcase oil went into ditches, or perhaps around a fence to kill the grass. Eventually, a lot of it probably washed into our streams and rivers.

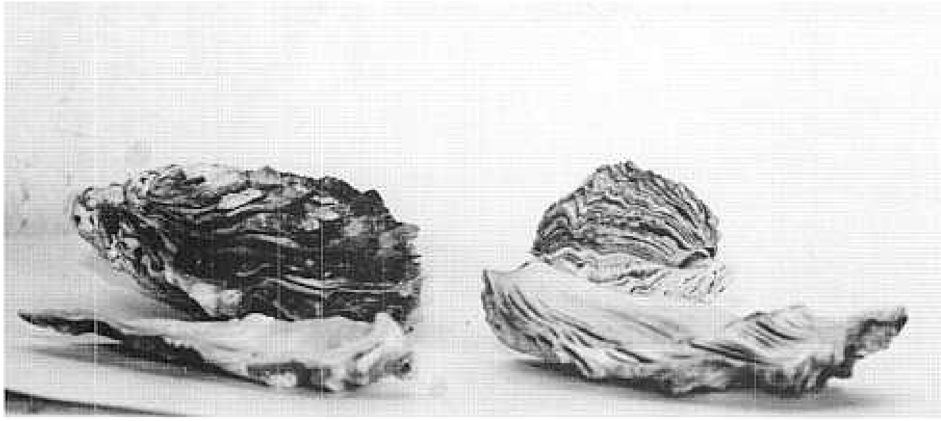
Gaseous emissions obviously are and were dispersed to be later removed by precipitation and then fell to the earth. Much of the home-generated wastes went down the drain and into the sewage system. Some of that goes out the other side into our waterways.

In the past much of our industrial wastes went the same route. Today that's not usually the case. There is now a much greater awareness of the threat of hazardous wastes than was the case in the past, and we have a number of laws and regulations designed to cope with the problem. But as I'm sure you are aware, we still have problems and I will separate these into two categories for the sake of clarity.

In the first category are existing problems which were generated in the past, and the second category contains problems which we are now or will be generating. There are numerous examples of past events which are now coming to light and causing a great deal of concern: Love Canal is a hazardous waste landfill which leaked; mercury in the Holston River of Virginia from a chloroalkali plant which used mercury in the process; Kepone in the James River; polychlorinated biphenyls in the Great Lakes, the Hudson River and more recently the New Bedford Harbor; mercury in the Clench River of Tennessee from the Oak Ridge National Laboratory; creosote, a mixture of PAH, in the Elizabeth River of Virginia; and the hundreds if not thousands of chemical waste dumps which were used in the past and are now leaking. Many more examples could be given. Indeed we have a problem.

Who's to blame? Well, in some cases there was obvious neglect or stupidity; in other instances there were criminal acts. Sometimes the laws were being complied with but the laws were inadequate; sometimes honest mistakes were made. It doesn't really matter why they happened, but rather what can now be done to clean them up and what can be done to keep them from happening again. This gets us into several pieces of federal legislation which have been enacted over the last decade to address the problem.

From the clean-up perspective we have Superfund. In the past year the media has been paying quite a bit of attention to the use or alleged mis-use of Superfund monies which are designed to be used to pay for clean-up of hazardous waste problems which threaten public health. Notice that it is important that there be a link to human health before a hazardous chemical contamination situation qualifies



Chris Plummer

Pacific oyster *(Crassostrea gigas)* deformed by TBT. Normal oyster on left.

as a Superfund site. In the case of the severe contamination of the Elizabeth River, since fish and benthic organisms are affected and there is little or no commercial fishing in the river and hence no human consumption of the seafood, it does not appear to qualify as a Superfund site.

There is approximately $1.6 billion in the Superfund for each year from 1986 to 1991. Cost of a particular clean-up is to be recouped by fines and penalties on the causes of the incident if legally possible or feasible. $1.6 billion sounds like a lot of money and it is; but to put it into perspective, the estimated cost of dredging the James River to remove the Kepone was $3 billion, not counting disposal of the contaminated sediments which would have been a deposit measuring 30 feet high by 20 square miles.

We have a large number of problems generated in the past, and we are going to discover many more. As scientists pursue the problem, they are finding more leaking landfills, more illegal dump sites and more contaminated ground water aquifers. Even if our existing federal regulations are 100% effective in keeping hazardous wastes out of the environment in the future, we will be kept busy for some years to come with our sins of the past.

Now for the other category, problems we are now generating or will generate in the future. I think it's safe to say that society is unwilling to accept the environmental cost of doing business as usual and indeed this has been reflected in several pieces of legislation designed to alleviate some of the problems. In September of 1976, Congress passed the Resource Conservation and Recovery Act, commonly called RCRA. This act created a new federal hazardous waste regulatory program. Among other things it prohibits the practice of open dumping. It regulates the treatment, storage, transportation and disposal of hazardous wastes. It is also intended to promote a national research and development program for improved solid waste management on resource conservation techniques.

Once a waste is designated as hazardous, then the requirements of the act apply to all persons who generate, store, treat or dispose of those wastes. It has the purpose of developing a "cradle to grave" monitoring and regulatory system for hazardous waste. The generator of the waste must create a manifest and everyone in the chain of custody of those wastes acknowledges receipt or transfer. In other words, it establishes rules and regulations on how to handle, store, treat and dispose of hazardous wastes.

Another act passed in 1976 is intended to keep hazardous materials out of the environment and is called the Toxic Substances Control Act (TOSCA). It is rather interesting in that it, in effect, assumes a new chemical to be toxic until proven nontoxic. Prior to this act, according to the Environmental Law Handbook, there was no general federal requirement that the thousands of new chemicals developed each year be tested for their potential environmental or health effects before they were introduced into commerce.

It is interesting, I think, that the authors of the Environmental Law Handbook state, and I quote, "The incident which led directly to passage of TOSCA was the discovery in mid-1975 that workers in a small Virginia manufacturing plant had sustained severe neurological and reproductive damage from exposure to the chemical Kepone." Under TOSCA, EPA must identify and evaluate the potential hazards from new and some old chemical substances if the administrator of EPA concludes that data are insufficient to permit a reasonable evaluation and that the chemical may pose a risk to man or the environment. EPA may restrict or prohibit any aspect of the chemical's production or distribution. This is an extremely difficult task for EPA and results in a large financial burden on industry.

I believe we do have a hazardous waste problem in this country. There is no way that I can see of totally eliminating the future production of such materials. There are now laws to control its disposition and reduce the volume. But if we conclude that we are going to generate hazardous wastes, then we must look at what we do with them after generation. There are but two options for those wastes which cannot be recycled (and many can't) — storage or destruction. I serve on the Science Advisory Board of the EPA, and we have looked at incineration of hazardous wastes. The Environmental Effects, Transport and Fate Committee of the Board has concluded that land filling or deep well injection of many types of hazardous wastes is in effect just storing them and perhaps passing the problem along to future generations. Leaking landfills show what can happen here.

Incineration, biological degradation, chemical conversions, etc. are examples of destruction. To me, destruction is preferable to storage although not all the data on effectiveness of destruction are in. But no one wants a hazardous waste incinerator in his back yard. At a hearing in Brownsville, Texas, less than two years ago on incineration of liquid hazardous waste in the middle of the Gulf of Mexico, 6,000 people showed up. Most were against. There is obvious public concern.

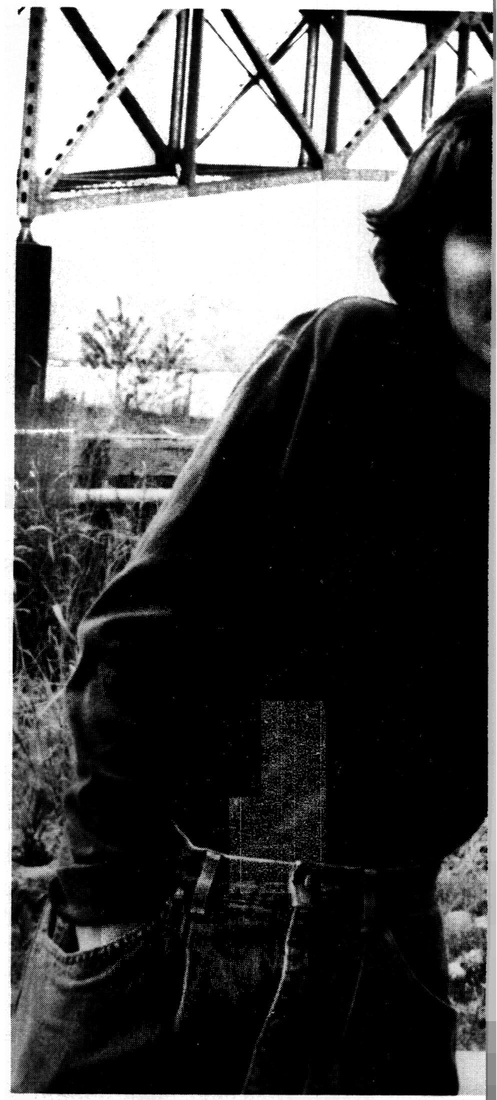
There are scientific, economic, political and social aspects to hazardous and toxic waste disposal. Unless we put forth a concerted effort, we will continue to have the problem, but it can be controlled.

Chris Plummer

Bob Huggett in one of several chemical research laboratories at VIMS.

Vanishing Eelgrass . . .

...another indicator of decreasing water quality?



Watermen whose families have scraped crabs for several generations tell of moving further and further south on the Bay in search of the grasses where crabs thrive. Marine botanists, Dick Wetzel and Ken Moore, have watched the existence of eelgrass beds move not only southward but also eastward in the tributaries as the Chesapeake Bay becomes unable to sustain what were once vast underwater meadows of undulating green.

"For three years now," says Wetzel, "we've transplanted healthy plants to an area in the York River where we know there were once large beds. The plants survive the winter, but fail to thrive during the spring growth season. During the summer, they die."

The scientists believe that it is the decline of water quality which is killing the eelgrass, and have begun a three year experiment funded by Sea Grant to support their theory. In order to determine the specific reasons for the decline of the seagrass, they are doing both field studies and a complex series of studies in a greenhouse at the Virginia Institute of Marine Science (VIMS). Their field work is literally out VIMS' back door on the York River.

At the mouth of the York River, the vast Guinea Marshes provide a site of thriving eelgrass; in front of VIMS an experimental area of eelgrass has responded to replanting and also thrives; but just a few miles upriver, near Clay Bank in Gloucester County, transplanted plants die every summer despite the evidence that huge beds once thrived there.

Based on the results of studies Wetzel and Moore have undertaken since 1978 on the production and ecology of submerged aquatic vegetation (SAV), they have identified three factors as the principal components that either directly or indirectly exercise control on the growth of *Zostera marina* (eelgrass) in lower Chesapeake Bay waters: 1) the intensity and perhaps duration of sunlight actually received by the plants, 2) the concentration and availability of dissolved inorganic nutrients (particularly nitrogen), and 3) the amount of algae growing on the plants. All three are highly inter-related and can be related to land-use practices for specific watersheds.

Submerged plants occur in all aquatic environments. Over broad geographic scales, the distribution of submerged plant species is governed largely by salinity and temperature regimes. Salt tolerant species, seagrasses, generally occur in estuarine and coastal marine areas that have mean annual salinities greater than 10 to 15 parts per thousand (ppt). Within a particular geographical area, submarine light, temperature, dissolved inorganic nutrients, and general water quality conditions govern the distribution, relative abundance, and growth of a given submerged aquatic species.

Of the twenty species of submerged aquatic vegetation that occur in the Chesapeake Bay and its tributaries, only eelgrass is considered a true seagrass and it is the dominant submerged plant in middle and lower portions of the Chesapeake Bay.

In the 1930s a sudden decline in eelgrass occurred throughout the North Atlantic Basin and involved estuaries in both North America and Western Europe. Most of that loss was slowly restored and was believed to have been caused by a regional disease. However, the decline since the 1970s of eelgrass in the Chesapeake Bay has been confined to this area although some stressed systems in Europe are now reporting similar rapid declines. The disappearance of *Zostera* follows nearly directly the increase in population densities beginning in the northern Bay and moving slowly southward and eastward.

The scientists have particularly observed an increase in epiphyte fouling. Epiphytes are plants that grow on other plants. In this case, microscopic algae, which increase in numbers quickly when nutrients are increased in the water, cover the eelgrass leaves and shut out light. Both the eelgrass and the algae need sunlight for photosynthesis, but the algae can continue to thrive with far less than the grass, so it becomes doubly competitive and far more successful.

Another problem is particulates in the water — tiny bits and pieces of sand, clay, debris — anything small enough to remain suspended in the water or to float on the water. This material cuts down on the amount of sunlight which can filter down to the eelgrass which grows on the bottom. When enough sunlight is cut out, either by the fouling on the leaves or combined with the non-organic particulates, the eelgrass begins to die.

Since the heaviest sediment load comes downriver during the spring run-off and rains, and since the algae begin to grow when the water warms at the same time; it is no wonder that transplanted eelgrass which has survived all winter slows its growth in the spring and dies by summer.

"What we propose in our study," says Wetzel, "Are controlled studies on

Nancy J. Chartier

(From left to right): Hilary Neckles, Ken Moore and Dick Wetzel just outside VIMS' greenhouses with the York River Bridge behind them.

eelgrass growth and survival under variable water quality regimes. Specifically, the studies will address cause-effect relationships between plant growth and nitrogen-phosphorus loading and amount of sunlight. These are the environmental variables that have changed as a result of human activities and the specific factors that have been identified over the past eight years of research that most influence eelgrass growth and survival in the field."

The scientists will recreate, in the greenhouse, five different natural environments in which the eelgrass grows. In order to assure that naturally occurring nutrients in the sediments do not become variable for the experiments, bottom soil from each of the locations will be used. To duplicate the lack of sunlight caused by particulates and fouling, the scientists will decrease the intensity of light available to the plants based on light readings below the surface in each location. Water from the York River will flow through the greenhouse systems reproducing the normal York River salinity and temperature regimes. In addition, nitrogen and phosphorus will be introduced in quantities similar to those for each location where the plants will also be field studied for comparisons.

Wetzel and Moore hope to accomplish three goals from their research: first, the relationship between nitrogen and phosphorus loading and its relationship to the algal growth and hence light available; the optimum water quality parameters for eelgrass; and finally, resource management guidelines relative to eelgrass conservation and enhancement.

Many other studies have proven that eelgrass is a vital habitat for crabs throughout various stages of their lives and provides an ideal habitat for a number of other species. In addition, eelgrass, as with all the submerged aquatic vegetation and wetland plants, helps hold the bottom sediments in place, decreasing erosion. Wetzel believes that eelgrass may also provide an excellent indicator for water quality, although he points out that he is referring to marine resources and not necessarily water quality in terms of human consumption.

"I think SAVs are a good indicator because they integrate so many processes related to water quality," he says. "If we begin cleaning up the Bay, we could watch the process over a period of years as eelgrass naturally increases or by the survival of transplanted plants. This isn't going to happen overnight, of course. The degradation began decades ago and certainly accelerated in the recent past; now we're just going to have to work patiently for the restoration. But it's been done and is being accomplished in other areas, like the Great Lakes, and it can be done here."

New Sta
Quality S

The State Water Control Board is one of eight agencies under the Secretary of Natural Resources which share only one percent of the overall State budget. Fewer than 350 people have the responsibility for "maintaining the state waters at such quality as will permit all reasonable, beneficial uses and will support the propagation and growth of all aquatic life..."

Presently, the Agency is revising some of the standards which make up the regulations for discharges into state waters. "We may have been a little slow in upgrading standards in Virginia," says Tom Felvey, "But our legislators have always insisted that regulations be 'defensible under the law.'" Felvey is the Program Manager for the Office of Environmental Research and Standards. "When the Environmental Protection Agency's recommended criteria first appeared after passage of the Clean Water Act in 1972, there wasn't sufficient scientific data to back up the criteria. We've done a pretty good job in this state of having research behind most of our regulations, which means that the first time a case goes to court the whole regulation doesn't get thrown out or a lot of exceptions added. Good standards," Felvey says, "meaning those backed up by scientific fact, are easier to apply across the board and easier to defend."

A standard which became effective in May designated nutrient enriched waters based on phosphorus and chlorophyll levels. Standards for toxic substances will be in effect before the end of 1988.

These new standards are in addition to regulations which already apply to 192 specifically identified substances, temperature ranges, fecal coliform levels, dissolved oxygen, and pH levels. In many cases, state requirements have exceeded minimal federal requirements. For instance, in 1983, Virginia began sampling effluents using aquatic toxicity tests — tests which determine whether aquatic plants and animals can live with whatever is being discharged into the water. These tests are still not required under federal law, and indeed many states don't use them.

As of July 1,1988, all municipalities in the country must meet more stringent standards for sewage treatment discharged into the water. This requirement came about as a result of the Clean Water Act and originally, federal funds were available to help municipalities improve their facilities. Those monies, unfortunately, have been reduced each year for the past several years, but municipalities must be either in line with standards by July 1 or they will be put under court order to meet the improved standards. The SWCB monitors all municipal discharge facilities. The Division of Shellfish Sanitation also monitors water quality around municipal facilities during regular sampling collections.

It is sometimes difficult to understand the different responsibilities in terms of water quality of the SWCB and the Health Department. However, part of the confusion is created at the federal level where EPA sets standards for general water quality, but the Food and Drug Administration sets different standards for drinking water and water used in the processing of food. The agencies coordinate all permits for municipalities, industry, developments — any activity which uses water; they work together in designing standards and they share engineering and research capabilities.

The DSS is responsible for all of the Commonwealth's shellfish and it falls under the Office of Water Programs within the Virginia Health Department. In 1925, a typhoid outbreak in a shellfish producing state led to an epidemic which caused the deaths of several hundred people in the northeast. Determined that nothing similar would occur again, the shellfish producing states in cooperation with the federal government under the old U.S. Public Health Service developed criteria and guidelines for shellfish production.

DSS has 36 employees, total, to cover all the potential shellfish areas of Virginia — several thousand miles of shoreline.

Bernard Caton is the Deputy Executive Director for Policy of the State Water Control Board. "There have been a lot of changes in water quality standards and public expectations in the past few years; there will be many more. Every time we identify a new pollutant or learn something more about a substance, policy and regulations will change. At the moment there are some complex problems for which we have no solutions, through research we'll develop solutions and incorporate them into state policy."

Chris Plummer

Chris Plummer

At the Division of Shellfish Sanitation's laboratory in Norfolk, Hanh T. Tran and Carol T. Cole perform FDA "triple blind" tests which verify results from their own and other testing laboratories. These regularly performed "checks" assure that human health is protected at seafood processing plants. John S. Alman, Supervisor of the office, looks on.

te Water
tandards

State-wide there are over 26,000 water samples taken from shellfish growing areas for analysis each year. In addition, approximately 1500 meat samples from shellfish producers and 1200 samples from crab production houses are taken for analysis. Last year, over 16,000 inspections of individual homes or businesses were made along the shoreline. DSS' responsibilities include water and growing area analyses, seafood processing plant inspections and shoreline surveys. Every six years, every shoreline survey is updated by a house-to-house review. Personnel literally knock on doors to ask about septic tanks, identify illegal discharges and inform residents about changes. Shellfish Sanitation notifies the owner of any violation or problem and then reports the violation to the local Health Department and the SWCB.

The Water Control Board has a powerful new scientific tool for finding substances discharged in effluent called "fingerprinting." The laboratory methodology was developed by the Chemistry and Toxicology Division of the Virginia Institute of Marine Science. Much like the FBI's ability to identify millions of individuals through fingerprints, chemical fingerprinting identifies chemical substances through chromatography and matches them with chemical descriptions in a computer program. Alan Pollock is the technical coordinator for Bay Programs within the agency, and he claims the new methodology allows regulators to quickly identify any new or combined substances that show up in yearly effluent testing. "We've had cases where something shows up in fingerprinting that we've never seen before. Then we sit down with the discharger and work together to identify what that substance is and how it entered the effluent."

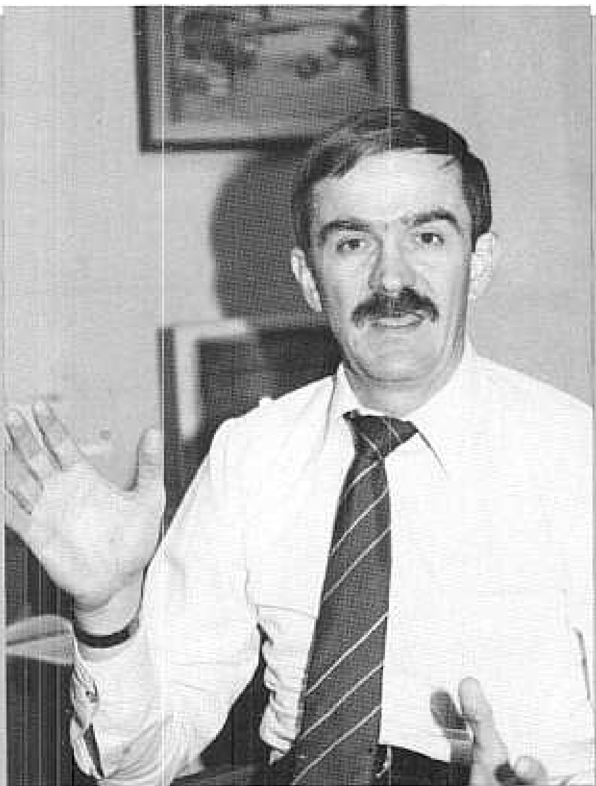
Pollock's position is a new one brought about by the Chesapeake Bay Clean Up. With all the attention focused on the Bay, citizens may wonder about efforts for the rest of the State. "Actually," says Pollock, "the Bay effort is leading to increased technology and research throughout the state. One example is a new mobile laboratory which allows onsite testing of the toxicity of wastewater discharges. The mobile unit was funded by Bay Programs, but has proven so helpful to water quality monitoring that a second mobile unit has been ordered to service the rest of the state."

Another major benefit of the Bay Initiatives according to Pollock is the regional cooperation which has resulted. "Because of efforts to clean up the Chesapeake Bay, the states that form the Bay's drainage basin are working together to improve water quality throughout the region."

To maintain the cleanup of the Bay and all of the state's waters, Governor Baliles has made it clear that his intent as Governor is to "institutionalize" the process. This means that if public interest wanes in the effort over the years, the process and programs will be as much a part of the state as human health requirements or roadworks.

As part of that process, regular monitoring, continued research and regulatory capability will have to keep pace with the intent of legislation. Monitoring — taking regular water samples — helps keep managers abreast of changes in water quality, provides a basis for supporting legislation, and increases investigators' knowledge of the movement and activity of substances within the water. Research allows scientists to find solutions to water quality problems and, as in the case of "fingerprinting," allows the development of new technologies to aid regulators. Until some new and advanced methods are invented, individuals from agencies will still have to walk the shoreline, knock on doors, take water samples and carefully examine every proposed and existing enterprise to assure compliance with regulations.

Under the direction of Richard Burton, Director of the State Water Control Board, the agency is making major contributions to the clean up of the Bay and improved water quality throughout Virginia.



Chris Plummer

Gerald Yagel, Supervisor, and B. Keith Fowler, Pollution Control Officer of the Kilmarnock branch of the Tidewater region SWCB sit behind a mountain of permit applications. The National Pollutant Discharge Elimination System (NPDES) requires potential dischargers to identify any substance which might enter the water from their site. In addition, monitoring on a regular basis is required by the discharger as well as spot-monitoring by the Agency. Every permit application goes through a process that includes investigation, joint agency meetings, scientific and engineering review, and monitoring schedule design. The Kilmarnock office is responsible for water quality in ten counties comprising all of the Northern Neck and Middle Peninsula.

Alan Pollock is the Chesapeake Bay Coordinator for the Bay Cleanup Initiatives. His job is to provide technical expertise within the SWCB on matters of water quality. Pollock says the Bay Programs are "Providing greater technology and research for the whole State."

Chris Plummer

Award-Winning Wastewater Facility

Wanda Cohen

Wastewater treatment facilities rarely receive commendations or acclaim. In fact, few of us are conscious of their existence. Yet, Hampton Roads Sanitation District (HRSD) has developed a new wastewater treatment process which is environmentally safe, highly effective and cost efficient and HRSD has received national awards for two of their nine facilities.

Conventional waste treatment plants rely on fundamental biological and physical reactions to remove organic and inorganic materials before effluent (treated liquid) is discharged into rivers and streams. In the primary treatment phase, waste passes into large tanks where solids settle out. The liquid (called primary effluent) passes into aeration tanks where air is injected and microbes (microscopic organisms) feed on organic materials such as sugars and starches, thereby stabilizing the remaining organic material. This process can be controlled by such things as food to microbes ratio, the amount of air forced into the tank and the length of time the liquid stays in the aeration tank. Final settling then follows in which the microbes are separated from the treated effluent and are returned to the start of the aeration process. In conventional treatment facilities, the effluent is treated with chlorine at this point for disinfection and in many cases dechlorinated and discharged from the facility back into rivers and streams.

The process developed by HRSD and CH_2 M Hill (an engineering consulting firm), is called the Virginia Initiative Plan (VIP). The process incorporates two additional phases into the treatment process. Effluent is passed through two additional tanks where nitrogen and phosphorus are reduced to lower levels. The process depends on three types of microbes to do three separate jobs in three different en-

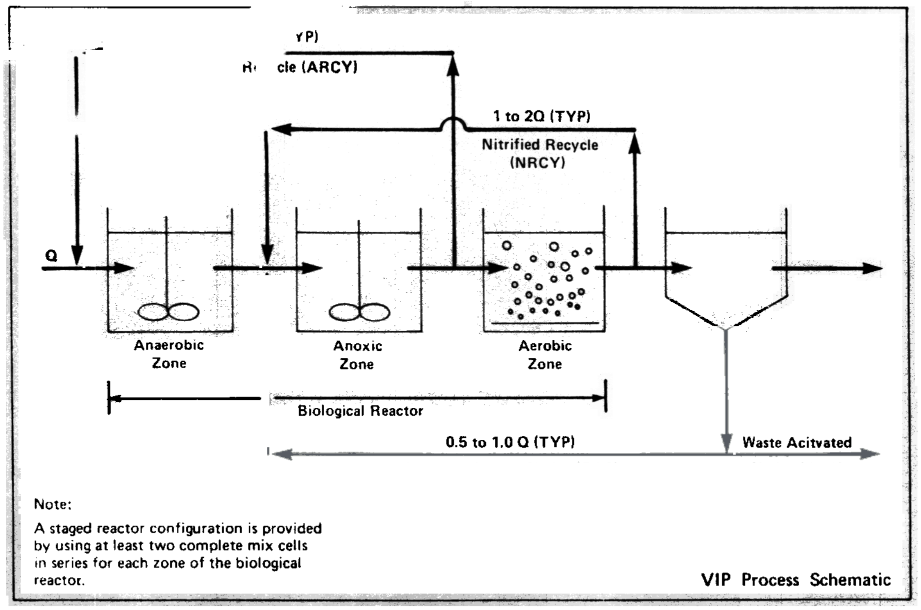
(Left) Wastewater arrives at Yorktown facility ready for treatment. HRSD facilities are intricate combinations of tanks and pipelines which are monitored 24 hours a day.
(Right) Belinda Houchens takes water sample at the HRSD York River Plant where the VIP process was tested.
Photos by Jeff Gray.

vironmental mixes:

1. Anaerobic Zone: environment without oxygen
2. Anoxic Zone: environment without free oxygen (available oxygen is tied to nitrogen)
3. Aerobic Zone: environment with free oxygen.

As in other treatment phases, the process is controlled by the types of microbes present in each tank, the amount or lack of aeration and the length of time effluent is exposed to the controlled conditions. In simple terms, microbes are returned from the final clarifier to the anoxic zone. Here there is no free oxygen. As bacteria break down the waste compounds, the released oxygen stabilizes the organic material and nitrogen gas is emitted harmlessly into the atmosphere.

The phosphorus is reduced by a somewhat different process. Bacteria take up phosphorus in their natural biological processes. Phosphorus literally becomes part of the microbe's body mass. By "wasting" these microbes from the system, phosphorus and organic material is removed from the sewage. The biological mass that remains can be composted, applied to farm land or incinerated. James Borberg, General Manager of HRSD, estimates that in the greater Hampton Roads region, approximately forty percent of the organic material wasted from treatment pla ts is reused as fertilizer.



VIP Process Schematic

While the processes that reduce levels of these elements are natural, environmental conditions must be carefully controlled to achieve the desired effect. Various microbe mixes are grown for several days until the most desirable mix is established in the treatment tanks. Again, the volume of air that is bubbled through the aeration tank and the amount of time the controlled conditions are maintained determine the effectiveness of the process.

HRSD adapted the VIP to the York River Plant to further test the process. This site was chosen because it could most easily be adapted to the process with minimal additional construction. After fifteen months of pilot plant operation, results indicate the VIP goals of reducing phosphorus and nitrogen by about two-thirds with expected seasonal variations are achievable. Additionally, the VIP process can be accomplished at less expense than normal conventional chemical methods.

According to Jolene Chinchilli, Senior Scientist at the Chesapeake Bay Foundation, this is an extremely important aspect of the project because municipalities will be able to afford to incorporate this process into their existing plants or restructure at a cost that is reasonable. "This appears to be the most promising technology yet available especially in areas where it is so badly needed." The need is greatest in heavily populated areas.

Both Borberg and Chinchilli are particularly pleased that the process is going to be constructed on the Elizabeth River and will include the flows from the present Lambert's Point and Pinners' Point Plants. This is a particularly vulnerable area because the Elizabeth is such a poorly flushed estuary. Borberg feels, "If there is a benefit, we should be able to see it at this facility because it will be easier to evaluate the results than if we were discharging into a faster flowing river or the Bay itself. The Elizabeth River is recognized as the most heavily polluted in Virginia."

Another highly unusual aspect of this project is that it was conceived, developed and implemented by a treatment agency. The State Water Control Board and federal agencies establish regulations that determine the level of treatment HRSD applies to waste. HRSD's mission is to provide operations that insure permitted standards are achieved and maintained. Development of the new process is a singular accomplishment for a treatment facility; in fact, it is the first time in nearly sixty years that such a facility has applied for a patent on innovations.

James Borberg, General Manager of HRSD, has provided innovative administration and upgrades to the lower Bay's largest regional wastewater district.

Borberg and the many other professionals who staff HRSD are beginning to reap the rewards of their efforts. Their Virginia Beach plant was chosen by EPA last year as the best secondary treatment plant in the country. Another plant was chosen as the best smaller plant in the region. As the Lambert's Point plant is upgraded to the VIP process it will be closely monitored by area scientists in order to evaluate the effects of the improved treatment on the Elizabeth River.

Hampton Roads Sanitation District serves 1.2 million people and the nine plants collectively handle 120 million gallons of waste per day. It would have been sufficient for them just to have done their very necessary job; to do it better than anyone else in the country and then invent a better process deserves special thanks from all Virginians.

Wanda Cohen is a free lance writer from Newport News.

Testing the Waters

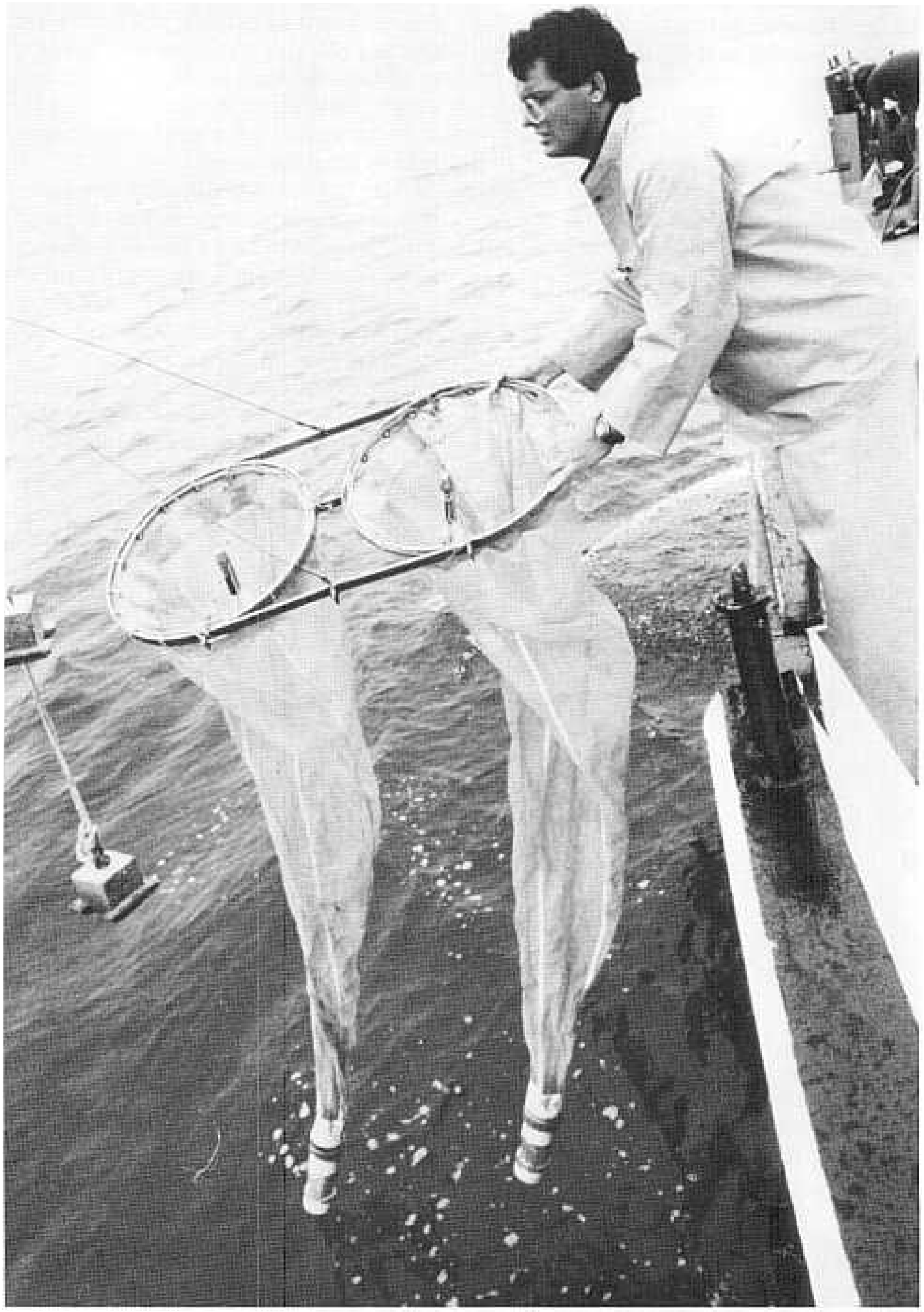
Nancy J. Chartier

Just before dawn, the R/V Ulysses is underway from the Virginia Institute of Marine Science (VIMS). Onboard, the field team is busy setting up equipment in preparation for the long day of sampling ahead. The winds are calm and the waters of the Chesapeake Bay glassy and pristine-looking. It's going to be an unusually good day for January sampling.

The vessel slows as it approaches the first station of the day. Supervised by Laboratory Mechanic Steven Snyder, the team springs into efficient and methodical action. The STD (Salinity-Temperature-Depth) probe is lowered into the water and samples of the surface water are collected. The probe is then cast to the bottom. Bottom water samples are collected using a hose connected to the probe. Laboratory Mechanic Karl Dydak operates the onboard personal computer. Steve raises the probe as Karl calls out the depths. At one meter intervals (indicated by the computer to within ±.1 meters), temperature and salinity are recorded automatically by the computer.

This station is one of the "mainstem" stations of the Bay, where a pycnocline (region of rapidly changing density) is present. The computer projects a contour image of the pycnocline on its screen and water samples are taken one meter above and below the pycnocline. For each depth interval sampled, the water sample numbers, the pH, and the dissolved oxygen (DO) concentration are entered into the computer.

A secchi disk is lowered into the water to check the turbidity. (The black and white faced disk is lowered by string into the water until it can no longer be seen. The string is marked off in meters and the depth of visibility is calculated).



David Byrd retrieves plankton sampling nets onboard the R/V *Holton*. Samples are processed onboard and returned to the ODU Zooplankton/Ichthyology Laboratory for analysis.

Five samples of water are collected at each of the required depth intervals. One sample is used immediately to measure the pH of the water at that depth. Two water samples at each depth interval will be taken back to the lab to run back-up salinity and dissolved oxygen tests to compare with the onboard instrument readings.

The other two samples are taken inside the cabin by laboratory technicians Grace Battisto and Jim Vescio, who are filtering the samples onboard. The water samples are filtered so that the concentrations of certain nutrients can be determined back at the shore-based laboratory. (Filtering the samples onboard saves one day of lab time). The filtered liquid of one sample will be used to measure the amounts of dissolved total phosphate, orthophosphate, silica, nitrate, nitrite, and ammonia. The filters are saved to determine the amount of particulate phosphorus and suspended solids (seston). The filters from the second water sample will be analyzed for particulate carbon, particulate nitrogen, and chlorophylls. The filtered water is saved to measure dissolved organic carbon and dissolved nitrogen. The filtered water samples and filters are marked and stored on ice until the end of the day.

Once the sampling is finished, Captain Charles Machen quickly heads the Ulysses towards the next station. There are 20 mid-Bay stations to cover in two days, weather permitting. As the vessel moves through the water, the two technicians continue their work inside the cabin. Before the next station is reached, they are finished with their samples and completely set up and ready for the new batch.

Like clockwork, this routine is repeated, station after station. Efficiency is important, and the sampling days are sometimes 12-14 hours. Today, there are no weather complications, and many stations are completed.

The water sampling team works for the Nutrient Center, part of the Division of Physical Oceanography and Ocean Engineering at VIMS. They are collecting water samples throughout the mid-Bay as part of the Chesapeake Bay Monitoring Program. This program is regulated by the State Water Control Board through Robert Siegfried for the Environmental Protection Agency (EPA). It is a collaborative effort between Maryland (covering the 27-28 upper Bay stations) and Virginia; (VIMS covers the 20 mid-Bay stations and Old Dominion University samples the 10 lower Bay stations). ODU's samples are taken from the R/V Holton, captained by Bob Bray. Ideally, the sampling occurs throughout the Bay within the same week. The samples are collected monthly November to February, and bi-weekly from

Chris Plummer

Betty Salley takes a break in her office at the VIMS' Nutrient Center. Salley oversees all of the lab's water quality analyses.

March until October.

For Betty Salley, quality assurance is the key to running a successful laboratory. She is in charge of the Nutrient Center.

The majority of the work done at the center involves working up water samples from the Chesapeake Bay Monitoring Program (CBMP). Because of their involvement with the CBMP, the Nutrient Center is monitored by the EPA through on-site visits and audits of the sample workups.

A great deal of emphasis is placed on quality assurance. "Our main goal is to process samples, run the analyses, and provide the scientists with the best data we can. Twenty percent of our time and effort is put into quality control and assurance," states Salley.

A good example of the effort expended to check the quality of analyses is in evidence with the handling of the CBMP samples. Two samples from each Bay set are "split" with Old Dominion University. The samples are analyzed by each institution and the results compared. Quarterly, triple "splits" are made between Maryland, VIMS, and ODU. "This duplication and replication of the tests helps to assure both inter- and intra-lab quality control," says Salley.

An impressive array of instruments is used to measure the nutrient concentrations (e.g. nitrogen and phosphorus) in the samples brought to the lab. Chlorophyll-a is considered the most important of the principal photosynthetic pigments found in the phytoplankton. The concentrations (micrograms/liter) of the pigment in the water samples are measured using a spectrometer, providing a measure of the biomass (amount) of phytoplankton present. The concentrations vary, depending upon factors such as season, light, and nutrient availability. Nitrogen and phosphorus are essential to photosynthesis and plant growth. However, plankton blooms often result from the influx of excessive amounts of these nutrients into the system. These blooms produce high DO concentrations in the surface waters, but increase the turbidity of the water and produce large quantities of detritus. These nutrients are also stored in the bottom sediments. During periods of low DO, the reserves can be released back into the water column.

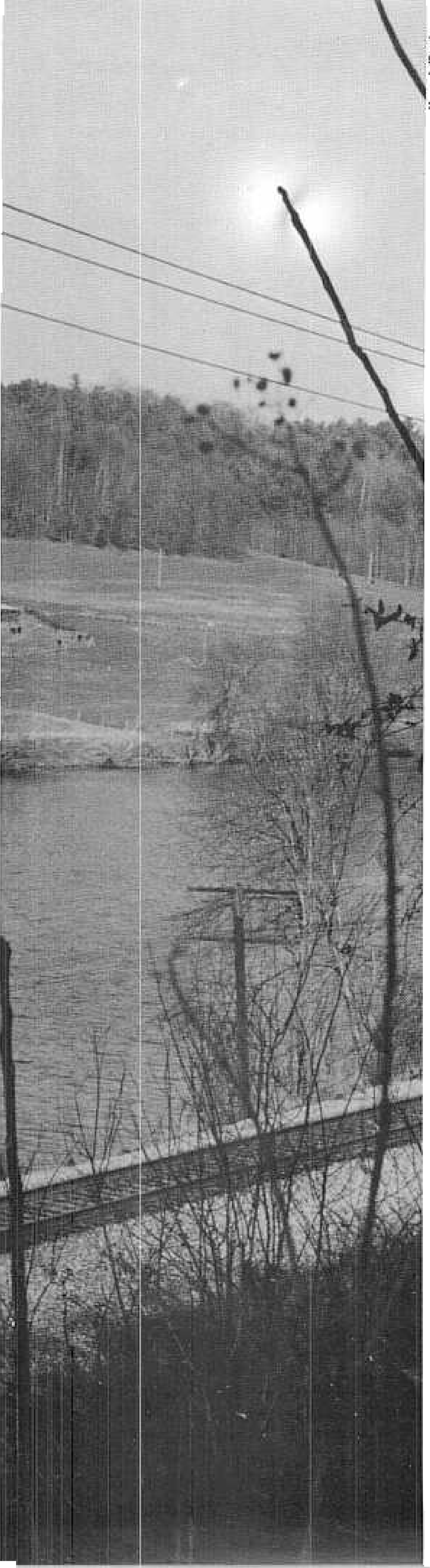
Carbon, nitrogen, and phosphorus are present in water in both dissolved and particulate forms. A Carbon-Nitrogen Analyzer is used to measure the particulates, and a Continuous Flow Analyzer to measure dissolved nutrients. The sum of the dissolved and particulate concentrations provides a total amount for these nutrients.

Turbidity is measured in two ways. A secchi disk reading is made at each station. Visibility can vary from less than one meter to more than three meters. The lab also measures turbidity levels by determining the amount of total suspended solids present in the water column.

The Nutrient Center at VIMS and the Applied Marine Research Laboratory at ODU are important components in water quality studies as well as supporting their university's testing needs. Steve Sokalowski at ODU, manager of the water quality section, and Betty Salley at VIMS concentrate on the quality of their work — scientists, managers and the Bay depend on their accuracy.

Nancy J. Charlier

Field team supervisor Steve Snyder fixes additional water samples which will be taken back to the Nutrient Center at VIMS.


Nancy J. Chartier

At the western limits of the Chesapeake's watershed, VPI works with improving farming practices. In this case, there is nothing to prevent the loose soil or chemicals from the field from entering a major tributary.

Water Questions? Call VPI

Nancy J. Chartier

Are the chemicals you're putting on your fields fertilizing your crops — or the Chesapeake Bay? Does your laundry detergent clean effectively in hard water? Is your septic system working safely and properly? What can you do to conserve and preserve Virginia's water resources?

The answers to these questions and thousands of others can be found in an old Georgian brick house on the edge of the Virginia Tech campus in Blacksburg. This house is the site of the Virginia Water Resources Research Center (VWRRC), which conducts research and disseminates information on many of Virginia's water problems.

The Virginia center is one of 54 centers located in all fifty states, Washington, D.C., the Virgin Islands, Guam, and Puerto Rico. These centers were established by federal law in 1964 and most are affiliated with a Land Grant College or University. Unlike many of the centers, the VWRRC was designated a state entity component of Tech in 1982 in legislation passed by the Virginia General Assembly.

The VWRRC has four general mandates: "to identify and assess water and land-related problems in Virginia; to sponsor, coordinate, administrate, and conduct research on these problems; to provide training opportunities in research for young individuals interested in water resource careers; and to collect and distribute information about water resources and research to a wide audience." A Statewide Advisory Board appointed by the Governor, a Technical Advisory Board comprised of researchers from throughout the state, and an Inter-Agency Research Board composed of nine different agencies all provide guidance and advice, in conducting its programs.

With the myriad of problems affecting the surface and groundwaters of Virginia and the large number of researchers vying for funds, how does the Center determine which research projects to support? "The Center funds applied research directed to solving specific water resource problems in Virginia," says Diana Weigmann, Assistant Director for Research and Administration at the VWRRC. After a state-wide request for proposals is issued, thirty reviewers and the Center's technical advisory committee rate and rank the research proposals. Ultimately, the number funded depends upon the amount of money that is available. Sources of funds include various departments in the federal government, the Virginia General Assembly, Virginia Tech, state agencies, and private foundations.

The staff at the Center establishes five year plans based on the priorities established by the Statewide Advisory Board. These objectives may change as information becomes available and/or new problems arise. Some of the current initiatives include examining the threat of synthetic organic chemicals to Virginia's drinking water supply and the contamination of surface and groundwater in localized areas caused by sanitary landfill leachate, leaking gasoline storage tanks, and pesticide/herbicide application.

Other research projects have looked at the potential use/benefits of applying sludge from public sewage treatment plants on croplands, and the use of "Best Management Plans (BMPs)" for controlling nonpoint source pollution from farm fields and urban stormwater runoff. A research project currently underway will help identify which portions of the watershed are responsible for nonpoint pollution runoff so that farms in those areas can be targeted for state cost-sharing programs which exist to encourage farmers to use BMPs to decrease nonpoint source pollution.

"The Center maintains an active role in all the research projects it funds. Advisory meetings which include potential users of the research are held quarterly to receive progress reports, which assure accountability of the funds provided, and that the project remains practical in nature," says Weigmann. Education Director Kathryn Sevebeck adds, "Once completed, all of the research projects are written up, peer-reviewed, and published. Occasionally, some of the information is incorporated into less technical brochures and publications for use by educators, schools, extension agents and the general public." The Center publishes the results of most Center-sponsored research in its research bulletin series. The Center also publishes special reports on water-related subjects such as water supply problems in southeastern Virginia and occasional papers that examine the human aspect of water resources problems.

In keeping with one of the Center's mandates, all of the research projects usually have at least one graduate student associated with them. "We keep track of these individuals long after they are finished with the projects. We are interested in finding out if the training and experience the students receive help them, especially if they stay in the field of water resources," says Sevebeck. "We also offer a graduate course each summer at Virginia Tech for teachers who are preparing to teach water-related units in the classroom."

The Center's projects reach far across the state, focusing primarily on freshwater problems. That is not to imply that the sponsored water resources research have no bearing on the Chesapeake Bay and its estuarine rivers. Activities in the western part of the state can have grave and far-reaching effects, not only on fresh surface and groundwaters, but also on the Bay itself. A greater effort must be made to consider the whole watershed when searching for cause-and-effect impacts on the Bay. (The watershed for the Bay covers approximately 64,000 square miles).

The VWRRC is also the source of vast amounts of information relating to water resources, research findings, and general interest information. This information takes a variety of forms and is available to anyone who requests it. "We have several computer databases available," says Sevebeck. "HISARS (Hydrologic Information Storage and Retrieval System) and HYDRODATA are two available databases which contain USGS information on streamflow, peakflow, rainfall, snowfall, temperature, and evaporation as well as water quality data for Virginia. These databases are complemented by a variety of statistical packages. In addition, the Center maintains "Research in Progress" (RIP) which contains over 250 abstracts of water-related research projects in Virginia. Abstracts on national and international water resources research projects are also accessible."

The Center responds to many requests for information annually. These queries vary from "where can I have my water tested?" to information requests from researchers and students of all ages. Their monthly newsletter "Water News," which is free to any Virginian, contains news reports on local, state, regional, and national water-related issues, along with information about Center projects and activities. The Center also sponsors a variety of research forums and workshops, including some for local government officials tailored to meet their locality's individual needs and concerns.

The next time you have a question or concern relating to water resources, turn to your state's "treasure trove" of information. Contact the staff at the Virginia Water Resources Research Center and let them try and help you. It can only benefit Virginia's waters.

For more information and a list of currently available publications, please contact:

Virginia Water Resources Research Center
Virginia Polytechnic Institute
and State University
617 North Main Street
Blacksburg, VA 24060-3397
(703) 961-5624

This Georgian brick house is the site of the Virginia Water Resources Research Center on the edge of the VPI campus in Blacksburg. Artwork by George Willis.

Publications on water quality:

Water News is published monthly by the Virginia Water Resources Research Center, VPI-SU, 617 Main St., Blacksburg, VA 240603397. Subscription is free within Virginia, $9 annually out-ofstate.

Safety on Tap — A Citizen's Drinking Water Handbook is available for $7.95 plus $1.75 postage and handling from the League of Women Voters, 1730 M St., NW, Washington, DC 20036.

Habitat Requirements for Chesapeake Bay Living Resources is available free of charge from the EPA Chesapeake Bay Program, 410 Severn Avenue, Annapolis, MD 21403. Phone (301) 266-6873.

Several excellent pamphlets are available free for single copies from the Water Pollution Control Federation, 601 Wythe Street, Alexandria, VA 22314-1994. Phone (703) 684-2438.

Household Hazardous Waste...What you should and shouldn't do.

Groundwater...Why you should care.

Clean water: A bargain at any cost.

Nature's Way...How wastewater treatment works for you.

Potomac Basin Reporter, a newsletter about the Potomac Basin published by the Interstate Commission on the Potomac River Basin, Suite 300, 6110 Executive Blvd., Rockville, MD 20852. Phone (301) 984-1908. Free upon request.

Some Graphic Effects of Water Pollution

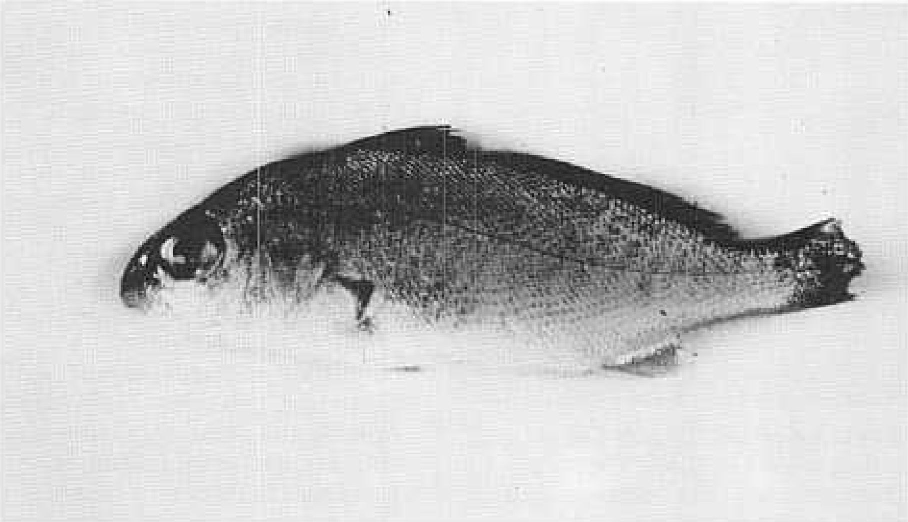
William J. Hargis is a Professor of Marine Science in the Chemistry and Toxicology Division of VIMS. "For years," Hargis says, "I wanted some way to graphically show people what water pollution was all about." Hargis found the graphic evidence when he returned to research after ten years as director of the Institute. In 1982 Hargis and a number of associates, including James Colvocoresses, Morris Roberts, and David Zwerner, began studying the effects of toxic wastes on finfish in the Elizabeth River.

One of their reports begins, "The Elizabeth River is Virginia's most heavily populated, industrialized and contaminated subestuary. Its sediments contain the residues of wastes discharged for several hundred years."

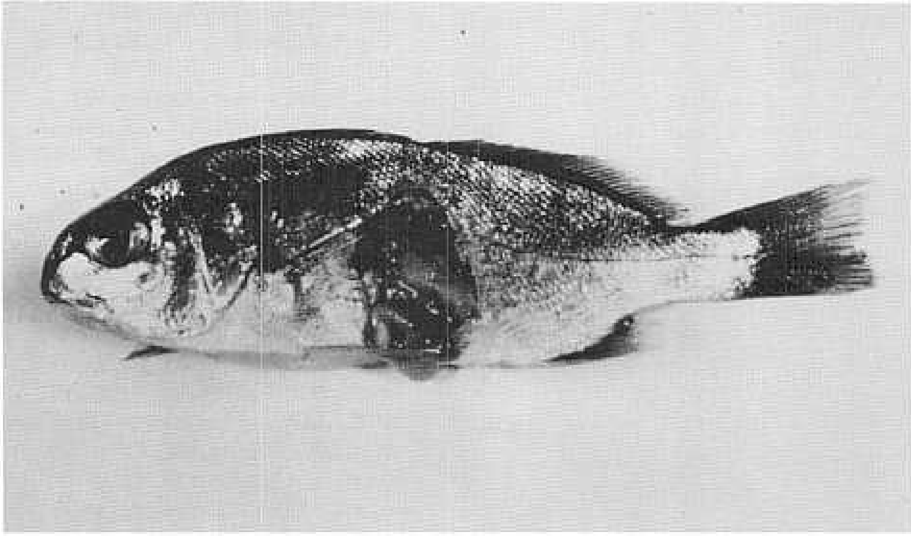
The scientists used a combination of field and laboratory studies to examine finfish in the Elizabeth. First, they collected finfish and examined them closely; in just one study, Hargis, Colvocoresses and other scientists, specialists and students examined 85,000 fish. What they found were fins eroded by toxics, skin lesions and cataracts. Internally, there were alterations in the pancreas and liver. In the lab, using only sediments from the Elizabeth in flow-through tanks and adding young spot from the Ware River, an uncontaminated subestuary off the York River, the scientists began seeing the duplication of conditions from fish collected in the Elizabeth. Spot were chosen for the experiments because they are a naturally occurring spring and summer migrant of the region, are bottom-feeders in close contact with sediments and are also adaptable to laboratory conditions.

Surprisingly, the acute toxicity of the contaminated sediments began affecting the fish almost immediately. "Spot experimentally exposed to contaminated sediments developed ulcerated lesions within eight days after exposure began and later severe fin and gill erosion; their hematocrits (cells which enable immune responses), were significantly reduced and no weight gain occurred; pancreatic and liver alterations were observed in some of the chemically stressed fish; control fish, exposed to York River sediments, exhibited no fin erosion or lesions. Control fish showed no hematocrit or growth reduction and dead fish were first observed in the contaminated-sediment tank after 8 days while no control fish died."

The Division of Chemistry and Toxicology is continuing with its laboratory experiments and field studies on the effects of contaminants on finfish and other marine animals through funding provided by the Commonwealth.



Spot *(L. xanthurus)* from contaminated-sediment tank with severe fin erosion. Only stumps remain of pectorals and caudal is almost gone.



Spot from contaminated-sediment tank with penetrating lesion on lower left side.

Water Surface Pollutants

Chris Plummer

Graduate student, Lino Gallo works in one of VIMS' Chemical Division labs. His samples take many hours to analyze.

Lino J. Gallo is a PhD candidate at VIMS who is establishing research criteria which will affect water pollution studies far into the future. Gallo is examining concentrations of pollutants in the critical sea surface micro-layer. This vital area, a layer of organic liquids usually from 60 to 100 microns thick, covers almost all natural bodies of water. (Approximately 25,000 microns equal one inch.) It contains microscopic plants and animals which provide food for larger fish and shellfish. It is a densely populated region where chemical and biological activities occur rapidly, fueled by direct sunlight.

According to Gallo, the micro-layer is more prominent in convergence zones, areas where water masses meet, such as the Gulf Stream moving through colder ocean waters or fresh water meeting saltwater in the York River. Where these convergence zones occur, foam lines and slicks accumulate pollutants such as polynuclear aromatic hydrocrabons (PAHs) and Tributyltin (TBT). To make matters worse, photo-oxidation from the effect of sunlight on these pollutants can chemically change them from nasty to deadly. Temperature, the presence of other chemicals, even the roughness or placidity of the water surface will determine how the chemicals react. Eventually, most of them will sink through the water column in combination with suspended solids and settle into the sediments.

A recent report from the VIMS Division of Chemistry and Toxicology states, "...it has long been known that finfish and invertebrates, exposed to chemically inhospitable environments, may develop readily observed lesions such as fin rot (finfish), skin ulceration or skin growths. Other disorders such as hyperaemia (congestion of blood in specific areas), emaciation, discolored or abnormally-textured gills, and eye disorders have also been associated with exposure to toxicants. Recently it has been found that cataracts (and other internal eye lesions) may be induced by exposure to contaminants in nature. In studies of the fishes exposed to the heavy burdens of sediment-associated toxicants in the Elizabeth River, all of these effects have been found. Further, responses have been observed in the bottom-dwelling organisms and in caged molluscs."

Gallo's interest in marine pollution increased when he worked in Bermuda during 1984 and 1985. The scientist cut across a coral skeleton from one of the reefs in the Caribbean and examined the yearly growth rings for concentrations of lead. The fifty year old sample provided a fascinating history of the use of fossil fuels. From 1930 until the Second World War, concentrations of lead were very low; then the amounts rose steadily until 1978 when there was a steep drop during the OPEC oil embaro. The rise was as steep as the decline after the embargo, but removal of lead from gasoline in 1980 brought the beginning of a continuous decline of lead concentrations in the coral.

The mouth of the York River in Virginia is the site of Gallo's present research. Using a sampler which took him nine months to build, he is examining the micro-layer of the river where it joins the Chesapeake Bay— a prime convergence zone.

The sampler is a stainless steel drum coated with teflon which has floats attached so that it will skim the surface. As the drum is pushed, rolling across the surface water, a teflon wiper, similar to a windshield wiper, brushes across the drum guiding the surface layer into collection containers. The problem is to collect a layer from an area so thin it cannot be seen. Gallo is primarily sampling for PAH and TBT concentrations. A single sample can take ten hours to analyze and every four hours the instruments must be recalibrated to assure accuracy. Although the research is not completed and not conclusive at this point, Gallo is seeing high concentrations of both pollutants in the convergence zone and in other areas.

In May, Gallo went back to Bermuda for an international conference on marine water pollution. He examined a more advanced sampling device which may enable him to measure an even thinner layer of the surface water. Gallo also had an opportunity to observe some of the large naturally occurring foam lines and slicks off the Island in the Sargasso Sea.

A graduate of the University of the Republic in Uruguay and Oregon State University, Gallo chose VIMS for his doctoral studies because of the reputation and work of the Chemistry and Toxicology Division and because he saw the Chesapeake Bay cleanup initiatives as an ideal arena for his research.

In addition to degrees in marine science and marine pollution, Gallo also has a Master's in marine resource management. He plans to put his combined education and research to work in the world-wide search for solutions to marine pollution. "This is not just a U.S. problem or a continental problem, but a world-wide problem of growing dimensions," Gallo says. "And the world must respond quickly if we are going to have enough uncontaminated water for use throughout the world."

"You know," he says, "About water and diamonds? Right now, there are very few diamonds and they are just a particularly beautiful, scarce commodity of very high cost. Water is the absolute necessity of life—nearly all life on earth depends on it, and yet it has seemed so plentiful that we place very little value on it. If we are not careful, clean water will be worth more than diamonds."

Physical Division Examines Water Quality

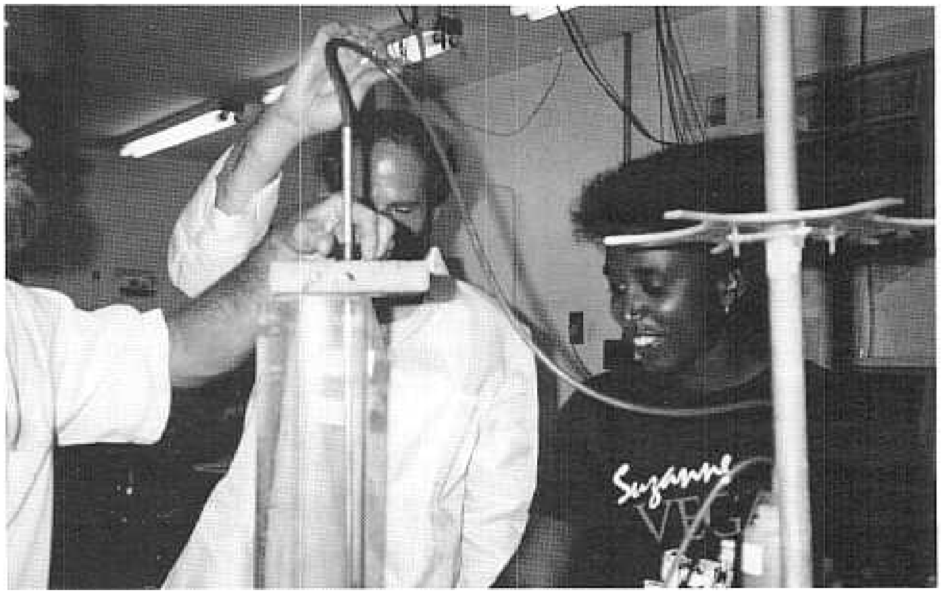
Can you raise edible shellfish in water that is clean enough for humans to swim in? "Not necessarily," says Bruce Neilson, Division Head and Assistant Director of Physical Oceanography and Ocean Engineering at VIMS. "The standards for maximum fecal coliform levels are much stricter for shellfish than they are for contact activities like swimming. As filter feeders, shellfish incorporate bacteria, pesticides, and heavy metals with the particulates they filter from the water column. The shellfish bioaccumulate these toxic substances in concentrations 3-5 times greater than they are present in the water. For this reason, stricter standards are required for shellfish."

Neilson and other members of the VIMS community are working with the SWCB to develop water quality standards that relate to nutrient enrichment. "With pesticides," states Neilson, "it is appropriate to pick absolute numbers as standards. However, nutrient enrichment is a more qualitative concept and involves a judgemental factor. It is not reasonable to simply label phytoplankton as 'good' or 'bad,' or to measure the health of the Bay in terms of overall pounds of fish produced." Examination of specific changes in the Bay's make-up must be made prior to judging which tactics should be undertaken to resolve the problems.

Two of Neilson's graduate students are working on different aspects of the water quality issue. Cheol Mo is synthesizing the literature relative to oysters and heavy metal uptake. He is postulating a mathematical model of likely mechanisms by which heavy metals are taken up by oysters from the water column and sediments, and how these metals affect the oysters.

Beverly Baker is examining sediment-water column nutrient exchange. Mathematical models have confirmed the importance of sediments in shallow water systems with regard to storing and releasing of nutrients such as nitrogen and phosphorus. Baker is looking at release rates of nutrients and the factors controlling them, trying to acquire some insight into the turnaround time of nutrients in sediments.

Long-term monitoring of the Bay's water quality through programs such as the Chesapeake Bay Monitoring Program (CBMP) is essential to the assessment and understanding of the changes that are occurring in the Bay waters. The system is dynamic and there are natural short- and long-term variations in the general overall condition of the Bay. The greatest challenge lies in distinguishing which are "natural" variations in the system and which are the result of man's impact.



Graduate student, Beverly Baker, (far right) works with senior scientists in the water quality testing lab.

Underwater Balance

At present, scientists are still studying the many effects of pollution and eutrophication on the plants and animals of the Chesapeake Bay and its tributaries. Researchers believe that increased turbidity from land-use has decreased the amount of light which can penetrate to the bottom-dwelling grasses. Also, increased phosophorus and nitrogen act as nutrients to the epiphytes, tiny plants which cover the eelgrass leaves, and thus prevent sunlight from reaching the leaves. As the water warms and the eelgrass begins its greatest growth period, the epiphytes increase in density. In a balanced environment, snails and other tiny animals would feed on the epiphytes preserving a balance between the "summer squatters" and the larger eelgrass. It may be that a combination of both increased sediment and nutrients have affected the eelgrass communities and other species of underwater marine plants.

Hilary Neckles is a PhD candidate at VIMS who believes that if nitrogen and phosphorus enrich the water too much, the epiphytes overwhelm their hosts, shutting out sunlight and carbon which the eelgrass leaves need for their own photosynthesis. "You realize how overwhelming the epiphytes can be when you understand that eelgrass grows new leaves every five to six days, sloughing off the old leaves and ridding itself of the epiphytes at the same time," says Neckles. "In order to kill the eelgrass, the epiphytes have to keep covering new leaves to the extent that sunlight will not penetrate to the eelgrass." Although many researchers believe that epiphytic fouling contributes to the decline of eelgrass, the causal relationship has rarely been experimentally demonstrated. In addition, Neckles' work represents the first effort to closely examine the interactive relationships in an eelgrass community.

To verify her thesis, Neckles set up twenty 30-gallon tanks for six weeks during each distinct growth period of eelgrass. Spring and fall are the fast-growing periods, summer and winter the slowest. In the tanks, she places eelgrass with their epiphytes and the animals which graze on the epiphytes from several locations in the York River. At the same time, she has already collected artificial eelgrass previously placed in the same locations which she has examined in order to quantify the number of epiphytes growing on the artificial leaves.

From the live eelgrass in her tanks, Neckles will examine the biomass accumulation per unit of surface, examine the photosynthetic capabilities of eelgrass under specific epiphyte loads and determine the amount of epiphyte removal accomplished by the grazers. The combined field and lab work will contribute both to an understanding of the integrated eelgrass community and to the effects of nutrient enrichment on the eelgrass.

When Neckles finishes her degree at VIMS, she plans to continue work in natural resource research. After completing undergraduate work at the University of Massachusetts, Neckles went to the University of Minnesota where she studied inland prairie marshes and worked with a wildlife center. She came to VIMS because "It is one of the few research centers in the country with a whole department devoted to wetlands and I also wanted the experience of working in the coastal environment."

(Top) Hilary Neckles and her major professor, Dick Wetzel, observe one of the eelgrass samples growing in tanks inside the VIMS' greenhouse.
(Bottom) Eelgrass is placed in flow-through tanks which simulate the York River environment. Snails will be added shortly to duplicate the eelgrass- epiphyte-snail balance that Neckles is studying.

How to Water Seafood

Donna Boone
Extension Specialist Seafood Utilization, VPI

Water is used for poaching, boiling and steaming seafood. Of these three moist heat methods of cooking, boiling is probably the least desirable for most seafoods. The action of boiling water causes the delicate structure of the seafood to break apart. When poaching the cooking liquid is at a simmering temperature and in steaming, the seafood is suspended over the liquid.

Firm-fleshed seafood such as salmon, trout or sole is usually best suited for poaching and steaming. In general, high-fat fish, such as mackerel and herring do not hold up well in moist-heat preparations because of their soft texture. However, cheesecloth or a fish poacher can help to keep more tender fish from falling apart. Even leaving the skin on the fish will help to hold the flesh together. Fillets, steaks or whole fish are suitable for poaching and steaming.

The liquid used for poaching can be water or a combination of water and wine, vinegar or milk. Various vegetables and spices can be added to further enhance the flavor of the fish. A court bouillon is usually some combination of water with wine, vinegar or milk and flavored with vegetables and herbs; whereas, a fumet is a fish stock made with water, wine and fish or fish trimmings and flavorful vegetables and herbs. Some of the common ingredients include onion, carrot, celery, lemon slices, bayleaf, thyme, parsley, fennel leaves, dill, garlic, leeks, salt and pepper. Red or white wine can be used in the quantity you prefer; however, a very high proportion of wine may be too strong for poaching a delicate fish such as flounder or turbot. When preparing a fumet, the stock is allowed to cook for 20-30 minutes before the fish is added to develop the flavor. Once the fish is poached, the fumet can be used to prepare a sauce.

Water is usually used for steaming. Some fresh herbs such as dill or fennel can be added to the water for just a hint of flavor in the fish. Slashes can also be made in the sides of the fish where sauce, herbs or thin slices of scallions and fresh ginger can be placed on the fish to allow flavors to penetrate into the fish during cooking.

Poached and steamed seafood can be eaten hot or cold. It is normally served hot with a sauce, and cold it makes a delightful salad.

Seafood should never be over cooked. It is especially important to keep this in mind with the moist heat cooking methods because flavor can be "washed" away in the poaching liquid or evaporated away in the steaming. Remember the Canadian cooking rule: 10 minutes per inch of thickness.

STEAMED BLACK SEA BASS

1-1 1/2 pound sea bass, drawn (cleaned but whole with head on)
4 slices ginger root, shredded
2 tablespoons black beans
1 teaspoon sherry or vodka
2 garlic cloves, smashed
1/4 cup peanut oil
1/4 cup chopped green onions for garnish

Make slashes in the flesh of the fish with a knife, cutting to the bone. Mix the ginger slices, black beans and sherry or vodka together in a small bowl, mashing the beans lightly with a spoon. Place some of the black bean mixture in each of the slashes on both sides of the fish. Place fish on aluminum foil or on a platter and steam about 20 minutes (just until done). Remove from steamer, keep warm, and quickly brown the garlic in oil. Pour the flavored oil over the fish, sprinkle with garnish and serve.

MORNAY SAUCE

Melt 3 tablespoons butter or margarine in a pan over low heat. Using a wire whip, stir in 2 tablespoons all-purpose flour and cook until bubbly. Remove from heat and gradually stir in 1 1/2 cups fumet and 1/2 cup whipping cream. Continue cooking, with stirring, until thickened; then stir in 3/4 cup shredded Gruyere or Swiss cheese and 1/4 cup grated Parmesan. Continue cooking over low heat just until cheese has melted. Makes 2 1/2 cups.

CUCUMBER-DILL SAUCE

1 large cucumber, peeled, seeded and finely chopped
1/3 cup sour cream
1/3 cup unflavored low-fat yogurt
2 tablespoons reduced-calorie or regular mayonnaise
1 1/2 teaspoons dried dill weed or 2 to 3 tablespoons finely chopped fresh dill
1/8 teaspoon salt
Dash freshly ground pepper
Dash hot pepper sauce

Combine all ingredients. Chill thoroughly, Serve chilled with hot to cold fish, either poached or steamed. Makes about 2 cups.

MUSTARD SAUCE

2 tablespoons dijon mustard
1 tablespoon white wine vinegar
Dash white pepper
Dash sugar
1/2 cup oil

In a food processor or blender, combine mustard, vinegar, pepper and sugar. With motor running, gradually add oil in thin stream; process until mixture is blended and slightly thickened. Serve at room temperature with steamed or baked fish. Makes about 3/4 cup.

NUTTY FISH SALAD

2 cups cooked, flaked fish
1 cup chopped celery
1/2 cup chopped onion
1/2 cup sweet pickle relish
1/2 cup chopped black walnuts
1/2 cup mayonnaise or salad dressing
1 tablespoon lemon juice
1/2 teaspoon salt

Combine fish, celery, onion, pickle and walnuts. Mix together mayonnaise, lemon juice and salt. Add dressing to fish mixture. Toss lightly and chill. Serve on lettuce, with crackers, or in a wedged tomato. **Note**: Fish may be cooked by poaching or steaming. Left over baked or broiled fish may also be used.

Marine Notes

Flounder Fishermen Reap Double Rewards

Joe Desfosse prepares to demonstrate flounder tagging onboard the F/V Anthony Anne for local media photographers.

A summer flounder tagging program was initiated in September of 1986 to help scientists at VIMS determine the stock composition of inshore populations; to assess the seasonal migratory patterns; and if different stock are present, to estimate the relative contribution of each stock to the total landings. These findings are made available to the Middle Atlantic Fisheries Council to aid the council's recommendations for the Fisheries Management Plan. The project is supported with federal funds under the Wallop-Breaux Program through the Virginia Marine Resources Commission.

On May 16, onboard the F/V *Anthony Anne* captained by Anthony Penello, returned tags were pulled from a basket and awards ranging from $50 to $500 were awarded to conscientious fishermen who returned the tags to the research facility. Mr. Robert Hutchinson, Outdoor writer for the Virginian-Pilot, selected the tag which earned the F/V *Charles D. Smith* $500.

Over 5,107 tags were attached to flounder last year. Approximately 200 tags were returned. This year's tagging is already underway aboard the F/V *Anthony Anne*, directed by Jack Musick, Dean Estes and Joe Desfosse.

U.S. House Passes Plastics Bill

Legislation to prohibit U.S. ships from dumping plastic debris in any ocean and any ship from dumping plastic in waters of the United States was approved overwhelmingly in October by the House of Representatives.

The indiscriminate ocean dumping of an estimated 45,000 tons of plastics each year kills one million seabirds and over 100,000 marine mammals. Because most plastic trash is lightweight and degrades slowly, it floats at or near the surface and can remain a threat to marine life for decades.

The bill imposes fines of up to $25,000 for violations of the ban. U.S. public vessels will have at least five years to comply with the bill's requirements.

The Fish Boat, January 1988.

Victory Center Highlights Shipwrecks

A group of 200-year-old shipwrecks, a legacy of the 1781 Revolutionary War battle at Yorktown, is the subject of a new exhibition planned for the Yorktown Victory Center.

"Yorktown's Sunken Fleet" will open June 1 in conjunction with publication of a 20-page article in the June issue of National Geographic about archaeological excavations of the wrecks which rest on the floor of the York River. The exhibition and the article will focus on a British merchant ship which has been extensively excavated over the past five years.

The National Geographic article was authored by John D. Broadwater, senior underwater archaeologist with the Historic Landmarks Division of the State Department of Conservation and Historic Resources, and director of the Yorktown Shipwreck Archaeological Project.

"Yorktown's Sunken Fleet" will review the history of efforts to gain information about the sunken ships and will display many artifacts which have been recovered and preserved. The ships were lost during the siege of Yorktown in the fall of 1781. The majority were British supply ships sunk intentionally to prevent their capture and to form a defensive barrier along the Yorktown Beach.

The Yorktown Victory Center, a museum of the American Revolution, is located on State Route 238 in Yorktown. For further information, call (804) 887-1776; or write P. O. Drawer JF, Williamsburg, VA 23187.

Hampton Roads Sanitation District Receives National Awards

The Atlantic Wastewater Treatment Plant in Virginia Beach was cited by the EPA as the best large secondary treatment plant in the nation in 1987 by the Water Pollution Control Federation. The plant treats 36 million gallons per day of wastewater and serves portions of Virginia Beach and Chesapeake. The Williamsburg Wastewater Treatment Plant was cited as the best medium-sized secondary treatment plant in EPA region III. This plant treats 10 million gallons per day and serves Williamsburg and James City County. The federal agency cited the plants for excellence in operation and maintenance. From: Water News, Vol. 19, No. 1, January 1988.

Offshore Mining Report Available

The Virginia Division of Mineral Resources and the Virginia Institute of Marine Science have just published a completed report on the "Reconnaissance of Economic Heavy Minerals of the Virginia Inner Continental Shelf."

This 74 page report written by C.R. Berquist, Jr. and C.H. Hobbs III describes the potential economic occurrences of heavy minerals off Virginia's coastline. The report is available as Open-File Report 88-1 from the Virginia Department of Mines, Minerals and Energy's Division of Mineral Resources. For additional information contact Information Services (804) 293-5121.

Bay Team Concludes Third Successful Year

Nancy J. Chartier

Bill Douglas, Bay Team Teacher, works with students at Botetourt Elementary School in Gloucester to increase their appreciation of Virginia's marine resources.

Book Review

The Natural History of Whales and Dolphins

Peter G. H. Evans, 1987
Facts on File, Inc., New York, 343 pp.

Marine mammals, particularly whales, dolphins, and porpoises, have intrigued the human imagination since the beginning of recorded history. There are many reasons for this fascination with cetaceans, ranging from the incredible size attained by the largest animal which has ever lived on earth, the blue whale, to historical accounts of wild dolphins' interactions with humans; however, it has been only in recent years that man has begun to approach the mystery of whales' lives underwater. Traditionally, our knowledge of cetaceans has come from the studies of scientists aboard whaling vessels. With the depletion of whale stocks and the subsequent demise of the fishery for them, stranded and beached cetaceans have assumed an increased importance in our quest for knowledge of cetacean biology. The advent of oceanaria holding captive dolphins has provided a wealth of information on marine mammal husbandry, medicine, captive social behavior, cognition, and general biology. Advanced methods of underwater observation, including SCUBA and hydroacoustics, have recently enabled researchers to study these fascinating creatures in their natural underwater habitat.

Peter G. H. Evans has produced the most complete account to date of the state of current knowledge of cetacean biology. Written with the informed lay reader in mind, the book is quite thorough, yet not overly technical. Because there still exists a great amount of controversy on the subjects of cetacean evolution, cognition, and behavior, the author is careful to present all sides of the arguments while only occasionally making his personal opinions known. This approach leads to a well balanced discussion and allows the reader to understand some of the problems encountered in studying these often elusive creatures. Although the referencing is not consistent from chapter to chapter, most of the current literature appears in the extensive bibliography and the book is reasonably well indexed. One serious error was noted on page 123. The author states "In the sperm whale there are no functional teeth in the lower jaw . . ." but it is suspected he meant to write that there are no functional teeth in the upper jaw of the sperm whale. Although this may seem a minor point, an introduction to cetacean natural history should not contain so obvious and misleading an error. Aside from this, and once one becomes accustomed to the British spelling which is used throughout, the book provides an enjoyable and informative introduction to cetacean biology for the scientist and non-scientist alike.

Reviewed by Robert A. Blaylock

Cover photo:
VIMS' scientist Kevin Curling and Tim Shannon prepare to cast STD probe from the R/V *Ulysses*.
(Photo by Nancy J. Chartier)

Summer issue:
Sea Grant Advisory Services

Sea Grant Communications
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

Address correction requested

BULK RATE
U.S. POSTAGE
PAID
ROANOKE, VA
PERMIT #192