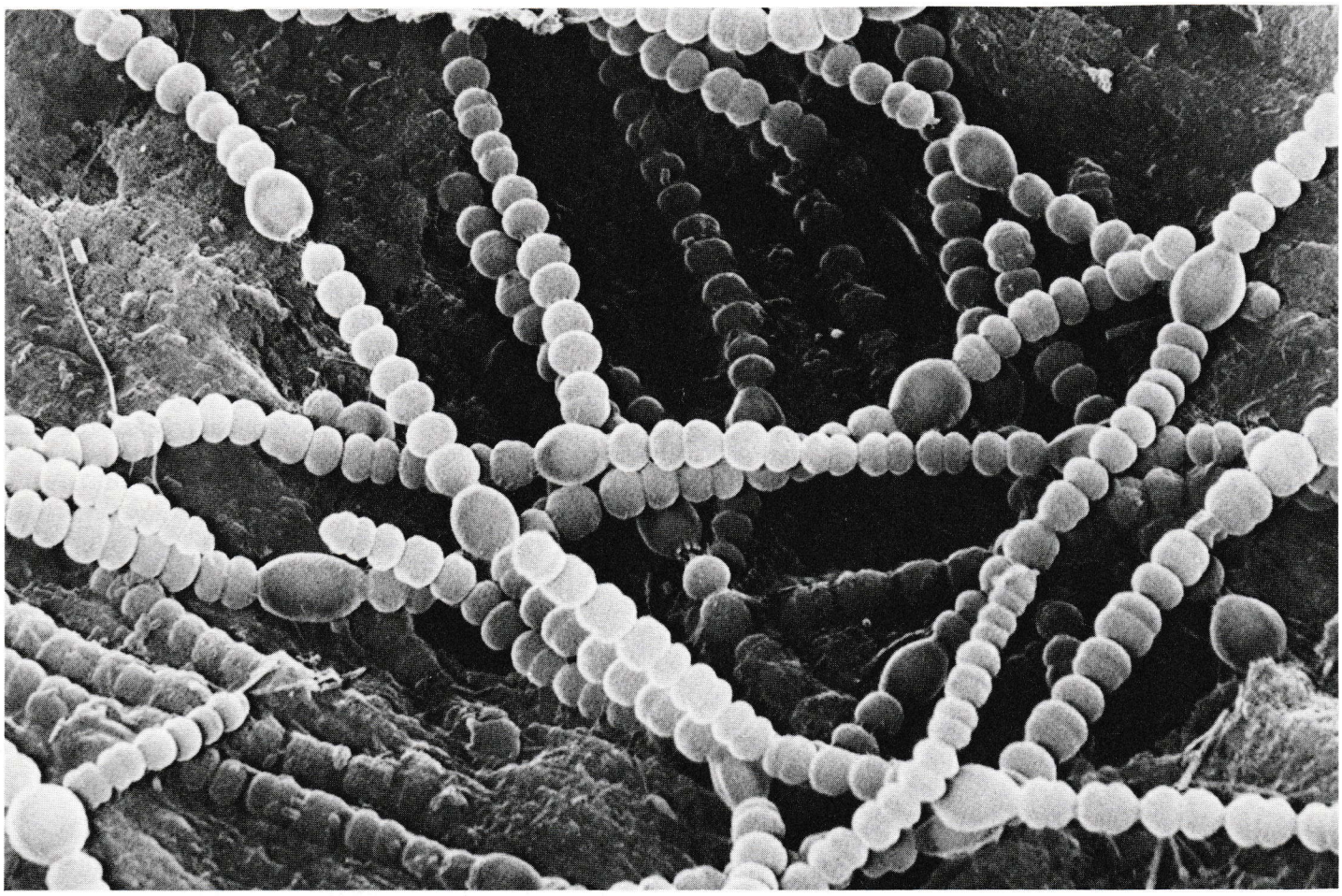
UNC Sea Grant October, 1983

COASTWATCH



An electron micrograph of nuisance blue-green algae

A bloom of algae

coated the Neuse River from Kinston to New Bern this summer. Residents along the river are learning to dread the smell of the algal slime. Boaters don't like the green wake behind their boats. Swimmers and water-skiers don't like the green scum on their bathing suits.

Those are the obvious effects. But the concerns go beyond the aesthetic, beyond the recreational, beyond the fresh water. The blooms are affecting the biological makeup of the river, and may ultimately affect what goes on downstream in the estuary—the estuaries that support our fisheries.

Solutions? Some are on the way. But at least one, a proposed ban on phosphate detergents, may be unpopular with some.

Inside, the causes, the impacts and the politics of the blue-green algal blooms on the Neuse River.

Looking for answers in a bloom

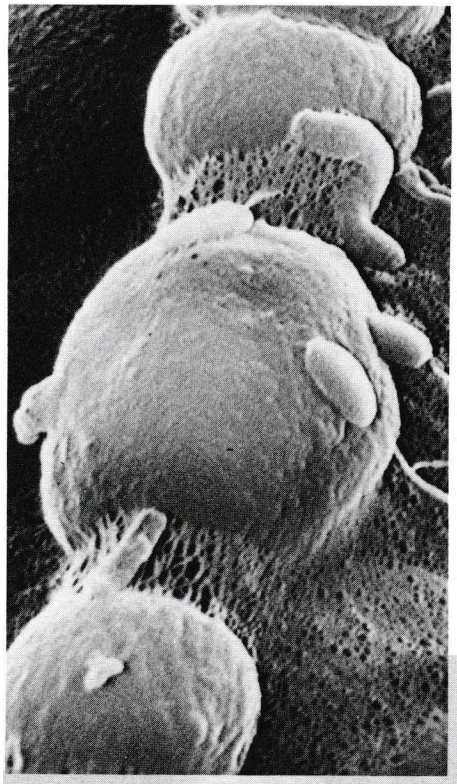


Photo by Neil Caudle

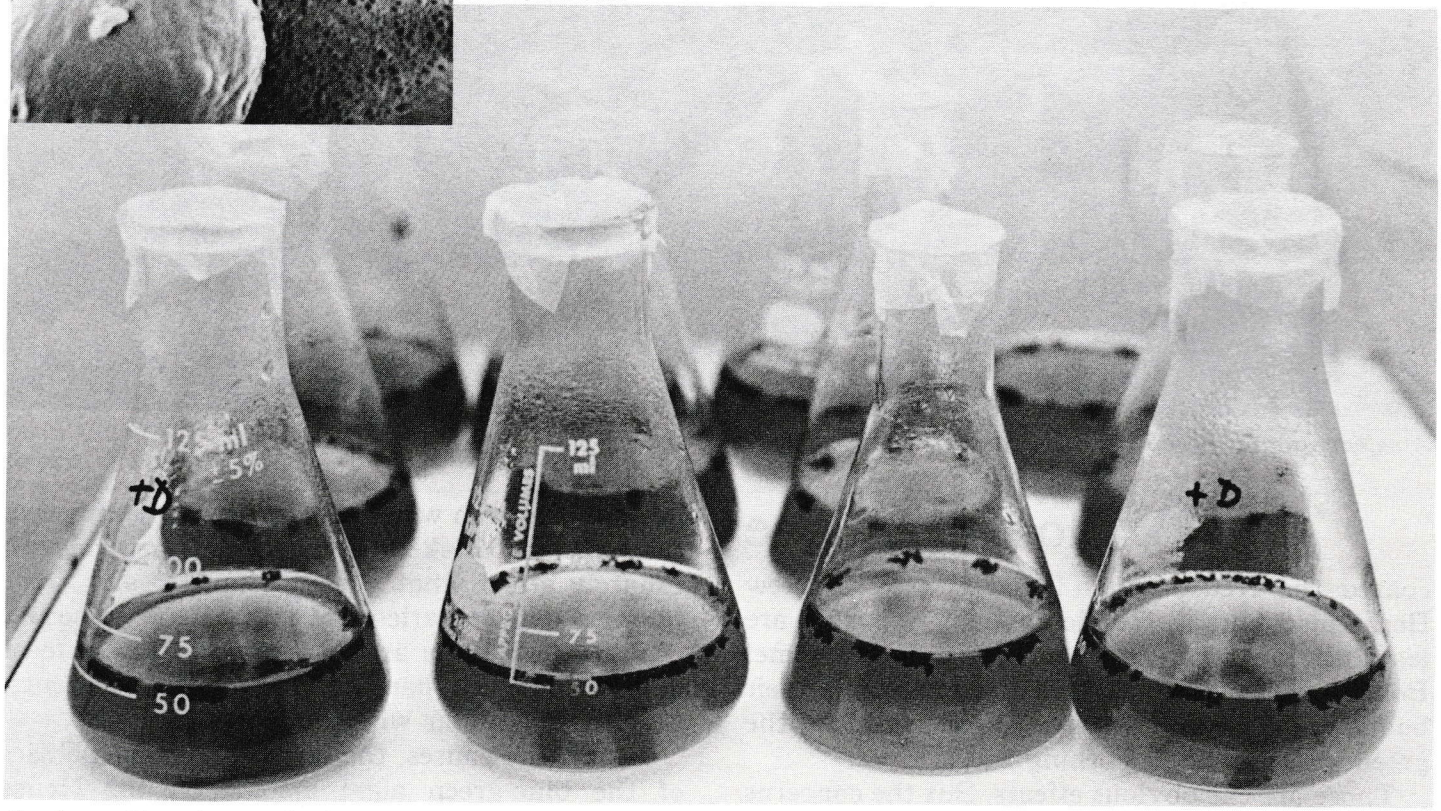
All the conditions were right. Warm water—above 70 degrees Fahrenheit. Long, sunny days. A stratified water column with low river flow and calm wind. And, most important, plenty of nutrients.

The river was ripe for a bloom. The blue-green algal cells multiplied rapidly by division. The organisms gathered, rose to the surface and formed colonies. Soon the scum floated in big patches. The nuisance algae were taking over, and it would be months before the bloom's demise. And, even then, its effects would linger long after.

Sea Grant researchers Hans Paerl, Donald Stanley and Robert Christian have been studying the blue-green algal problem on the Neuse River. And, they all agree. Underneath all that scum, even more drastic changes may be occurring—changes that may alter the chemical and biological make-up of the river.

Scientists attribute the blooms to the excess of nutrients being pumped into the river from upstream. (See story, page 4). Paerl has found that factors such as oxygen, salinity levels, temperature and sunlight affect the production and survival of blue-green algae. The difference between a bloom year and a non-bloom year is usually attributed to hydrological or climatic conditions, he says. Last year, for example, there wasn't a bloom on the Neuse because of the high river flow.

Other algae, some of which are desirable food sources for other organisms, fare badly when the blue-greens begin to take over. A blue-green



Surface slime layer of blue-green algae and bacteria (top); Paerl's cultured algae stored in a refrigerator

"You find quite a different food chain than the one that's normally present."—Hans Paerl

algal bloom excludes 95 percent of all the other algae in the water. That could mean bad news for the food chain. Paerl has found that blue-green algae are not a desirable food source and that the blooms are probably altering the food chain.

Zooplankton, a major food source for many fish and shellfish, feed on phytoplankton, the base of the food chain. But as soon as the blue-greens begin to take over, the zooplankters disappear from the water column. It may be that the blooms form particles too large for the zooplankton to eat or that the algae are toxic to the zooplankton.

Whatever the case, Paerl says the food chain undergoes major changes under bloom conditions. "You find quite a different food chain than the one that's normally present," he says. "Our experiments indicate there's not efficient transfer of this material into the food chain."

Since the larger zooplankton won't eat the algae, smaller organisms must consume the green scum. The smaller organisms may not be desirable food sources for fish in the food chain, says Paerl.

It also could mean a change in the fish community from plankton-feeders to bottom-dwellers. Paerl says, for example, catfish may survive the blooms on the Chowan while the striped bass population could suffer.

Paerl says there's such a supply of nutrients constantly being recycled in the Neuse that, when conditions are right, a bloom can flourish for months without using up the supply.

Usually, it's a change in the weather or in the salinity of the water that kills a bloom. Paerl says blue-green algae can't tolerate even low levels of salinity. He's found that as river flow slows, the fresh water moves toward the salt water in the estuary at a slower rate. At the same time, the heavier salt water moves along the bottom in a "wedge," until it eventually mixes with the rest of the water column. When the salt wedge meets the bloom, the algae die and sink down the water column.

Once the algae are dead, the troubles are only just beginning, says Paerl. The oxygen demand from the decomposition process lowers the oxygen level in the water. This year, when the salt wedge moved into the bloom area, the oxygen level went from five milligrams per liter to less than one milligram per liter in one week—a drastic change, says Paerl. According to the state water quality standards, five milligrams per liter are necessary to support a variety of fish life.

Although there were no big fish kills on the Neuse as a result of that bloom, biologists say low oxygen levels often cause kills.

Stanley and Christian have found that the blooms upriver may cause even more changes in the estuary. After the bloom dies, its breakdown products are probably swept downstream into the estuary, says Christian. There they may decompose or settle to the bottom and become part of the sediments.

Stanley and Christian say that all that dead algae affect the nitrogen-cycling, or where the nitrogen atoms are going in the water, in the lower Neuse and in the estuary.

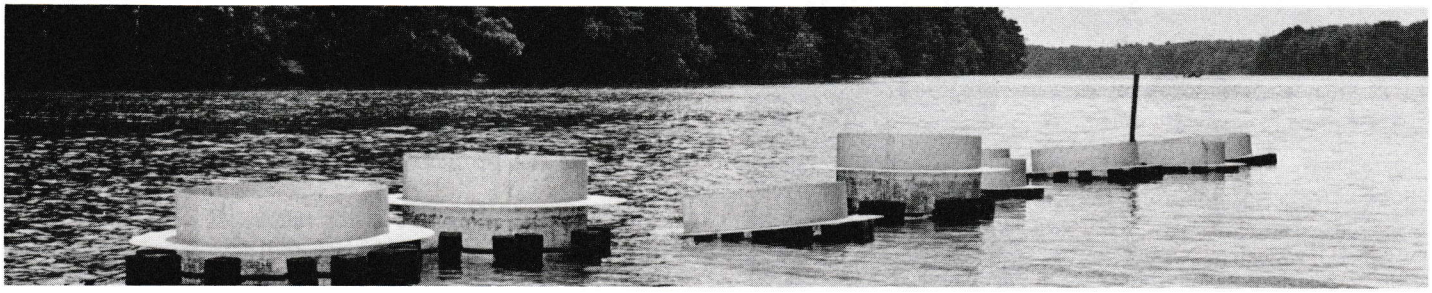
Under non-bloom conditions, there is a lot of inorganic nitrogen available in the estuary. But Stanley and Christian have found that, under bloom conditions, the algae use up that inorganic nitrogen and release organic nitrogen. That could mean that organisms that use inorganic nitrogen in the estuary may not be finding all they need.

One of the problems in studying an algal bloom is that the bloom lasts only a few months. Researchers are forced to take as many samples as possible during the bloom and retreat to the laboratory during the winter months to find answers to their questions.

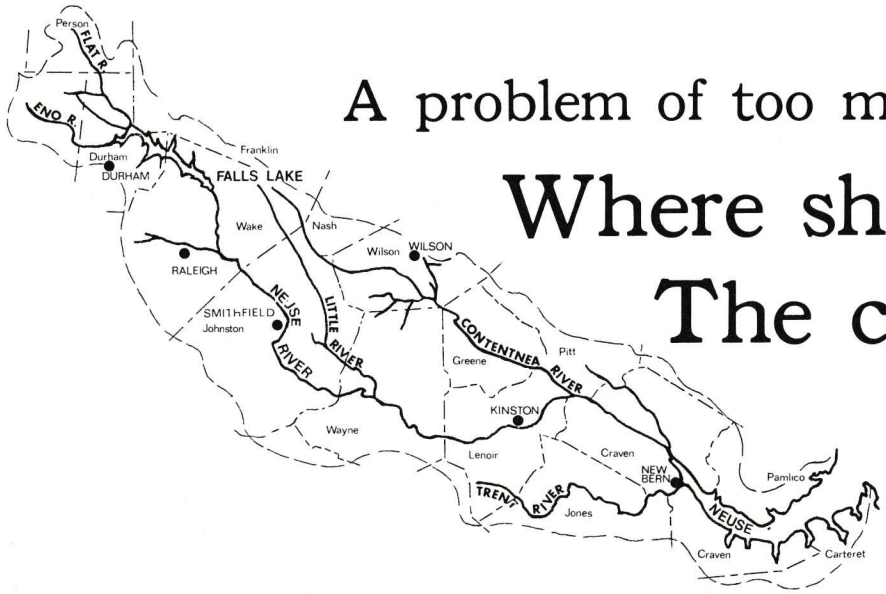
Stanley and Christian have freezers full of blue-green algae they've collected from this year's bloom. By the time the next bloom is choking the Neuse, they may be able to answer questions like, where the algae go when they die, how the algae release nutrients in the decomposition process, and what effects the algae from upstream will have on the estuary.

—Nancy Davis

Photo by Nancy Davis



Paerl uses hydrocorrals like these to trace the fate of algal blooms



A problem of too many nutrients:

Where should The cleanup begin?

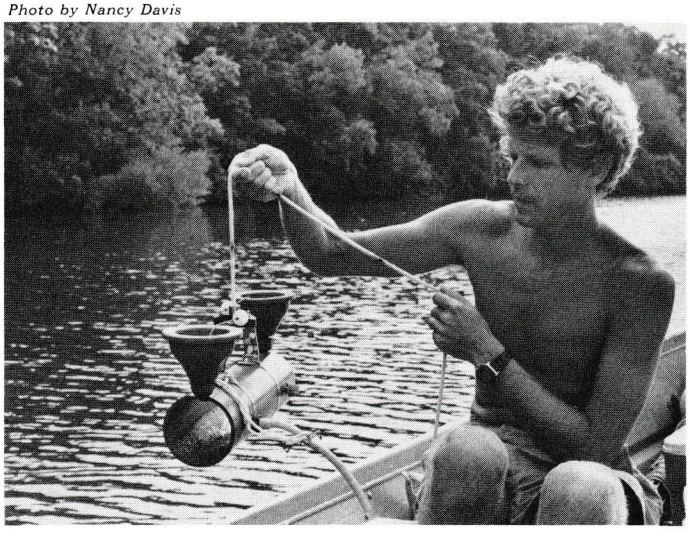
From its headwaters near Hillsborough to its base in the Pamlico Sound, the Neuse River is a body of troubled water.

As the Neuse winds along its 220-mile course, 34 major municipal or industrial treatment plants discharge nutrient-rich effluent into its watershed. Urban run-off from the likes of Durham, Raleigh, Wilson, Smithfield, Kinston and Goldsboro wash more nutrients into the river. And the Neuse acts as a drainage basin for 1.1 million acres of prime farmland regularly dosed with fertilizer.

All of this run-off, effluent and drainage adds up to a river chocked full of nutrients, particularly nitrogen and phosphorus. And combined with the right weather conditions (see page 2), these nutrients can cause the river to blossom a malodorous scum of nuisance blue-green algae.

This summer a bloom coated the Neuse from Kinston to New Bern. Blooms developed as far upstream as Goldsboro. And state environmental officials warned that the newly completed Falls Lake Reservoir along the upper Neuse, slated to become Raleigh's sole source of drinking water by 1985, would face problems from algal blooms unless preventive steps were taken soon. And if the Falls Lake blooms, Raleigh residents are likely to taste the effects of the algae in their drinking water, scientists say.

Photo by Nancy Davis



Paerl sampling the waters of the Neuse

State officials, scientists and citizens are worried that the Neuse will follow in the footsteps of the Chowan River in northeastern North Carolina. Green mats of algae clogged the Chowan from Tunis to Edenhouse this summer, one of the most extensive blooms to plague the river.

The state issues an "algal index" for the Chowan, which rates the river from zero to 10 based on the size of the algal blooms. The higher the rating, the more algae present and the greater the interference with swimming, boating, fishing and wildlife. During late summer, the Chowan was rated at 8.5.

But the state Environmental Management Commission (EMC) has already classified the Chowan as "nutrient sensitive," a designation which allows the commission to place stringent controls on point-source discharge of effluent. Most of the sewage treatment plants along the Chowan will convert to land-application systems by 1986, to comply with an EMC ruling that limits phosphorus input to 1 milligram per liter. Most sewage treatment facilities found it cheaper to convert to land-application systems than to install chemical treatment equipment.

But not all of the Chowan's problems originate at North Carolina sewage treatment plants. Much of the river's basin lies in Virginia.

"If we can get agriculture and Virginia to do their part, we expect things to improve on the Chowan in the next five years," says George Everett, an environmental scientist for the water quality section of the state Division of Environmental Management (DEM).

The state's experience with the Chowan has prepared it for the eutrophication (rich in dissolved nutrients) problems now cropping up along the Neuse. Officials say they hope to slow the nutrient input along the Neuse before the problem reaches the magnitude of the problem on the Chowan.

But the state must be prepared to act quickly on the Neuse, Everett says. "We waited until things were bad on the Chowan before we acted," he says. "We can't wait that long on the Neuse. During our first five years of studying the Neuse, the problem has accelerated faster than we expected."

But Everett says the state needs to know how much nutrient reduction is needed before it starts imposing costly clean-up measures. "We're looking to Hans Paerl (Sea Grant researcher at the UNC Institute of Marine Science)

A Phosphate Ban?

Some state officials believe a ban on phosphate detergents would be a beneficial first step toward lessening phosphorus levels in the Neuse and other state rivers. But the Soap and Detergent Association disagrees, saying phosphate reductions would be insignificant (about 11 percent in the upper Neuse).

George Everett of the Division of Environmental Management says the proposed ban alone may not be enough to solve the problem of algal blooms. But the ban used in conjunction with measures to control agricultural and urban run-off, might be enough to keep the state from imposing strict nutrient limitations, he says.

Besides disagreeing over the need for a ban, the groups are also at odds over the cleaning power of non-phosphate detergents. Bob Singer, vice-president for the New York-based association, says non-phosphate detergents require more hot water and laundry additives to do the same job. He says non-phosphate detergents also cause more wear on washing machines and clothes because the cleaning substitute, sodium carbonate, combines with minerals in the water to form limestone deposits that accumulate on fabrics and in machines.

But state officials say precipitation won't be a problem in soft-water areas (87 percent of North Carolina's water supply is classified as soft). And in hard-water areas, use of a liquid non-phosphate detergent will prevent problems with precipitation.

Association spokesmen maintain the ban would cost the average person $9 per year in extra hot water, additives and wear, while chemical removal at the waste treatment plant would cost $8 per person. State officials say there would be little or no extra cost if the ban were imposed. The costs associated with wear could be eliminated with use of liquids and, officials say, non-phosphates are generally cheaper.

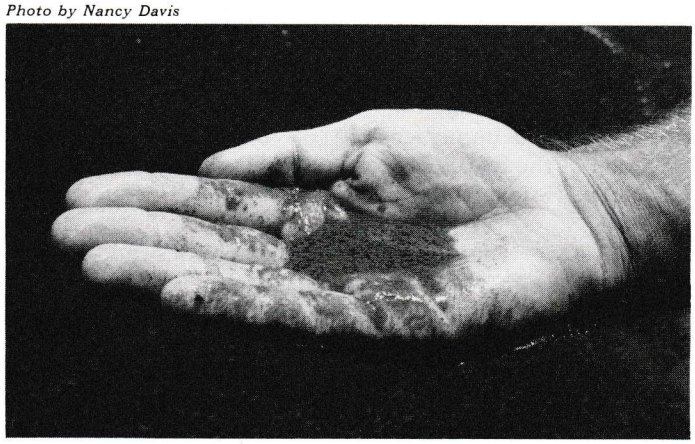
Jamie King, president of the Neuse River Foundation, an organization dedicated to upholding environmental quality in the Neuse River basin, says his organization is in favor of the ban.

for some answers," he says. "We're hoping Hans can tell us just how far we need to cut back."

Paerl says he is waiting on test results from this summer's bloom before making any statements about nutrient loads. But he says, "We're not talking about small excesses. We're talking a thirty to fifty percent excess of nutrients in the Neuse system. And it's probably been like this for the last fifteen to twenty years.

"The Neuse flows through one of the most populated areas of the state and one of the most highly developed agricultural areas. And every year there are more farmers, more people flushing their toilets and more industries. We shouldn't be so surprised we're suddenly having blooms.

Photo by Nancy Davis



The bloom forms a scum that coats the surface

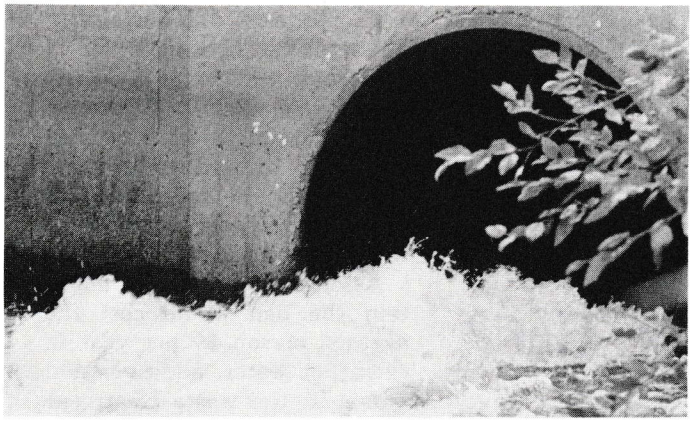
Everett says the DEM began monitoring the Neuse in 1978. Scientists studied nutrient levels, chlorophyll *a* levels, biomass of algae, algal species present and water parameters. They examined land-use in the basin and began analyzing the nutrient content of major point-source dischargers. Here are some of the things they learned:

- Average summer levels of chlorophyll *a*, an indicator of algal biomass, for the Neuse at New Bern have doubled since the early 1970s. The state water-quality standard is 40 micrograms of chlorophyll *a* per liter. This summer in bloom areas, levels were as high as 300 to 500 micrograms per liter in the water column and 1,700 micrograms per liter near the water's surface.
- Harvested cropland in the Neuse River basin increased approximately 30 percent from 1967 to 1980. A DEM report released this year indicated that agriculture contributed 40 percent of the nutrient nitrogen and 25 percent of the phosphorus released into the river.
- Census figures indicate that the urban population using centralized sewage treatment facilities increased by 29 percent between 1970 and 1980. The DEM report showed that 17 percent of the nitrogen and 42 percent of the phosphorus are discharged from municipal waste treatment plants.
- Forest and wetlands account for 20 percent of the nitrogen input and slightly less than 10 percent of the phosphorus input.
- Industry contributed four percent of the nitrogen and three percent of the phosphorus.

Continued on next page

• Six municipal dischargers (Durham-Northside, Raleigh, Wilson, Goldsboro, Kinston-Peachtree and New Bern) account for 95 percent of the estimated municipal phosphorus inputs and 81 percent of the municipal nitrogen inputs.

Photo by Kathy Hart



Treated effluent flows from a waste treatment plant

The 1983 General Assembly established a 10-member legislative committee that will continue to study the Neuse's problems. The legislative commission, with the technical assistance of state Department of Natural Resources and Community Development (NRCD) personnel, will prepare a Neuse River Action Plan by June 1, 1984, and a report for legislative action by February 1, 1985. Finally, it will produce a Neuse River Basin Water Quality Management Plan by May 1, 1986.

But some steps are already being taken to lower nutrient inputs into the river. The EMC will decide at its October 13 meeting whether to designate the upper Neuse, the portion of the river above the Falls Lake Reservoir, as nutrient-sensitive. Indications are that the commission will vote to apply the designation.

David H. Howells, a member of the EMC, says the commission chose to begin with the upper Neuse because proposed development around the Falls of the Neuse Lake was likely to increase nutrient input from urban run-off. The intended use of the lake for recreation and as Raleigh's water supply could be questionable if the lake became eutrophic.

Residents in the lower Neuse, who must live with the blooms, have long claimed that much of the problem originates upstream. Municipal waste treatment plants in the upper Neuse supply eight percent of the phosphorus released into the river, while the middle Neuse (from the Falls Reservoir to New Bern) releases 30.7 percent of the phosphorus.

DEM Director Robert H. Helms voiced the need at the EMC's August meeting for the entire Neuse basin to be classified as nutrient-sensitive. The commission endorsed the concept, but took no action to impose restrictions.

If municipalities are required to limit the nutrient input from their waste treatment plants, the costs will likely be passed on to the citizens, state officials say. "Right now there are no funds available at the federal or state level to aid the cities and counties with nutrient removal," says Lee Flemming, director of DEM's water quality section.

Nutrient removal at point source locations will be aimed at removing phosphorus, which is easier and less costly to remove than nitrogen. And the majority of the phosphorus (as shown earlier) is discharged by known point sources which must abide by EMC decisions. Nitrogen, on the other hand, comes largely from non-point sources—agriculture, forestry, wetlands—areas beyond the control of the EMC.

One alternative to point source removal considered by state officials would be a ban on phosphate detergents and soaps (see inset, page 5). The EMC has recommended that the legislature enact a phosphate ban for 66 North Carolina counties. Six other states have enacted phosphate bans (one rescinded its ban).

While state officials are focusing on the point source removal of phosphorus inputs, they are also looking to agriculture and forestry for help in removing nitrogen. Since the EMC has no control over agricultural practices, nutrient limitations by farmers would be voluntary.

Maurice Cook, director of the state Division of Soil and Water Conservation, says implementation of "best management practices" (BMP) could go a long way toward reducing nitrogen input from farming (nitrogen comes largely from fertilizer). Best management practices include the implementation of conservation tillage, contour farming, filter strips, grass waterways, terraces, reduced fertilizer application rates and proper timing of fertilizer application.

"The main thrust of BMPs is to keep soil in the field," Cook says. "But reducing erosion also keeps the nutrients in the field and out of the rivers." Cook says his division, along with the N.C. Agriculture Extension Service, is trying to educate the farmer in better use of BMPs.

Farm runoff carries heavy doses of nitrogen

According to Cook, the state is trying to initiate a cost-sharing program that would provide an economic incentive for farmers to implement BMPs. But Richard Barber, a member of the EMC, says the rising cost of fertilizer may be an incentive for using best management practices and less fertilizer.

The state would like for municipalities and county governments to take the lead in nutrient clean-up, Flemming says. But city and county officials from counties surrounding the upper Neuse told NRCD Secretary Joseph W. Grimsley in an August meeting that the state must be the enforcer in this problem. Only the state could ensure adequate, uniform controls, they told Grimsley.

—Kathy Hart

THE BACK PAGE

"The Back Page" is an update on Sea Grant activities—on research, marine education and advisory services. It's also a good place to find out about meetings, workshops and new publications. For more information on any of the projects described, contact the Sea Grant offices in Raleigh (919/737-2454).

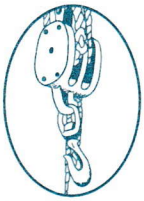
A fishing method — handed down from the Stone Age — is still putting fish on the table today. The method? Spearing. Today fishermen spear or gig flounder during the fall.

But unlike Stone Age men, fishermen today stalk their prey at night, using lights they can immerse under water. Fishermen gig flounder along the shallow edges of sounds, bays and creeks. Or, they work the beach, between the surf line and tide line. They use immersible lights to reveal the shadowy outline of a flounder hiding in the sand. The fisherman spots his prey and spears it.

Larry Giardina, the Sea Grant marine advisory agent at Bogue Banks, says it's important to spear the fish just behind the gills to save as much meat as possible. Once caught, the flounder are pushed up the metal gig and threaded onto a stringer. By placing the fish on the stringer and trailing them along in the surf, the fish can be kept alive during fishing.

The best times for gigging are one-and-a-half hours before and after low tide on a moonless night. For surf-gigging, choose a calm night when waves are less than one foot.

For more information about gigging flounder, contact the marine advisory agent nearest you. (Jim Bahen, Marine Resources Center/Ft. Fisher, 458-5498; Bob Hines or Larry Giardina, Marine Resources Center/Bogue Banks, 247-4007; Wayne Wescott or Rich Novak, Marine Resources Center/Roanoke Island, 473-3937.)



UNC Sea Grant and the South Carolina Sea Grant Consortium are sponsoring a longlining conference Nov. 2 at the Blockade Runner Motor Hotel in Wrightsville Beach, N.C.

The program, geared toward fishermen interested in longlining for snapper and grouper, will include sessions on the reef and bottom-fish resources, gear and fishing methods, and the economics of converting to longlining. Discussions will also include information on longlining for shark and the marketing of shark.

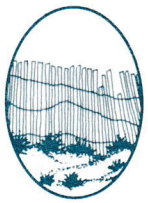
The day-long conference is sponsored in cooperation with the National Marine Fisheries Service's Beaufort Lab, the N.C. Division of Marine Fisheries, the N.C. Fisheries Association, the South Atlantic Fishery Management Council, and the S.C. Wildlife and Marine Resources Department.

To register, send $7.50 (before October 19) or $10 (after October 19) to Jim Murray, UNC Sea Grant, 105 1911 Building, North Carolina State University, Raleigh, N.C. 27650. For more information, call (919) 737-2454.

Jim Murray, director of Sea Grant's Marine Advisory Service, and Jeff Johnson, of the Institute for Coastal and Marine Resources at East Carolina University, have received a grant from the National Marine Fisheries Service's Southeast Regional Office to develop a program to increase the demand for underutilized species among marine recreational fishermen.

The National Marine Fisheries Service estimates that over 30 percent of the total poundage of finfish harvested for food is caught by recreational fishermen. Often these fishermen seek the same species of fish as commercial fishermen, while other, under-used species go unharvested.

In the first year of the study, Murray and Johnson will be developing a program to educate the public about the merits of underutilized species in the waters from Texas to North Carolina. They hope they can make species such as sea catfishes, dogfish and toadfish as sought-after as striped bass, bluefish and flounder.



If you're thinking of selling some coastal property and you're concerned about how the land will be used, there's something you can do about it. Walter Clark, Sea Grant's coastal law specialist, says that property owners can protect the aesthetic and environmental qualities of their land by using several non-regulatory devices that will impose limitations on the future use of the land.

Suppose a coastal developer owns a large tract of land that includes a maritime forest—a forest that he'd like to protect. Clark says the developer, in subdividing his property, might include restrictive covenants in each of the deeds to protect the forest.

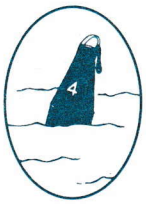
Clark says that towns and counties also have other options, such as conservation easements, to protect the future use of property. For more information, write Clark at 105 1911 Building, North Carolina State University, Raleigh, N.C. 27650 or call (919) 737-2454.

Is the estuary's role as a nursery more important than its role as an outlet for water drained from agricultural fields? Resource managers can only vaguely estimate the answer.

But John Miller, a zoologist at North Carolina State University, and Steve Ross of the N.C. Division of Marine Fisheries, are working on a way to help managers make such decisions easier. Using mini-grant funds awarded by Sea Grant Director B.J. Copeland, the researchers will compile an extensive bibliography of estuarine research. They will be looking

Continued on next page

primarily at research that estimates the habitat value of estuaries as nursery areas for juvenile fish and shellfish. The team will draw extensively on data collected by the Division of Marine Fisheries, which has been sampling fish and shellfish, and studying water parameters, in the state's estuaries since 1972.



In its September meeting, the N.C. Marine Science Council selected a task force to establish a marine and coastal policy for North Carolina. The task force will examine three aspects of North Carolina's policy: the state's role in the state-federal partnership that manages coastal and marine resources, the state's influence on national ocean policies, and the state's role in international ocean policies, particularly in respect to trade and technology.

Sea Grant Director B.J.Copeland was appointed to the task force, along with William Queen, Director of the Institute for Coastal and Marine Resources at East Carolina University (ECU), and coordinator of Sea Grant's estuarine research, and Michael Orbach, an expert in ocean policy at ECU and a Sea Grant researcher.

Raking the ocean floor for fish may net a few North Carolina fishermen more than they bargained for. Occasionally fishermen come up with an old torpedo or other explosive ordnance left behind after military training exercises, sea dumps and combat operations. But if handled and disposed of properly, explosives can be of little or no danger to fishermen.

For information about the identification and safe disposal of explosive ordnance, write for the free Sea Grant publication, *A Fisherman's Guide to Explosive Ordnance*, 105 1911 Building, North Carolina State University, Raleigh, N.C. 27650. Ask for UNC-SG-81-05.

Lifting nets and pulling pots can be backbreaking work for the small-boat fisherman, who often works alone. But fishermen can prevent aching muscles and save valuable time by installing hydraulic equipment to do the job for them. Hydraulic systems, which are simple to use, can power many types of fishing equipment.

For more information about hydraulics, write for the free Sea Grant publication, *Hydraulics: Handy Helpmate on Small Fishing Boats*. Ask for UNC-SG-75-19.

The Mid-Atlantic Marine Education Association Conference will be held at the Marine Resources Center at Bogue Banks, October 21 and 22. Workshops, field trips, papers and programs will center on the conference theme, "barrier islands and people."

Lundie Spence, Sea Grant's marine education specialist, will present a program using Sea Grant educational materials developed to teach children about hurricanes.

The conference is expected to draw educators from five states (educators do not have to be members of the association to attend). For more information about the conference, call Mark Joyner at the Marine Resources Center at Bogue Banks (919/247-4003).

Coastwatch is published monthly except July and December by the University of North Carolina Sea Grant College Program, 105 1911 Building, Raleigh, NC 27650-5001. Vol. 10, No. 9, October, 1983. Dr. B.J. Copeland, director. Neil Caudle, editor. Kathy Hart and Nancy Davis, staff writers. Second-class postage paid at Raleigh, NC 27611.

COASTWATCH

105 1911 Building
North Carolina State University
Raleigh, NC 27650

Second-class postage paid
at Raleigh, NC 27611
(ISSN 0161-8369)