# COASTLINES

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# MICROBES, METALS AND THE HUDSON RIVER

Dr. Levandowsky taking a sample for analysis of water from the Hudson River. *Photo courtesy Mike Levandowsky.*

By Mike Levandowsky

### The River

There is a saying that a person standing on the bank of the Hudson River will see a floating object seven times as it moves up and down with the tide before finally disappearing downstream. This refluxing tidal system in the Hudson River is fed by an enormous watershed in eastern and northern New York State and parts of Vermont,

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## Microbes and the Hudson

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Massachusetts, Connecticut and New Jersey. It can be thought of as a sort of cauldron in which things are constantly mixing together in a "stew" that eventually pours into the ocean.

In this stew, and in fact a very important, active part of it, is a complex food web of interacting organisms. How are they affected by the numerous chemical inputs from point and nonpoint sources? A pioneer of applied ecology, Dr. Ruth Patrick of the Philadelphia Academy of Sciences, recently wrote:

"Whereas previously the public and government were generally concerned with controlling pollution at the end of the pipe, today the concern is mainly on the functioning of the whole ecosystem, and whether or not it can maintain its condition or is very fragile and probably will be destroyed."

With three colleagues, Drs. Nicholas Fisher and Vincent Breslin (SUNY at Stony Brook) and Gerard Capriulo (SUNY at Purchase), I have researched the effects of a potentially toxic set of chemicals, the heavy metals, on one critical group of organisms, the microzooplankton. Under a grant from NY Sea Grant we have focused on the effects of two of these: silver and lead.

### The Microbes

First, the organisms: the microzooplankton are planktonic organisms, ranging in size from 10–100 microns (a micron is a millionth of a meter), which eat other microscopic organisms. They include very small invertebrates, including many larval stages, and the single-celled protozoa. These organisms are an understudied group, but quite important. They form the "microbial loop" in the food web (Fig. 1), and account for much of the flow of energy from bacteria and algae to the larger zooplankton, fish, and fish-eating animals such as humans. Thus, things that affect the microzooplankton will also affect these other groups that feed on them. In turn, the microzooplankton also affect the species composition of the algal and bacterial populations that they graze upon—a significant change in predation might lead to algal blooms or other ecological upheavals.

### The Metals: What the Organism "Sees"

Heavy metals like copper or cadmium can be quite toxic to aquatic organisms, but metal toxicity depends very much on their chemical state, which determines the extent to which the metals can interact chemically with the organism. Copper, for example, is present in seawater at concentrations that could be lethal to many aquatic organisms living near the shore, but in these waters copper is tightly bound to organ molecules such as humic acids and therefore biologically unavailable. The organisms swim about in copper-laden water without "seeing" it—they do not take it up the copper or interact with it.

Similarly, cadmium is quite lethal at low levels in most freshwater systems, but in seawater it binds to charged chlorine atoms or chloride ions in a way that renders it unavailable. Thus, cadmium is rarely of concern in marine systems, but it is a very serious pollutant in freshwater systems. In an estuary, there is a gradual increase in the toxic potential of cadmium as one goes inland and salinity content decreases from the sea to freshwater.

We decided to focus on two metals that occur at very high levels in the lower Hudson River water column: silver and lead. The general public is well aware that lead can be toxic, but what about silver? We wear silver jewelry and eat with silverware. Can silver really be toxic? The answer is: it depends. Pure metallic si[l]ver, in jewelry and silver[ware], is relatively inert and harmless. Ionic silver, on the other hand, in compounds such as silver nitrate, can be quite toxic, especially to microorganisms. Silver nitrate and silver proteinate (argyrol) are used in medicine to treat certain infections because of their toxicity to microorganisms.

The question we have posed is: are these metals a potential problem to the microzooplankton component of the food web in the lower Hudson River estuary? Our approach was to look at uptake and toxicity in a common estuarine protozoan, the ciliate *Fabrea salina*.

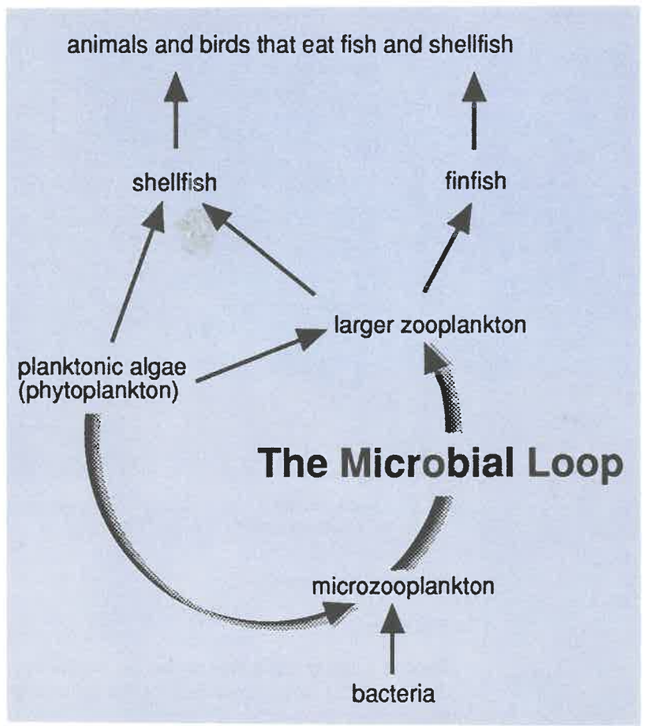


Fig. 1. **The Planktonic Food Web**. The major categories of planktonic organisms, and paths of energy and carbon that connect them. (All of the organisms also produce organic materials that are utilized by the bacteria, but these arrows are not shown.)

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# Researchers Probe the Influence of Plankton Community Dynamics on Noxious Algae Bloom Formation

By Trent R. Schneider

**The thousands of microscopic plants and animals (called phytoplankton and zooplankton, respectively) contained in just a few drops of water photosynthesize, feed, reproduce, and otherwise interact with daunting complexity. To better understand the role of biological interactions in the formation of noxious algae blooms plaguing the region, the New York Sea Grant Institute (NYSGI) funded researchers Dr. Elizabeth Cosper and Dr. Darcy Lonsdale of the Marine Sciences Research Center (MSRC) at the State University of New York at Stony Brook to look closely into the trophic (or feeding) relationships among the various plankton in local bays. The researchers began their project in 1991,** focusing on the Peconic and Great South Bay systems on eastern Long Island.

To get a comprehensive picture of the coupling between phytoplankton and the zooplankton who consume them, Cosper, a phytoplankton ecologist, teamed up with Lonsdale, who specializes in zooplankton ecology. They examined water samples from locations in the bays, and determined both the species and abundance of phytoplankton and zooplankton contained in the samples. Plankton were sorted by sieving into distinct size-groups, or fractions. Since plankton size is a rough indicator of the role organisms play in the plankton community (whether they are producers or consumers), sorting by size allows researchers to measure the abundances of and ratios between the groups. Sorting by size also provides insight into the dynamics of the plankton assemblage at the sampling sites.

The larger-sized organisms, greater than 202 microns (one micron equals a millionth of a meter), are mostly adult copepods, an important source of food for larval fishes. Copepods feed on the plankton-size fractions smaller than themselves and are abundant in the Long Island bays. The size fraction between 64 and 202 microns includes juvenile copepods, the larvae of many benthic species such as clams, mussels and barnacles, and the occasional large protozoa. This group appears to include efficient grazers on the smaller plankton. Many of the phytoplankton species fall

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## Microbes and the Hudson

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### A Surprising Result on Toxicity Thresholds

We found that silver was lethal to this species when added at levels of 1 part per million, and changes in swimming behaviors occurred at .01 ppm. Lead, on the other hand, appeared to have no effect at ecologically meaningful levels. At very high levels, almost 100 times higher than the lethal threshold for silver, lead produced some toxicity.

### The Explanation: Concentration by the Organism

We wanted to know what actual concentrations of metal the organism "sees" when silver and lead were present at given concentrations in the environment. Using radioactive isotopes, we determined the uptake of these metals by the cells under natural conditions. The cells concentrate silver from the medium by a factor of about 6,000, whereas lead is concentrated by a factor of only 200. This is probably the explanation of much of the great difference in toxicity found in our experiments. When silver and lead are added at the same levels, the protozoan takes up much more silver than lead, so it is not surprising that silver is much more toxic than lead.

### Background Levels

We have found that compared with most other rivers, such as the Mississippi, the levels of silver and lead in the Hudson are quite high. Looking at the suspended particles in the river, we found that silver was about 100 times more concentrated in the Hudson than in the Mississippi, and lead was nearly ten times more concentrated. Lead is used in many industrial processes and occurs in many products, from ink to batteries. Silver is a bit more mysterious. The only likely source appears to be related to photographic materials and processing.

### Some Unanswered Questions

As Yogi Berra is rumored to have said, "A person without a fixed destination is likely to end up somewhere else," so where do we go from here? There are still many gaps in this story. It is clear that silver in the Hudson River **could** be a problem for these organisms, but is it? Normally one finds lots of ciliates and other microzooplankton in the water column. Have they developed a resistance to this metal? What is the chemical state of the silver, and how available is it biologically? Where does it accumulate in the cell, and what does it do there? The experiments raise many questions, which is usually a good sign.

I've continued to study the effects of these and other heavy metals, concentrating now on the native protozoans. Preliminary indications are that the water is indeed toxic to these organisms at times and that this toxicity is "cured" by chemicals that bind to heavy metals. Thus, we are starting to understand some of the effects of one class of pollutants on one component of the ecosystem. A program for the longer run is to see how such effects reverberate through the rest of the system. This would give us some hope of predicting the effects of heavy metals on the system as a whole.

*Dr. Michael Levandowsky is a marine biologist at the Haskins Laboratories, Pace University, New York City, New York.*

## Researchers Probe Influence of Plankton Community Dynamics

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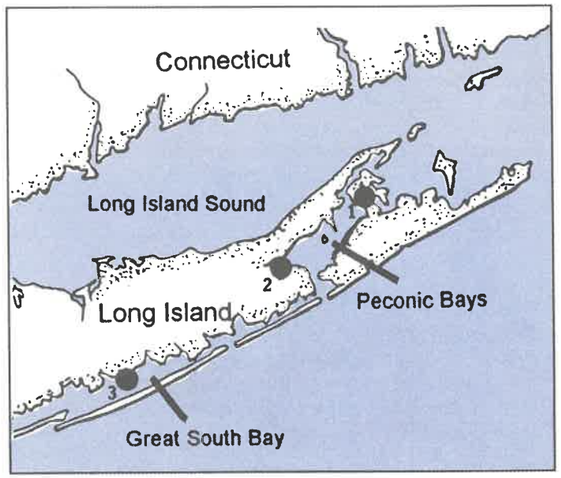
into the 5 to 64 micron size fraction, including common diatoms and the toxic dinoflagellates that can cause red tides. Some phytoplankton grazers such as smaller protozoa also occur in this size fraction.

The smallest size fraction of phytoplankton measured, less than 5 microns, is a very important component of the plankton community, accounting for more than 95 percent of the total plankton biomass and productivity during the warmest months. This size fraction includes the small phytoplankton such as *Aureococcus anophagefferens* (the brown tide alga), and *Nanochloris*. Because they are hard to identify and preserve, these sizes are very difficult to work with.

Laboratory experiments were conducted to assess the feeding preferences and grazing potential of the various size fractions. The researchers took representative species of algae from both the less-than- and greater-than-5 micron fractions, labeled them with carbon-14 and performed short-term tracer experiments in which a natural assemblage of phytoplankton is presented to zooplankton grazers to see if any selectivity is apparent in the grazing behavior.




Plankton assemblages were sampled at 1) West Neck Bay, 2) Reeves Bay and 3) Blue Point.

What they found is that the larger zooplankton, particularly the copepods, prefer to eat phytoplankton between 5 and 20 microns. Copepods may at times be grazing up to 100 percent of the production in the 5 to 20 micron range, which can cause shifts in the types and abundances of plankton found in the bays. Overall, however, the larger zooplankton grazed only a limited portion of the total phytoplankton being produced. The smallest phytoplankton, which the large zooplankton do not choose to eat, have the highest levels of production during the summer. In contrast, the smaller zooplankton showed no size preference in grazing and usually removed a greater portion of the phytoplankton being produced, compared with larger zooplankton. These results raised the question that, if the vast majority of the phytoplankton in the bays during the summer months is not the preferred size of the larger zooplankton grazers, how are robust populations of the copepods being maintained?

The researchers felt there must be some other food source that the copepods relied on. To investigate this alternate food source, Lonsdale and her graduate assistant, Woong-Seo Kim, did some grazing experiments with ciliates (protozoans) also found in the bays. Preliminary results from that study and findings from others studying similar plankton communities lead to the hypothesis that ciliates are very important to the larger zooplankton and may also be important grazers of the abundant, small phytoplankton in Long Island bays. The ciliates, therefore, may have a major impact in the flow of energy to copepods and other large zooplankton. To further investigate this hypothesis and advance the understanding of the microbial-plankton dynamics in Long Island bays, NYSGI hopes to fund a complementary study directed by Dr. Lonsdale in its 1994-1995 research package.

Another interesting finding from this research is that grazing zooplankton actively avoided eating the toxic dinoflagellate *Anphidinium* when added to a natural plankton assemblage, while readily consuming another similarly sized diatom. This finding has important implications in the understanding of the biological mechanisms of bloom formation. In theory, if certain phytoplankton populations are not being limited, compared with other species, by grazing from larger organisms, they could grow rapidly and form a bloom. Based on these observations, Cosper and Lonsdale formulated a hypothesis to explain the recurring brown tide blooms that have plagued Long Island embayments over the past decade. *Aureococcus* is a very small alga (less than 5 microns) that the larger zooplankton, especially copepods, do not choose to eat. The brown tide organism might also be toxic, causing the smaller zooplankton, which normally feed on this sized plankton, to avoid them. When grazers fail to control the brown tide populations and environmental conditions support algal growth, the stage may be set for a bloom to occur.

The researchers' preliminary evidence suggests that as the population of brown tide algae rapidly increases there is a "negative effect" of brown tide at high concentrations. This negative effect harms the protozoan community, knocking the entire microscopic food web in the bays out of whack. With the protozoan population (perhaps the main source of food for the copepods during the summer) compromised, the copepod populations crash,

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# Extension News . . .

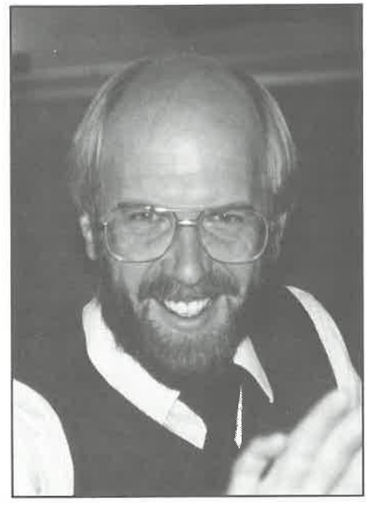
Ken Gall. *Photo by Susan Hamill.*

### Ken Gall Receives Award

Ken Gall, NY Sea Grant extension specialist, was awarded a superior performance award from the Cornell University chapter of Epsilon Sigma Phi for his work in developing a voluntary quality program for seafood retailers. Epsilon Sigma Phi is a national honorary extension fraternity that recognizes individuals or programs for outstanding achievements.

The seafood quality program was a joint pilot project with the New York Seafood Council and the Seafood Retailers of New York. Its aim was to develop procedures that can be easily and effectively used to maintain product quality and safety. Twenty seafood retailers participated in this voluntary program, and two of those retailers have since been involved in a national pilot project to test a HACCP-based inspection program in seafood stores.

Gall, who specializes in seafood technology, safety, retailing, processing and nutrition, is located at 125 Nassau Hall, SUNY at Stony Brook, Stony Brook, NY 11794–5002.



Mark Malchoff. *Photo by Avery Klauber.*

### Catch-and-Release Angling Study Funded

Mark Malchoff, Sea Grant extension specialist, recently received a $77,000 grant for a project titled *Effects of Catch-and-Release Angling on Important Northeast Marine Fishes: Mortality Factors and Applications to Recreational Fisheries*. This grant was awarded to Malchoff from the National Oceanic and Atmospheric Administration (NOAA) via the Saltonstall-Kennedy Program.

According to Malchoff, "Our objectives are to determine the percentage survival of bluefish, porgies, striped bass, and black sea bass following catch-and-release angling. We'll also study the various ways recreational anglers catch and release bluefish, scup, weakfish, striped bass and black sea bass and try to identify tackle and techniques which minimize angling induced mortality."

Voluntary catch-and-release practices have become more popular with anglers recently. The practice benefits both fish and anglers. It can lengthen the fishing trip when legal maximums have been reached and can also reduce fishing mortality on heavily fished populations. A fact sheet on catch-and-release, written by Malchoff, Mike Voiland and Dave MacNeill is available.

For further information contact Malchoff at, New York Sea Grant, Cornell University Laboratory, 39 Sound Avenue, Riverhead, NY 11901–1098, phone (516) 727–3910.

### Tourism Interpretation Conference to be Held

By Diane Kuehn

New York Sea Grant is a major sponsor for an upcoming northeast regional tourism conference. *Enhancing Visitor Experiences Through Interpretation* is scheduled for October 17–19, 1993, in Syracuse, New York.

According to extension specialist Diane Kuehn, "The conference is designed for community leaders, not-for-profit group members, tourism professionals and extension agents. It will focus on how to promote community, regional and scenic byway resources to visitors by using interpretive or educational techniques."

Presenters include keynote speaker Peter McCarthy from the Statue of Liberty National Monument; John Veverka, one of the foremost interpretive consultants in the U.S. today; and David Walbridge, the site supervisor of historic Plimoth Plantations in Massachusetts. Conference highlights include a trip to Sainte Marie Among the Iroquois, a state-of-the-art interpretive center in Liverpool, New York, and an interpretation of Renaissance etiquette by costumed performers from the Renaissance Festival of Sterling, New York.

Kuehn stated, "This is truly a cooperative project. In addition to Sea Grant, there are three other main sponsors: Cornell Cooperative Extension; Seaway Trail, Inc.; and SUNY College of Environmental Science and Forestry. There are also nine cosponsoring agencies."

For more information or to register, contact Kuehn at New York Sea Grant, Swetman Hall, SUNY College at Oswego, Oswego, NY 13126–3599, or phone (315) 341–3042. Registration deadline is September 1.

## NYSG Accepting Applications for Knauss Fellowship

New York Sea Grant is looking for graduate students who are interested in marine resources and the policies that affect them. John A. Knauss Marine Policy Fellowships are awarded yearly to highly motivated and qualified students who have an academic interest in marine resource policy-making. Fellows are matched to "hosts" in either the legislative or executive branches of the federal government, or at an appropriate association/institution in the Washington, DC, area.

According to Sean Downing, a Knauss Fellow currently appointed to the Office of Global Programs at NOAA, "This fellowship is a wonderful chance to use my classroom knowledge and participate in the political process. I highly recommend this learning experience."

Applicants should be in a master's, doctoral or professional program in a marine or Great Lakes-related field at the time of application. Knauss Fellowship appointments are for one year and include a stipend.

To apply for this unique educational experience, contact Ruth Tompkins, Fiscal Officer, New York Sea Grant Institute, 115 Nassau Hall, SUNY at Stony Brook, Stony Brook, NY 11794–5001, phone (516) 632–6908. Completed applications must be received by September 1, 1993.

## *Coastlines* Survey — What You Told Us

Thanks to all who took the time to send in your *Coastlines* survey. Of those that returned the survey (726 total respondents, 18% response rate), here's what you told us:

### Who reads *Coastlines*?

- Geographically, 46% of you are from the NY Marine district, 17% from the Great Lakes district, 21% from outside New York State and 15% from other New York counties.
- Your occupations are: with coastal-related businesses (33%); as educators/university researchers (28%); as government officials or employees (20%); and 10% of you are retired.
- More than half of you belong to an environmental or conservation group (371 respondents), and more than half are also involved in water-related sports and recreation (410 respondents).
- 47% of you have been reading *Coastlines* for more than four years; 27% have been readers from two to four years. You pass on your copy of *Coastlines* to an average of three other readers.

### What you want to read about:

- The most important areas to you were, in order of priority: research news; publications (93% have ordered a publication within the past year); outreach/extension efforts; and conferences/workshops.

## New Projects Funded by New York Sea Grant in 1993

The following new research projects received funding in 1993 as part of New York Sea Grant's core research program.

### Technology and Product Development

*Methods for Predicting Susceptibility to Decompression Sickness Based on Complement Activation and Bubble Occurrence in Divers.* R/DP-4. Claes E. G. Lundgren, and Gerald L. Logue, SUNY at Buffalo.

*Hispanics in Metropolitan New York: Perceptions and Practices Related to the Quality, Safety, and Healthfulness of Fish and Seafood.* R/SHH-2. Carole A. Bisogni, Diva Sanjur, Barbara A. Knuth and Joe M. Regenstein, Cornell University.

### Fisheries

*Benthic-Pelagic Coupling in Great Lakes Ecosystems: The Role of Deepwater and Slimy Sculpins.* R/CE-6. Donald J. Stewart, SUNY College at Oswego and SUNY College of Environmental Science and Forestry.

*The Relationship Between Shell Microgrowth Patterns and Physiological Energetics of Mya arenaria.* R/FBM-9. Robert M. Cerrato, V. Monica Bricelj and Glenn R. Lopez, SUNY at Stony Brook.

*Fate of Paralytic Shellfish Poisoning (PSP) Toxins in Surfclams: Implications for Management of the Offshore Fishery.* R/FBM-13. V. Monica Bricelj, SUNY at Stony Brook.

### Coastal Studies

*Atmospheric Deposition of Organic Contaminants and Nutrients to an Urban Nearshore Environment.* R/CTP-13. Bruce J. Brownawell and R. Lawrence Swanson, SUNY at Stony Brook.

*Environmental Factors Enhancing "Brown Tide" Blooms: A Field Experimental Approach.* R/CE-5. Elizabeth M. Cosper, Darcy J. Lonsdale and Edward J. Carpenter, SUNY at Stony Brook.



Sea Grant Pubs

# New NY Sea Grant Publications

Please send requests for the following publications (including checks payable to **New York Sea Grant**) to: Communications, New York Sea Grant Institute, 117 Nassau Hall, SUNY at Stony Brook, Stony Brook, NY 11794–5001. Call (516) 632–9124 if you would like further information.

### Journal Reprints

**Alveolar gas exchange during simulated breath-hold diving to 20 m.** M. H. Liner, M. Ferrigno, and C. E. G. Lundgren. 1993. *Undersea & Hyperbaric Medicine,* 20(1):27–38. Free.

**Disposition and metabolism of 2,3,7,8 - tetrachlorodibenzofuran (TCDF) in rainbow trout.** R. Maslanka, A. R. Steward, J. Pangrekar, S. Kumar, and H. C. Sikka. 1992. *Marine Environmental Research,* 34:255–259. Not available from New York Sea Grant.

**Factors limiting primary productivity in Lake Ontario tributaries receiving salmon migrations.** P. S. Rand, C. A. S. Hall, W. H. McDowell, N. H. Ringler, and J. G. Kennen. 1992. *Canadian Journal of Fisheries and Aquatic Sciences,* 49(11):2377–2385. Free.

**Ontogenetic shift in the diet of young-of-year bluefish *Pomatomus saltatrix* during the oceanic phase of the early life history.** R. E. Marks and D. O. Conover. 1993. *Fishery Bulletin, U.S.,* 91:97–106. Free.

**Profile: The role of agency goals and local context in Great Lakes water resources public involvement programs.** B. K. Landre and B. A. Knuth. 1993. *Environmental Management.* 17(2):153–165. Free.

**Propagation and trapping of obliquely incident wave groups over a trench with currents.** P. L.-F. Liu, Y.-S. Cho, J. K. Kostense, and M. W. Dingemans. 1992. *Applied Ocean Research,* 14:201–213. Free.

**Solid phase extraction techniques for the isolation of siderophores from aquatic environments.** R. A. Freeman and G. L. Boyer. 1992. *Journal of Plant Nutrition,* 15(10):2263–2276. Free.

### Fact Sheets, Directories and Guides

**Seafood Savvy: A consumer's guide to seafood nutrition, safety, handling, and preparation.** K. Gall. 1992. $4.95.

### Video

**Zebra Mussels.** Produced by New York Sea Grant and WLIW, Long Island. 1993. 30 minutes. $12.00.

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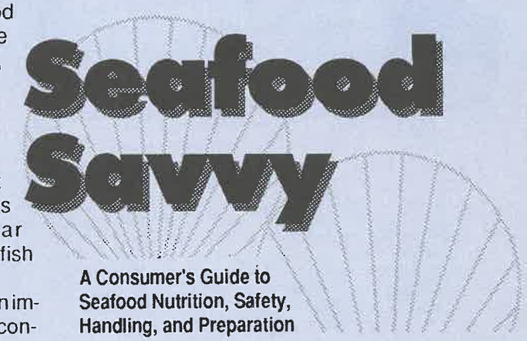
Please send requests for the following video (including checks **payable to Cornell University**) to:

New York Sea Grant Communications
Swetman Hall
SUNY College at Oswego
Oswego, NY 13126–3599

**Protecting Your Boat From Zebra Mussels.** 15 minute video. Revised July 1993. $10.00.




Ken Gall, an extension specialist in seafood safety and technology for New York Sea Grant, has written a new consumer-oriented publication to help people buy, handle, store and prepare seafood. According to Gall, seafood has become more popular in the American diet since consumers have become aware of the variety of products available, their great taste and their nutritional benefits. But some consumers lack confidence in their ability to select, handle and prepare seafood.

This 34-page booklet was written to help consumers understand seafood nutrition and safety issues and to tell them how to select and prepare seafood safely and confidently.

In *Seafood Savvy*, Gall provides an overview of seafood nutrition including the calorie, protein, fat, cholesterol and sodium content of various seafoods. A new table specifying nutrient composition that will help consumers compare 60 popular kinds of fish and shellfish is also included.

"Seafood safety is an important issue for the consumer," says Gall. He provides specific tips for purchasing high quality seafood and for maintaining its quality and safety when storing and cooking seafood at home. *Seafood Savvy* also discusses possible toxins and contaminants and eating raw seafood.

To order, see "New NY Sea Grant Publications," above.

## Researchers Probe Influence of Plankton Community Dynamics

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which may have an impact on fisheries in the bay. Fortunately, while brown tide blooms seem to be recurrent, their durations are short-lived. Their data also suggest that once a bloom subsides, protozoan populations rebound rapidly, and things begin to return to normal. The dominant summer copepods may not recover as quickly, however, due to their normally low energy reserves; as they begin to starve, they quickly die and/or stop producing eggs. This may trigger longer-term difficulties for juvenile fishes who come into the bay to feed on the copepods.

Cosper and Lonsdale's findings are important for resource management in Long Island bays, since fisheries and the shellfish industry in these highly productive areas depend on the transfer of energy through the various trophic levels. The pivotal role of the small zooplankton and protozoan communities in transferring new production into higher trophic levels is a significant finding that needs further examination.

*Cosper joined the faculty at MSRC in 1983, and has worked on several phytoplankton studies funded by NYSGI over the years. Lonsdale joined MSRC in 1987 and is currently working with Cosper on another NYSGI-funded study investigating the physical factors controlling brown tide bloom formation.*

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Interim Editor: Pat Peterson
Computer Layout: Pat Peterson
Production Assistants:
Sharon O'Donovan
Susan Hamill
Contributors: Diane Kuehn
Mike Levandowsky
Trent R. Schneider

**New York Sea Grant**

117 Nassau Hall
SUNY at Stony Brook
Stony Brook, New York 11794–5001

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