The Watershed

Vol. 7, No. 1

The Oyster Pond Environmental Trust Newsletter

Winter 2002

OPET, P.O. Box 496, Woods Hole, MA 02543-0496

OPET Board meetings are open to all *OPET* members. Meetings are usually held on the third Sunday of the month, at 4 pm in the Treetops Clubhouse.

We'd love to have you come! For information call 508-540-7345.

OPET does not have an official phone, but you can leave a message at 508-540-7345. We'll gladly get back to you!
Or e-mail *opus132@rcn.com* or *brose@cape.com*. And do visit our website, www.opet.org.

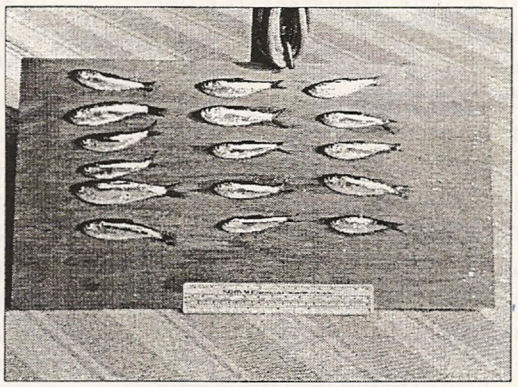
Mystery of the Dead Herring

AN UNEXPLAINED NATURAL MORTALITY TO YOUNG HERRING EXITING OYSTER POND TO VINEYARD SOUND

Robert Livingston III

Sept. 28, 2002 10;30 am. I'm at the weir in Oyster Pond where I'm taking a water sample in amongst thousands of young herring (alewives) that are heading for the culvert under Surf Drive. The flow is out with a 4½ inch head of water rushing over the top of the weir boards. The temperature is 25 C (77 F); salinity expressed in parts per thousand is 2, somewhat freshened by all the recent rain.

The herring appear to be top condition as their bodies flash by on their way to the culvert. A note in my field book at 10:30 am says "herring are crossing the weir boards by the thousands." A sample collected at the weir several days earlier and photographed is presented here.



I decided to check the Trunk River next. At the Trunk River at 11:00 am the herring were in mass as lines of individuals making up small schools, were heading downstream to the Sound. I was attempting to photograph some of the interesting behavior patterns. A young man, curious about what I was doing began asking questions. But

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PROFILE: Pat Kerfoot, OPET Secretary

According to Pat Kerfoot, who has served as Secretary on OPET's board for 5 years, it is her husband Bill's fault that she is on the board at all: Bill was a founding member of OPET, but eventually had to concede that business commitments interfered with his ability to attend meetings, and she replaced him. We are most thankful for Pat's secretarial skills!

The Kerfoots are long-time members of the Woods Hole/ Falmouth community, having moved here in 1971, when Bill accepted a position with the Woods Hole Oceanographic Institution. Pat's own educational background includes college degrees in both German and Education, but as she points out, "The best provision of a college education is learning to learn." That ability has enabled Pat to engage in a wide range of activities during her checkered career, which has led to proficiency in many diverse areas, including graphic arts (working for Hallmark Cards in Kansas City) and even feeding lizards (one of Pat's tasks in an early job as secretary to the Herpetology Dept. at Harvard!). Together Pat and Bill own K-V Associates, Inc., which markets various environmental monitoring and remediation devices invented by Bill. All of the devices are related to water quality, so Pat's environmental awareness and interest have grown out of her daily involvement with this business.

Like so many of our volunteers, Pat's civic participation isn't limited to board membership with OPET: she has been involved in town

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Prof. Ivan Valiela: Reports on Health of Oyster Pond at Annual Meeting

Professor Ivan Valiela of the Boston University Marine Program (BUMP) at the Marine Biological Laboratory in Woods Hole was OPET's Keynote Speaker at the Annual Meeting. Prof. Valiela has studied coastal ecology on Cape Cod for about 30 years. Recently, his students have used Oyster Pond as their "field laboratory."

Dr. Valiela pointed out that the problem of coastal pollution and eutrophication (blooms of growth of unwanted algae that destroy habitat for aquatic plants and animals) experienced here on Cape Cod are similar to those along much of the eastern seaboard of the US and elsewhere. About 50% of the population lives within 50 miles of shorelines. That population is rapidly increasing, leading to conversion of forested land for residential and commercial usage and also leading to increased sewage production.

Prof. Valiela and his students have studied extensively several watersheds in the Waquoit Bay area, including some that are densely populated and some that are relatively undeveloped. These studies have shown that, in undeveloped areas, rainwater is the most important source of nitrogen (N) to the ecosystem. In contrast, septic tank effluent is by far the most important source of N to the estuary in watersheds that are thickly populated with houses. Runoff of lawn fertilizers is also a significant source of N, but less so than septic systems. Seagrass, which forms the best habitat for common many shellfish, disappears in estuaries where the nitrogen concentration is high.

Oyster Pond, Valiela reported, is "in pretty good shape." The inputs of N to Oyster Pond are low relative to some of the more heavily populated areas of east Falmouth. Nevertheless, increased inputs of both nitrogen and phosphorus via septic systems and lawn fertilizers should be considered potential threats to the health of Oyster Pond as new homes are constructed within the watershed. A study conducted in October 2001 by a class project showed that both the algae and the fish in the pond have a form of nitrogen (specifically, the abundance of the15N isotope) that is characteristic of being derived from human sewage. Therefore, although septic effluent has not yet caused severe or frequent algal blooms, the impact of human sewage on the cycling of nutrients in the pond is definitely detectable. Studying the role of sewage inputs to the health of the pond is the subject of further studies by Valiela's students.

Valiela's class also used Oyster Pond as their field laboratory in an intensive study carried out in September 2002. The students first met with area residents at the beginning of the month to hear their concerns and suggestions for topics of research. The students then presented the results of their studies to a meeting of residents at the end of that month. This year's study further confirmed the importance of septic systems as the main source of N to the pond. The students also measured the amount of N present in the mass of submerged and floating vascular plants, which is probably where a lot of the N goes each summer. The students' reports for 2001 are already posted on OPET's web site, and the 2002 reports will be posted soon. If this class is repeated in future years, participation of area residents in the pre-and post-study "stakeholders meetings" is highly encouraged and recommended. The students are very articulate and adept at explaining their work to a lay audience, making for an informative and entertaining evening.

Eric Davidson

(KERFOOT...Continued from page 1)

politics since 1988, first serving as vice-chair on the Charter Committee, one of 9 elected to fulfill the mission of codifying the Town of Falmouth's form of government; later as vice-chair on the Charter Review Committee; and most recently as a member of the Planning Board, since being elected in May, 2000. As if that isn't enough, Pat is also involved with her church, St. Joseph's in Woods Hole, where she taught confirmation classes for 9 years and is now chairman of the Pastoral Council. She somehow finds time to enjoy reading ("mostly mysteries"), gardening and cross-stitch, as well.

But Pat's real pride and joy are her two children (now adults) and three grandsons. Motherhood, she says, was "the most satisfying and challenging work of my life." The family is widespread now: son Christopher, who has a Ph. D., lives with his wife and three sons in California, where he oversees cancer drug trials; daughter Kerry is in upstate New York working at Cornell University, putting her degree in exercise physiology to good use in their wellness program. We hope Pat and Bill are not tempted to leave the area, however, as their expertise has been invaluable to OPET over the years. Thank you, Kerfoots!

Mindy Hall

Summer Studies of the Nutrient Limitations to Phytoplankton Growth in Oyster Pond

The following is condensed from a larger report available on the OPET web site:
http://opet.org/html/studentp.html

To see the full report and the student publications, go to this web page and click on "Boston University Marine Program Undergraduate Studies on Oyster Pond"

During the summer of 2002, we jointly supervised two undergraduate students in a National Science Foundation training program, directed by Professor Ivan Valiela of the Boston University Marine Program, designed to provide research experience for undergraduates. These students, Stacy Barron (Bowdoin College) and Carolyn Weber (Cornell College), conducted experiments on nutrient limitation and salinity in Oyster Pond. The students also conducted 3 transects along 4 stations in Oyster Pond, where they measured chlorophyll, inorganic nitrogen (N) and phosphorous (P) concentrations, and salinity at 3 depths, as well as secchi depth, light, and dissolved oxygen

Nutrients are now generally recognized as the largest pollution problem for coastal rivers and bays. In the United States, two-thirds of these ecosystems are moderately to severely degraded by nutrients. One symptom is excessive growth of phytoplankton, which are the microscopic, photosynthetic organisms (mostly algae, but also some types of bacteria) that make up the base of the food chain. While nutrients are defined as things that nourish, and are therefore often viewed as good things, too much of a good thing is clearly deleterious, just as eating too much food can cause obesity and a host of health problems. Excessive growth of phytoplankton causes the water to become murky, can give off odors, can lead to lost of high-quality bottom habitat such as seagrass beds, and lead to oxygen depletion in the water, with death of fish and other animals. Coastal marine ecosystems vary in their sensitivity to nutrients, and many other factors interact with nutrients to control the growth of phytoplankton, including light, mixing of the water, and grazing various kinds of animals. For many ecosystems, adding more nutrients will increase phytoplankton and plant growth, but the response can be amplified or damped by these other controlling factors.

For coastal marine ecosystems of moderate to high salinity (greater than about 10 parts per thousand, or ‰), nitrogen is generally the nutrient most limiting to production. In contrast, freshwater lakes of moderate to high productivity are generally more phosphorus (P) limited. However, there have been relatively few studies to determine whether nitrogen or phosphorus is more limiting in brackish coastal ecosystems with intermediate salinities in the range of Oyster Pond (2.3 ‰ during June-August 2002). In Oyster Pond, two previous studies found that neither N nor P additions affected phytoplankton growth, but both of these experiments were conducted in October, and the pond might react differently during summer months.

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(HERRING ...Cont. from page 1)

then I learned from him that he had seen quite a number of dead herring along the beach east of the Trunk River. He showed me the location where he said he had counted seventy or so.

To my amazement the young man was right. Freshly dead herring about 3 inches in length were scattered all along the shore as though they had been washed up by a wave and left there. I estimated in a ten foot strip there were some 25 or more dead herring (Figure 2) I did not survey the beach beyond this one area. Two blackback gulls east of our area were feeding along the shore-perhaps on young herring. I thanked the young man and told him that it was a mystery why the herring had died.

Later that day with dead herring still on my mind I returned to the Trunk River at 4:45 pm and took a water sample. Herring were still heading for the Sound. Water temperature was 26 C; salinity was 3 ppt. But hereby hangs a tale. I had been in the habit of tasting the water sample to check saltiness. But with this one my nose said no. It smelled strongly of hydrogen sulfide-the rotten-egg smell. Talking to Bill Kerfoot, long time board member of OPET, he suggested that the H2S odor might have also meant low oxygen which could have caused the death of the herring – in other words anoxia.

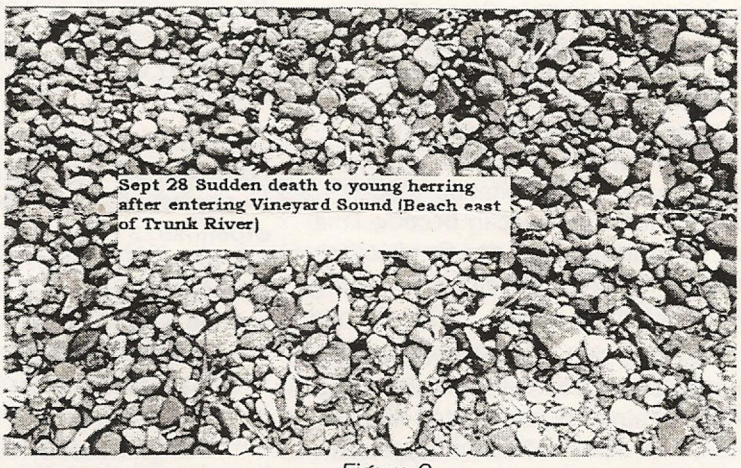

Figure 2

SOMETHING TO THINK ABOUT!

Nov 21, 2002

(SUMMER STUDIES ...Cont. from page 3)

The 2002 summer experiments in Oyster Pond:

Stacy and Caroline conducted short-term experiments (5-10 days) in 2-liter bottles. The bottles were incubated either in the pond at about 20 inches depth, or in a growth chamber at pond temperatures and under lights which provided an average light intensity similar to that in the upper 3 feet of the pond. Such small-scale, short-term experiments should be interpreted with care because of limitations and constraints of the experimental design, but short-term bottle experiments have been an important tool that has been used by many investigators (including ourselves) to gain information on the relative importance of one nutrient versus another to primary producers in an aquatic system.

First, we ran experiments where ambient water was enriched with either N or P. Adding a bit more of a nutrient and measuring the phytoplankton response indicates whether that nutrient is limiting growth under the pre-existing nutrient conditions. Both experiments showed increased phytoplankton growth after N addition, indicating that N is more limiting. This suggests that the best way to prevent the blooms of algae and noxious plants in Oyster Pond may be to reduce nitrogen inputs to the pond. In one experiment, N and P were also added together, resulting in a much greater increase in phytoplankton growth than that of N alone. This indicates that once N limitation is overcome, then P can quickly become limiting to further growth, and so effective management may require reductions of both nutrients.

Another set of experiments examined the importance of salinity. Pond water that contained phytoplankton was diluted with deionized water or with filtered seawater from Vineyard Sound to provide salinities of 0.2, 2.3 and 5.0 ‰. In one of these experiments, both N and P were added to determine whether the phytoplankton present in Oyster Pond were adapted for best growth at the ambient salinity. Surprisingly, salinity had little influence in our experiment, and the phytoplankton grew well with added nutrients at all three salinities tested.

In another experiment with varying salinities, the bottles were enriched only with P. The purpose of this experiment was to examine whether nitrogen-fixing cyanobacteria ("bluegreen algae") present in Oyster Pond would respond more or less strongly to different salinities. These organisms are able to take the gaseous form of N present in the atmosphere and dissolved in water and convert it into biologically available nitrogen (the process of nitrogen fixation), which has been shown to aggravate nutrient pollution problems in freshwaters. We had predicted that the cyanobacteria would grow better and fix more nitrogen at the lowest salinity (0.2 ‰). However, our preliminary analysis of these results shows that the greatest increase in cyanobacteria occurred at the ambient salinity (2.3 ‰), suggesting that they are well adapted to the ambient Oyster Pond salinity.

Management implications:

The experiments with nutrient enrichments of ambient water from Oyster Pond indicate that control nitrogen inputs to the Pond may be necessary to reduce phytoplankton growth and associated eutrophication problems. As is now generally recommended for estuaries, it is probably also prudent to consider and control phosphorus inputs, especially as these inputs might change over time.

Would altering the salinity of the Pond have an affect on algal production and eutrophication? The 2002 summer experiments were too short in duration and do not encompass enough of the potential responses of the ecosystem to provide a clear answer to this question. For example, changing the salinity is likely to alter the net exchange of nutrients with bottom sediments, which may have a profound effect on eutrophication. Nonetheless, the experiment did show the presence of nitrogen-fixing cyanobacteria. These organisms can aggravate nutrient pollution problems by fixing nitrogen when it is in short supply and phosphorous is available, and potentially can counteract some of the benefit of reducing watershed inputs of nitrogen to an ecosystem. From other information, we think it likely that lowering the salinity of Oyster Pond would generally favor these nitrogen-fixing cyanobacteria (over a longer time period than examined in the short-term 2002 summer experiment), while increasing the salinity might suppress them. However, the response might depend on many factors, including changes in nutrient availabilities due to the response of sediments, and changes in the abundances and species composition of zooplankton and benthic filter-feeding animals.

Opportunities and needs for further research on nutrient pollution in Oyster Pond:

These experiments provided some interesting preliminary information on how Oyster Pond might respond in the future to nutrient inputs from septic systems, road runoff, and lawn fertilizer and to changes in salinity. To study how salinity changes might interact with nutrient pollution in Oyster Pond requires experiments of longer duration and larger size than those conducted by the summer students. We believe such experiments could be performed in "limnocorrals," or large plastic enclosures (usually between about 1.5 and 4 feet in diameter) within Oyster Pond during several weeks to months. A critical question would be the response of the nitrogen-fixing cyanobacteria to the salinity change. Provided that the residents are interested in seeing this type of research conducted on Oyster Pond, we are interested in seeking funding from the National Science Foundation or other granting agencies to carry out such studies.

by

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