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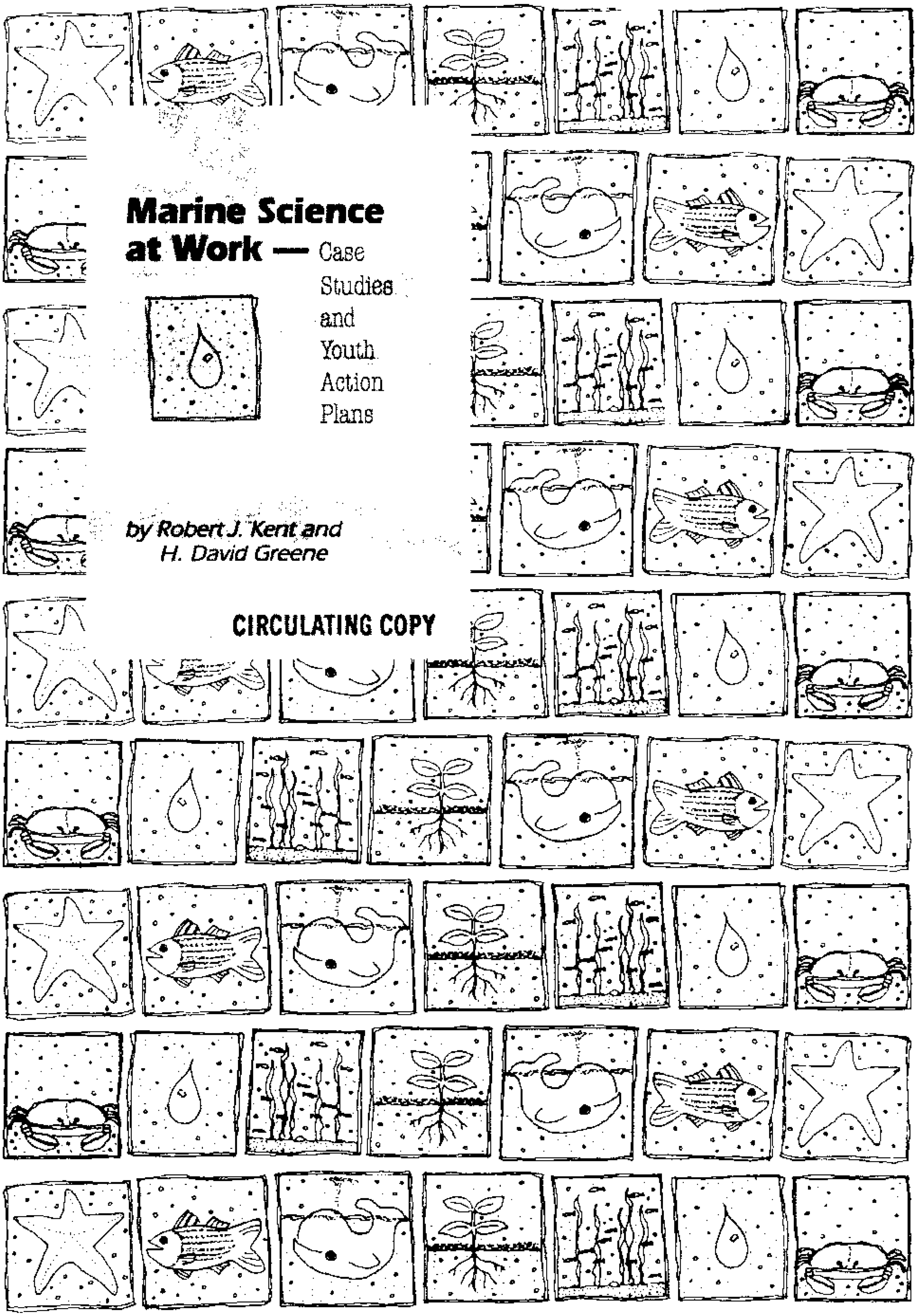

Marine Science at Work — Case Studies and Youth Action Plans

by Robert J. Kent and
H. David Greene

The Authors

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Helping You Put Knowledge to Work

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Cornell Cooperative Extension Marine Science at Work — Case Studies and Youth Action Plans

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Introduction

Our nation and the world face a wide variety of environmental problems. We need trained scientists to help us better understand these environmental issues, and we need educated citizens, knowledgeable about the environment and willing to take actions to protect and enhance environmental quality.

Unfortunately, some recent reports conclude that science education in the United States is not as good as it needs to be. One reason may be lack of interest in science as a field of study. Some reasons that have been mentioned as to why people and students are not interested in science include:

- irrelevant and unattractive subject materials used in science education;
- lack of "hands-on" scientific experiences;
- a perception that science is difficult (Walker, et al 1992).

The goal of this publication is to help educators of youth, in both formal and nonformal educational settings, learn that science is relevant to their lives and to a wide variety of environmental issues. It is the hope of the authors that youth who become involved with the units in this publication will both increase their interest in science and become better environmental stewards.

Topics covered in this publication include water quality issues, seafood safety, and fisheries management—all important environmental issues in many localities. In each unit, science plays an important role in understanding the issue and in finding solutions to the problems. As an educator, you can help by bringing this information to your youth group.

Each of the units in this publication stands alone. You may choose to do any number of the units in any order. The interests of your youth group and your time constraints will determine how involved you wish to become in the Marine Science at Work program. Each unit provides some background information about an environmental problem, discusses briefly the role of science in the issue, and has an activity to use with your group. Some of these activities can be conducted indoors, others will involve field trips and field work. It is the authors' expectation that you will not spend a lot of time lecturing to your youth group. After providing them with a brief introduction to the issue, it is hoped you will get them involved in a project. Each unit has a suggested lesson plan.

For formal educators, suggestions for fitting these units into New York State curriculums are in the appendix.

Science can be fun! Environmental science is a tool for answering our questions about how the natural world operates and how we can best protect our natural resources. As one person wrote, "What's been missing in science education is the AAAH!, the excitement of doing science with your hands and your eyes." (Roger Hogen as quoted by John Farrington, 1990). In this project we do not expect you to replicate experiments someone else has done, but to use science to better understand our environment.

Unit I. Fish Contaminants: Are the Fish Safe to Eat?

PCBs and Seafood

Our coastal and inland waters provide abundant and diverse fishing opportunities. Recently, concerns have arisen about the safety of eating some species of fish caught by recreational anglers. For example, the bluefish *(Pomatomus saltatrix)* is the backbone of recreational fishing in the marine waters of Long Island. It is plentiful, and it is a strong fighter that is fun to catch! Bluefish are predators at the top of the food chain; they commonly weigh one to 10 pounds, but individuals weighing as much as 22 pounds are caught occasionally. Bluefish swim in large schools. When one of these schools passes nearby, the fishing action can be very exciting. Bluefish action really picks up in the fall, when they move into shallow waters to feed. Bluefish are also harvested commercially, but the majority are landed by recreational anglers. In the Great Lakes, brown trout, Pacific salmon, and walleye are three popular fish. Like the bluefish of the marine waters, these predators provide hours of enjoyment to recreational anglers.

In the mid-1970s, PCBs (polychlorinated biphenyls) were found in these fish. PCBs are chemicals used in a variety of manufacturing processes, and in the past they were freely discharged into numerous waterways. Long-term exposure to high levels of these chemicals has been linked to negative health effects such as cancer or reproductive and developmental harm.

The federal government establishes standards ("tolerance levels" or "action levels") for chemical residues in food, including fish. A tolerance level is the amount of chemical residue that may be expected if a pesticide is used properly. This amount of residue is considered not to be a health risk. Action levels are established for chemicals not approved for agriculture that end up in the environment and eventually in our food. Fish cannot be legally sold if they contain a contaminant at a level greater than its tolerance or action level.

Studies have been conducted to gauge the level of the contaminant problem with the fish we eat. In 1984, the United States Congress, because it was concerned about the potential health and economic effects of PCBs in bluefish, asked the National Marine Fisheries Service (NMFS), an agency of the National Oceanic and Atmospheric Administration (NOAA), to conduct a survey in cooperation with the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) to determine how serious the bluefish-PCB situation was. PCBs are an economic issue as well; commercial and recreational fisheries are important industries in several states.

In the research project, small (less than or equal to 11.8 inches), medium (11.8 - 19.7 inches), and large (greater than 19.7 inches) fish were analyzed separately to determine PCB levels. Since size is related to age, older fish exposed to chemicals in the water longer can be expected to contain more contaminants. No samples in the small and medium size categories at any site exceeded the FDA tolerance level of 2 parts per million (ppm). However, PCB levels in some samples in the large size category at every site exceeded the tolerance level. The FDA tolerance level of 2 ppm for PCBs was established to control exposure to PCBs from all food sold in interstate commerce. This tolerance standard is considered sufficient to protect the consumers of commercially caught fish. The tolerance level assumes that people eat about one-half pound of fish each month.

The FDA has acknowledged, however, that the 2 ppm criterion might not sufficiently control PCB intake for people who regularly consume PCB-contaminated fish, especially recreational anglers who consistently fish for a few favorite species in the same waters and eat their catch.

The decision to eat the fish one catches is left up to the individual. In New York State, the Department of Health issues health advisories to assist with individuals' decisions. The health advisory for bluefish is to eat no more than one meal (one-half pound) per week.

The PCB issue described above is not unique to New York State. PCBs are a problem throughout the Great Lakes and in many coastal bays and estuaries. Contact your state health department or department of environmental protection for information on your local PCB situation.

Should you take the risk of eating bluefish? You decide!

In life, we are constantly taking risks. Society takes the responsibility for managing some risks for us. Robert Reinert suggests we think about risks with the following example (Reinert et al, 1991). We know that driving a car is risky; every year people die in car accidents. Still, people need to get around, and so they drive. Society allows driving, but it manages the risk by controlling the speed limits. The higher the speed limit, the more people are likely to be killed, but if we set the speed limit so low that no one is at risk of being killed, we would not have a practical means of transportation. In questions of risk, we compare the *benefits* to the *risks*. Driving a car offers many benefits, and some risks.

Each person may have their own perception of risks and risky behavior. Following is a list of 15 activities. Try ranking them, beginning with what you consider to be the most risky activity: place a number 1 by it. Continue until all 15 activities are numbered in order, from most risky to least risky.

_____ Non-nuclear electric power
_____ Smoking
_____ General (private) aviation
_____ Pesticides
_____ Handguns
_____ Bicycles
_____ Medical x-rays
_____ Motorcycles
_____ Nuclear power
_____ Alcoholic beverages
_____ Motor vehicles
_____ Contraceptives
_____ Large construction
_____ Surgery
_____ Swimming

The League of Women Voters (LWV), a group of students, and experts in the field of toxicology also ranked these risks. Compare your ranking to theirs.

Activity	**LWV**	**Students**	**Experts**
Non-nuclear electric power	12	13	9
Smoking	4	3	2
General (private) aviation	7	11	12
Pesticides	8	4	8
Handguns	3	2	4
Bicycles	11	14	14
Medical X-rays	15	12	7
Motorcycles	5	6	6
Nuclear Power	1	1	15
Alcoholic beverages	6	7	3
Motor vehicles	2	5	1
Contraceptives	14	8	11
Large construction	10	10	13
Surgery	9	9	5
Swimming	13	15	10

Source: *Toxicology and Public Health: Understanding Chemical Exposure*. Appling, et al. 1987.

As you can see, there were large differences of opinion regarding risk. Factors that affect our perception of risk include whether we have control of the situation (driving a car versus exposure to fallout, for example), whether our participation in the action is voluntary or not, whether we can observe the risk, and whether the activity is familiar or new.

Do you think the benefits of driving outweigh the risks? Are you willing to take the risk of driving to get where you want to go? The same principle applies to the food we eat. We allow some risk so that there will be a quantity and diversity of food on the table.

How risky is it to eat bluefish, and how does the risk of eating bluefish compare with other risks we take in life? One researcher reports that the cancer risk associated with eating 1.4 pounds of fish containing the FDA tolerance of 2 ppm of PCBs in a year is about equal to the risk of smoking 1.4 cigarettes per year, or traveling 150 miles in a car in a year. In each case, there is about a one-in-a-million chance of dying.

Fish are not the only thing that people consume that may have a health advisory associated with it.

Aspirin, for example, has this warning:

"It is especially important not to use aspirin during the last three months of pregnancy unless specifically directed to do so by a doctor because it may cause problems in the unborn child or complications during delivery."

Beer carries this warning:

"According to the surgeon general, women should not drink alcoholic beverages during pregnancy because of the risk of birth defects. Consumption of alcoholic beverages may cause health problems."

Cigarettes carry this warning:

"Smoking by Pregnant Women May Result in Fetal Injury, Premature Birth, and Low Birth Weight."

Research at Work: Can the risks of eating contaminated fish be reduced?

Sea Grant specialists and researchers at Cornell University wanted to find out if the amount of PCBs in fish could be reduced through trimming and cooking procedures. If this were true, the risk associated with eating fish containing PCBs could be lowered. Some chemical contaminants are water soluble, and others are fat soluble. Since PCBs are fat soluble, their residues accumulate in fat and are associated with natural oils and fatty deposits in fish. Contaminant levels are measured by the federal government in samples of skin-on fillets that have not been trimmed.

For this experiment, bluefish were caught by a commercial fishing vessel off the South Shore of Long Island. Whole fish weighing five pounds or more were randomly selected from the catch, immediately frozen, and held in a frozen storage at -23°C until they could be shipped to Cornell University. Ten bluefish were randomly selected from the shipment to study the effects of fillet trimming. A standard fillet with the skin on was taken from one side of each fish. The fillet from the other side was trimmed to reduce the amount of fat. The standard and trimmed fillets were ground, mixed, and subsampled for PCB analysis.

Forty bluefish were randomly selected to study the combined effects of the trimming procedure and common cooking methods on PCB levels. One standard and one trimmed fillet were taken from each whole bluefish to make comparisons. Cooking procedures duplicated the commonly used household preparation methods, which included baking, broiling, frying, and poaching. Following cooking, the fillets were allowed to drain and cool before they were analyzed for PCBs. The oil drippings released during baking, broiling, and frying were also collected and analyzed.

This research demonstrated that for equal amounts, dry weight basis, skin contains about twice the amount of PCBs found in fillet muscle. Trimmed fillets had a significantly lower concentration of PCBs than standard fillets (skin on). The major portion of PCB contamination in bluefish appears to be associated with fatty deposits attached to the skin. There were no significant differences in the magnitude of PCB residues among the fillets cooked by any of the four methods.

Research conducted on other species of fish found similar results, as shown in the table below.

Table 1. Reduction of contaminants in fish by trimming fatty areas.

Species	Average Percent Reduction PCBs
Lake trout	50
Brown trout	43
Coho salmon	32
Chinook salmon	25
Smallmouth bass	64
Striped bass	60
American shad	44
Bluefish	44
Carp (skin removal only)	26

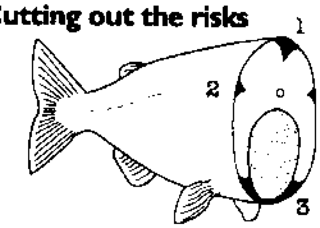
Source: *Contaminants in Sport Fish: Managing Risks.* Gall and Voiland, 1990.

Research at Work: Applying the results

One of the great pleasures of going fishing is coming home with fish to eat. Bluefish is a particularly tasty fish, especially when cooked right after being caught. Research has demonstrated that PCB levels can be reduced through trimming the fish properly. The location of fatty tissue that could contain toxic chemicals is shown in Figure A. Chemical contaminants are also likely to be concentrated in various internal organs. The internal organs of fish from potentially contaminated waters should never be eaten, and fish should be carefully handled and gutted to prevent these organs from contaminating other parts of the fish.

Figure A. Cutting out the risks.

Cutting out the risks

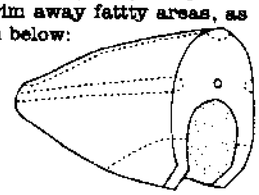


Toxic chemicals tend to concentrate in the fatty tissue, shown in the black above, found in the:

1) dorsal fin 2) lateral line

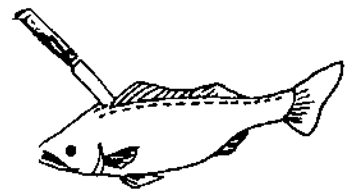
3) belly flaps

When cleaning fish, always skin it and trim away fattty areas, as shown below:

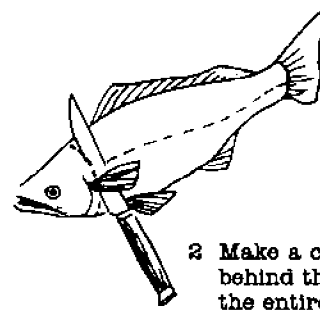


Source: Michigan Department of Public Health

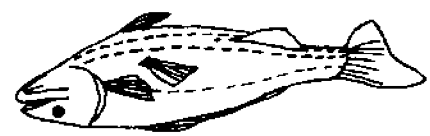
Figure B. The following trimming procedure will reduce fat soluble contaminants in fish:



1 Make a shallow cut through the skin (on either side of the dorsal fin) from the top of the head to the tail.

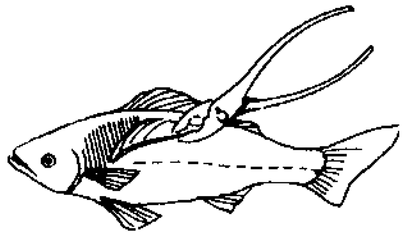


2 Make a cut behind the the entire length of the gill cover, cutting through the skin and flesh to the bone.

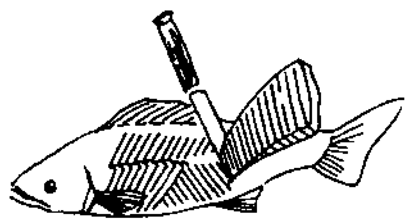


3 Make a cut along the belly from the base of the pectoral fin to the tail. This cut is made on both sides of the anus and the fin directly behind it. Do not cut into gut cavity.

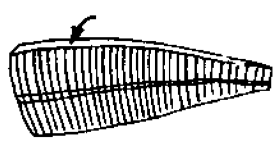
Adapted from NYSDEC, 1984. *Reducing toxics: Fish filleting guide.* Publ. No. FW-P116, Albany, N.Y.



4 **Grasp the skin at the base of the head (preferably with pliers) and pull toward the tail removing both the skin and the belly meat. If belly meat does not come off with skin, trim it off. Discard this trimmed material along with the skin.**



5 **Remove the fillet and repeat steps 2 through 5 for the other side.**



6 **Trim the two fillets as follows:**

a. Remove 1/2-inch strip from the top of the fillet and discard

b. Remove 1/2-inch strip (1/4-inch from each side of the lateral line) along the entire length of the fillet and discard.

7 **The four fillets are now ready to be cooked.**

When preparing fish that may contain contaminants, the following should be kept in mind:

- Trim off the fatty areas;
- Use cooking methods that allow fats to drain away, such as baking or broiling on a rack or deep frying;
- Avoid pan frying or making soups or chowders that contain fat-laden juices;
- Always discard dripping or cooking liquids from all preparation methods.

Scientific experiments have demonstrated that it is possible to reduce the risks associated with eating fish from contaminated waters. Have some fun, go out and catch some fish. Then practice the fish cleaning methods shown here. They are an example of science at work, helping to protect public health. If you are not able to catch your own fish, buy a whole one from a fish market on which to practice.

Note: The New York State Department of Health issues advisories for various kinds of fish in 40 different freshwater lakes and rivers. The New York State Department of Environmental Conservation (DEC) publishes these Department of Health advisories for many species of fish and for specific bodies of water. Contact your nearest DEC office for information regarding health advisories. Request the *New York State Fishing Regulations Guide,* available wherever fishing licenses are sold. People living outside of New York State should contact their equivalent state agencies for site-specific information.

Unit I Teaching Outline - Key Points to Cover with Youth Audiences

I. PCBs and Bluefish: Introductory Comments

A. Bluefish are the backbone of the recreational fishery in New York's marine waters, and an important commercial fish as well. Upstate, brown trout, Pacific salmon, and walleye are popular freshwater fish to catch.

B. Bluefish are large predatory fish weighing as much as 22 pounds, and they travel in schools.

C. In the mid-1970s, PCBs were found in bluefish, threatening the fishery. PCBs were found in other fish species as well.

D. Long-term exposure to high levels of PCBs has been linked to negative health problems such as cancer and reproductive harm.

E. The FDA established a tolerance of 2 ppm PCBs in fish and other foods.

F. New York State issues a health advisory regarding fish that contain contaminants; individuals make their own decisions regarding how much fish to eat.

II. Research at Work

A. Scientists at Cornell were interested in learning if the risks associated with eating bluefish could be reduced through trimming and cooking techniques.

B. Fish caught off of Long Island were analyzed for PCB contamination.

C. Research showed skin contained more contaminants than muscle.

D. PCBs accumulate in fat and natural oils in fish.

E. Removing skin and fatty tissue reduces contaminant levels and the health risks of eating bluefish.

III. Applying Research: Projects for Youth Groups

A. Discuss the concept of risk and weighing benefits to risks.
   1. Many things we do are risky, like driving cars, but we make decisions to take the risk when the benefits seem worthwhile.
   2. Do the risk ranking activity.
   3. Discuss factors that affect our perception of risk.

B. Take a fishing trip.
   1. 4-H Sportfishing Aquatic Resources Education Program (SAREP) volunteers can provide help if needed. They have information on teaching young people about fishing in New York.
   2. Contact your local Cornell Cooperative Extension 4-H Youth Development Program for information on SAREP.

C. Practice fish filleting methods described in this unit with your group.

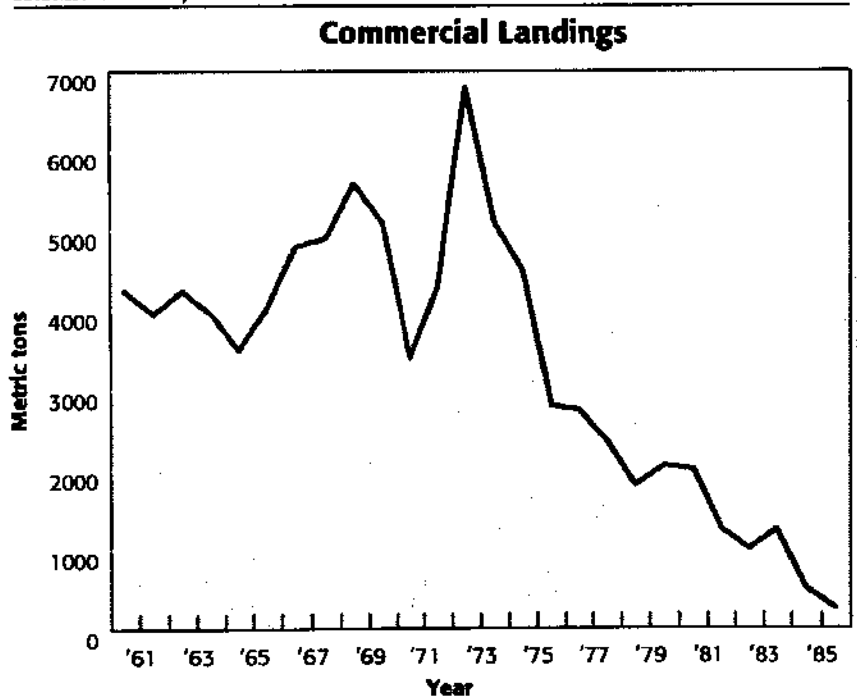
Unit II. Counting Striped Bass

Striped Bass in Trouble

The striped bass *(Morone saxatilis)* is a favorite fish of many people. They are large predatory fish positioned at the top of the food chain and they are aggressive carnivores. These fish travel in large schools feeding on other fish and invertebrates, especially crabs. The largest striped bass ever caught was landed in 1891 and it weighed 125 pounds. While it is unlikely that a fish that big will be caught again soon, 30-pound fish are commonly caught in the marine waters of New York and other states, often by surf casters. When a school of feeding striped bass swims by, the angling excitement can really pick up. Anglers love to cast for them in the surf. One of the most famous places to catch striped bass is under the Montauk Point lighthouse at the eastern tip of Long Island.

Striped bass are especially good to eat, and for this reason they are a favorite of commercial seafood harvesters. Until recently, the preferred method for catching striped bass by commercial operators on Long Island was with the haulseine. As a school of striped bass swim by, the crew encircles them with a net, and hauls them up on the beach. Recently, this method of catching striped bass was prohibited by the New York State Department of Environmental Conser-

Figure C. Reported commercial landings of striped bass along the Atlantic Coast, 1961-86.



Source: *Emergency Striped Bass Research Study Report for 1987*. US Fish and Wildlife Service, National Marine Fisheries Service. 1989.

vation. Commercial seafood harvesters now use gill nets to catch striped bass.

Striped bass begin their lives in fresh water. In New York State, the Hudson River is an important spawning ground. The Chesapeake Bay and its tributaries are another major spawning area. As the young fish grow older, they move from freshwater to saltwater. Fish from the Chesapeake often find their way to New York.

In the mid 1970s, the population of striped bass along the entire East Coast started to decline seriously (Fig. C). This was a great concern because this fish was so important to both commercial and recreational fishers. The 1980, commercial and recreational striped bass fishery produced over $200 million in economic output and employment for over 5,600 people in the 10 coastal states from Maine to North Carolina. If the 1970 fish population were still around, an additional $200 million in economic activity and 7,000 jobs would have existed in 1980.

The Anadromous Fish Conservation Act (anadromous means migrating up rivers from the sea to spawn in fresh water) was amended in 1979 to provide for an Emergency Striped Bass Study to discover what caused the decline, to monitor the population, and to evaluate the economic consequences. Scientists studying the problem hypothesized that as many as nine factors could have caused the striped bass populations to decline: 1) toxic contaminants, 2) starvation of larval fish, 3) overfishing, 4) predation of small fish, 5) unfavorable climatic conditions, 6) changes in water use practices that affected natural ecosystems, 7) increased competition with other species for food and space, 8) pesticides and fertilizers entering water, and 9) effluent from sewage treatment plants.

Since the situation was so serious, a ban on catching striped bass was instituted. This hurt many people economically, especially commercial seafood harvesters, charter boat captains specializing in striped bass fishing, and tourism industries related to fishing. The ban has helped the striped bass population to rebound somewhat, which supports the hypothesis that overfishing was one of the primary reasons for the decline in the striped bass population. Research is still being conducted on the other possible causes of this species' decline.

At times of resource shortages, conflicts often arise among people dependent on that resource. This has been true in the case of striped bass. Commercial and recreational fishers each want the right to catch striped bass and tend to blame the other group for the fish's decline. The use of haulseines has been banned, and in response, one group of Long Island commercial operators set a net as a protest. Several people were arrested. There is a movement now to make striped bass a game fish only, thus keeping commercial seafood harvesters out of the fishery completely. Understandably, the commercial fishing group opposes this.

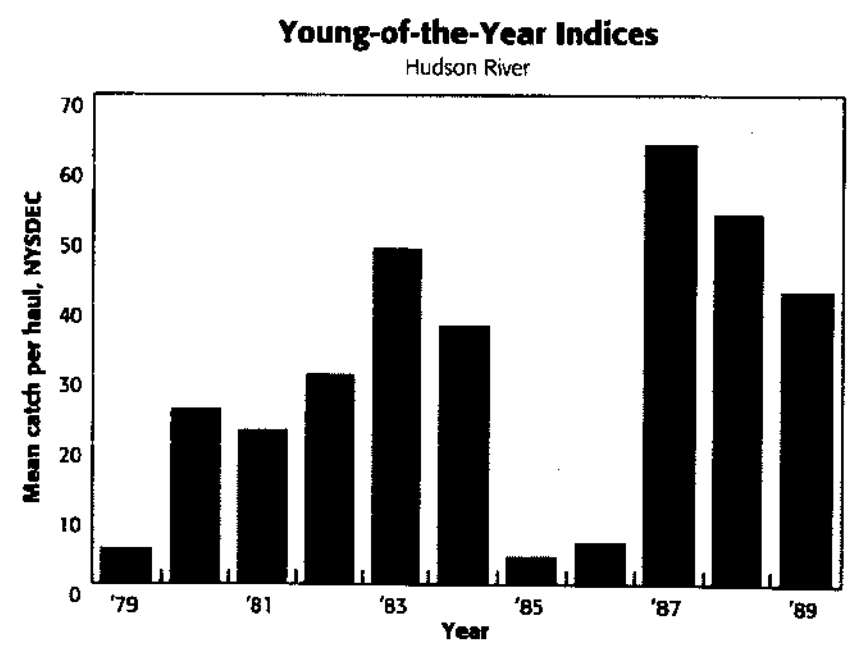
Research at Work: Monitoring the population

It is the job of fisheries managers to monitor the striped bass fishery. They need to obtain information on the population (is it growing, declining, or stable?) so that they can make management decisions. How many fish can be caught and still allow the population to survive is a primary question.

Since it is not possible to catch and count all the fish in an area, scientists must estimate their number. There are

(continued on page 14)

Figure D. Young-of-the year indices, Hudson River.



Source: *Emergency Striped Bass Research Study Report for 1981.* US Fish and Wildlife Service, National Marine Fisheries Service. 1993.

Striped Bass Cooperative Anglers

New York State Department of Environmental Conservation
S.U.N.Y. BLDG. 40, Stony Brook, NY 11790-2356
516-751-8200

Dear Angler,

Thanks for your interest in the New York State Department of Environmental Conservation's Striped Bass Cooperative Anglers Program. The information that you provide will aid in identifying the age and length composition of that portion of the striped bass stock utilized by recreational anglers.

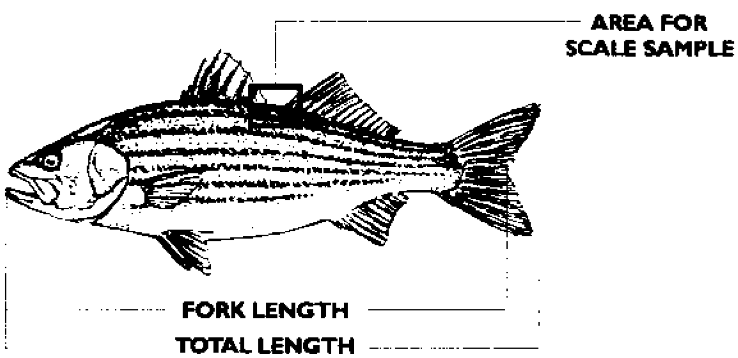
Following are "How to..." instructions for collecting the necessary information. Please take the time to look these items over. You'll find that the procedures are very simple. This is a "low tech" operation; after your first sample you'll see just how easy it really is. For fish scale collection envelopes, write or telephone the DEC at the address above. You'll need these to complete your project.

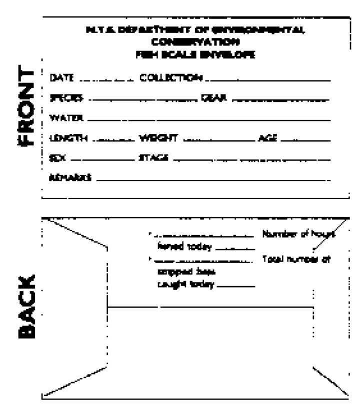
Keep a few things in mind:

- Samples can come from any size striped bass and any location.
- The removal of a few scales from the fish will not harm it. They will grow back.
- If a fish is too played out to endure handling, feel free to just release it. You decide what's best.
- If you go fishing and don't catch any stripers, fill out as much of the scale envelope as you can and send it in anyway. Just answer the question on the back of the envelope "TOTAL NUMBER OF STRIPED BASS CAUGHT TODAY" with "0" or "NONE." (We won't tell anybody ya got skunked!)
- For the latest info on fishing regulations, including those pertaining to stripers, dial 1-800-REGSDEC.

The SBCA program provides the angler the opportunity to participate in a fishery research project on its most important level, that of the data collection. A copy of the program's annual report will be mailed to each participant.

Your completed scale envelope(s) can be mailed to the address, or give us a call and we'll make arrangements to pick them up. Additional envelopes are available upon request.





How To Collect the Data

Remove Scales	-Using a knife, spoon, or tweezers, remove 10 to 15 scales from the area between the two dorsal fins and above the lateral line. Place them in the envelope.
Date	-Write in the month/day/year the fish was caught.
Collector	-Write in the name of the person submitting this sample.
Species	-STRIPED BASS!!!
Gear	-Write in the type of fishing gear used.
Water	-Write in where the fish was caught.
Length	-Write in the fork length and the total length.
Weight	-Write in the weight of the fish only if you used a scale. If you estimate, please make a note on the envelope.
Age	-Please leave blank.
Sex	-Write in male, female, or leave blank.
Stage	-Please leave blank.
Remarks	-Write in any observations. For example; condition of the fish, tag numbers, disease, time of day, tide. etc.

several methods available to fisheries people for estimating the number of fish and their status in an area.

The New York State Department of Environmental Conservation, in its striped bass study, uses several techniques to estimate fish populations, as do fisheries managers everywhere. One is called the young-of-the-year (YOY) survey. In this method, beach seines are set by boat from July through November. Captured fish are counted, measured for length, and environmental data such as water temperature, salinity, and dissolved oxygen levels are recorded. This method provides information on the number of YOY fish, and comparisons over the years provide information on the population. A growing population depends on the production and survival of large numbers of young fish. Figure D illustrates YOY data collected by fisheries researchers.

The ocean haulseine project samples for adult fish. The net used is 1,800 feet long, and the fish caught in it are held in a 400 gallon tank for study. Fish are measured for length and weight, and checked for tags. As in the YOY survey, information on physical and chemical parameters of the water is collected as well.

Tagging fish is another method used to estimate fish populations. Fish caught in the Hudson River estuary are tagged with a marker and released. Most recaptured fish are caught on hook and line (77 percent), followed by seine (8.8 percent), and gill net (7.1 percent). As tagged fish are recaught, it is possible to estimate the population size using mathematical formulas. The Peterson Estimate of the number of fish in the population is equal to the number of fish marked, multiplied by the total number of fish caught, divided by the number of fish recaptured.

Peterson Estimate:

$$\text{population} = \frac{\text{no. marked} \times \text{no. caught}}{\text{no. recaptured}}$$

Tagging also gives us information on where fish travel. Most were recaptured in New York (48.6 percent), New Jersey (17.3 percent), and Massachusetts (15.6 percent). Of the 6,777 tagged fish released between 1987 and 1991, 1,048 (15.5 percent) have been recaptured.

Changes in these indicators of fish abundance are used to adopt more- or less-restrictive management plans for striped bass. The monitoring process continues each year to provide fisheries managers with the information they need.

Participate in striped bass population monitoring work

As noted previously, fisheries managers use a variety of methods to determine the abundance of fish in an area. One method requires the help of people like you. This program, the Striped Bass Cooperative Anglers Program, was started in 1985. The information collected is used to monitor trends in the population of striped bass.

One important part of the program is collecting scales from fish for determining their age. Done properly, the fish are not hurt, and they grow new scales to replace the ones lost. Just as one can tell how old a tree is by counting its annual rings, a fish can be aged by counting the rings on its scales. The collected scales are placed in a special envelope and mailed to the DEC.

Other important information provided by the person catching the fish includes the length of the fish, and the date and location of capture. By knowing the age (from the scale) and the length, scientists can determine how quickly fish are growing, which is an indicator of the competition for and abundance of food. Cooperators also indicate the numbers of hours fished per day and the number of striped bass caught. This yields information on catch per unit of effort, another indicator of fish abundance.

When the DEC research staff receive the scales, they make impressions of them in cellulose acetate, which are easier to view on a microfilm projector while counting the rings.

Many people participate in this project, but more are needed! In 1991, DEC received 2,863 samples from volunteer cooperators. A sample copy of the letter of instructions to cooperators in the striped bass program appears on the preceeding page. Contact the DEC at the address indicated for the materials you will need to participate in the program.

Unit II Teaching Outline - Key Points to Cover with Youth Audiences

I. Striped Bass: Introductory Comments

A. Striped bass is an important commercial and recreational sportfish and both groups of fisherpeople prize this species.

B. Striped bass travel in schools, feeding on other fish and invertebrates, 30-pound fish are frequently caught in New York's marine waters.

C. The Hudson River is a major spawning ground for striped bass. Young fish eventually move to saltwater. The Chesapeake Bay is also a major spawning area.

D. Surf casting or fishing from charter boats or private boats with a rod and reel are techniques used by recreational anglers.

E. Commercial seafood harvesters use gill nets.

F. The economic worth of the fishery was over $200 million in 1980.

G. In the 1970s, the number of striped bass being caught dropped drastically, causing tremendous public concern; research programs were started to identify the cause of the decline.

II. Research at Work

A. It is the job of fisheries managers to monitor the striped bass fishery, and attempt to bring the population level back up.

B. Fisheries managers need information to make management decisions.

1. They need to estimate the number of fish that currently exist in a region.
2. They need to know the population trends—is the number of fish increasing, staying the same, or declining?
3. They need to estimate how many (if any) fish can be harvested without harming the population.

C. Fisheries managers use several methods to estimate fish populations, since it is not possible to actually count all of them.

1. Young-of-the-year surveys in rivers.
2. Ocean haulseine samples of adult fish.
3. Tagging fish for catch-and-release studies.
4. These surveys give estimates of fish populations.

III. Participating in a Striped Bass Survey

A. The New York State Department of Environmental Conservation needs volunteers for the Striped Bass Cooperative Anglers Program.

B. In this program, volunteers take scales off fish they catch and mail them to the DEC, and furnish information about fish they catch.

1. Fish scales have rings similar to tree rings, which can be counted to tell how old a fish is.
2. Comparing the size of the fish to its age, gives an indication of how rapidly fish are growing.
3. Cooperators also list the number of hours they fish. When compared to numbers of fish caught, this indicates catch per unit of effort, an estimate of fish populations.

IV. Going Fishing!

A. Follow closely the instructions provided by DEC on collecting samples.

B. Consult the Sportfishing Aquatic Resources Education Program or SAREP manual available from your local Cornell Cooperative Extension Education Center for tips on leading fishing trips and catching striped bass.

C. Contact your nearest Sea Grant Extension office for information on catch-and-release fishing.

Unit III. Gardening and Water Quality: Being a Water Quality Steward

The Need to Garden Carefully

The Long Island Sound is one of many estuaries in the United States that has been included in the National Estuary Program (NEP). An estuary is a place where fresh and salt water meet and mix. It is a biologically productive area, rich in diversity of plant and animal species, and a very beautiful place! After the Long Island Sound was designated an "Estuary of National Significance" in the NEP program, the Long Island Sound Study (LISS) was started to research, monitor, and assess the water quality of the sound. Over 8 million people live and work in the sound's watershed. Their wastes threaten the existence of the sound as a functioning ecosystem.

LISS found numerous environmental problems in Long Island Sound. According to this study, the problem of hypoxia (very low oxygen levels) in Long Island Sound is serious and getting worse. Indeed, hypoxia was found to be perhaps the most serious threat Long Island Sound faces. Hypoxia results from too much nitrogen entering the sound. When

Table 2. Possible ecological effects on Long Island Sound marine life exposed to certain ranges or levels of dissolved oxygen.

Dissolved Oxygen Concentration	Effect
0–0.5 mg/L	Inhospitable to living organisms other than sulfur bacteria
0.5–1 mg/L	Some benthic organisms can tolerate for a few days
0–2 mg/L	More than 90% of benthic fishes and lobsters absent
1.5–3.0 mg/L	Many pelagic early life stages die within exposure duration of 1–4 days
3–4.3 mg/L	25-50% mortality in some organisms in 96-h laboratory exposures. Lobster and fish catches reduced in trawl samples compared to well-oxygenated waters. Atlantic silverside threshold effect value for four-week early-life stage exposure (4.3 mg/L); effects possible at even higher concentrations
5.0 mg/L	Believed to be protective of most Long Island Sound marine life

Source: *Status Report and Interim Actions for Hypoxia Management*. Long Island Sound Study. US Environmental Protection Agency. 1990.

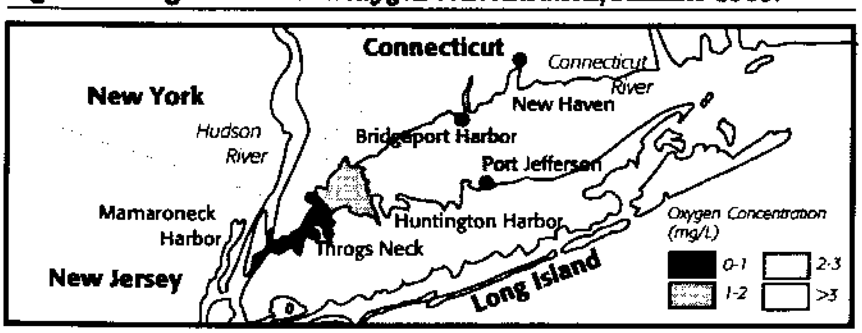
oxygen levels fall below 5 milligrams per liter, it is defined as hypoxia. Figure E shows the extent of hypoxia in Long Island Sound.

Nutrients such as nitrogen are necessary for the growth and survival of algae and other plants in the sound. Nitrogen has always been found in the sound, but in recent years the amount of nitrogen has increased dramatically. When too much nitrogen enters the sound, phytoplankton (unicellular algae) grow in excess of natural levels. When they die, they fall to the bottom and decay, using up oxygen. In the summer, the waters of Long Island Sound often stratify, meaning that cool, deep waters do not mix with warm surface waters. Therefore, oxygen cannot get to the bottom, and the decaying plants use up all the oxygen in the deep waters.

One important goal of the LISS is to increase dissolved oxygen levels in Long Island Sound. Reducing the adverse impacts of hypoxia that result from human activities can only be accomplished by reducing the amount of nitrogen that enters the sound. The primary sources of nitrogen are sewage treatment plants and runoff of rainwater that carries nitrogen (including fertilizers used by farmers and homeowners) to the sound.

To insure that the hypoxia problem gets no worse, LISS is proposing a "no net increase" policy for controlling nitrogen discharges. This means that officials will be encouraged to keep the level of nitrogen entering the sound from increasing any further. The goal for the future is to actually decrease nitrogen discharges by improving sewage treatment plants and reducing the amount of nitrogen entering in runoff from the land, including agricultural and residential lands.

Figure E. Long Island Sound oxygen concentration, summer 1989.



Source: *Long Island Sound Study Annual Report 1989/1990*. GPO 1991.

Putting Science to Work: Preventing hypoxia

While sewage treatment plants are the primary source of nitrogen entering Long Island Sound and many other bodies of water, runoff from the land carrying fertilizers is an important secondary source. Horticultural scientists have been working with Sea Grant specialists to reduce the amount of nitrogen and other potential pollutants (pesticides) from home landscapes and gardens that reach the sound and other water bodies.

To help people understand that fertilizers, pesticides, and even soil can wash off their property and cause water quality problems miles away, Sea Grant and Cornell Cooperative Extension began the "Environmentally Sound Gardening" program. The program teaches people that we all live in a watershed, and what we do on the land around our homes can indeed contribute to water pollution. Along the Great Lakes, the program was named "Great Lakes, Great Gardening." Along the Hudson River, it is called "River View Gardening." You may wish to contact your local Cornell Cooperative Extension or Sea Grant office to obtain information on how to garden "with an eye on water quality."

The key to environmentally sound gardening is to reduce the amount of potential contaminants introduced into the environment by over-fertilization and indiscriminate use of pesticides, and to minimize soil erosion and the amount of water that runs off property.

In this section, working individually or as a member of a group, you are asked to help protect water quality by working either at your home, your school grounds, or some other landscaped area. Your job will be to examine how water moves over your selected landscape, to look for signs of runoff, and to make changes in your landscape to retain water and reduce pollutant runoff. Your second job is to insure that the fertilizers and pesticides used on your landscape are applied in such a way that they do not pollute.

The environmentally sound gardening approach is to prevent soil erosion, thereby reducing runoff and contamination of coastal waters by:

- Planting ground covers, shrubs, and trees to promote infiltration of water into the soil;
- Covering bare areas as soon as possible;
- Directing water across vegetated areas to promote infiltration.

How can you determine if soil erosion is a problem on your property? A gully is obvious evidence of soil erosion. Look for these other signs:

- muddy or cloudy water in the driveway, roadway, or gutter following rain or watering,

- bare spots in lawns,
- newly exposed tree roots (however, some species do grow with roots near the surface),
- small stones or rocks appearing where none were before,
- small rills or gullies beginning to show,
- deposits of fine soils, usually in low-lying areas,
- soil splashed on windows and outside walls,
- widening or deepening of stream channels,
- fallen trees in stream channels,
- cloudy or muddy appearance of puddles.

If the soil is eroding, it is probably taking with it fertilizers and pesticides that have recently been placed on the land. In most neighborhoods, rainwater runoff eventually enters a storm drain, which frequently directs the untreated water directly into surface waters (pond, lake, bay, or river) or into the groundwater. Gardeners can help alleviate the runoff problem by reducing the volume of water leaving their property. Remember the ultimate destination of runoff from the land is either a pond, stream, river, lake, or coastal water body. Runoff can also contribute to groundwater pollution.

To control runoff, think about the path of rainwater. Runoff from roofs and paved surfaces can be deflected onto and spread over well-drained soil where infiltration will occur. Encourage retention and infiltration of runoff by:

- using gravel or paving blocks in low-lying areas where runoff may be detained, allowing it to infiltrate the soil more efficiently;
- using gravel seepage pits, a Dutch drain or a series of infiltration beds underlain by either a gravel or tile drainage system;
- using gravel trenches or French or curtain drains along driveways and pathways;
- terracing;
- directing runoff across vegetated surfaces; reseeding bare patches in lawn as soon as possible.

Perhaps you have noticed excess water entering the street and running into a storm drain when people are watering their lawns and landscapes. Proper watering is part of the picture for preventing water pollution. Overwatering, or the rapid application of water, can wash away soil, chemicals, and plant nutrients. Soaker hoses and trickle or drip irrigation systems are relatively efficient ways to apply water slowly and properly compared to standard sprinklers. These systems can reduce water use by as much as 50–80 percent. Turn off water at the first sign of puddling. Do not apply water at rates greater than 1/4–1/2 inch per hour. Use small measuring containers or a rain gauge to record the amount of water being applied. A lawn can generally use 1–1 1/2 inches of water once per week during hot, dry weather.

To reduce the need for water in the landscape:

- select plants that require less water for healthy growth;
- add organic matter to the soil to increase the water holding capacity and to allow for better air and water movement; compost is good for this purpose;
- consolidate plants requiring similar amounts of irrigation in specific sections of your garden;
- select a turfgrass like tall fescue that excels in low water conditions;
- mulch all landscape beds.

Remember:

- water deeply and slowly;
- water when needed, not according to a predetermined schedule;
- water only as fast as it can be absorbed by the soil.

Unit III Teaching Outline - Key Points to Cover with Youth Audiences

I. Water Quality Problems

A. The Long Island Sound Study identified key water quality problems in that particular body of water.

1. Low dissolved oxygen—hypoxia caused by too many nutrients entering the water—is seen as the primary threat to water quality.
2. Hypoxia is aggravated by too much nitrogen entering the water.
3. Too many nutrients and toxic materials entering bodies of water is an issue nationwide.

II. Keeping Water Clean

A. It is everyone's responsibility to use toxic materials carefully, and to dispose of them properly.

B. We all live in a watershed, what we put on the ground may enter a waterbody.

III. Preventing Runoff—A project for individuals and groups

A. Decide on a piece of land the group wishes to study - this could be a backyard, school yard, a local park, etc.

B. Take an inventory of the site looking for indications of:

1. Soil erosion.
2. Water running off the property.

C. Using *Sound Gardening* materials, develop a plan to reduce runoff and erosion.

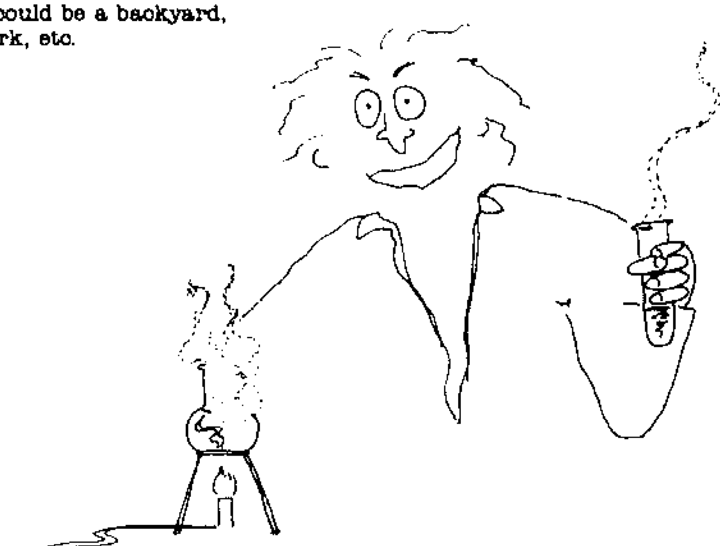
D. Implement as many aspects of your plan as feasible. It may take several years to implement them all.

E. Notify Cornell Cooperative Extension of your actions to receive recognition.(See instructions that follow.)

F. *Sound Gardening* materials that focus on Long Island's marine waters are available from N.Y. Sea Grant, 39 Sound Avenue, Riverhead, NY 11901, 516-727-3910.

G. *River View Gardening* materials appropriate for the Hudson River are available from N.Y. Sea Grant, 74 John Street, Kingston, NY 12401, 914-338-3494.

H. *Great Lakes-Great Gardening* materials are available from N.Y. Sea Grant, 21 South Grove Street, East Aurora, NY 14052, 716-652-5453



LANDSCAPE EVALUATION CHECKLIST

Look for these signs of soil erosion and water running off your property. Place a check mark by all that you can find.

____ muddy or cloudy water in the driveway, roadway, or gutter following rain or watering
____ bare spots in lawns
____ newly exposed tree roots (however, some species do grow with roots near the surface)
____ small stones or rocks appearing where none were before
____ small rills or gullies beginning to show
____ deposits of fine soils, usually in low-lying areas
____ soil splashed on windows and outside walls
____ widening or deepening of stream channels
____ fallen trees in stream channels
____ cloudy or muddy appearance of puddles.

Remember, if the soil is eroding, it is probably taking with it fertilizers and pesticides that have been placed on the land.

Now that you have located areas with eroding soil, you need to consider how you will prevent it. Some suggestions follow. The first group are landscape engineering activities. Place a check mark by those you plan to install.

____ using gravel or modular paver installed in low-lying areas were runoff may be detained, allowing water to infiltrate the soil more efficiently
____ using gravel seepage pits, a Dutch drain or a series of infiltration beds underlain by either a gravel or tile drainage system
____ using gravel trenches or French or curtain drains along driveways and pathways
____ terracing
____ directing runoff across vegetated surfaces; reseeding bare patches in the lawn as soon as possible

How you water and how you garden can also affect soil erosion and water runoff from your land. Place a check mark by all the gardening activities you plan to use to control soil erosion and water runoff from your site.

____ select plants that require less water for healthy growth
____ add organic matter to the soil to increase the water holding capacity and to allow for better air and water movement; compost is good for this purpose
____ consolidate plants requiring similar amounts of irrigation in regions of your garden
____ select a turfgrass that excels in low water conditions
____ mulch tilled areas
____ plant ground covers, shrubs, and trees to promote infiltration of water into the soil
____ cover bare areas as soon as possible.

If you wish to receive recognition from Sea Grant and Cornell Cooperative Extension for your efforts to control soil erosion and runoff, and to protect coastal water quality, answer the following questions:

1. Tell us about your site. Where is it located, who owns it, how large is it?

2. Tell us what indicators you found that water and soil were running off the property.

3. Tell us what steps you took to control and limit the amount of water and soil running off your property.

If you live in downstate New York, send this form to:
New York Sea Grant, 39 Sound Ave., Riverhead, NY 11901-1098.

If you live in upstate New York, send this form to:
New York Sea Grant; Farm and Home Center; 21 South Grove Street; East Aurora, NY 14052.

We will send you a water quality decal and certificate.

List names and addresses of all people involved with the project. If you need additional space, add an attachment. All people listed will receive decals and certificates.

Name	**Address**

Name **Address**

APPENDIX
for New York State Curriculum Teachers

The educational units described in this publication can be used to illustrate concepts in the *Science Syllabus for Middle and Junior High Schools*, and in some Regents science syllabuses. This appendix will assist educators to determine where to fit these units in existing New York State science syllabuses.

Unit I. Fish Contaminants

Biology Regents Syllabus

- page 9, Section B. Chemistry of Living Organisms, subheading b. Organic Compounds
- page 11, Section 2. Lipids, b. Lipids include fats and oils
- page 133, Section 5. Technological Oversight, a. Water Pollution

Science Syllabus for Middle and Junior High Schools

Block H - The Chemistry of Matter

- page 34, Section C. The Balance of Nature

Science Syllabus for Middle and Junior High Schools

Block D - The Earth's Changing Surface

- page 11, Section 4. Economic Importance of the Oceans.

Earth Science Syllabus (1970 edition)

- page 5, Section C-1.2 Environmental Pollution
- page 26, Section A-3.1 Sources of Pollutants, Section A-3.2 Types of Pollutants

Science Syllabus for Middle and Junior High Schools

Block A - Living Systems: Organisms

- page 37, Section 5. Wildlife Resources, a. Importance of Wildlife

Science Syllabus for Middle and Junior High Schools Block J - Science, Technology and Society

- page 22, Section 2. Technological Advantages and Disadvantages
- page 26, Section 3. Pollution from Toxic Wastes

Unit II. Counting Striped Bass

Biology Regents Syllabus (Reprinted 1984)

- page 132, Section 6. Human Activities, 1. Overhunting, 3. Exploitation
- page 133, Section 5. Technological Oversight, a. Water pollution; Section 2. Positive Aspects, b. Conservation of Resources

Living Systems - Organisms

Science Syllabus for Middle and Junior High Schools

Block A:

- page 33, Section C. Resource Conservation
- page 37, Section 5. Wildlife Resources

Unit III. Gardening and Water Quality

Biology Regents Syllabus

- page 123, Section C. Nitrogen Cycle
- page 130, Section IV. Biosphere and Humans, A.1. Negative Aspects
- page 132, Section 4. Poor Land Use Management
- page 133, Section 5a. Water Pollution
- page 133, Section 2b. Conservation of Resources

Science Syllabus for Middle and Junior High Schools

Block H - The Chemistry of Matter

- page 34, Section C. The Balance of Nature

Science Syllabus for Middle and Junior High Schools

Block D - The Earth's Changing Surface

- page 17, Section 2. Erosion

Earth Science Syllabus (1970 Edition)

- page 5, Section C-1.1 Environmental Balance; Section C-1.2 Environmental Pollution
- page 32, Section B-2.5 Effect of Man; Section B-2.6 Predominant Agent
- page 50, Section B-1.6 Man

Science Syllabus for Middle and Junior High Schools: Block A - Living Systems: Organisms

- page 10, Section 2a. Life in Water
- page 36, Section b. Methods of Conservation

Science Syllabus for Middle and Junior High Schools

Block J - Science, Technology and Society

- page 22, Section 2. Pesticides and Herbicides
- page 23, Section C. Technology and Decision-Making
- page 26, Section 3. Society and Responsibility

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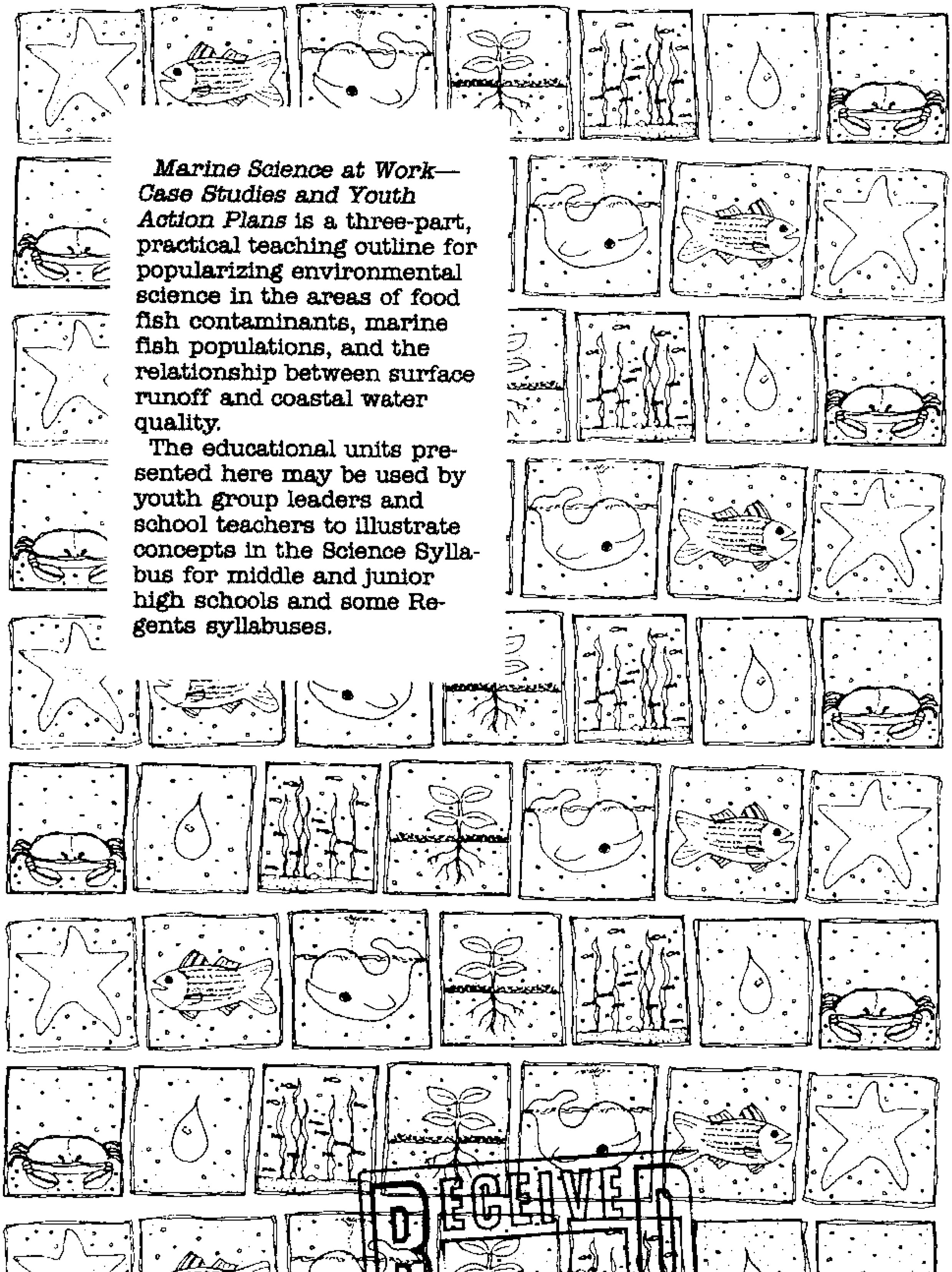

Marine Science at Work—Case Studies and Youth Action Plans is a three-part, practical teaching outline for popularizing environmental science in the areas of food fish contaminants, marine fish populations, and the relationship between surface runoff and coastal water quality.

The educational units presented here may be used by youth group leaders and school teachers to illustrate concepts in the Science Syllabus for middle and junior high schools and some Regents syllabuses.