TEACHER'S GUIDE

The

Harlem/Hudson

INTERPRETIVE PROJECT

A PILOT PROGRAM of the **NEW YORK CITY SOIL AND WATER CONSERVATION DISTRICT**

Funding provided by a grant from the
Department of Environmental Conservation's
Hudson River Estuary Grants Program.

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Introduction to the Program

This program focuses on a nationally recognized, important body of water: the Hudson River. Participants will learn about the river's ecology, history and relationship to New York City, Harlem specifically. Students and teachers will also learn the importance of monitoring environmental health through water testing, wildlife study and surveys in river use. Students will participate in activities to clarify the concepts of biotic/abiotic, the nature of water and the interdependency of living things. We will introduce plant and animal species that rely on the river and the food webs to which they belong.

This is not a solely water/science program. Elements of history, community and social justice will be addressed. The Hudson River theme will act as a vehicle to augment reading, writing, communication, science, art and technology skills in students. Classroom time with the New York City Soil and Water Conservation District educator and the pre- and post-visit materials implemented by the classroom teacher will spark discussion about Harlem/Hudson history, waste management and environmental ethics. These goals will be met by the presentations and programs described below.

This program is funded through a grant from the New York State Department of Environmental Conservation's Hudson River Estuary Grants Program, and is administered by the New York City Soil and Water Conservation District. The ultimate goal of this project is to establish a permanent Hudson River Interpretive Center for the community of West Harlem.

In order to accomplish this we have developed this educational program for local schools. The structure of this program easily allows for future collaboration with school, community and weekend programs.

Teacher training

Teacher development is the cornerstone of this program. Each teacher will attend a short workshop in order to be introduced to the program, see demonstrations, review the materials, and try out some of the activities. This program depends on active teacher participation and facilitation, and it is important for the teachers to reinforce the concepts brought into the classroom by the New York City Soil and Water Conservation District educator. Teachers will receive support materials to assist them in becoming active program partners. The primary resource is this Teacher's Guide written specifically for the program that includes background information and activities.

Pre- and Post-Activities

The Teacher's Guide will assist the teacher in becoming a master of the information. As an extension of the teacher/student experience, the Guide will provide the teacher with pre– and post-visit activities that represent an array of skill levels. These pre– and post-visit activities are designed to augment the classroom experience by encouraging students to experience the concepts in a variety of ways.

Students will receive journals to keep, targeting the literacy element of the program. Besides improving writing and communication skills, journals provide an outlet for personal expression, a forum for experimentation, and a window through which teachers and parents can see progress.

Classroom visits

A NYCSWCD educators will visit each classroom five times to introduce Hudson River ecology, historical points and related hands-on activities. They will knit the concepts of these activities together and generate excitement about the process. Students will participate in play-acting to help gain an understanding of tides, estuarine systems and food webs. Between visits, students and teachers will engage in the pre-and post-visit activities provided. Classes will participate in school water monitoring and handling live oysters.

Field Trip

The field trip is where it all comes together. Our field trip will take place at Riverbank State Park which is between 139th Street and 145th Street on the West Side of Harlem. Students will make observations, record data, discuss findings and manipulate scientific tools. Educators will lead the group in water testing exercises. Here, the classroom teacher and educators will team teach to reinforce the links with classroom exercises.

Assessment

Students and teachers will both complete pre- and post-program questionnaires assessing both their general knowledge and opinions on the Hudson River and its environment. Student portfolio reviews (writings, art work, journals) will be essential to gauge conceptual and topical understanding.

Family Programming

Biannually, during the spring and fall, the New York City Soil and Water Conservation District offers a Family Event in the Harlem area to reinforce the important issues concepts that surround the Hudson River within the Harlem community. Parents, caretakers and children of all ages are encouraged to attend this event, which will offer educational and fun hands-on activities to students. Previous events have covered concepts such as the food chains of the river ecosystem and have exhibited Hudson River animals for attendees to observe and touch.

Teacher's Materials Guide

NYCSWCD's Harlem/Hudson program links many ideas and concepts in science, language, history and art. The pre/post visit activities and background material which follows will assist the teachers in making the most of this program. In addition, we provide for free several terrific books for teachers and their classrooms.

The section of the Hudson that runs by along Manhattan is unique in that it has qualities of the ocean as well as a river. In fact, it is an estuary.

Golden Guides

The Hudson River represents many different environments which have not been described in field guides suitable for the novice. To solve this problem we've recommended two Golden Guides that suitably represent plants and animals found in both marine and freshwater environments. These books provide the basics of water ecology and also aid in mastering the field guide as a reference source. In some cases the pictures seem dated, but rest assured, they're still current and clear. Here are some sections to consider:

Pond Life

- p.10-16, The Characteristics of Water (includes diagrams)
- p.22-23, Food Webs.
- p.30-53, Aquatic Plants.
- p.74, Animals. The copepod and insect section is wonderful.
- p.122-128, Many Hudson River fish are described here.

Seashore Life

- p.4, A visual key that can help students learn how to use this type of reference book.
- p.14, An excellent shoreline illustration.
- p.16, Plankton.
- p.18-35, Algae.
- p.38, A highly simplified version of taxonomy.
- p.73-79, Crabs.
- p.81-136, Shelled invertebrates.

Eyewitness Books

This series is great to have around the classroom for students for free reading time. It is also great for teachers who want to brush up. Please note: many of the species discussed in this book and other books by DK/Knopf may be European species. However, this resource has far better photographs and more concise descriptions of the history and adaptations of animals and ecosystems than most others.

Pond and River

- p.22-27, Freshwater Fish. Our tidal Hudson has both freshwater and salt-water fishes .
- p.28-31, Birds.
- p.32-35, Reeds.
- p.60-61, Salt Marshes.
- p.46, Underwater Plants.
- p.48-51, Insects.
- p.58, The River's Mouth.

Fish

- p.6-11, What is a Fish?
- p.12-21, 24-31, Evolution and fish adaptations.
- p.22, Pipefishes and Seahorses. We have these in the Hudson.

General Information About Keeping Journals

Topics
Science, Language arts, Art; with extensions into other disciplines.

Skills
Writing, Reading, Drawing, Discussing, Observation.

Journals in the classroom can have many uses:

- Recording Scientific data
- Taking notes
- Keeping plant specimens
- Making drawings or sketches
- Recording thoughts or feelings
- As a scrapbook (photographs, keepsakes)

In this program we will utilize blank bound books as journals. Journals are a wonderful way to give children a sense of ownership during a project such as this. They also foster skills such as written and visual communication, data recording, and problem solving. At the end of the program, the parent, child and teacher have a complete record of what the child gained from the program.

During our first classroom visit, we will introduce journals and explain that we would like students to record/draw/write about the topics and activities in the Harlem/Hudson Program. Have the students personalize the covers right away, so they can see the connection between the program and themselves. Have them glue in related worksheets, parent/student assignments, and/or artwork where possible. Students may use field guides and other reference sources to identify unknown plants and animals, fungi, etc., they encounter.

Suggested materials:
Pencils, Colored pencils, crayons and paints. Field guides, Reference materials and web access should be on grade level, but professional books can also be used. Simply explain how experts may use these materials.

Optional materials for outdoor and nature journaling:
Hand lenses, binoculars, flashlight, gloves, something to sit on -- things that encourage students to get closer to examine small things and stay longer in the outdoors.
Introducing other media like magazine cutouts, fabric or the student's own photography is usually very successful.

Brainstorming Techniques
Introduce students to the idea of writing down what they see or hear in a nature journal by showing examples of your own or other's work in books. Explain that not only artists, but scientists, architects and individuals in many different fields use journaling to assist with their thought processes, problem solving, careers, and lives.

The part that most beginners have trouble with is that there really aren't any rules. Come up with a format. This may be something you can decide as a class. Some suggestions:

Date and time - This is a concrete item that everyone can agree on. Putting it down may set off some ideas about what is happening.

Place - Where are you? Is this a leaf in Riverbank State Park, or one in the classroom? Again, making a note of this may lead to further explanation and description.

Weather - Is it hot or cold? Do you know the exact temperature? How does this affect what you are seeing?

Focus! - Start out by drawing the most interesting thing. In some cases, this may be the hardest thing to draw (water, moving leaves). Tune in to details and write supporting words to describe what you are seeing.

Journaling Skills
Journaling can access many skills and disciplines, including language arts, earth science, social studies and art. For ideas, consult the concept web on the following page.

NATURE JOURNALING

Earth Science
- Plant Descriptions
- Insect Descriptions
- Bird Descriptions
- Trees/shrub Descriptions
- Discussion of Habitats and seasons

Weather
- Observations
- Identifications
- Measurements
- Comparisons

Social Studies
- Local History Discussions
- Comparisons between natural and human communities
- Discussions Environmental health in history
- Map making

Physical Education
- Descriptions of Walking and exploring
- Stories about Outdoor activities
- Hiking logs

Language Arts
- Written: poetry, fiction, non-fiction
- Oral learning: description, problem solving, communication
- Listening: writing about group
- communication, sharing

Math
- Measurements
- Charts
- Graphs
- Computation
- Map making

Art
- Drawing which hones Hand/eye skills
- Observational drawing versus imaginative drawing
- Learning to compose work supportively
- Different forms of art expression
- Map making

Suggested Journal Activities

For Activity 1: Now That's Living!

Materials
Markers/Crayons, Scissors, Glue, Enough photocopies of pg. 14 for the entire class.

Procedure
- Have students locate two blank pages in their journals.
- Label the top of one page *ALIVE* and the top of the other page *NOT ALIVE.*
- Each student should color the objects on their photocopied sheet.
- Have them cut the objects out and then glue the items on their appropriate page (Living things under *ALIVE*, non-living things under *NOT ALIVE*).

Variation
- Incorporate a neighborhood walk into this activity.
- Repeat the same procedure but instead of using the photocopied animals and objects, look for real things that are *ALIVE* and *NOT ALIVE* as the class walks around the block.
- Make sure that students record their findings on *ALIVE* and *NOT ALIVE* journal pages.

For Activity 2: Observation Station

Materials
Markers/Crayons/Pen or Pencil, A safe place outside such as the playground or the front of the school.

Procedure
- Have students quietly examine their surroundings for a few minutes.
- Encourage students to sketch what they see around them or record their observations in a list (i.e. Blue Car on street, bird in sky, empty coke bottle).
- Discuss with the class what they see.
- Return the next day.
- Have students review what they recorded in their journals and reassess their surroundings.
- Discuss: *How have things changed?, What is missing?, What is the same?, Does their journal record help?*
- Have students make a new sketch of their surroundings.
- Encourage the use of descriptive words and include lots of details.
- Record time of day and weather.

Variation
- Have students take their journals home and try an observation activity with an object of their choosing.
- Students should pick an object (Alive or Not Alive), and sketch a quick picture.
- Underneath the sketch students should describe the object's characteristics.
- Encourage the use of descriptive words. It also helps to establish parameters for description. Tell students to concentrate on characteristics like color, shape, texture, smell, size, unique quirks, etc.
- Have students describe their object to the class using their recorded descriptions.
- The class should attempt to guess the object's identity. As a clue, the student may show their sketch.

For Activity 3: Food Web Game

Materials
Construction Paper, Scissors, Markers/Crayons, Glue, Pieces of Grass or Flowers, Old magazines.

Procedure
- Have students design food chains in their journals (Encourage Creativity).
- First have students cut out plants, animals and people from the old magazines.
- Next have them draw, paste or otherwise create a sun (the foundation for all food chains) on a blank page of their journal.
- Have students glue grass, flowers or magazine pictures of plants onto the journal page to represent the producers of the food chain.
- Provide pictures of various animals, and brainstorm with the students. (*What eats plants? What animals eat other animals? What do humans eat?*) From there have students design the ascending links in the food chain.

Have students share and explain their personal food chains.

For Activities 4: River Research, 5: Bulletin Board or 6: My Hudson River

Procedure

- Have students brainstorm questions concerning the Hudson in their journals. Have them concentrate on what interests them, confuses them, or even scares them about the river.
- Encourage each student to generate at least three questions of interest. Have students share their questions with the class, perhaps other students share similar concerns.
- Students should pick one question to explore.
- Allow in class time for research using the internet, the reference materials provided by the NYCSWCD educator and the school library .
- Make sure students use their journals to record information, draw pictures or write down thoughts.
- Have students share their findings with the class.

For Activity 8: Oyster Extension

Materials

Plates, Oysters, NYCSWCD Laminated Oyster Diagrams

Procedure

- This is an extension of the NYCSWCD classroom visit dealing with oysters.
- Students should examine the oysters and generate questions.
- Students should sketch a picture of their oyster. Students should describe what they see, smell and touch in detail using descriptive words. Suggest that students pretend they must explain what an oyster is to a person who has never seen one.
- Use the oyster diagrams to help student imagine what the inside of the oyster looks like and how it functions.
- Discuss the habitat and lifecycle of oysters. Have students write a story or a poem about their oysters in their journals. Encourage creativity but establish certain parameters , i.e, Oysters live in the estuary, they eat plankton, they attach to substrate and are stationary, etc.
- Have students share their writings with the class.

Grading

If you wish to grade your student's work suggested rubric to use in journal grading is provided below.

Rubric:

5 Journal regularly contains detailed observations that include scientific terms or unusually abstract thoughts or predictions.

4 Regularly contains detailed observations with some evidence of abstract thinking or scientific terms.

3 Makes regular entries that contain some details

2 Makes minimal entries on an irregular basis with little or no detail

1 Makes no entries other than information provided by the teacher or does not bring journal to class more than 10 times.

SECTION TWO: PRE AND POST VISIT ACTIVITIES

Activity 1: Now That's Living!

Objective and Skills:
This activity should be done before Classroom Visit 3. When studying a complex ecosystem such as the Hudson River, it is essential that students begin with a strong foundation and understanding of living and non-living characteristics.

Students will differentiate and list the characteristics of living and non-living things. Students will list and compare the similarities and differences between living creatures e.g., plants and animals.

Materials:
- A wind up toy
- Books or blocks
- Living (Plants, [if possible] a live animal) and Non-living things (toys, rocks, and a plastic or fabric plant)
- FROG AND TREE DEVELOPMENT CARDS
- Old magazines
- Glue
- Large paper
- Markers
- *I Know What's Alive* Poem

Activity 1A: Discovering Different Kinds of Growth
Procedure:
- Using blocks or books put a small stack on the table and let students comment on the stack's size.
- Add more books or blocks to the stack.
- Ask students if the stack got bigger.
- Discuss the concept of growth, and how even though the stack increased in size, it did not grow on its own.
- Discuss how living things grow by themselves from the inside, requiring energy (fuel such as food, sunlight or water) to do so.
- Use the *BULLFROG AND TREE DEVELOPMENT CARDS* to explore the idea that the growth of living animals or plants involves more than just a change in size.
- Present the series of pictures in order. Have a discussion of what is happening in each picture.
- Mix the pictures up and ask the students to put them in the proper sequence.

Activity 1B: Discovering Different Kinds of Movement
Procedure:
- Show your students a wind up toy in action.
- Have them watch its movement and ask them whether or not it is alive.
- Explain to them that though movement is a characteristic of some living things, many non-living things, such as machines, are also capable of movement.
- Make sure students understand the distinction between the two. (Machines can move, but humans are in control of this movement. Machines don't grow or change by themselves. Machines do not reproduce, eat or breathe, other essential characteristics of living things).
- Make a list of possible movements or motions on the board.
- Identify living and non-living things that can perform these movements (i.e. A bird and a plane can both fly, but only one is alive, why?).

Activity 1C: Integrating Art
Procedure:
- Have groups of students pictures of living or non-living things from the old magazines.
- Have each group of students chose theme such as :
  - *What kind of non-living things do living things need?*
  - *All living things in this collage eat animals.*
  - *All the living things in this collage can make their own food (i.e. plants).*
  - *Non-living and living things in the students' homes or even the classroom.*
- Have each group explain their collage to the class.

Activity 1D: Characteristics of Living Things
Procedure:
- Review and make a poster size copy of the *I Know What's Alive* poem.
- Before class, set up a display of living and non-living things.
- Make signs for the following:
  - *Does it breathe?*
  - *Does it move?*
  - *Does it grow?*
  - *Does it eat and drink?*
  - *Does it hear, see, smell, touch and taste?*
- Try to have a live animal, a gerbil perhaps, in the classroom for the day.
- When class begins, read the "I Know What's Alive" poem.
- Focus your students' attention to your display of living and non-living things.
- Hold up the living plant and the plastic or fabric plant. Ask: *Which one is alive?*
- To help the students discuss the differences between the two plants hold up your signs *Does it breathe?, Does it grow?* and *Does it eat and drink?* one at a time.
- Have students answer each question for the plants.
- Show your students the human baby doll. Ask: *Is this alive? How can you tell?*
- Again, hold up your signs, adding, *Does it breathe?, Does it move?, Does it grow?, Does it eat and drink?, Does it hear, see, smell, touch and taste?*
- Then ask: *What can the real baby do that the doll cannot?*
- Using a large piece of paper or the Black Board, create a *Being Alive* list with your students, identifying the many functions or characteristics of living things.
- You may wish to provide the following characteristics, or encourage the students to make their own suggestions.

Characteristics of Living Things
- Living things grow. To do this they need food, water, air and sunlight.
- Some living things are plants while others are animals. Some living things *including people* eat both plants and animals.
- Plants take in water and nutrients through their leaves and roots to make food.
- All living things need to breathe or respire.
- Plants obtain air through holes in their leaves and stalks.
- Living things reproduce their own kind

Activity 1E: The Difference Between Plants and Animals

Procedure:

- Using the *BULLFROG AND TREE DEVELOPMENT CARDS*, select the adult or full-grown card from each group.
- Ask students what makes them alike and what makes them different.
- Make a list with students of all the things that make a plant different from an animal.
  For example:
  - A animals can make sounds to communicate with other animals.
  - Plants make no sounds.
  - Adult animals can breathe air with the lungs in its chest.
  - Plants have no lungs for breathing.
  - Many animals can move by themselves, while plants can not.
- Incorporate the concepts below to help students further distinguish the difference between plants and animals.

Being Alive-Animals

- Take in oxygen (O2)
- Eat and drink
- Grow
- Die
- Eliminate waste
- Need to rest
- Move/locomote
- Communicate
- See, hear, hear, touch, smell, taste (have senses)
- Reproduce (make more of their own kind)

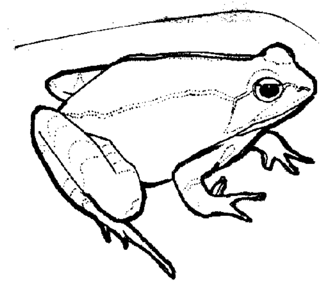
Being Alive-Plants

- Grow (from seed)
- Need nutrients and water
- Take in carbon dioxide (C02)
- Need sunlight (to make food)
- Can make more of their own kind (reproduce)
- Die

Extensions

- Have students look around the school or their home and find 5 living things. Students should either share their finds with the class or show them to a friend or family member. They should explain what characteristics their finds have which make them alive.
- Using an empty egg carton, fill the egg spaces with soil and then plant marigold seeds (or other easy to grow flower seeds) in some of the soil spaces. In the remaining spaces plant other objects like marbles or paper clips. Make sure that students water and care for their cartons. Keep a record. What happens?
- Ask students the question: *Do non-living things change?* Have students plan an experiment and report to the class.

Look at the pictures on this page.
Color the items that are ALIVE,
and circle the items that are NOT ALIVE.



I Know What's Alive

I know how to look at things, so come along with me.
We'll take a look at what's alive,
This time you will see.

'Cause I know what's alive
And you know what's alive
It takes some very special things to help some things survive.

I know what's alive
And you know what's alive
It will eat and grow –ooh!
And even make babies, too.

All living things will eat
They slurp it up, tear it, or even hold it with their feet,
They catch it in a tree or find it on the ground.
Even leftovers are yummy, if they can be found.

All living things will grow –oh
They start out being smaller, but before you know,
They get big and long and wise and tall.
Some look really different,
Others don't change at all.

All living things have young
Some have a dozen babies, others just have one.
Some babies are hatched like snakes and birdies,
Some are born kind of shaky then get really sturdy.

In the air or under the sea,
Crawling along – you can see
Running, eating, flying free,
The world is full of diversity!

You know there are so many living things to look at…
Why, oh, let me think there are…
[list everything you can think of!]

ADAPTED FROM "I KNOW WHAT'S ALIVE," PABLO PYTHON LOOKS AT ANIMALS, WILDLIFE CONSERVATION SOCIETY, 1996.

Activity 2: Observation Station

Objective and Skills:
This activity can be done any time before the field trip. Students will sharpen their observation skills while practicing a partner activity.

Materials:
None

Procedure:
- Divide students up into partners.
- Have students stand in two rows facing their partner.
- On your signal, have students turn their backs to their partner and direct them to change 1 - 5 things about their appearance (For example: turn up their collar, take glasses off, cuff pants, etc. Try not to give them too many ideas, as they will come up with plenty of their own after a few tries.)
- Signal again. Have the students turn around. Can students identify how their partner altered their appearance? Can they put it in to words? (i.e. no pointing)
- Repeat with varying pair-ups.

Activity 3: Food Web Game

Objective and Skills:

This activity can be done anytime between Classroom Visit 1 and 3. Students will be introduced to the concept of the interdependency of plants and animals of the Hudson River. Students will recognize the "energy pyramid" illustrated by this activity. Students will recognize that adaptations and relationships are necessary for a healthy ecosystem. This activity will strengthen students verbal communication, problem solving and cooperation skills.

Materials:

- Laminated drawings
    - Plants
    - Animals (carnivores to pollinators)
    - The sun
- Yarn
- Scissors.

Procedure:

- Begin with a brief conversation about the basic workings of living and non-living things.
- After the discussion, students should stand in a circle with the instructor.
- The instructor should be holding the laminated picture of the sun.
- Each student should select a picture. Be sure animals of all sizes, plants and the sun are represented.
- Have students look around the circle and notice the pictures which their neighbors hold.
- Ask: *Who has a card with something that is alive?, Who has a plant?, Who has an animal?*
- Stress the point that both plants and animals are very important in an ecosystem. Try to help students recognize that both these groups rely on the sun for survival.
- Begin with the sun.
- Ask: *Who here needs the sun?* Everyone should raise his or her hand.
- Ask: *Who needs the sun to make food*? Students holding pictures of plants should raise their hands.
- Hold the beginning of the yarn tightly. Choose a student who raised their hand during the previous question on the opposite side of the circle.
- Toss the yarn to the student.
- Pull the yarn taut across circle, and have the student wrap the yarn loosely around his/her finger.
- Then ask: *Who eats plants?* Students with pictures of herbivorous (plant-eating) animals should raise their hands.
- Have the student with the yarn pick a student who raised their hand correctly during the previous question.
- The student should toss the yarn to the chosen student, pull the yarn taut across circle, and have the other student wrap the yarn loosely around his/her finger.
- Then ask: *Who eats animals?*
- Repeat the previous yarn tossing strategy.
- Once the process has reached the top of the food, the instructor has two choices.
    - The final picture may "die" and decay, allowing other pictures to consume the remains (For example, crabs will often consume dead fish) OR
    - The teacher can start the process over by asking: *Who else needs the sun to make food?*
- Once all the pictures have been incorporated, then have the students talk about what they have created, an actual Food Web.

Extension:

- Explain to students or brainstorm with them, a scenario where something may become extinct or migrate due to the alteration of its habitat. Suggestions include:
    - The paving of a meadow to build a parking lot. This may remove grasses, bees, birds

- and more.
- A drought might dry up a local lake, killing the fish and other aquatic animals which live there.
- Excessive over-harvesting of timber may take away the homes of many small creatures like birds, snakes and squirrels.

- Make sure students understand that snipping a string of one member of the community may have effects on the entire community. Snip some of the web's strands and discuss this with the students.

BIODIVERSITY AND THE INTERDEPENDENCY OF LIVING THINGS ARE ESSENTIAL TO CONTINUE THE LIFE CYCLE OF AN ECOSYSTEM.

Activity 4: River Research

Objective and Skills:

This activity should be done anytime before or after Classroom Visit 1, and if possible before Classroom Visit 1. Students will learn about the organisms of the Hudson River and become familiar with the use of various reference resources. They will hone both their research, written, verbal and presentation skills.

Materials:

- NYCSWCD provided classroom books
- Library books
- Encyclopedias
- Field guides
- Internet (ex: www.enature.com)
- Laminated animal pictures

Procedure:

- Assign or have each student choose an organism from the laminated Hudson River animal pictures. Additional animals and plants can be found in a list in this guide.
- Students should use different reference materials to find out as much as they can about their organism.
- Talk students through the use of each of these different resources (library books, encyclopedias, field guides, the internet).
- Assign or have each student choose between writing a brief report, writing a poem, or creating a poster about their Hudson River animal.
- Students should present and explain their work to the class.

Extension:

- Present reports and poems in neighboring classrooms, hang the posters in hallway or hold an art show.
- Students can work in teams to create larger research-oriented presentations or art pieces.
- Have students research and design food chains or webs with the organisms they have chosen. They can then act out their food chains before the class.
- Students can use these same research resources to investigate the history of the Hudson River and their neighborhood. Have them write down the story of their neighborhood and present it to the class.

Activity 5: Bulletin Board

Objective and Skills:

This activity can be done before or after Classroom Visit 1. Students will become familiar with river ecosystems, especially focusing on the urban setting of New York City. This activity strengthens observation and research skills

Materials:

- Butcher paper.
- Markers
- Paints
- Stapler
- Glue
- Materials with textures, patterns and colors, such as:
    - Tissue paper
    - Cord
    - Yarn
    - Shiny magazine pages
    - Foil
    - Construction paper.
- Reference materials

Procedure:

Creating the Bulletin Board

- Cover a large bulletin board with butcher paper.
- Tell students they will create a bulletin board that depicts their neighborhood and the Hudson River.
- Start a Hudson River vocabulary list on the side of the board.
- Have students paint a background.
- Using the textured, patterned and colored materials, help students to create buildings, palisades, trees and bridges to attach to the bulletin board. Make sure roads and the water are included in the scene.
- Set aside a section for Riverbank State Park or Riverside Park.
- Include a map, current community events and contact information.
- Change and add materials and pictures as months and seasons change.
- As the classroom visits progress, have the students create and add all the Hudson River animals and environments they learn about to the board.

After the Field Trip

- Ask for suggestions or additions to the river bulletin board now that the students have been on the field trip.
- Each student should make at least one new item to place on the bulletin board.
- As students complete their animals, plants, people, forms of transportation, etc., discuss where in the river ecosystem they belong.
- Encourage students to remember what they actually saw at the river.
- Refer to journal entries and field study sheets.

Activity 6: My Hudson River

Objective and Skills:

Part 1 should be done after Classroom Visit 1 or 2. Students will communicate their knowledge of river ecosystems and their community through writing, speaking and art. Students will compare and contrast classroom and field experiences, helping them to strengthen their observation, verbal, written and creative skills.

Materials

- Construction paper
- Markers or crayons

Procedure:

- Have students draw what a river looks like.
- Make sure to save these drawings because the students will review them after the field trip.
- Have students write (on level) about what they think the field trip will be like.
- Encourage them to write about:
    - What the river/site will look like
    - What kind of animals or objects will be there
    - How they will feel.

After the Field Trip

- Have students review the previous drawings and the class bulletin boards.
- Ask them: *What is the same?, What is different?, Is there anything we need to add now?*
- Have the students review their predictions about the field trip.
- Ask them to write about what the river really looked like, what kind of animals they saw there and how the trip really made them feel.

Activity 7: Water Families

Objective and Skills:

Students learn about their neighborhood and local perceptions of the Hudson River and can be done before or after Classroom Visit 2. Students discover the "hidden" resource that is the older members of their family and community. This activity will strengthen verbal, observation, research and presentation skills. It can be done at home or in the classroom.

Materials:

- Pencil
- Paper
- Construction Paper

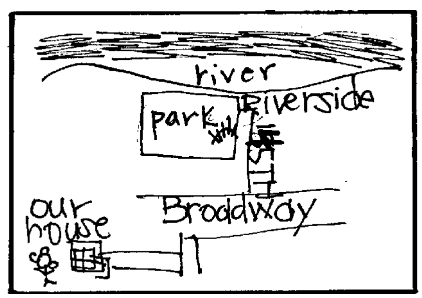
Activity 7A: The Neighborhood Times

Procedure:

- Brainstorm with the class and consider what questions can be asked to find out how people feel about the neighborhood and the Hudson River. Some questions may be:
    - *Were you born here?*
    - *How long have you lived here?*
    - *What has changed?*
    - *What has not changed?*
    - *Was there a seashore, river or pond that was special to you when you were a child?*
    - *What is your favorite place now?*
- Have students use the questions to interview an adult from their family or with supervision, a neighbor who has lived in the neighborhood a "long time."
- Students should write down the adult's answers and present the interview to the class.

Activity 7B: Family Mapmaker!

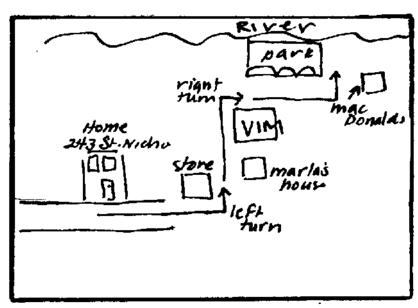
Procedure:



Sample Student Map

- This is an activity for an adult in the family and the student.
- They should sit down with two pieces of construction paper and a pencil.
- First, the adult gets a piece of paper and the pencil.
- The student, not sitting close enough to see the paper, should think for a moment and describe to the adult the best way to get from their home to the Hudson River.
- The student can use landmarks like a favorite store or a friend's house.
- The parent should draw the map as described by the student.
- Next, the two trade places. The parent should describe how they would get to the Hudson River, and the child should draw the map.
- Compare the maps. Does the student rely on landmarks or street names? How about the adult?
- Bring both maps to school.
- Have students explain to their classmates what happened when they did this activity at home.
- Try this for other places in the neighborhood.

This can be a very difficult activity, but the secondary and perhaps more important outcome is a discussion between parent and child about what they find important and/or familiar in their neighborhood. It also gives parents a turn at the project while allowing equal time for the student.



Sample Adult Map

Activity 8: Oyster Extension

Objective and Skills:

After the oyster classroom segment led by the NYCSWCD educator, you may wish to extend the oyster exploration on your own. Many students benefit by repeating the activity. Now they know what to expect, and some different lines of inquiry may surface. It also gives students more time to work in their journals and more closely examine the other creatures they may find among the oysters. As before, this activity will strengthen student's observation, description and recording skills.

Materials:

- Plates
- Oysters
- Access to running water
- Laminated oyster diagrams
- Journals and material for drawing or writing
- Flashlight – for getting a closer look (if available)
- Hand lenses or magnifying glasses (if available).
- A large tank of Hudson River water – if you wish to keep them for extended periods or want students to witness filtration.

Procedure:

- The teacher should initially repeat exercises as in the previous NYCSWCD visit.
- Have students examine the oysters and then draw a picture of what they see.
- Explore reasons the oysters exhibit certain characteristics.
- Try more extensive exploration and diagramming using the charts and diagrams provided as guides.

Extension:

- Try model making.
- Write a newspaper article on the event.
- Have the students write a story about their oyster and its habitat.
- Have interested students do personal research to discover more about the oyster's historical relationship with Manhattan and the threats it has faced throughout the previous century. Have them present to the class.
- Also try to find more information on the Web – this is a fun search for students.

For Advanced Labs and more Information :

The Maryland Sea Grant's *Oysters in the Classroom Oyster Anatomy Lab Segment*:

- http://www.mdsg.umces.edu/oysters/anatlab
- http://www.wsg.washington.edu/oysterstew/cool/oystercool.html

Things to Remember:

- Desks must be clear of any non-essential materials.
- The oysters are living things and deserve to be treated with care and respect. Mishandling may injure or kill them.
- Students must share with their neighbors - this includes hand lenses, diagrams and the oysters themselves.
- Once the oysters are distributed they may not leave their seats. If they have a question they can raise their hands to get assistance.
- Students will be handling oysters with their bare hands: They MUST refrain from putting their hands in their mouths or on their faces.

Activity 9: Water Testing

Objective and Skills

During the 5th classroom visit, the NYCSWCD educator will discuss the nature of water and introduce the tools that scientists use to monitor water quality. We will be using some of these very same tools during our field trip. Before the field trip, the class may practice field-testing protocols with the provided instructions and water-testing kit. These simple experiments will strengthen students' observation, recording, description and direction-following skills.

Materials:

- Water testing kit
- Tap water

Procedure:

- Follow the kit instructions carefully.
- Test for Dissolved Oxygen, pH, and salinity. (For more background information, see the Water Quality Monitoring section in this guide).
- Try water from other sources such as water from home, dishwater, puddles or rain water.
- Also try vinegar, cola, baking soda and ammonia (teacher only).

SECTION THREE: WATER QUALITY MONITORING PRIMER

Temperature

Dissolved Oxygen

Turbidity

pH

Salinity

The Nature of Water

The Properties of Water

Water is arguably the most valuable substance on the planet, and supports all life on earth. It is the common name applied to the liquid state of the hydrogen oxygen compound H_2O. It covers 75% of the surface of the Earth forming swamps, lakes, rivers, glacial ice and oceans. Pure water has a blue tint, which may be detected only in layers of considerable depth. It is transparent with no taste or odor. Water molecules are strongly attracted to one another through their two hydrogen atoms. At the surface this attraction produces a tight film over the water known as surface tension. A number of organisms live both on the upper and lower sides of this film.

The density of water is greatest at 39.2º Fahrenheit (4º Celsius). It becomes less as water warms and, more important, as it cools to freezing at 32º Fahrenheit (0º Celsius), and becomes ice. Ice is a poor heat conductor. Therefore, ice sheets on ponds, lakes and rivers trap heat in the water below. For this reason, only very shallow waterbodies ever freeze solid. The Hudson River rarely freezes as it flows by the New York City area because of its constant movement, tidal changes, and varying levels of salinity.

Water is the only substance that occurs at ordinary temperatures in all three states of matter: solid, liquid, and gas. In its solid state, water is ice, and can be found as glaciers, snow, hail, and frost, as well as ice crystals in clouds and across liquid water surfaces. It occurs in the liquid state as rain clouds formed of water droplets, and on vegetation as dew. In addition, liquid water occurs as moisture in the soil. Under the influence of gravity, water may accumulate in the openings of hard rock beneath the surface of the earth. These underground reservoirs of water are known as aquifers. This groundwater sustains wells, springs and some streams. As a gas, or water vapor, it occurs as fog, steam, clouds, and humidity.

Water and Living Organisms

Water can dissolve more substances than any other liquid, and for this reason it is called "the universal solvent." Oxygen, carbon dioxide, and nitrogen are absorbed from the atmosphere and then dissolved in water. Phosphates, chlorides and similar mineral salts are dissolved in agricultural or urban runoff and seepage water. Because of its capacity to dissolve numerous substances and in large amounts, pure water rarely occurs in nature.

Fifty to ninety percent of the weight of living organisms is water. The basic material of living cells, known as protoplasm, consists of a solution of water, fats, carbohydrates, proteins, salts and similar chemicals. Water acts as a solvent, transporting, combining, and chemically breaking down the substances. Blood in animals and sap in plants consists largely of water and serves to transport food and remove waste material. Water also plays a key role in the metabolic breakdown of such essential molecules as proteins and carbohydrates. This process, called hydrolysis, goes on continually in living cells.

The transparency of water permits enough light to penetrate for plants to carry on photosynthesis. The depths to which light can penetrate decrease as water contains more suspended materials and becomes turbid (or less clear). Less light means fewer plants can grow, thus attracting less wildlife. The shadows cast by piers and large buildings on the shoreline create a similar situation.

Oxygen in Water

Oxygen and carbon dioxide are passed back and forth between plants and animals and their environment. The proportion of these gases in the atmosphere is generally constant: oxygen, 21%; carbon dioxide, 0.03%. In the water of rivers and estuaries, the proportion may vary greatly, even from night to day. Oxygen, which is necessary for the survival of all plants and animals, is quite soluble in water, but the amount dissolved in fresh water is much lower than the atmosphere. Oxygen from the air is absorbed slowly, but the process is speeds up when wind and waves disturb the water surface (This would create higher dissolved oxygen, or DO readings, during water testing). Also, cooler water holds more dissolved oxygen.

During the day, when sunlight penetrates the water, plants give off oxygen as a byproduct of photosynthesis. This oxygen is produced more rapidly than it is used in respiration by plants and animals. Thus, a reserve of oxygen builds up. In darkness, when photosynthesis stops, both plants and animals use this oxygen. For this reason the oxygen content in shallow water varies greatly in a 24-hour period.

Carbon Dioxide in Water

Carbon dioxide, more soluble in water than oxygen, comes both from the decay of organic material and from respiration of plants and animals. Some is also contributed by groundwater and from the atmosphere, either directly or with rain. Plants use carbon dioxide in photosynthesis. Near the bottom of deep water the amount of dissolved carbon dioxide may be quite high. Few plants and animals can survive in this region due to the lack of light and oxygen. At such depth, there is no photosynthesis, only decomposition.

Carbon dioxide is also important in determining water's pH—its degree of acidity or alkalinity. It combines with water to form weak carbonic acid, which can react with limestone or dissolved lime, if present, to form carbonates and bicarbonates. These compounds are indirect sources of carbon and serve also as "buffers" that regulate pH. The pH of water helps to determine what animals and plants live there. For example, mollusks with limy shells cannot live in acidic waters.

Water Cycles

The amount of water we have on the earth is the same amount we have always had – no more – no less. This water has cycled and will continue to cycle through the natural processes of living organisms and the earth itself. This continuous movement of water between the Earth and the atmosphere is known as the hydrologic cycle. Under several influences, of which heat is predominant, water evaporates from the surface of the earth and transpires from living organisms. This vapor circulating through the atmosphere is condensed in clouds and then precipitated in the form of rain or snow.

During these cycles water can get trapped for long periods in glaciers, clouds or aquifers (underground rivers). During condensation and precipitation, rain or snow absorbs varying amounts of carbon dioxide and other gases as well as traces of organic and/or inorganic material from the atmosphere. In addition, precipitation may absorb SO^2 (sulfur dioxide), a product of fossil fuel combustion. This is better known as acid rain.

Upon striking the land, water follows two paths. It may flow directly as surface runoff into streams and rivers and then into oceans and landlocked bodies of water or it may drain directly into the soil, a process called infiltration. Portions of infiltrated water will become soil moisture. This may eventually be evaporated directly or it may be taken up by the roots of vegetation to be transpired from the leaves. Water that overcomes these two previous forces percolates downward, accumulating as ground water. The surface of underground water accumulation is known as the water table.

Under natural conditions, the water table rises intermittently in response to replenishment, and declines as a result of continuous natural drainage into natural outlets such as springs or artificial pumping. This process is drastically interrupted in urban areas by streets, sidewalks, buildings and sewer systems, where water can not infiltrate into the soil. Urban areas increase runoff by decreasing percolation and also increase runoff contamination (by sweeping up chemicals, trash and other pollutants from city sidewalks and streets). Eventually this run off discharges into the Hudson River.

Our Water Supply

Lately we hear of drought and the scarcity of water not only in the desert regions of the world, but right here in New York City. Sometimes this is hard to understand especially when we experience many snowy or rainy days. However, drought is a cumulative problem, and the metro area has experienced technical drought conditions for over 6 years, due to fluctuating weather patterns and global warming as well as waste and human abuse. Water is not as useful when it is polluted, salted (as in the ocean), or trapped within other living systems, like the family pet, or a rose. This leaves only a small percentage of drinkable (potable) water available for people. That is why we must work hard to both conserve and preserve our water resources.

General Characteristics of Rivers

A river is a stream of water larger than a brook or a creek. Land surfaces are never perfectly flat, and as result the runoff after precipitation flows downward by the shortest and steepest course in landscape depressions. Runoff with a large volume and velocity will form a stream which will erode the underlying rock and earth beneath it, creating a bed. It becomes perennial when it cuts deeply enough to be fed by ground water or when it has as its source an unlimited water reservoir, for example, the St. Lawrence River flowing from the Great Lakes.

The lowest level to which a river can erode its bed is called base level. Sea level is the ultimate base level but the floor of a lake or basin into which a river flows may become a local and temporary base level. Cliffs or escarpments as well as differences in the resistance of rocks create irregularities in the bed of a river and can thus cause rapids and waterfalls. Over thousands of years, a river tends to eliminate irregularities and to form a smooth gradient from its source to its base level (or mouth). As it approaches base level, downward cutting is replaced by lateral cutting; the river widens its bed and valley. It develops a sinuous course that forms exaggerated loops and bands called meanders. A river may open up a new channel across the arc of a meander, thereby cutting off the arc and creating an oxbow lake.

Rivers modify topography by deposition as well as erosion. River velocity determines the quantity and size of rock fragments and sediment carried by the river. Velocity is often slowed by changes in the direction or depth of the river. This happens when the river body meets another water mass such as a lake or ocean, or when the river overflows due to large volumes of water. When this occurs part of the load carried by the river is deposited in the riverbed or beyond the channel. Landforms produced by such deposition include deltas, flood plains and channel bars, as well as alluvial fans and combs.

The discharge of a river, known as the rate of outflow, depends on the width of its channel and its velocity. Velocity is determined by the volume of water, the slope of the bed, and the shape of the channel (which determines the amount of frictional resistance). River volume is affected by duration and rate of precipitation in the drainage basin of the river. A river system may be enlarged by piracy. Piracy occurs when one river, cutting through the divide that separates its drainage basin from that of another river, diverts the waters of the other river into its own.

Traditionally, river systems have been classified according to their stage of development as young, mature, or old. The young river is marked by a steep sided valley, steep gradients, and irregularities in the bed. The mature river is marked by a valley with a wide floor and flaring sides, by advanced headward erosion by tributaries, and by a more smoothly graded bed. The old river is marked by a course graded to base level and running through a peneplain, a broad flat area (very low relief and very gentle slope). The age classification of rivers is diminishing in popularity now that quantitative studies of river behavior are more common.

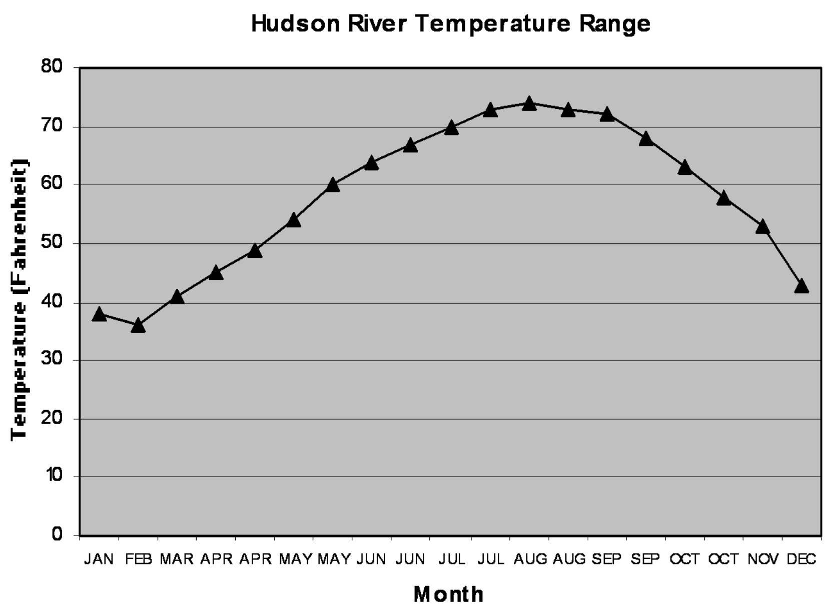
Temperature

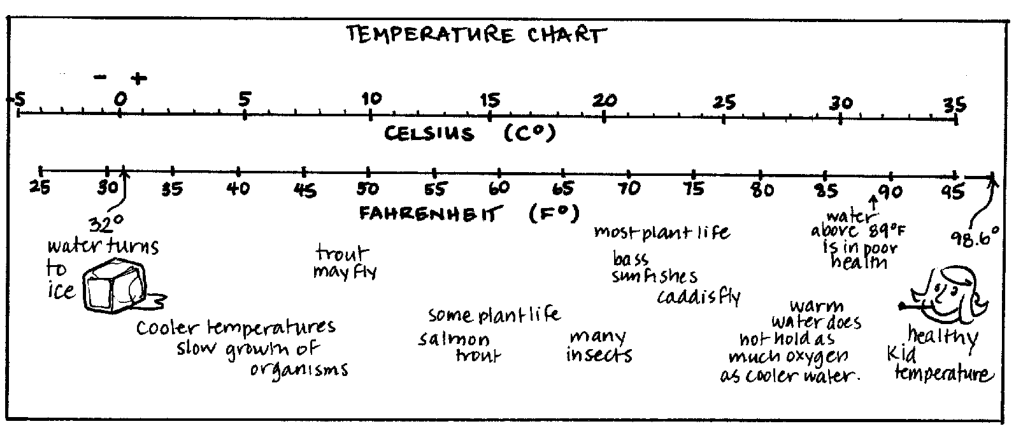
Temperature is commonly measured on two different scales, Celsius and Fahrenheit. The one we use most frequently in the United States is Fahrenheit. The graph below compares the two scales. To mathematically convert temperature Celsius to temperature Fahrenheit, multiply the Celsius temperature by 9/5 and add 32°. For example, when converting 37° C to Fahrenheit, one would multiply 37 * 9/5 = 333/5 = 66.6 66.6 + 32 = 98.6° F. So, if it is a very hot day in the city, it might be 98˚ Fahrenheit or 37° Celsius.

Water temperature is one factor in determining what species may or may not be present in a water body. Most aquatic organisms have adapted to survive within a specific water temperature range and many organisms cannot tolerate extremes of heat or cold. Temperature affects the feeding, reproduction, and metabolism of aquatic animals. Fish larvae and eggs are usually more sensitive to temperature than adult fish. Temperature also affects oxygen levels in water. Warm water holds less oxygen than cool water and thus directly affects the amount of oxygen that is available to aquatic organisms. Cold water is also denser than warm water and sinks to the bottom, creating a temperature difference between the surface and bottom water layers.

Water temperatures in the Hudson River generally drop to 32°F during the months of January and February, and they gradually increase after February to eventually reach the maximum temperatures of 77°F-79°F in August. Water temperatures drop gradually along the estuary toward the ocean end of the river at the Battery. During the summer months, June, July, and August, the water temperatures at the Battery are generally 3°F-6°F lower than the maximum temperatures which occur throughout the estuary.

People can negatively impact the health of a body of water through thermal pollution. Thermal pollution is caused when warm water is added to a waterway. Thermal pollution occurs in built up areas where buildings, parking lots, and sidewalks trap heat and warm up the rainwater that runs off of them. The warm water runs into storm drains and into local waterways. The temperature of river water also increases when some industries and power plants use water to cool machinery and then return warm water back to the river. Smarter city planning can prevent this run off while maintaining adjacent forestation can shade the river from the sun and help keep it cool.





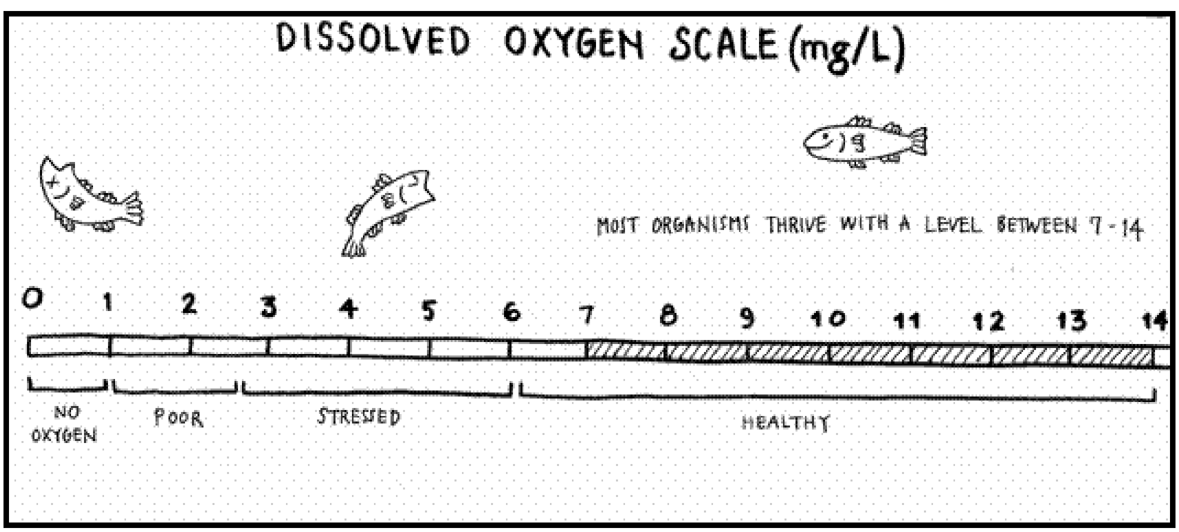
Dissolved Oxygen

Water absorbs or dissolves many substances including oxygen. The presence of oxygen in natural water is a healthy sign and the absence of oxygen may be a sign of severe pollution. All plants and animals respire oxygen, which is essential to the health of aquatic ecosystems. Some fish species, like trout, require high levels of dissolved oxygen in the water to live, while other species, such as carp and catfish, flourish in conditions of low dissolved oxygen levels.

Most oxygen enters water from the atmosphere. Also waves and wind, as well as waterfalls and rapids, mix air and water together, thus adding oxygen. In aquariums, bubblers and diffusers do the same thing but on a smaller scale. In water treatment plants, water is often sprayed into the air like a fountain to add more oxygen to the water. Aquatic plants also add oxygen to the water during photosynthesis.

Aquatic organisms require different amounts of dissolved oxygen. Levels of 5 parts per million (ppm) are usually required for the growth and activity of aquatic organisms. Parts per million is a unit of concentration used when measuring substances in air, water or other fluids and is equal to the more common measure mg/liter. For example, four drops of dye in a 55 gallon container of liquid, produces a dye concentration of 1ppm. Most organisms thrive on dissolved oxygen levels between 7ppm to 14ppm. Cooler water always holds more oxygen. Dissolved oxygen levels below 3ppm are stressful to most aquatic organisms and dissolved oxygen levels below 2ppm will not support fish survival. Animals that can migrate will leave areas of low dissolved oxygen.

Dissolved oxygen in rivers is reduced by a high amount of organic waste. Organic waste can enter rivers as sewage or urban runoff, including runoff from over-fertilized lawns, as well as discharge from food processing plants, meat packing houses and other industrial sources. One of the largest contributors of organic matter in the estuary is the algae in the system. As bacterial decomposers break down all this organic matter and waste, they respire large amounts of oxygen in the process and thus deplete the water of its store of dissolved oxygen.



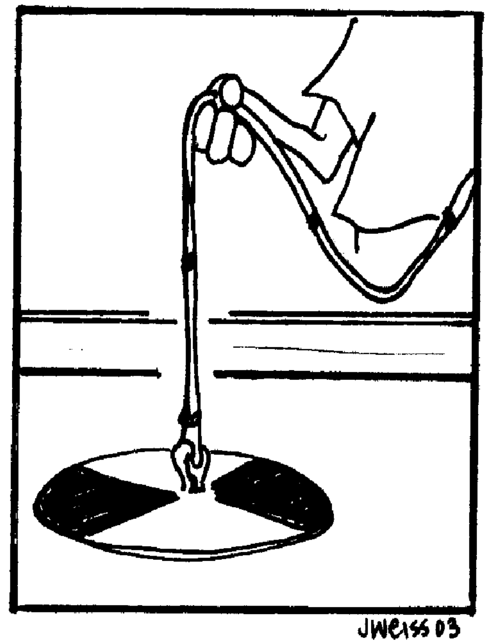
Turbidity

Turbidity is the measure of the relative clarity of water. Turbidity should not be strictly associated with color or pollution. Turbid water is caused by suspended matter such as clay, silt, organic and inorganic matter, and microscopic organisms, which all reduce the amount of light in the water. Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances. The Hudson River is a naturally turbid water body and is normally cloudy, not crystal clear due to the sediment which washes into the river from the upstream watersheds.

For our program we will use a Secchi disk to measure turbidity. The Secchi disk provides a very simple means of making transparency determinations in natural waters. Water that is clear has a high transparency. Transparency usually decreases in the summer when plankton, silt and organic matter are more likely to be prevalent.

The Secchi disk is a black and white circular plastic plate, 20cm in diameter. A measured line is attached to the center of the disk which stabilizes it parallel to the water surface. Measurements are taken by lowering the disk into the water until the black and white pattern on the disk is no longer discernible. The recording the length of the rope from the submerged disk to the water's surface, is recorded in either feet or meters, as the Secchi depth.

Highly turbid waters will have short lengths because the disk will disappear relatively quickly in the cloudy water. Waters with relatively low turbidity will have long lengths because the black and white pattern will remain discernible for greater depths in clear water. Best results are obtained in the shade of a boat or dock in the late morning or early afternoon.



Secchi Disk

LOW ——	HIGH TRANSPARENCY READING	—— LOW
UNHEALTHY	HEALTHY	UNHEALTHY
brown, cloudy from erosion sediment. Yellow – sulphur runoff from industrial site. other unnatural discoloration.	Water is clear and allows sunlight to penetrate. This helps plants grow and make food.	green water may mean too many nutrients from fertilizer or other sources. This causes excess algal bloom.

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pH

“pH” measures the hydrogen concentration (H^+) in water and other substances. The value tells us how acidic or basic a substance is. It is measured on a scale, which normally ranges from 0 to 14. Acids, like lemon juice, are normally very sour-tasting and strong acids can badly burn skin. Bases are very slippery to the touch (soap), bitter tasting, and like acids, strong bases can badly burn your skin. Battery acid is very acidic with a pH of almost zero. Bleach is very basic with a pH of 12.6. The neutral pH, pH 7, is at the middle of the scale. It is neither acidic nor basic. Distilled water has a pH of 7 because there is nothing dissolved in it.

Human blood has a pH of approximately 7.4. Normal rain, sleet or snow may have a pH as low as 6. Tap water may read up to 8 if it has been treated to protect pipes from corroding. Acid rain and snow are formed when moisture in the atmosphere combines with pollutants from automobile and coal fired power plant emissions. The areas hardest hit by acid rain are those downwind of urban and industrial areas. Acid rain, with a pH of less than 6, damages buildings, statues, forests, rivers and streams.

The pH of water is critical to aquatic life. Most organisms are used to living in water with a specific pH and may die if pH levels change even slightly. A range between a ph of 5 to 9 is optimum for most organisms.

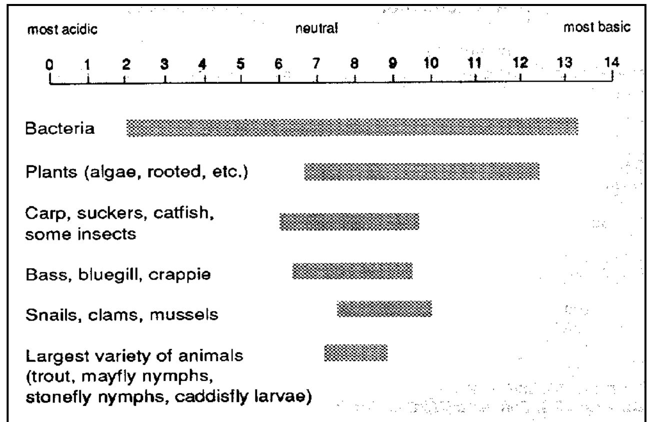
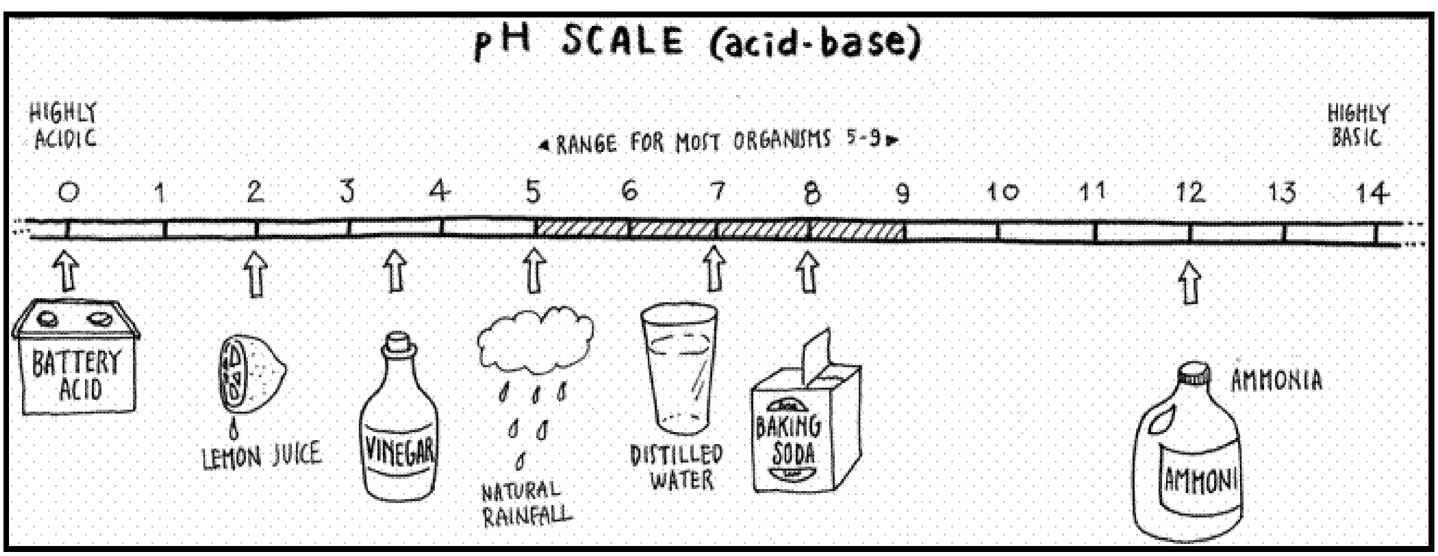


Figure 3.12. pH ranges that support aquatic life.



Salinity

Salinity is the concentration of dissolved salts in water. It is an important factor in marine and estuarine habitats, and pivotal to our Hudson River estuary. Aquatic animals are adapted to living in certain salinity ranges. Sunfish, for example, are common in ponds and freshwater streams, but cannot survive in salty water. Animals that live in salty environments tend to be more tolerant of wider salinity ranges. Some species of fish migrate from salt to fresh water to reproduce.

Weather can affect the salinity of the water, especially on the surface. After a rainstorm, surface water may have a lower salt content, where as readings from deeper water may have a higher salt content because fresh water is lighter than salt water.

Salinity, like temperature, affects the amount of dissolved oxygen in the water. At high salinity levels, molecules of salts take up more space between water molecules, so there is less space for oxygen molecules.

Salinity is measured as a ratio of salts to water, and is expressed in parts per thousand (ppt), which means the number of units of salts per thousand units of water. There are three main categories of salinity: fresh water (0 – 0.5 ppt), brackish water or partly salty (0.5 – 30 ppt), and salt water or full seawater (above 30 ppt). When studying an estuary, such as the Hudson River's, scientists divide it into many different salinity zones. The Hudson River Estuary is fed with fresh water from the north, and seawater from the bay. With this wide range of habitats, it supports an abundance of life.

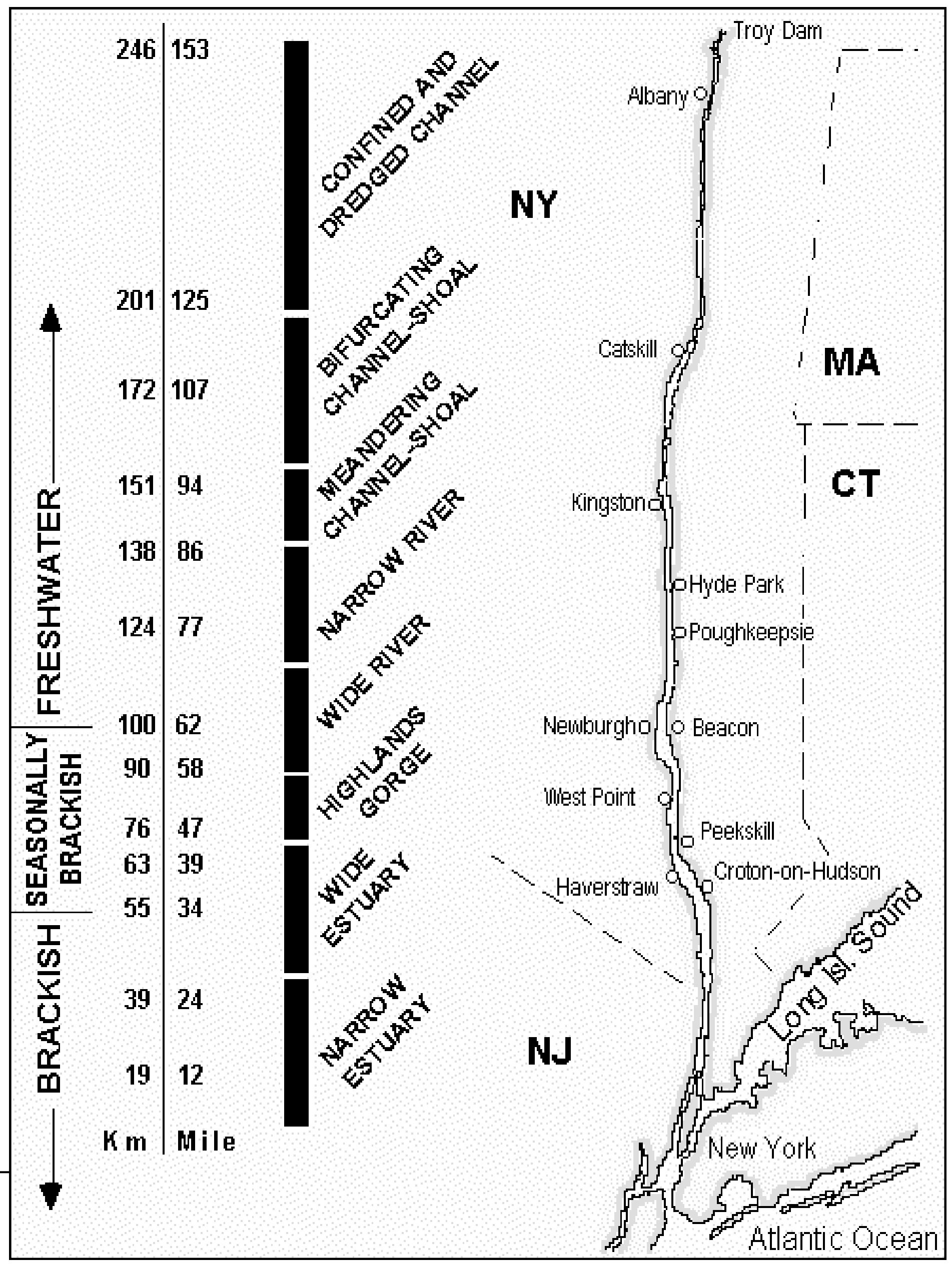
The area of the Hudson River which is considered estuarine stretches from the Battery at the tip of Manhattan all way to the Troy Dam in Albany. The estuary is distinguished by the amount tidal influence in the area and the salinity of the water. The major regions of the estuary from least saline to most saline are:

Poughkeepsie to Troy: Waters with salinity between 0 and 0.5 parts per thousand (ppt). These areas are at the extreme reach of tidal influence.

Newburgh/Beacon to Poughkeepsie/Hyde Park: Waters with salinity between 0.5 and 5 ppt. These areas are typically in the upper portion of an estuary.

Haverstraw to Newburgh/Beacon: Waters with salinity between 5 and 18 ppt. These areas are typically in the middle portion of an estuary.

The Battery to Haverstraw: Waters with salinity between 18 and 30 ppt. These areas are typically in the lower portion of an estuary, where the ocean and estuary meet.



SECTION FOUR: WATER IN THE URBAN ENVIRONMENT

Hudson River History

Environmental Justice and Harlem

TheNorth River Water Treatment Plant

Diagrams:

Water Treatment

NYC Water Supply

The Urban Water Cycle

Hudson River History and its Relationship with NYC

The Hudson River varies from the more conventional rivers described previously, in that its 315 mile length experiences multiple elevations, levels of salinity, and acts as host to one of the most important ports and estuaries in the world: New York/New Jersey Harbor. Because of its ecological and historical significance, it has been named one of 14 American Heritage Rivers in the United States.

Its story begins at Lake Tear of the Clouds, on Mount Marcy in the Adirondack Mountains, in northeast New York State. It flows generally south to upper New York Bay by New York City with the Mohawk River as its chief tributary. The Hudson is navigable by ocean vessels up to Albany and by smaller vessels to Troy. Leisure boats and self propelled barges use the tightest section between Troy and Fort Edward, the head of navigation. Branches of the New York State Barge Canal connect the Hudson with the Great Lakes, Lake Champlain and the St. Lawrence River. The Hudson is tidal to Troy (which is located 150 mi. upstream) and this section is considered to be an estuary.

An estuary is a partially enclosed coastal body of water, with an open connection with the ocean, where freshwater from inland is mixed with salt water from the sea. Estuaries represent one of the most sensitive and ecologically important habitats on earth. They provide sanctuary for many species of animals, both terrestrial and marine, store nutrients for larval and juvenile marine life, and serve as breeding grounds for many desirable species of ocean fish. Areas such as this have proved to be, as in New York's case, excellent harbors.

Most of the large ports in United States (including Philadelphia, Baltimore, Galveston, Seattle, and San Francisco) are located in estuaries. Consequently, development of high-density population centers has occurred around estuaries, causing deleterious effects that can destroy the very properties of the estuary that have made development of the region possible. Human impact on estuaries includes destruction of tidal land by filling; pollution from sewage, solid waste, industrial effluent, and hot water from power generation and manufacturing; increased sedimentation filling the estuary; and alteration of the salinity of estuarine waters by diversion of fresh water. Increasingly, federal and state governments are passing legislation protecting these environments.

The upper course of the river has many waterfalls and rapids. The middle course, between Albany and Newburgh, is noted for the Catskill and Shawangunk Mountains on the west bank and by the large estates (the Roosevelt Estate at Hyde Park is the most famous) on the east. From Newburgh to Peekskill the river crosses the mountainous and forested Hudson Highlands in a deep scenic gorge. West Point Military Academy overlooks the river at West Point, and Bear Mountain Bridge spans this section. Near Tarrytown the river widens and passes under the New York State Thruway and the Tappan Zee Bridge. From the Tappen Zee to its mouth, the Hudson is flanked on the west by the sheer cliffs of the Palisades. At the mouth are the ports of New York and New Jersey. The Hudson forms part of the New York-New Jersey border, while the George Washington Bridge, the Holland and Lincoln tunnels, and railway tubes link the two states.

Beginning in the Woodland Period (1500 B.C. to the European colonization of the 17th C.) the Hudson was a major route and focus of settlement for Native Americans. It was known as the *Muhheakantuck;* the river that flows two ways. The bands of Eastern Algonquins that lived along its banks cleared and farmed the land. Along the banks of West Harlem, lived a clan known as the Rechgawanks of the Munsee Highland tribe or the Wappingers. Oysters and other shellfish were a primary food source proved by the hundreds of middens, or shell mounds found throughout the region. It is believed the Native Americans of what is now the New York City Metro Area possessed a complex and rich society at the time of European exploration.

First sighted by the Italian explorer Giovanni da Verrazzano in 1524, the river was explored by Henry Hudson in 1609. Hudson was searching for a northwest water passage through the North American continent, a passage which many believed would connect Europe and China, making trade more feasible. Hudson, hired by a company from the Netherlands known as the Dutch East India Co., believed that he had found the passage when he discovered New York Bay. He followed the river 150 miles up to Troy, before accepting that the river did not actually flow through the continent to the western ocean. Hudson claimed the land for the Dutch, which was named New Amsterdam and in 1658 Peter Stuyvesant established the Dutch settlement of Nieuw Haarlem, where Harlem currently exists today.

Originally, being a Dutch settlement, the people of the area spoke Dutch not English. However, a continuing influx of English settlers eventually forced the Netherlands to hand over New Amsterdam to Britain, who renamed the area New York.

When the American colonists began the fight for their independence from England, the Hudson River played a significant role. During the Revolution both sides fought for control of the Hudson and many battles were fought along its banks. The British believed that control of the river would allow them to cut off the supply route of the American army. One of the more local battles occurred on September 16, 1776 near Columbia University, where British and American forces fought the Battle of Harlem Heights.

In 1825 the Erie Canal was built, linking the river with the Great Lakes and providing the first all-water trans-Appalachian route. The canal, which served as gateway to the western United States, transformed the Hudson into a major route of trade and ushered in a new era of trade and industrialism. Around 1850, after the advent of the steamboat, the river became a means of recreational travel. During this time, the river was often bustling with the 150 steamboats that traversed the area, each carrying hundreds of passengers.

Originally Harlem, including all the area north of 59th Street was known as *Muscotta*, or flat place. The originally inhabitants of the area, the Manhattan Indians, named the region for its flat fertile flood plans (flat lands) which were conducive to plentiful crop growth. After the Dutch, followed by Henry Hudson, colonized the southern portion of Manhattan, many settlers began to move upward into the fertile Muscotta lands where the Native Americans lived. One of the early governors of the region sentenced some of the Native Americans living in Muscotta to death, for no credible reason. This caused war to erupt between the Dutch settlers and the Native Americans. All the colonists in Muscotta were killed, and the Dutch did not venture back to the area until the rule of a new governor, Peter Stuyvesant. Stuyvesant built a town in Muscotta and renamed the region Nieuw Harlem. In 1664, the Dutch lost their hold on the region to the English during the Second Anglo-Dutch War. Once the English took control of the area, they shortened the existing settlement's name to Harlem.

Harlem remained rural until the nineteenth century when improved transportation facilities linked it with lower Manhattan. It then became a fashionable residential section of New York City.

By the turn of the 20th century it had a large Jewish population. Between 1910 and 1926, Harlem became the scene of an increasing African American migration from the South. This time period is referred to as the Harlem Renaissance, and lasted from after World War I to the mid-1930's. It was characterized by an explosion of African-American written and artistic innovation and talent. It soon became the largest and most influential African-American community in the nation, one of the centers of creativity and jazz.

Sadly, this period was characterized by marked apathy towards the Hudson. Even though Riverside Park Promenade was constructed in the early 1900's, the Hudson River remained solely a transporter of people and goods, a division from New Jersey, and not much else to local residents. Polluters and manufacturers dominated its view and use from the 1870's to the 1970's.

Many industries were located on the Hudson's banks, and pollution by raw sewage and industrial wastes became a serious problem. Anti-pollution legislation passed in 1965 sought to protect the river from further contamination. Although pollution continued throughout the 1970's and 80's, New York state and municipal governments as well as environmental groups have contributed to a significant cleanup effort, complete with anti-pollution regulation. In the 1980's a major sewage treatment facility, known as the North River Water Treatment Plant was constructed along the river at 145th Street in Harlem.

West Harlem and Environmental Justice

As the 21st century moves forward, West Harlem is undergoing a renaissance, as a vibrant commercial district emerges and an influx of middle-class families buys and renovates brownstones. However, this recent economic gain has not yet addressed the environmental justice concerns of the Latino and Black neighborhoods of West Harlem. This area suffers from some of the highest asthma and lead poisoning rates in New York City. Many community groups believe that this high incidence of asthma and lead poisoning is linked to a concentration of environmental hazards in their community. The MTA bus fleet garage is located at W. 133rd St. and reconstruction work in the area has increased the already heavy truck traffic on and around Amsterdam Avenue. Previously, the unpredictable odors emanating from the North River Pollution Control Plant harassed local residents.

Though the area boasts more parkland than other NYC Districts, the majority of this land is in disrepair due to lack of funding. Riverbank State Park, on the Hudson River from 137th St. to 145th St. is situated on the roof of the North River Pollution Control Plant and was designed to increase safe park space and river access for the neighborhood. Not everyone agrees. Some feel the park is only a small mitigation for the placement and construction of the sewage treatment plant.

West Harlem Environmental Action (WE ACT) was founded in March 1988 to address ongoing West Harlem community struggles around the poor management of the North River Sewage Treatment Plant and the construction of the sixth bus depot across from an intermediate school and a large housing development.
WE ACT evolved into an environmental justice organization committed to empowering the community to become a vocal, informed and proactive force that determines and implements a vision of what the West Harlem environment can and should be.

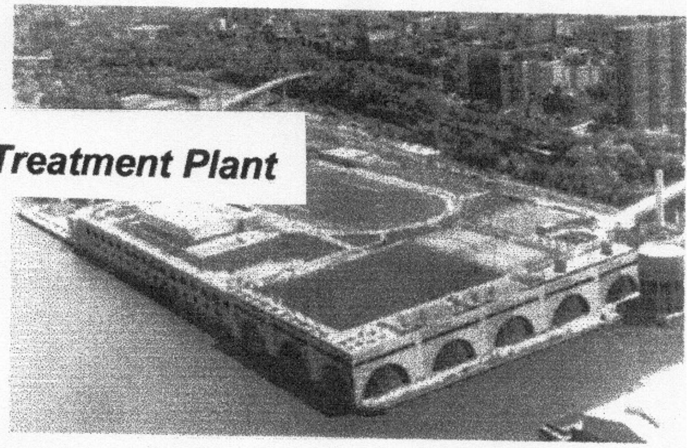
The North River Plant's problem proved to be a rallying point with residents who complained about the its foul odors and the increase in local respiratory problems since its initialization in April 1986. Using strong community mobilization tactics, civil disobedience strategies and the legal system, New York City was made aware of one community's burden of environmental hazard.

With the Natural Resources Defense Council as co-plaintiff, WE ACT sued and won a ruling that called for a $1.1 million fund that has been established to address community concerns related to public health and the environment. Since then, the plant has undergone several design improvements and has been operating without incident for several years, improving its relationship with the community.

It is important to note here, however, that the building of wastewater treatment plants in New York is still considered an environmental victory. Few can remember when the Hudson and other rivers smelled of raw sewage, as dumping ceased to be common practice 20 years ago. The Riverbank State Park now enjoys high usage and is a sports, cultural and environmental resource for the community.

Environmental conflicts are difficult to resolve, especially in urban areas not only because of the diversity and conflicting needs of the stakeholders (including plants and animals), but the unknowns. The plant design was not considered flawed until the health of a community came into question.

Improved communication between communities, their representatives and environmental experts can help avoid these conflicts in the future.



North River Wastewater Treatment Plant

The New York City Department of Environmental Protection's (DEP) Bureau of Water Pollution Control manages a comprehensive program to improve water quality in the New York City area. The City's 14 wastewater treatment plants, including the North River facility, play a crucial role in the City's efforts to improve water quality. Also called sewage treatment or water pollution control plants, these facilities remove most pollutants from used water before it is discharged into local waterways. New York City's plants treat about 1.4 billion gallons of wastewater from homes, businesses, schools, and streets in the five boroughs every day.

Effective wastewater treatment is critical to the quality of life and the physical health of New York City residents and visitors. It not only protects people who use local beaches and waterways for swimming, fishing and other recreational activities, it also protects local wildlife and their habitats.

Improving the Hudson's water quality

The North River wastewater treatment plant is located on the Hudson River, west of the West Side Highway from 137th Street to 145th Street. The plant provides wastewater treatment for the hundreds of thousands of people who live and work in or visit the west side of Manhattan, from Bank Street in Greenwich Village to Inwood Hill at the island's northern tip. North River treats about 170 million gallons of wastewater every day during dry weather, and it is designed to handle up to 340 million gallons a day when the weather is wet.

North River's history

From the first proposal in 1914, seven locations were investigated as possible sites for the construction of a plant to handle the sewage flow from western Manhattan. However, it was not until 1962, after considering several locations, that the City Planning Commission held a public hearing and finally approved the present site for the treatment plant. Design studies were started in the early 1960s and detailed plans were finished in 1971. Construction of the foundation platform was completed in 1978.

Construction of the treatment plant went forward in two phases. Work on the advanced preliminary treatment facilities began in 1983; the secondary treatment facilities were started in 1985. In March 1986, advanced preliminary treatment went into operation, eliminating the daily discharge of raw sewage into the Hudson River for the first time in the City's history. Secondary treatment began in April 1991.

The plant

The North River wastewater treatment plant is built on a 28-acre reinforced concrete platform over the Hudson River. It rests on 2,300 caissons pinned into bedrock up to 230 feet beneath the river. The roof of the building is the home of Riverbank State Park, a popular recreational facility with three swimming pools, an amphitheater, an athletic center, a skating rink, a restaurant and sports fields — and, of the two New York State park facilities in the City, the only one built on top of a water pollution control plant.

North River has been widely recognized for its innovative design. Its many awards include citations from the Concrete Industry Board, the National Society of Professional Engineers, the New York State Association of Architects, and the City Club of New York. In 1994, the plant received the Water Environment Federation's Award for Outstanding Achievement in Water Pollution Control for its significant contribution to improving water quality in New York Harbor.

The wastewater treatment process

Several stories underground, wastewater flows into the North River plant from an 11-mile-long intercepting sewer that extends along Manhattan's west side. Upon entering the plant, the wastewater first passes through upright bars that remove large items, including rags, sticks, newspapers, cans and other debris. The trash is automatically scraped from the bars and later transported to a landfill. Five main sewage pumps lift the wastewater to the surface level primary settling tanks. The flow of the water is slowed, allowing the heavier solids

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to settle on the bottom and the lighter materials to float. Oil and grease are skimmed from the top of the tanks and the heavy solids, called "primary sludge," are scraped off the bottom for further processing.

The partially-treated wastewater then flows to the secondary treatment system. Secondary treatment is called the "activated sludge process," because air and "seed" sludge from the plant treatment process are added to the wastewater to break it down further. Air pumped into five, 30-foot-deep aeration tanks stimulates the growth of oxygen-using bacteria and other tiny organisms that consume most of the remaining organic materials that pollute the water.

The aerated wastewater then flows to 16 final settling tanks, where heavy particles and other solids again settle to the bottom. Some of this sludge is recirculated back to the aeration tanks as "seed" to stimulate the treatment process. The remaining solids are removed and join the primary sludge for further processing in sludge-handling facilities.

To destroy disease-causing organisms, the wastewater is disinfected with sodium hypochlorite, the same chemical found in common household chlorine bleach. The treated wastewater, called effluent, is then released into the Hudson River.

Sludge treatment

Sludge produced by primary and secondary treatment is approximately 97 percent water, and must be concentrated for further processing. It is sent to thickening tanks for a period of up to 24 hours, where it settles to the bottom. The water that remains is directed back to the aeration tanks for additional treatment.

The thickened sludge, which is about 96 percent water, is then placed in oxygen-free tanks called digesters and heated first to 95 degrees fahrenheit. This stimulates the growth of anaerobic bacteria (bacteria that thrive without oxygen), which consume the organic material in the sludge. Methane gas, one of the byproducts of the digestion process, is used as fuel in certain plant operations.

Converting sludge into biosolids

After digestion, the sludge is dewatered. Dewatering reduces the amount of water the sludge contains, producing a moist, soil-like substance called "biosolids" that is easier to handle. Because North River has no dewatering facilities, sludge from the plant is transferred by boat for dewatering at the Wards Island wastewater treatment plant, the site of one of the City's eight dewatering facilities.

After dewatering, all of the City's biosolids, including those generated at North River, are recycled and reused. The biosolids are removed from the dewatering facilities by companies that have been awarded long-term contracts by the City. These companies either convert biosolids into environmentally safe fertilizer products or directly apply them onto land to enrich nutrient depleted soil. North River's biosolids are either thermally dried into fertilizer pellets, composted, or alkalline stabilized into a product which resembles soil and is used as an agricultural liming agent.

Odor control

To improve the control of odors from the plant, New York City has recently spent an additional $55 million beyond the cost of construction of the original odor control facilities. North River's odor control facilities are among the most elaborate in the country.

During the odor control process, plant air is pumped into a large tank and scrubbed clean with a mixture of two chemicals, sodium hydrochloride and sodium hydroxide (lye). The air is then funneled through activated carbon filters, which absorb odors and chemicals and remove the remaining odor-producing particles. The air is then released through 100-foot ventilation stacks on the plant roof.

Monitoring the system

All of the plant's systems are controlled by a sophisticated computer system. From the main control console, operators can oversee plant operations, energy use and North River's security system.

More information

For more information about the New York City water supply or wastewater treatment systems, visit our Web site at:

www.ci.nyc.ny.us/dep

or contact us at:

New York City
Department of Environmental Protection
Bureau of Public & Intergovernmental Affairs
59-17 Junction Boulevard, 19th floor
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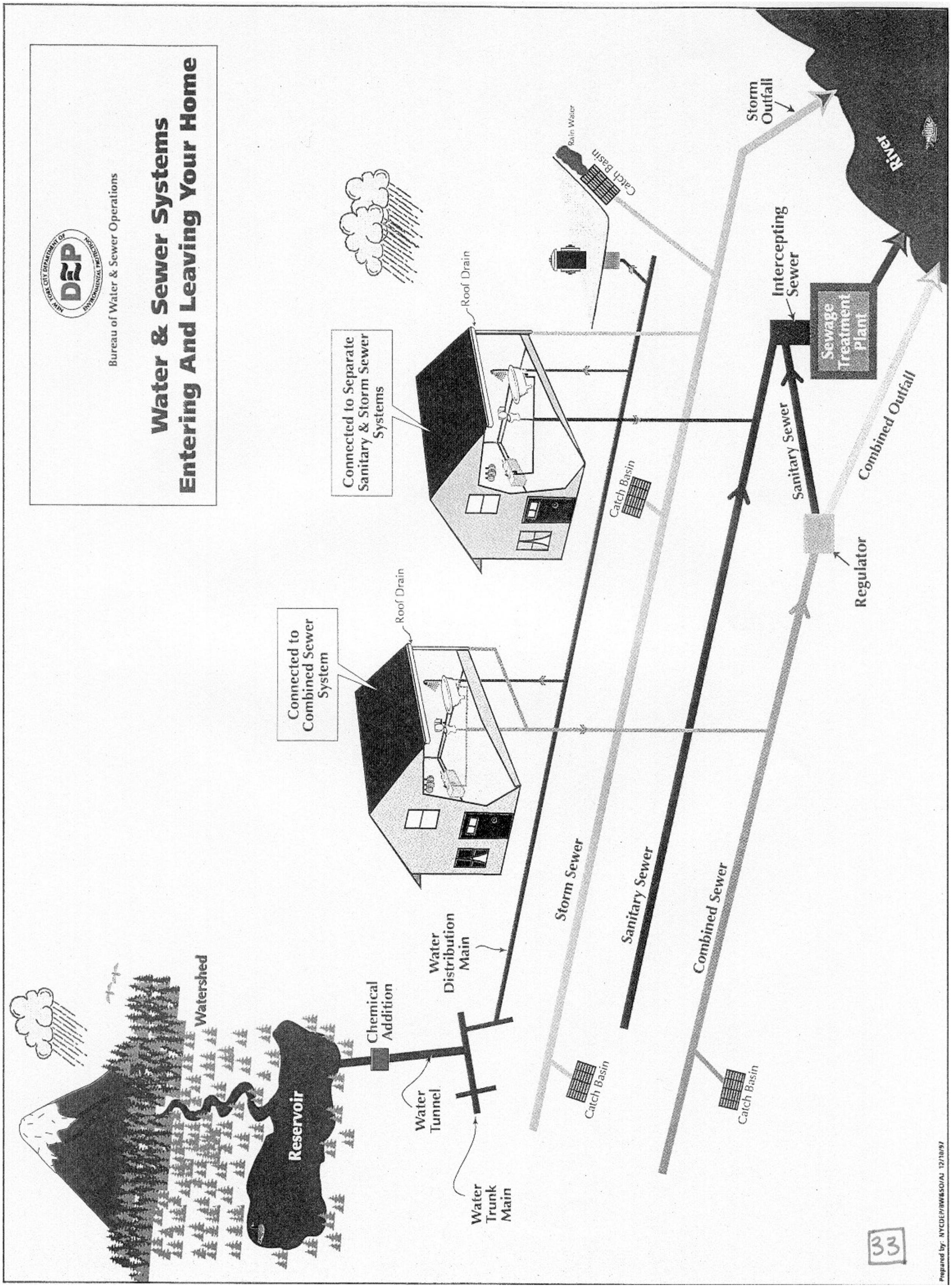
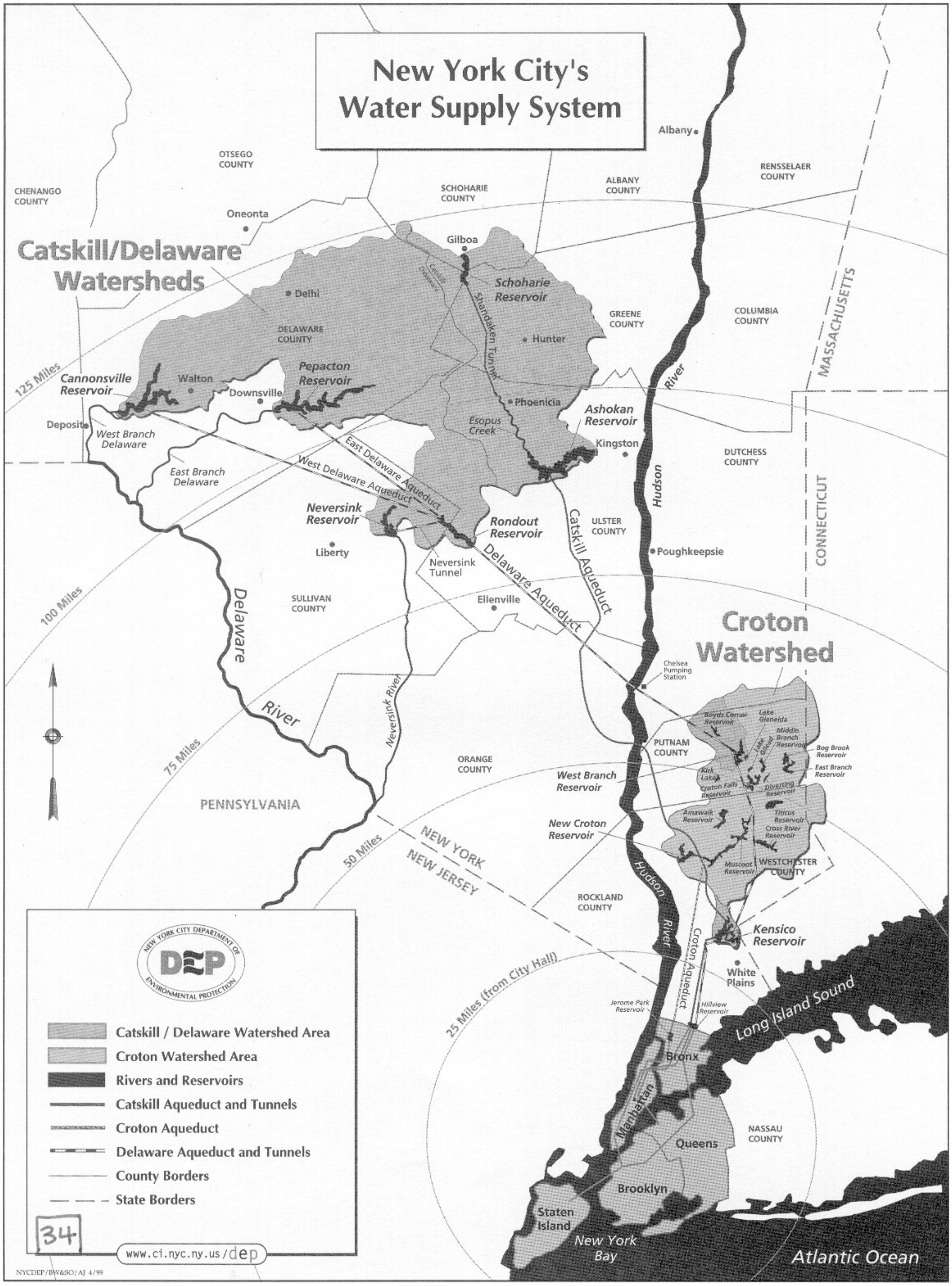
Rudolph W. Giuliani, Mayor
Joel A. Miele Sr., P.E., Commissioner


Bureau of Water & Sewer Operations
Water & Sewer Systems
Entering And Leaving Your Home
Connected to Combined Sewer System
Connected to Separate Sanitary & Storm Sewer Systems
Roof Drain
Roof Drain
Rain Water
Catch Basin
Storm Outfall
River
Intercepting Sewer
Sewage Treatment Plant
Sanitary Sewer
Combined Outfall
Regulator
Catch Basin
Storm Sewer
Sanitary Sewer
Combined Sewer
Water Distribution Main
Chemical Addition
Watershed
Reservoir
Water Tunnel
Water Trunk Main
Catch Basin
Catch Basin
33


New York City's
Water Supply System
Catskill/Delaware
Watersheds
Croton
Watershed
Albany
OTSEGO COUNTY
CHENANGO COUNTY
SCHOHARIE COUNTY
ALBANY COUNTY
RENSSELAER COUNTY
Oneonta
Gilboa
Delhi
Schoharie Reservoir
Shandaken Tunnel
DELAWARE COUNTY
Hunter
GREENE COUNTY
COLUMBIA COUNTY
MASSACHUSETTS
125 Miles
Cannonsville Reservoir
Walton
Downsville
Pepacton Reservoir
Phoenicia
Ashokan Reservoir
Esopus Creek
Deposit
West Branch Delaware
East Branch Delaware
Kingston
East Delaware Aqueduct
West Delaware Aqueduct
Hudson River
DUTCHESS COUNTY
CONNECTICUT
Neversink Reservoir
Rondout Reservoir
ULSTER COUNTY
Catskill Aqueduct
Liberty
Neversink Tunnel
Poughkeepsie
Delaware Aqueduct
100 Miles
SULLIVAN COUNTY
Ellenville
Delaware River
Chelsea Pumping Station
Neversink River
Boyds Corner Reservoir
Lake Gleneida
Middle Branch Reservoir
Lake Gilead
PUTNAM COUNTY
Bog Brook Reservoir
East Branch Reservoir
Kirk Lake
Croton Falls Reservoir
Diverting Reservoir
ORANGE COUNTY
West Branch Reservoir
75 Miles
PENNSYLVANIA
Amawalk Reservoir
Titicus Reservoir
Cross River Reservoir
New Croton Reservoir
NEW YORK
NEW JERSEY
50 Miles
Muscoot Reservoir
WESTCHESTER COUNTY
ROCKLAND COUNTY
Kensico Reservoir
Croton Aqueduct
White Plains
25 Miles (from City Hall)
Long Island Sound
Jerome Park Reservoir
Hillview Reservoir
Bronx
Manhattan
Queens
NASSAU COUNTY
Brooklyn
Staten Island
New York Bay
Atlantic Ocean
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEP
Catskill / Delaware Watershed Area
Croton Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Croton Aqueduct
Delaware Aqueduct and Tunnels
County Borders
State Borders
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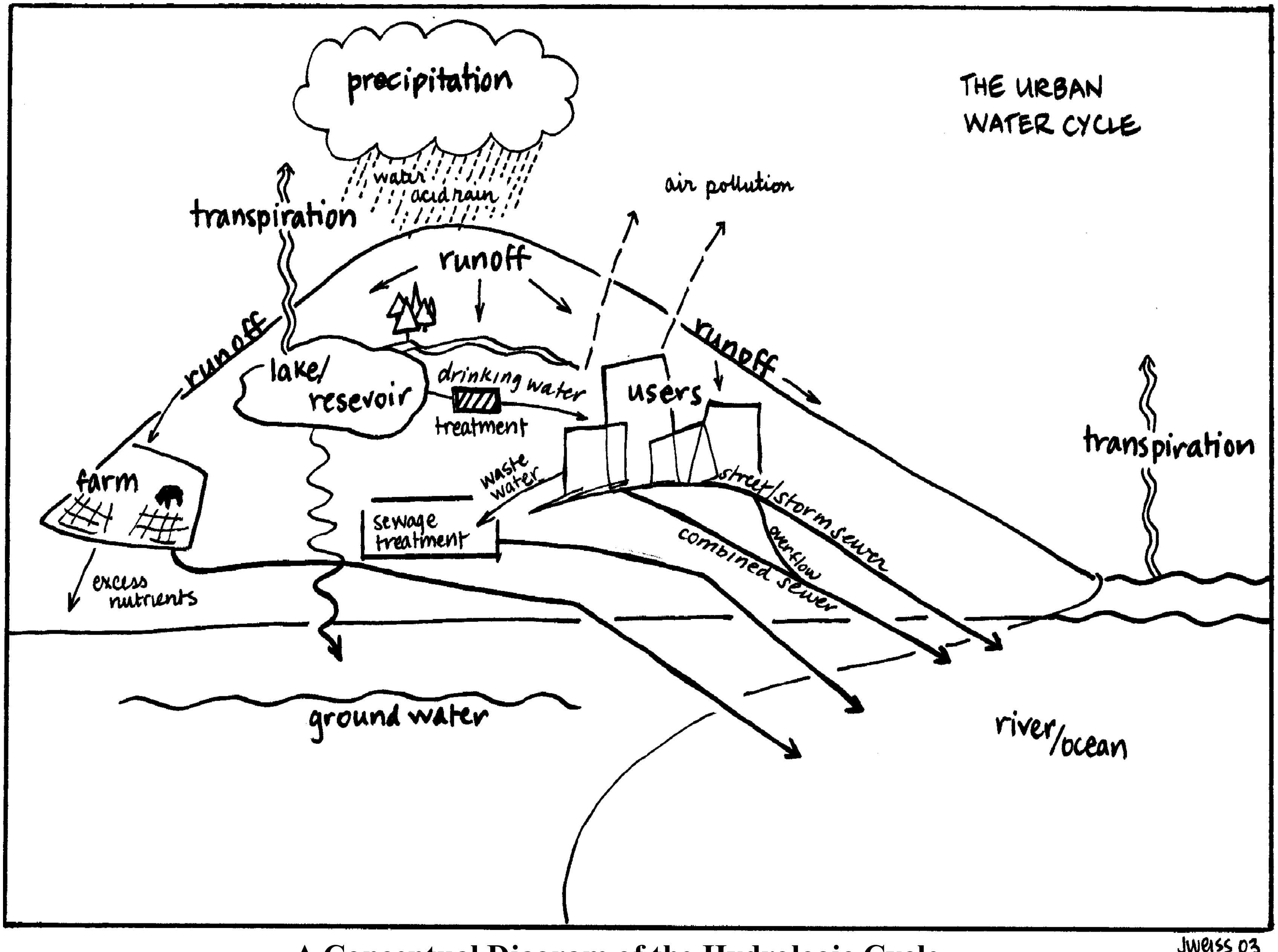


A Conceptual Diagram of the Hydrologic Cycle

SECTION FIVE: HUDSON RIVER ECOLOGY

Our Hudson River is one of the most biologically diverse rivers in the world. Even though it has tolerated centuries of abuse, this diversity remains in part due to its sweeping current and resilient habitats. The following pages and supplemental materials provide brief descriptions and commentary about habitats and organisms most important to this river system and/or those which an observer is most likely to encounter during a study of the area adjacent to West Harlem.

Ecological Communities of the Hudson

River Habitats and Niches

- **Ecosystem = the community**
  Let's think of our Hudson River as several adjacent neighborhoods within a community.

- **Habitat = a neighborhood**
  Let's think of a habitat as a neighborhood of family homes, a place where the organism can find the healthy air, water, food and shelter it needs to survive.

- **Niche = occupation**
  A niche is the occupation of a plant, animal or other organism within its habitat – its job! It refers to a more specific concept of "homesite" than usually described by the term habitat.
  Some occupations include:
  - *Detrivores:* decomposers that feed on dead plants and animals.
  - *Herbivores*: animals that eat only plants.
  - *Predators*: animals that eat other animals.
  - *Omnivores:* animals that eat both plants and animals, and in some cases detritus. An example of this last type is the blue crab.

Habitat Creation
The movement of water creates habitats within the river ecosystem. The Hudson River is tidal. Tides are the periodic movement of water resulting from gravitational attraction between the Earth, sun and moon. A complete tidal cycle usually takes 24 hours and 50 minutes. Rivers, as a rule, flow from the highest point to the lowest. This is true of the Hudson, but the current is slowed by this tidal activity – creating the "back and forth" one can see in the current during a tidal change. During high tide, as salt water from the ocean inundates the river, the water elevation (level) rises, and at low tide, the ocean water retreats, the fresh water from the upland areas travels further downriver, and the water level decreases.

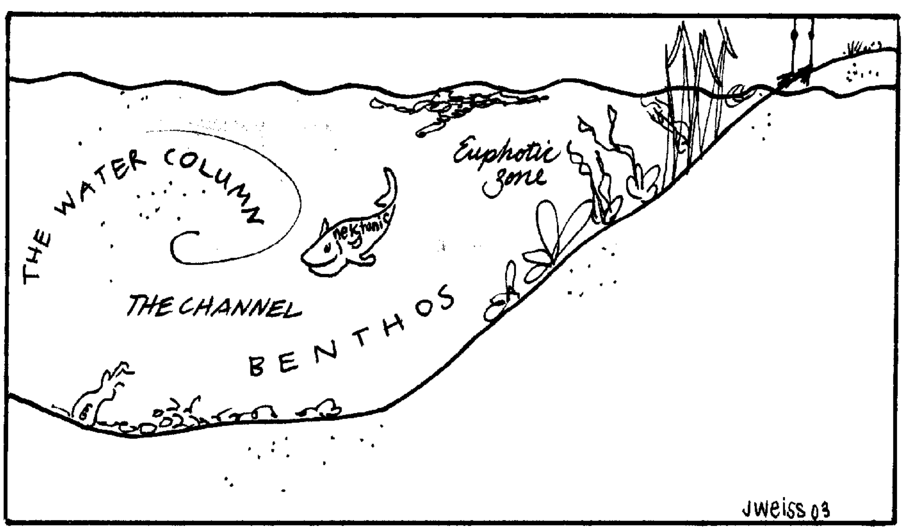
These forces cause erosion and deposition of salts, sand, rock and detritus that form the foundations for individual communities of plants and animals. Chemical composition of the water, diffusion of light, and the presence or absence of nutrients can change these habitats drastically, and may modify what plants, animals and other residents can live there. Runoff from the city creates special problems for some organisms while creating new niches for others, thus determining the overall productivity of the Hudson.

Habitats and Communities of the Hudson

The Channel
The deep, open water portion of the river. Below Albany its depth varies between 20 and 60 ft. The channel is not always in the middle. This area experiences the full force of tidal currents.

The Euphotic Zone
The depth of water to which there is enough light for plants to grow—quite shallow, generally ranging from 2 ft. in late winter to 13 ft. in late summer.

The Benthic Community or Benthos
Typically no light penetrates here, so there are no green plants and therefore no herbivores. Animals that live on the bottom are known as



Communities of the Hudson River

bottom dwellers or benthic organisms. Benthic organisms include pipefish, crabs, shrimp and snails. Many are detrivores. They eat and help decompose dead plant and animal matter drifting in the water or deposited on and in the bottom sediments. In doing so, they release minerals and nutrients for other plants and animals in the river to use. Worms are examples of such organisms.
Detrivores such as these are present all year round. Carp, shiners, perch, sunfish and other fish depend on these creatures as a food source. Amphipods play key roles in supporting the fish populations of the Hudson. Snails and worms are herbivores that feed on plants such as phytoplankton, algae and seaweed floating in the water.

Water column organisms
These organism drift in the water column and include the planktonic community. In open water, phytoplankton drift near the surface where light is sufficient for their growth. These are the real pastures of the Hudson, providing food for the billions of tiny animals that graze there. River currents carry comb jellies, jellyfish, zooplankton and baby fish. Many of these animals are small predators that feed on each other. Others are herbivores which feed on the phytoplankton.

Nektonic organisms
These organisms are free-swimming. They include large striped bass, white perch, and squid. They are strong enough to swim against powerful currents, and visit all levels of the river.

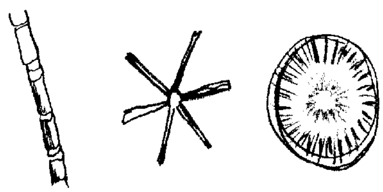
Microscopic Organisms & Plankton

Plankton are tiny free-floating organisms which live in aquatic environments such as the Hudson River. They are so small that they can not been seen by the unaided eye. To see them, we must look through microscopes, which make small things appear much bigger. Plankton can be small plants (known as **phytoplankton**) or small animals (known as **zooplankton**). Plankton are an important food source in the Hudson, feeding oysters (and other bivalves), shrimp and blue crabs (crustaceans) as well as many small fish (including pipefish).

Types of Microscopic Organisms and Plankton

Diatoms

These phytoplankton appear with the greatest regularity in the Hudson. They have cell walls made of silica which fit together like two halves of a pill box. The diatoms dominate the phytoplankton community in the cooler months and populations usually peak in early summer or fall.

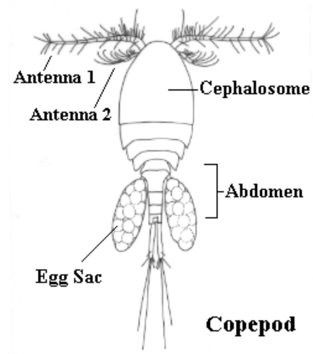


Dinoflagellates

These phytoplankton exhibit characteristics of both plants and animals. A long flagella propels them through the water. Some engage in photosynthesis, others are predators, and still others can do both. A large population of these organisms may indicate high levels of nutrients (sewage pollution, fertilizer, red tide). Some dinoflagellates contain toxins, thus affecting shellfish and other filter feeding animals which may people eat.

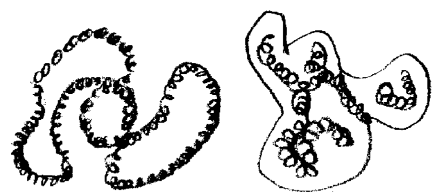
Copepods

These microscopic zooplankton consist of many different species, which all share the unifying characteristic of a single, simple eye in the middle of the head (at least during the larval stage if not in the adult stage). These organisms are typically less than 1mm long and feed on bacteria, diatoms or other unicellular organisms.



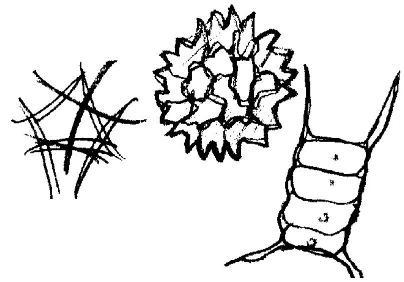
Cyanobacteria (blue-green algae)

These organisms lack most true cell organelles such as nuclei or chloroplasts. Their photosynthetic processes are similar to that of plants and they appear green in color because of chlorophyll. They are found in the water column as well as on mud surfaces or pilings. Many species grow in filamentous strands.



Green algae

These organisms are characterized by an abundance of green chlorophyll localized in cell parts called chloroplasts. Most species are common to fresh and salt water. Green algae often out competes other species in the water during the summer.



Animals of the Hudson

Life in the Hudson is complex and diverse, as reflected in its animal population. Here we have included a representative list of creatures passing by your neighborhood. The list is by no means complete, but as they say – one has to start somewhere!

* - RARE FROM THIS VIEW (145TH ST.) OF THE HUDSON.

WATER COLUMN-FREE FLOATING PLANKTON, UNLESS OTHERWISE NOTED		
Invertebrates	Siphomedusal	Leidy's comb jelly
		Lion's mane (large jellyfish)
		Clapper hydromedusa
	Arthropods	Copepods
	Larval crustaceans	Barnacles
		American lobster
		Crab larvae
	Planktonic Insects	Phantom midge larvae*

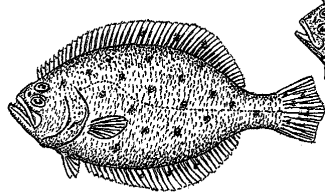
BENTHOS– BOTTOM DWELLERS		
Invertebrates	Sponges	Red beard sponge
		Boring sponge
	Sea Anemones, Hydroids	Snail fur
		White anemone*
	Worms	Red gilled mud worm
	Gastropods	Gastropods
		Channeled whelk*
		Atlantic slipper shell
		Seaweed snails
	Bivalves	Blue mussel
		American oyster
		Zebra mussel
	Arthropods	Water mites (Arachnid)
		Ostracods
		Isopods
		Amphipods

BENTHOS– BOTTOM DWELLERS		
Invertebrates	Arthropods, crustaceans	Atlantic Horseshoe Crab
		Barnacles
		American lobster (adult)
		Sand shrimp
		Hermit crab
		Fiddler crab*
		Rock crab
		Blue crab
	Benthic Insects	Mayfly nymphs*
		Dragonfly nymphs
	Echinoderms	Common sea star
	Tunicates	Sea grapes

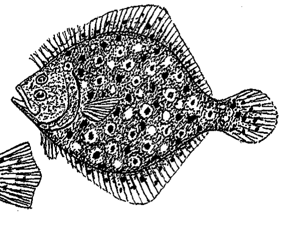
NEKTONIC – FREE SWIMMERS		
Invertebrates	Cephalopod	Long finned squid
Vertebrates	Fish	See Pages 44 & 45
	Reptiles	Diamond backed terrapin Spends 90% in water

TERRESTRIAL – LAND AND AIR		
Vertebrates	Birds	Canada goose
		Mallard
		Black duck
		Bufflehead
		Double crested cormorant
		Killdeer*
		Sandpipers*
		Snowy egret*
		Great blue heron
		Red winged blackbird
		Common crow
		Rock dove (Pigeon)
		Warblers
		Herring gull
		Belted kingfisher*
		Red tailed hawk
		Osprey*
		Bald eagle*
	Mammals	White footed mouse
		Norway rat
		Short tailed shrew
		Muskrat*

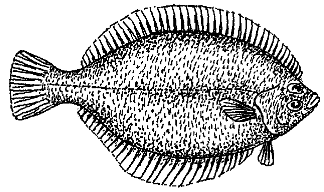
Fish of the Hudson



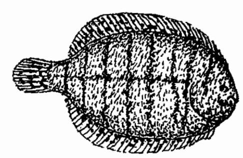
Summer flounder or fluke (*Paralichthys dentatus*) are the largest left-eyed flatfish of the Hudson; big ones, 30 inches long or more, are often called doormats. The fish's brown body is dotted with white spots surrounded by black rings. This is the only flatfish in the Hudson area that has conspicuous teeth. Active predators, fluke range from bottom to top in search of prey; fish form a major part of their diet. They are called summer flounder because, after spawning deep in the ocean, they enter the estuary during the warmer months, when they are a major quarry of anglers.



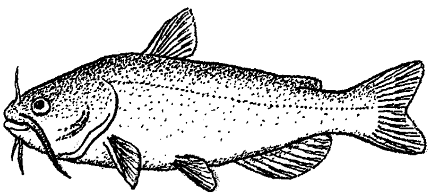
Windowpane (*Scophthalmus aquosus*) are also left-eyed. They are commonly called sundials. The name windowpane comes from its thin body; its underside is nearly transparent. This flatfish can be up to 18 inches long.



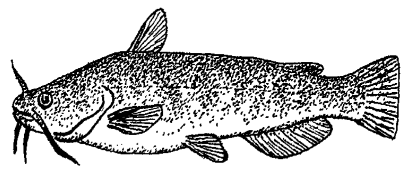
Winter flounder (*Pleuronectes americanus*) are right-eyed, solid brown above, and rarely over 16–18 inches long. This flounder lacks visible teeth but has prominent lips. Adults enter the estuary to spawn in late winter/early spring (hence their name) and move into deeper, cooler water in summer. Young-of-the-year and year-old fish are common residents of the estuary. When New York anglers say "flounder," they are usually referring to this species, a very popular catch.



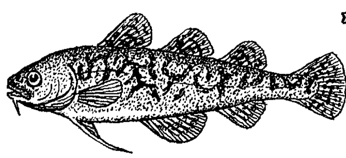
Hogchoker (*Trinectes maculatus*), another right-eyed flatfish, is typically 3–4 inches long, solid or mottled brown, and nearly oval in shape, with a narrow tail and tiny, beadlike black eyes. The body is covered with small rough scales and thick, viscous slime. Its name reputedly comes from a historic practice of feeding river fish to livestock, whereupon many pigs, which swallow food whole, met their demise as the hogchoker's rough scales caused the fish to stick in their throats.



White catfish (*Ameiurus catus*) is grayish above, white below, and has a forked tail. These catfish can grow to 22 inches, but typically are 12–14 inches long. They are found in fresh and brackish water, commonly as far downriver as Yonkers.

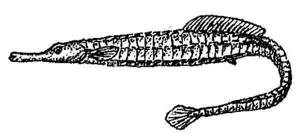


Brown bullhead (*Ameiurus nebulosus*) is olive-green to brown above, pale white or yellow below, with a rounded or square tail. The bullhead, generally 8–12 inches long, is usually found in fresh water.

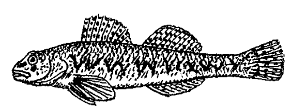


Atlantic tomcod (*Microgadus tomcod*) has three dorsal fins. The body is rarely more than 12 inches long, olive-green to brown with darker mottling and a distinctly white belly. Sometimes called frostfish, tomcod enter fresh water to spawn in late fall and winter; the eggs hatch at a chilly 40 degrees, sometimes while ice covers the Hudson. Tomcod grow fast, feeding first on zooplankton and later on small benthic organisms. Nearly all mature in one year.

Lined seahorse (*Hippocampus erectus*), a fish people are surprised to see here, is quite common from the George Washington Bridge south. Seahorses cling to plants and other objects with prehensile tails and suck up small invertebrates with their tube snouts. They swim by fluttering their pectoral and dorsal fins. The male gives birth; the young hatch from eggs that a female deposits in his abdominal pouch.

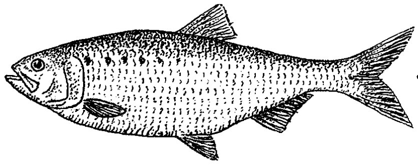


Northern pipefish (*Syngnathus fuscus*) is a close relative of the seahorse, and similarly adapted. Its body looks very much like a twig or piece of grass. It is fairly common from Peekskill south into more marine waters. An average pipefish is 6 inches long; a big one may reach 12 inches.

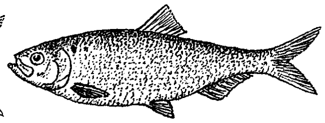


Tesselated darter (*Etheostoma olmstedi*) is an odd little fish (3–4 inches long) of freshwater habitats. Its name comes from its staccato, darting movements. It is a mottled brown color, with two large dorsal fins and a pair of very large pectoral fins. Darters feed mostly on insects.

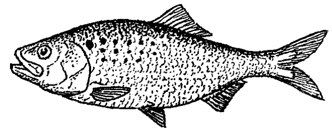
All Illustrations and descriptions from *The Hudson*, Stanne et al, 1996.



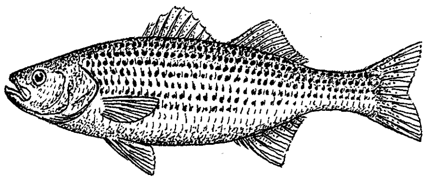
American shad (*Alosa sapidissima*) is the Hudson's largest river herring, reaching a length of 30 inches and a weight of more than 10 pounds. Adults appear in late March, spawning mostly between Hyde Park and Catskill. The young grow to 4.5 inches long before migrating to sea in fall. Maturing females return after 5–7 years, males after 4 years. Many Hudson shad survive the spawning migration, and may live 10 or 11 years, spawning each year after maturity.



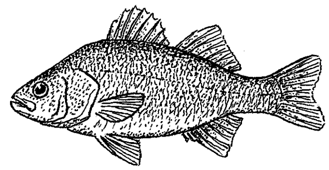
Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) look much alike, and both resemble shad in looks and anadromous habit. However, they seldom grow to more than one foot long. Both migrate up the Hudson in spring, spawning in freshwater shallows and tributaries, where they are avidly pursued by people with all manner of nets. The catch is typically pickled for food or used as bait for striped bass and blue crab.



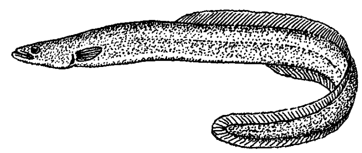
Menhaden (*Brevoortia tyrannus*), also called mossbunker or simply bunker, are usually less than a foot long. Their silvery sides may have a golden or brassy cast. This coastal fish spawns offshore in late spring, after which both adults and juveniles enter the estuary, moving upriver as far as Newburgh Bay. They are the major bait used by commercial crabbers from Peekskill to the Tappan Zee.



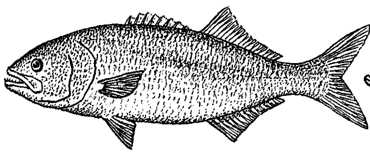
Striped bass (*Morone saxatilis*), sleek and silver with dark horizontal stripes, commonly reach a weight of 30 pounds and a length of 3 feet; a 125-pounder was caught in North Carolina in 1891. The species is anadromous; adults enter the river in April to spawn, chiefly between the Highlands and Kingston. Young remain for at least two years, many wintering among the piers on Manhattan's West Side. Stripers feed primarily on silversides, anchovies, herring, and shrimp.



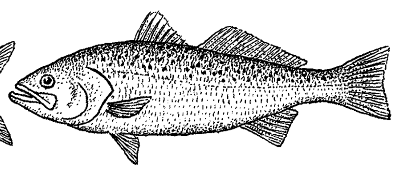
White perch (*Morone americana*) rarely exceeds 10 inches in length and is a uniform silver color, slightly darker above, with no striping. The body is deeper than that of the striped bass, the back having a distinct arch. This fish, common throughout the river, is most abundant in brackish water. There is a slight upstream migration during spawning in May and June. Young perch feed primarily on small invertebrates, older ones mostly on small fish.



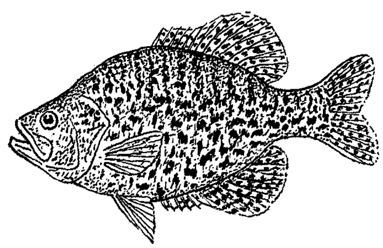
American Eel (*Anguilla rostrata*)
This eel, up to 3.5 feet long, is grayish green above, white below, becoming more yellow-brown with age, and metallic silver or bronze immediately prior to the spawning migration. Eels have distinct nares on the head and are on a par with dogs in their acute sense of smell. They feed on invertebrates, small fish, and carrion, and are generally most active at night.



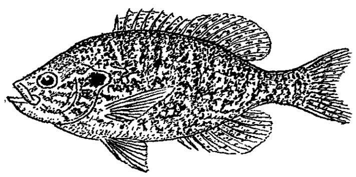
Bluefish (*Pomatomus saltatrix*)
Bluefish are shiny silver with a green or blue cast on the back and a black spot at the base of the pectoral fin. Young-of-the-year "snapper" bluefish range north to New Hamburg, feeding voraciously and reaching a length of 10 inches while in the river. Schools of adult "blues," some up to 15 pounds, sometimes enter the estuary and make the water churn and boil as they attack menhaden and other prey.



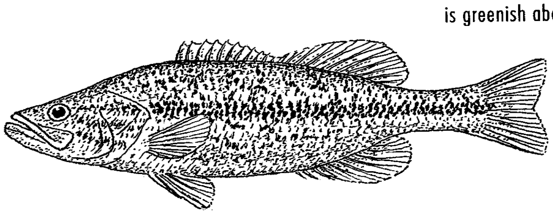
Weakfish (*Cynoscion regalis*)
Weakfish are long and slender, their body gray above, silvery below, with a yellowish cast to their pelvic and pectoral fins. Weakfish are less dramatic in their predatory behavior than bluefish, and they don't penetrate as far north, juveniles having been found upriver to Indian Point.



Black crappie (*Pomoxis nigromaculatus*) have the deep, compressed (from side to side) bodies of sunnies but grow to greater size (commonly to 12 inches) and have a larger mouth. The fish is greenish above, silvery on the sides, and cov- spots and mottlings which give it name, calico bass.

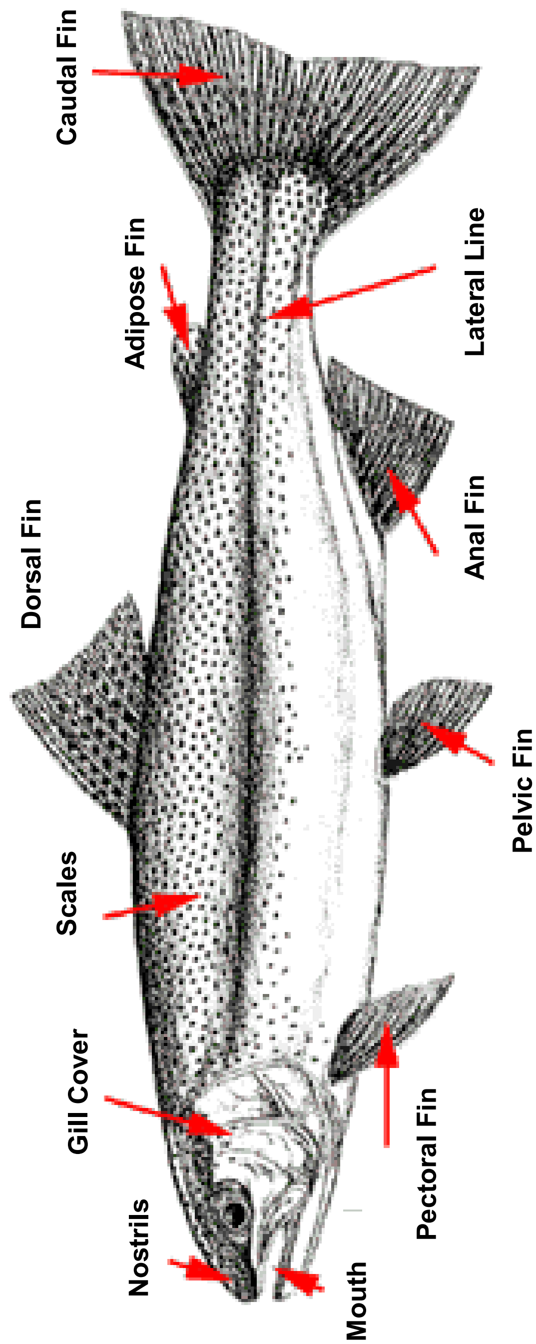


Pumpkinseed (*Lepomis gibbosus*), the Hudson's most common sunfish, is very colorful: green with dark mottling, a yellow breast, blue on the side of the head and lower jaw, and a red spot on the black opercular flap. A pumpkinseed more than 6 inches long is a big one. Other sunfish common here include the redbreast sunfish (*Lepomis auritus*) and bluegill (*Lepomis macrochirus*). Both grow a bit larger than the pumpkinseed and lack the red spot on the opercular flap.



Largemouth bass (*Micropterus salmoides*) supports a notable recreational fishery—including fishing tournaments—on the Hudson. It is the largest of the sunfishes, the New York record being close to 11 pounds. The body is greenish bronze in color with a dark horizontal band along its side. Largemouths, common residents of the river's shallows, are voracious feeders, known to eat almost anything that moves. Smallmouth bass (*Micropterus dolomieu*) have only slightly smaller mouths and generally prefer cooler, clearer, and rockier areas of the Hudson.

The Anatomy of a Fish



Source: http://www.versaquatics.comFish_Anatomy.htm

Oysters

During our pilot program, students will have the opportunity to "meet" oysters right in the classroom! Huge mounds of Eastern oysters formed reefs in and around the New York-New Jersey Harbor. For centuries they dominated the bottom of the NY/NJ Harbor as well as the lower Hudson River and were a primary food source for many for the Native Americans as well as the early settlers. Reports from the early 1700's record oysters 10 or more inches in size – their communal reefs creating navigational hazards for ships.

Pollution, disease and dredging wiped out these legendary communities. Recently however, clean up efforts have made today's Hudson a viable environment for the Eastern oyster, and organizations like NY/NJ BAYKEEPER are conducting preliminary experiments for reintroduction. An artificial reef has been started just off of Jersey City as a potential home for new colonies.

Meeting oysters from this program will help students link the Hudson's ecological and historical past and present as well as provide an example of people in their area creating positive environmental change.

Crassostrea virginica, also known as the **Eastern Oyster**, was once so plentiful in the New York Harbor that seasonal harvests were in the millions of bushels. People have long valued this bivalve as an important food source, and many consider it a delicacy. These voracious filter feeders perform additional functions that are vital to the harbor's ecosystem:

- Oysters consume algae and plankton by filtering water at a rate of up to 5 liters per hour. Scientists believe that the Hudson's once flourishing oyster populations historically served as a natural water cleansing system, filtering the estuary's entire water volume every three or four days. Today's oyster population is reduced to perhaps a quarter of 1% of what it was 100 years ago. Increasing the number of oysters in the harbor would improve the water quality of the entire estuary.

A small oyster reef

- Oyster reefs, with their many folds and crevices, can have 50 times the surface area of an equally expansive flat area. Its convolutions provide habitat for an enormous range of other animals, such as worms, snails, sea squirts, sponges, small crabs, and fishes.
- Oysters that lay exposed on tidal shore areas provide food for shore birds.

Habitat and life cycle stages

- The Eastern Oyster usually lives in water depths of between eight and 25 feet.

- An oyster's shape and size often depends on the type of bottom to which it was originally attached. An oyster orients itself on the bottom of the outer, flared edge of its shell and tilts upward. The left valve is cupped, while the right valve is flat. The shell opens periodically to permit the oyster to feed on plankton.

- Oysters mature usually in about one year. They are protandric, which means that in the first year they spawn as males, but as they grow larger and develop more energy reserves in the next two to three years, they spawn as females. They usually spawn at the end of June when an increase in water temperature triggers the males to release sperm and females to release eggs into the water. This triggers a chain reaction of spawning, which clouds the water with millions of eggs and sperm. A single female oyster produces ten to 100 million eggs annually.

- The eggs are fertilized in the water and soon develop into larvae, which are drawn to the chemicals released by older oysters on the bottom and eventually find a suitable site to settle, such as another oyster's shell. Juvenile attached oysters are called "spat."

What's threatening our oysters?

- Historic over-harvest, which remove huge volumes of large oyster shells. This destroyed reef habitats and suitable sites for oysters' spat settlement; dredging has also contributed to this problem.

- Two parasites that are harmless to humans but are lethal to oysters within the first two years of life – MSX (*Haplosporidium nelsoni*), which thrives in higher salinity brought on by dry years, and Dermo (*Perkinsus marinus*), which tolerate low salinity and therefore is even more damaging to the oyster population.

- Loss of habitat due to environmental pollution:
  - Algal blooms promoted by eutrophication, the process by which the harbor's water becomes over-enriched with nutrients such as nitrogen and phosphorus (which are derived from lawn and other fertilizers, septic system drainage, animal waste, and other runoff). Nutrient-rich water leads to a severe depletion of oxygen which may hinder the development of oyster larvae.
  - Pollutants such as metals are directly toxic to oysters in the vulnerable juvenile life-stages.
  - Siltation from eroded soil at land development sites, poor land management, and construction, smothers oysters and prevents them from feeding.
- Natural predators such as sea anemones, sea stars, sea nettles and other filter feeders, which eat oyster larvae as well as flatworms and small crabs which consume new spat (juvenile oysters).

Some of the threats facing the oysters living in the NY/NJ Harbor are man-made and some are natural, however combined these factors threaten the entire oyster population.

The Pacific oyster has a similar interior to the Eastern. Though we will not be dissecting these in our program, remind students they may get to see this up close at a restaurant sometime!

Pacific Oyster Culture in British Columbia, D.B. Quayle, © 1988, Department of Fisheries and Oceans, Ottawa.

SECTION SIX: FIELD TRIP

Classroom Visit Lesson Plans

Water Testing Activity Sheets

Field Trip Notes for Teachers

Lesson Plans

Classroom Visit 1: Program Introduction

Objectives:
Students will:
- Be introduced to the Harlem Hudson program
- Take a pre-program survey to assess their thoughts on the Hudson River
- Be introduced to the Hudson River
- Discuss the concept of environment

Materials used: Hudson River Mural, Hudson River puzzle
Total time: 55 minutes

Vocabulary:
River, Estuary, Environment, Water, Water Cycle, Oxygen, Carbon Dioxide

Classroom Visit Activities:
1. During the class period the SWCD educator will introduce herself. She will also explain how the program will run.
2. Next students will take a brief survey, to be used in program assessment and to start their thoughts flowing on the Hudson River. Journals will be distributed and a copy of the Hudson River mural will be pasted in the journal.
3. The educator and students will assemble a Hudson River Estuary Puzzle.
4. The educator and students discuss the characteristics of rivers and estuaries. They will discuss the Hudson River, where it is, and how it fits into their neighborhood.
5. The educator and students will discuss water and its characteristics.
6. The educator and students will then discuss the concept of environment and the Hudson River as an environment.

Suggested Pre-Visit Activities:
Activity #5: Bulletin Board (pg 26)
Activity #6: My Hudson River (pg. 27)

Suggested Post-Visit Activities:
Decorate Journals and begin journal writing (pg. 10)

Classroom Visit 2: Living with the Food Web

Objectives:
Students will:
- Review vocabulary and clarify information previously covered
- Discuss the concept of living/non-living
- Discuss the concept of ecosystems
- Discuss the different places in which plants and animals can live in the aquatic environment
- Discuss the concept of food chains and webs

Materials used: Living/Non-Living cards, Laminated plant and animal cards, string
Total time: 55 minutes

Vocabulary:
Ecosystem, Habitat, Food Chain

Lesson Plans

Classroom Visit Activities:
1. The SWCD educator will review the material previously covered to be sure of its clarity.
2. The educator and students will then discuss the concept of living and non-living
3. This discussion will lead into an explanation of ecosystems and communities of animals within the aquatic environment.
4. The educator and students will then play a food web demonstration game.

Suggested Pre-Visit Activities:
Activity #4: River Research (pg. 25)

Suggested Post-Visit Activities:
Journal Writing (pg. 10)
Activity #1: Now That's Living! (pg. 17)
Activity #3: Food Web Game (pg. 23)

Classroom Visit 3: Hudson River History

Objectives:
Students will:
- Review previous information covered
- Explore the history of the Hudson River
- Learn how tides influence the Hudson River

Materials used: counting set, book: *Harlem Lost and Found*, Tide model
Total time: 55 minutes

Vocabulary:
Muhheakantuck, Tides, Wappingers, Henry Hudson, Revolutionary War, Harlem Renaissance, Water Treatment Plant

Classroom Visit Activities:
1. Briefly review the vocabulary and the material covered in the last classroom visit.
2. The educator and students will explore how ecosystems and communities are related.
3. The educator will then explain a little of the Harlem History to the students and take a look at some historical visuals out of the book *Harlem Lost and Found*.
4. Next, the educator will talk to the students about why the tidal nature of the Hudson is important and do an activity designed to represent tidal movement.

Suggested Pre-Visit Activities:
Activity #7: Water Families (pg. 28)

Suggested Post-Visit Activities:
Journal Writing (pg. 10)

Classroom Visit 4: Oysters

Objectives:
Students will:
- Review and clarify information previously covered
- Handle and become familiar with oysters

Lesson Plans

- Ask questions and learn about oyster anatomy, habitat, and ecosystem function.

Materials used: Oysters and companion diagrams
Total time: 45 minutes
Classroom Visit Activities:
1. The SWCD educator will first review the material previously covered to be sure of its clarity.
2. The educator will distribute oysters for students to examine, ask questions, and make hypotheses.

Suggested Pre-Visit Activities:
Activity #2: Observation Station (pg. 22)

Suggested Post-Visit Activities:
Activity #8: Oyster Extension (pg. 29)

Classroom Visit 5: Water Testing

Objectives:
Students will:
- Review previous information covered
- Learn how test for the parameters that indicate waterbody health.

Materials used: Water testing kit, Parameter Posters
Total time: 55 minutes

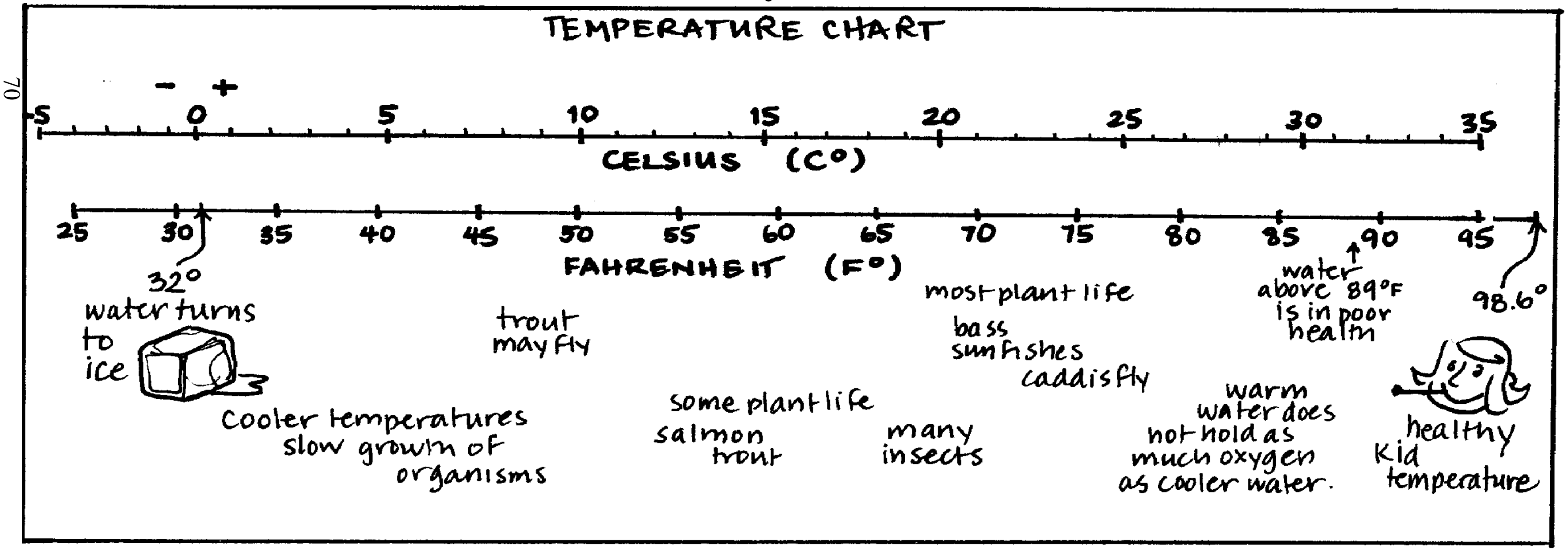
Vocabulary:
Dissolved Oxygen, Temperature, Salinity, Turbidity, pH

Classroom Visit Activities:
1. Review and clarify information previously covered
2. Educator will distribute water testing activity sheets and discuss the five parameters of water testing: dissolved oxygen, temperature, salinity, turbidity, and pH.
3. Educator will perform simple water testing of dissolved oxygen and pH with the students on a water sample from the sink.

Suggested Pre-Visit Activities:
None

Suggested Post-Visit Activities:
Activity #9: Watering Testing (pg. 30)

Temperature

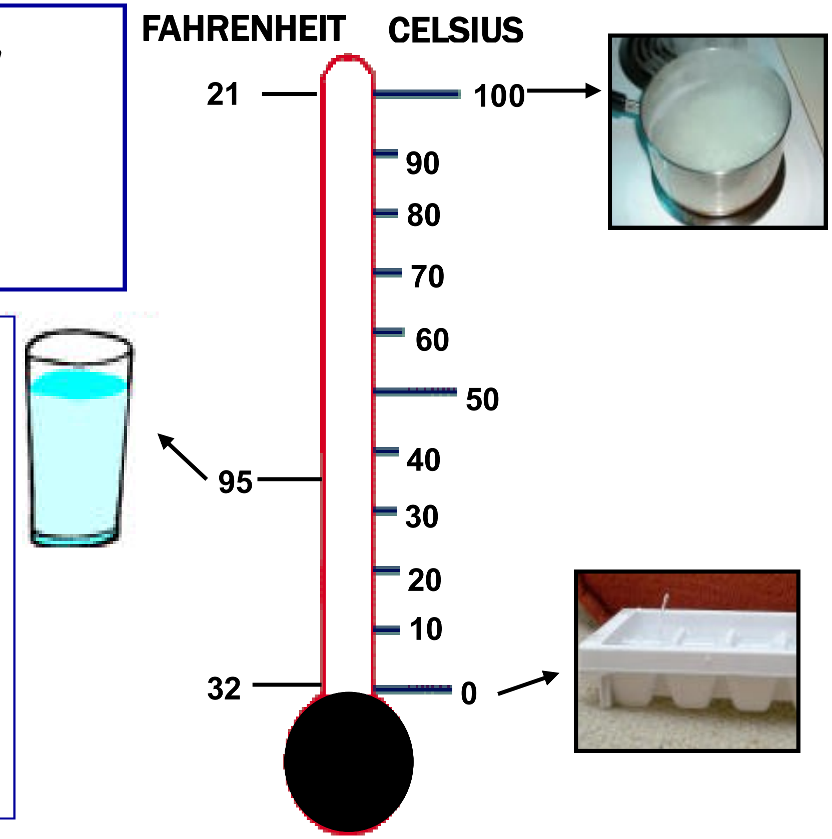


Temperature is the measure of how hot or cold something is! It is measured in Celsius and Fahrenheit

Use the Pictures to Answer the Questions:

Water turns to ice at 32° Fahrenheit!
What temperature is that in Celsius? ______

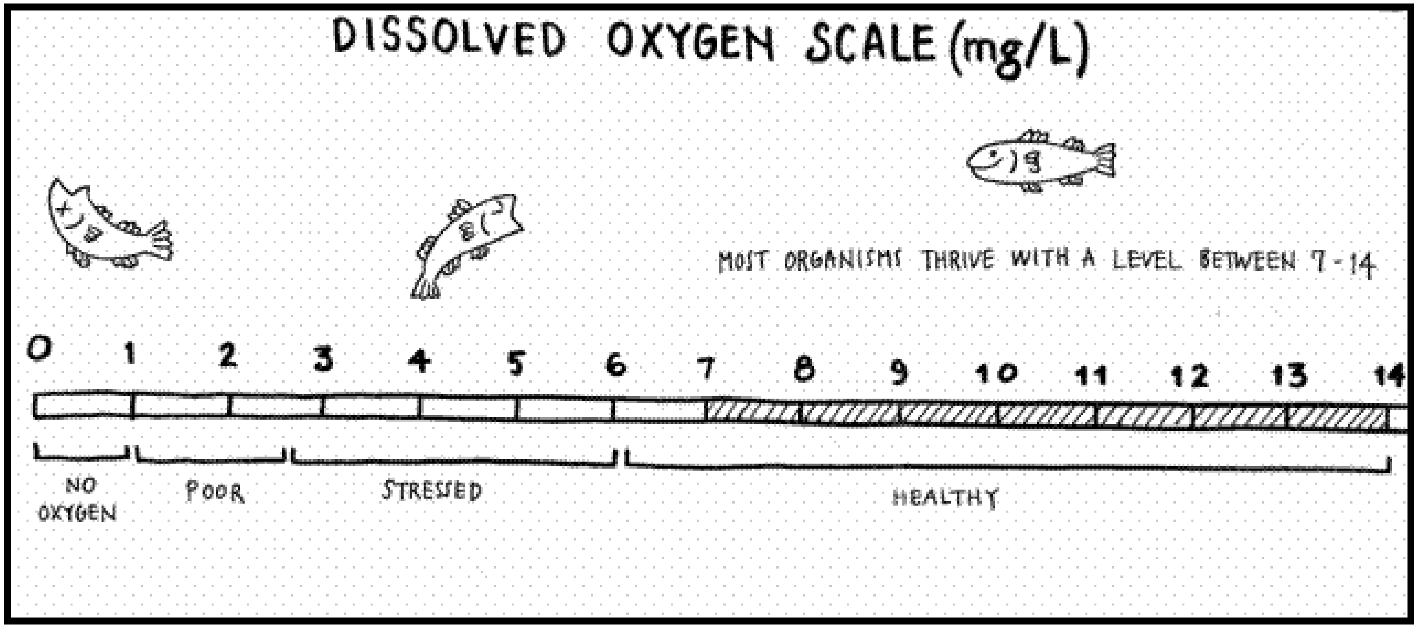
What temperatures make water plants and animals happy? ______



Oxygen in the Water!

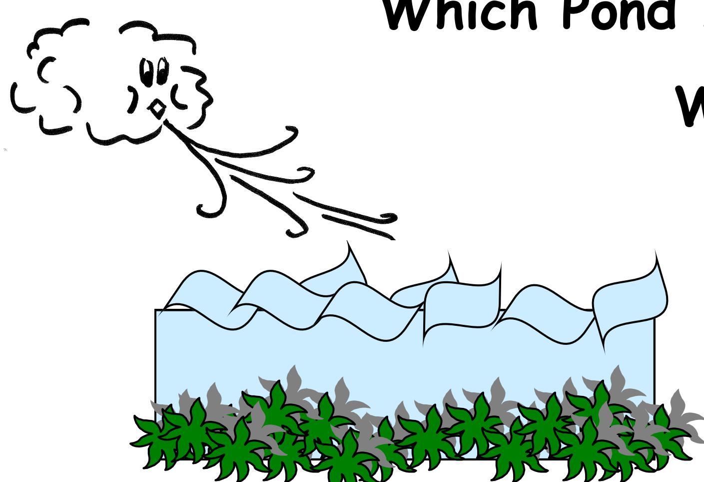
There is oxygen in the Hudson River! Animals breathe oxygen and can live in the water!

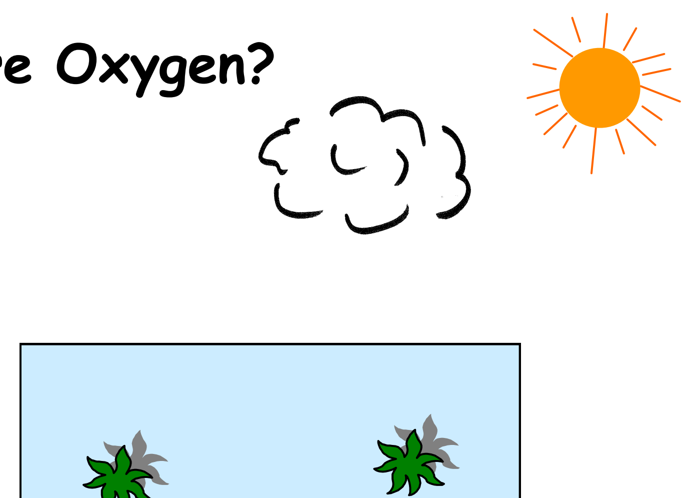
Use the scale below. How much oxygen makes water animals happy? ________



Which Pond has more Oxygen?

Why?

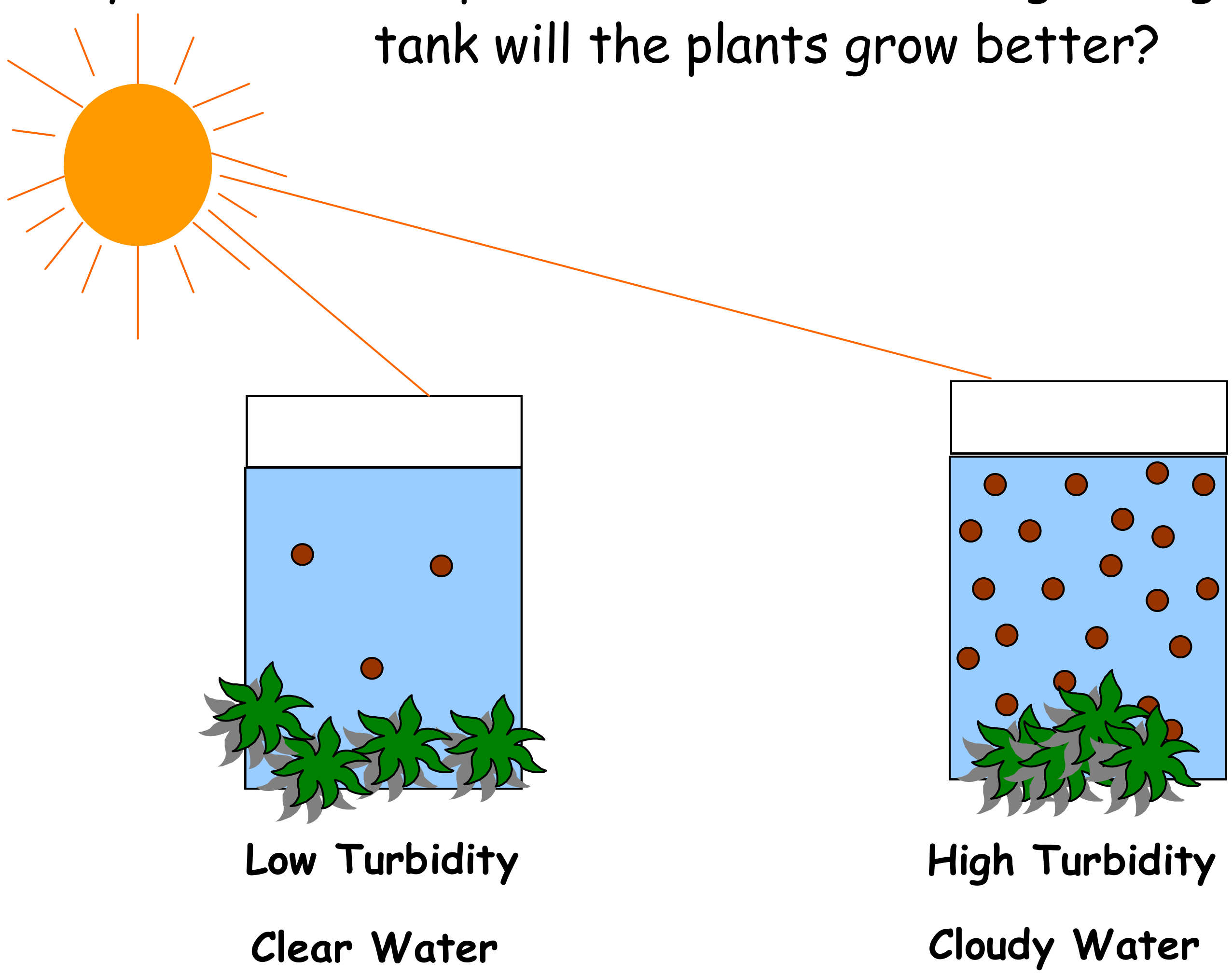




Turbidity

Turbidity is how clear or cloudy the water is !

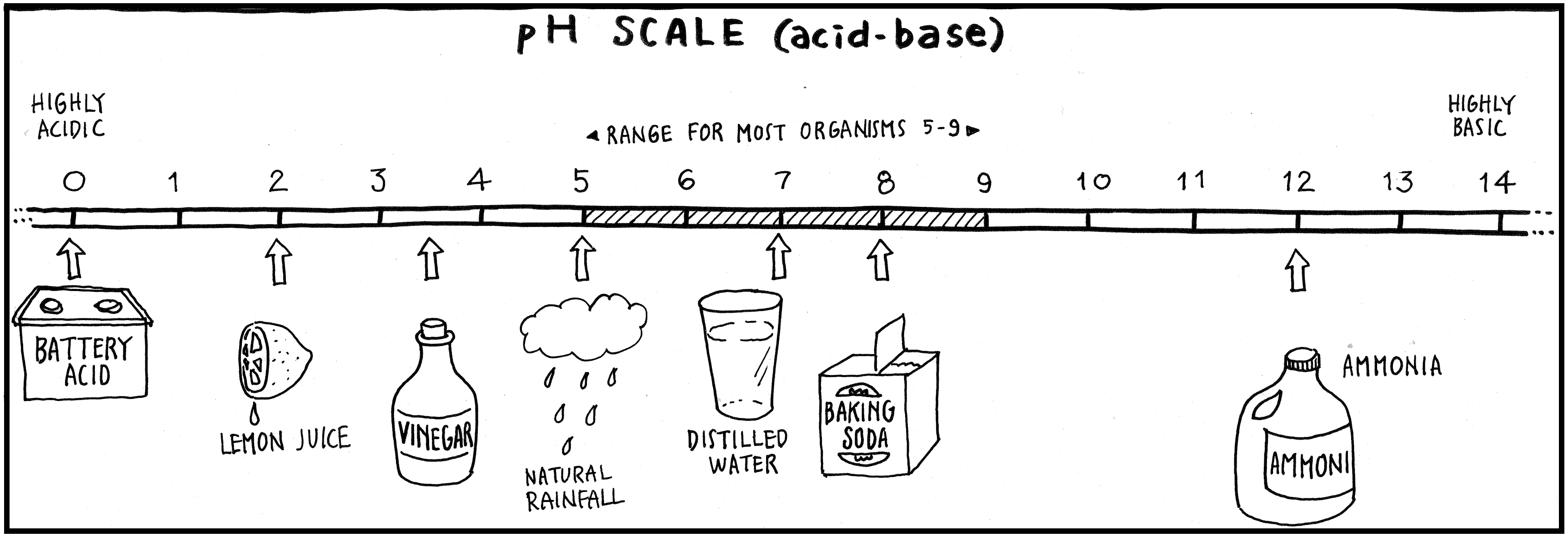
Both tanks below have plants growing in them. The tank on the left is full of semi-clear water, and the tank on the right is full of cloudy water. Both plants need lots of sunlight to grow. In which tank will the plants grow better?



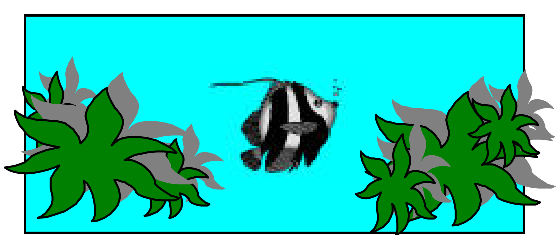
pH

pH tells us how acidic the water is! Animals like a pH between 5 and 9.

Use the scale and the picture below to answer the questions:



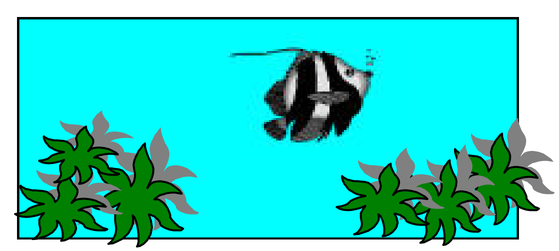
The owner of the fish tanks below poured ammonia into the fish tank on the left and vinegar into the fish tank on the right.



Which tank has acidic water?

Which tank has basic water?

Will the fish survive?

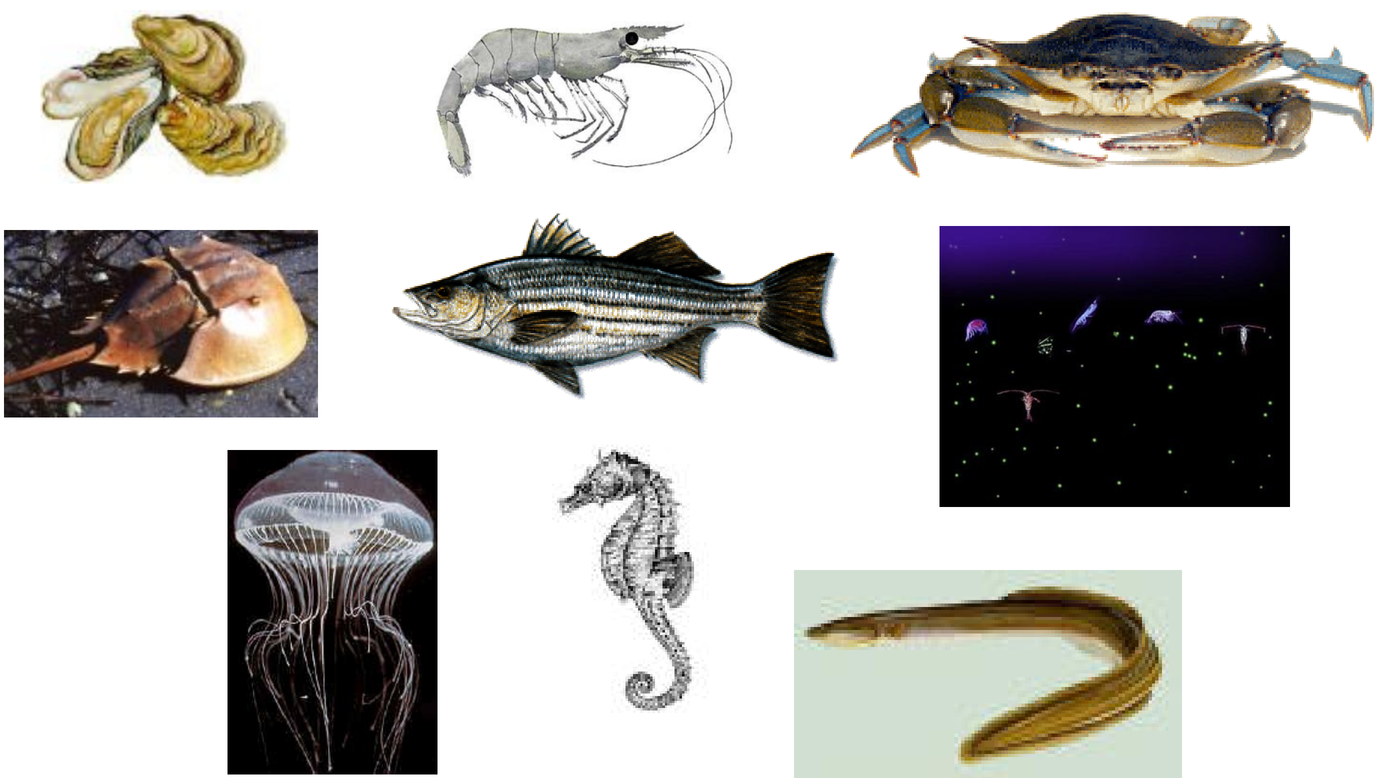


Salinity

Salinity is how salty water is!
Salt disappears in water.

The water around Manhattan is brackish.
Brackish = a mix of salty and fresh water, like in an estuary!

Can you name some of the animals below that live
in the brackish water around Manhattan?



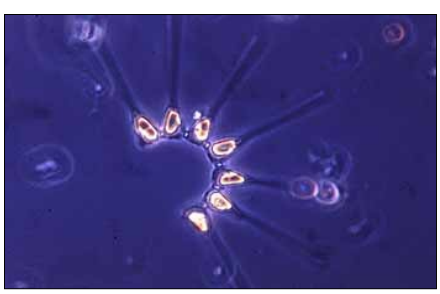
What are Plankton?

Plankton are tiny floating animals (Zooplankton) and plants (Phytoplankton) which in live the water. They are so small that you can not see them with just your eyes.

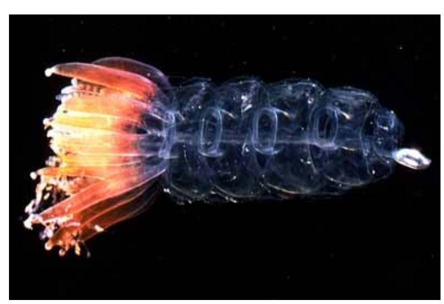
To see them, we must look through **microscopes**. **Microscopes** make small things look big.

Plankton in the Water:

The green dots are plants and the big shapes are animals.



Phytoplankton
=
Animals



Zooplankton
=
Plants

Field Trip Schedule

Class: ______________________________

Field Trip date: ______________________

Field Trip Schedule

8:30 am	Meet in the classroom, review field trip schedule and rules, paste activity sheets in journals
9:00 am	Leave the School, begin neighborhood ecology walk to Riverbank State Park.
10:00 am	Arrive at Riverbank State Park,
10:15 am	descend to the Amphitheatre, discuss the history of Riverbank State Park and the North River Waste Treatment Plant
10:30 am	River Observation, River Survey
10:45 am	Begin Station Rotation
11:45 am	River Reflection, Wrap up
12:00 pm	Students are escorted to the upper level, to wash up and eat lunch
12:45 pm	Begin the walk back to the school

Stations
Each station will be approximately 20 minutes.

Water Quality Station	Rate of flow, Dissolved Oxygen, Salinity and pH	Anne Carpenter
Plankton Station	Plankton Observation, Turbidity, Blue Crab Observation (hopefully)	Education Assistant
Measurement Station	Air and Water Temperature, Measurement Conversion Activity	Classroom Teacher

Preparing for the Field Trip

Journal
Students will be bringing their journal on the field trip. We will be pasting the field trip worksheets in the journal on the day of the field trip.

Student Groups
During the learning stations, the students will be traveling in groups. We will be making nametags for each student.

Measurement Station
The classroom teacher will be running the measurement station. You will be taking air and water temperature readings with the students, and then using two calibrated lines to do a simple conversion activity. For the conversion activity, there will be two calibrated lines laid out by your station. At either end there will be a colored marker or shell. Students will look at how far apart the markers are by using the colored tape on the calibrated lines. The line with the shorter periods between tapes is measurement in feet; the other is measurement in meters. If you have any questions about this station, please feel free to ask Anne or the Education Assistant.

Inclement Weather
Hopefully, the weather will cooperate. If not, there are a few rain dates that we have reserved. We will make the weather call on the morning of the field trip. As only precipitation will keep us from going, please remind your students that they will probably need heavy jackets and gloves if the weather is chilly. We will be outside for awhile, so we want everyone to be nice and warm.

Safety
We will be walking to the park, so everyone will be required to stay together in a group. Students will also be required to hold hands in pairs when crossing the street.
When at the park, students will not be allowed on the water side of the fence in the amphitheater, nor in the gates that go to the water. If any student must use the restroom, they will have to be escorted there by an adult.

Anne and the Education Assistant will reiterate safety rules to the students (probably a number of times).

Other Concerns
Students must bring their lunch or have it provided for them by the cafeteria!!

There will possibly volunteers from local colleges and organizations. Anne and the Education Assistant will make sure they are introduced to the students and that they also have name tags.

Field Trip Station Activities

River Observation
The River Observation worksheet asks the students to observe and write down what they feel and experience around them. If students are having trouble it is okay to lead them along a little. It is an opinion question, so there is no right or wrong.

River Survey
The first question asks the students to observe what they can actually see using the river. The second question is more of a recall question that asks them to remember the types of animals that live in the river.

River Reflection
The reflection portion is another opinion section. It asks the students to use their imaginations a little and write about how they feel.

Water Quality
Students will use their observation skills to observe the rate of flow (how fast the Hudson is moving and in which direction). They will also conduct water testing. After we finish testing the water, we will discuss if the Hudson River is healthy enough to support life. We will keep data for all of the classes, and after the field trips are finished the data will be available for you to use in the classroom if you so wish.

Plankton Station
Students will help the Education Assistant collect plankton and then they will use the Discovery Scopes to observe plankton. We may also have a blue crab available for students to observe (but not touch as they pinch). Students will discuss how plankton (both algae and animal species) are important to the river and the other animals that live in the river.

Measurement Station
Students will take temperature readings with their teacher. Both air and water temperature will be sampled. Teachers will be provided with a conversion chart for Celsius and Fahrenheit, as well as a healthy temperature range guide. The measurement activity will go over the process of conversion in a more concrete fashion. Students will use calibrated lines to tell how far apart two markers lay on the ground. One line is calibrated in feet, the other in meters.

River Observation Station

Describe what you see and feel. What do you see on the river, smell in the air? What can you hear? What is the weather like?

River Observation Station

Describe what you see and feel. What do you see on the river, smell in the air? What can you hear? What is the weather like?

page 1

River Survey

Make a list of things you **see** using the river.

What may be using the river that you can't see?

River Survey

Make a list of things you **see** using the river.

What may be using the river that you can't see?

page 2

River Reflection

Look at the Hudson River. What color is it? Why may it be that color?

Write a sentence describing how being at the River makes you feel.

Choose something that you see that is interesting. Draw it here.

page 3

River Reflection

Look at the Hudson River. What color is it? Why may it be that color?

Write a sentence describing how being at the River makes you feel.

Choose something that you see that is interesting. Draw it here.

page 3

Water Quality Station

Rate of Flow
Can you see the water of the Hudson River moving? In what direction is it moving? How fast?

Dissolved Oxygen
What is the dissolved oxygen measurement?
___ ppm (parts per million)

Is this healthy for river life? Why or why not?

Salinity
What is the salinity measurement? ___ ppt

Is this salty, fresh, or a mix?

pH
The Hudson River has a pH of: ___

Is this healthy for plants and animals living in the river? Why or why not?

Water Quality Station

Rate of Flow
Can you see the water of the Hudson River moving? In what direction is it moving? How fast?

Dissolved Oxygen
What is the dissolved oxygen measurement?
___ ppm (parts per million)

Is this healthy for river life? Why or why not?

Salinity
What is the salinity measurement? ___ ppt

Is this salty, fresh, or a mix?

pH
The Hudson River has a pH of: ___

Is this healthy for plants and animals living in the river? Why or why not?

page 4

Plankton Station

What tools do we use to study plankton in the Hudson River?

Do you see anything through the Discovery Scopes? Draw it here.

Do you have any observations or questions? Write them here.

Plankton Station

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page 5

MEASUREMENT STATION

Temperature Readings

Air: _____ °C _____ °F

Water: _____ °C _____ °F

Is the water temperature reading healthy for plants and animals living in the Hudson River? Why or why not?

Measurement Activity

How many feet are between the markers? _____

How many meters are between the markers? _____

MEASUREMENT STATION

Temperature Readings

Air: _____ °C _____ °F

Water: _____ °C _____ °F

Is the water temperature reading healthy for plants and animals living in the Hudson River? Why or why not?

Measurement Activity

How many feet are between the markers? _____

How many meters are between the markers? _____

page 6

SECTION SEVEN: ADDITIONAL RESOURCES

Books for Children

Aldis, Rodney, Towns and Cities, Dillon Press, 1992.

Anderson, Margaret J., Food Chains: The Unending Cycle, Enslow, 1991.

Asch, Frank, Water, Harcourt, New York, 1995.

Avakian, Monique and Smith, Carter, Historical Album of New York, Millbrook Press, 1993.

Burnie, David, Dictionary of Nature, Dorling Kindersley, 1994.

Cherry, Lynne, A River Ran Wild, Harcourt, Brace and Co., New York, 1992.

Chinery, Michael, ed., The Usbourne Complete First Book of Nature, Usbourne, 1990.

Cole, Joanna, The Magic School Bus at the Waterworks: NYC Edition, Ill. Bruce Degan, Scholastic, NYC, 1986.

Cole, Joanna, The Magic School Bus: Wet All Over, Ill. Bruce Degan, Scholastic, New York, 1996.

Cook, Ann, What was It Like When Your Grandparents Were Your Age?, Pantheon, 1996.

Dorris, Arthur, Follow the Water from Brook to Ocean, Harper Collins, New York, 1991.

Goldin, Augusta, Ducks Don't Get Wet, Ill. Helen K. Davie, Harper Trophy, New York, 1996.

Hesse, Karen, Come On, Rain, Ill. John Muth, Scholastic, New York, 1999.

Hooper, Meredith, River Story, Ill. Bee Willey, Candlewick, Cambridge, 2000.

Hurd, Edith Thacher, Starfish, Ill. Robin Brickman, Harper Trophy, New York, 1962, 2000.Jackobsen, Kathy, My New York, Little Brown and Co., New York, 1993.

Lauber, Patricia, Who Eats What?, Ill. Holly Keller, Harper Trophy, New York, 1995.

Loeper, John J., Going to School in 1776, Antheum, 1973.

MacDonald, Fiona, Water, Ill. Peter Bull, Sarah John & Carolyn Scrace, Franklin Watts, New York, 2000.

McKinney, Barbara Shaw, A Drop Around the World, Ill. Michael Mayday, Dawn Pub., Nevada City, 1998.

Parker, Steve, Eyewitness Books: Fish, Knopf, New York, 1990, 2002. [**PROVIDED**]

Parker, Steve, Eyewitness Books: Pond and River, Knopf, New York, 1988, 2002. [**PROVIDED**]

Pfeffer, Wendy, What's it Like to Be a Fish?, Ill. Holly Keller, Harper Trophy, New York, 1996.

Seuling, Barbara, Drip! Drop! How Water Gets to Your Tap, Ill. Nancy Tobin, Holiday House, NYC, 2000.

Yardley, Thomas, Down the Drain: Explore Your Plumbing, Millbrook Press, CT, 1991.

Web for Children

The US Environmental Protection Agency's environmental education website, with links to "kids' pages". http://www.epa.gov/enviroed

The US Geological Survey's web page for schools. http://water.usgs.gov/droplet

The Eddie Files Math Trail for NYC Drinking Water. Math standards. http://eddiefiles.org/mathtrails/nycwater/index.html

Field guide site sponsored by the National Wildlife Federation. May require adult assistance to get started. http://www.enature.com

Water Environment Federation's coloring pages and source book. http://www.wef.org/wefstudents/elementary/index.htm

New York's Department of Environmental Protection's website. http://www.nyc.gov/dep

American Waterworks website, New Jersey section. http://njawwa.org/kidsweb.htm

Books for Teachers

Black, Mary, Old New York in Early Photographs: 1853-1901, Dover Pub., New York, 1976.

Braus, Judy, Ed., Ranger Rick's Nature Scope: Wading in to Wetlands, National Wildlife Federation, c/o Learning Triangle Press, 1989.

Burns, Ric, et al., New York: An Illustrated History, (based on the documentary), Knopf, 1999.

Galusha, Diane, Liquid Assets: A History of New York City's Water System, Purple Mountain Press, Fleischmanns, 1999.

Nelson, Dennis, Dir., Project Wet K – 12 Curriculum & Activity Guide, The Watercourse, Bozeman, 1995.

Roberts, Janet Wier, et al., City Kids and City Critters, Houston Arboretum c/o Learning Triangle Press, Houston, 1996.

Slattery, Britt Eckhard, et al., WOW! The Wonders of Wetland: An Educator's Guide, Environmental Concern, St. Michaels, 1995.

Stanne, Stephen, et al., The Hudson: An Illustrated Guide to the Living River, Clearwater, Inc. c/o Rutgers University Press, New Brunswick, 1996.

Symons, Dr. James, M., Plain Talk About Drinking Water: Questions & Answers About the Water You Drink, American Water Works Assoc., New York, 1997.

Thoreau, Henry D., Walden, Princeton University Press/Bantam Paperback, 1854, 1981.

[Staff], Project Wild Aquatic: Education Activity Guide, The Council for Environmental Education, 1987, 1992.

Web for Teachers

The US Environmental Protection Agency's environmental education website.
http://www.epa.gov/enviroed

National Geographic article: core sample of underground NYC
http://www.nationalgeographic.com/features/97/nyindergrou nd

A "Hudson River Portfolio": a series of digital resources and virtual tour from the New York Public Library.
http://www2.nypl.org/home/Hudson/index.html

Additional historical engravings of the Hudson River from the New York Public Library
http://digital.nypl.org/mmpco/searchresultsK.cfm?keyword=hudson

New York State Parks listing for Riverbank State Park
http://nysparks.state.ny.us/cgi-bin/cgiwrap/nysparks/parks.cgi?p+146

About Riverside Park, the NYC Dept. of Parks and Recreation
http://www.nycgovparks.org/sub_your_park/vt_riverside_park/vt_riverside_park.html

Field guide site sponsored by the National Wildlife Federation
http://www.enature.com

EELink: Endangered Species - Excellent overview of the endangered species situation. Many lists.
http://www.eelink.net/EndSpp/

Journey North - Project of Annenberg CPB. A global study of wildlife migration.
http://www.learner.org/jnorth

The National Wildlife Federation: Environmental Education - Listings of NWF's education efforts.
http://www.nwf.org/education/

The NWF: Schoolyard Habitats Program - How to start a "habitat" and join their program.
http://nwf.org/habitats/schoolyard/index.html

Wildlife Web - Links to a variety of animal websites.
http://www.selu.com/bio/wildlife

GLOBE - Water, soil and atmospheric testing: a worldwide network of students, teachers, and scientists working together to study and understand the global environment.
http://spacelink.nasa.gov/Educational.Services/NASA.Education.Programs/Student.Support/Global.Learning.and.Observations.to.Benefit.the.Environment.-.GLOBE/

National Geographic Society
http://www.nationalgeographic.com

Green Map
Students and teachers can make their own local Green Map, and add to the database.
http://www.greenmap.org

For advanced labs see: Sea Grant's Oysters in the Classroom Oyster Anatomy Lab Segment:
http://www.mdsg.umces.edu/oysters/anatlab

More on Oysters:
http://www.wsg.washington.edu/oysterstew/cool/oystercool.html

http://www.mdsg.umd.edu/Education/edmaterial.html see this link for various workbooks from the University of Maryland

Glossary

Acid rain - Natural rainfall, which contains nitric and sulfuric acids due to oxides of nitrogen and sulfur dioxide discharged into the air by industries, power plants, and automobiles. See box p. ___

Algae - Simple rootless plants that grow in bodies of water (e.g. estuaries) at rates in relative proportion to the amounts of nutrients (e.g. nitrogen and phosphorus) available in water.

Amphibian - a cold-blooded vertebrate that spends some time on land but must breed and develop into an adult in water. frogs, salamanders, and toads are amphibians.

Amphipods - Small, shrimp-like crustaceans

Anaerobic - Not containing oxygen or not requiring oxygen.

Anoxic - A condition where no oxygen is present. Much of the "anoxic zone" is anaerobic, with absolutely no oxygen, a condition in which toxic hydrogen sulfide gas is emitted in the decomposition process.

Aquatic - Living in water.

Arthropod - A large group of invertebrate animals with jointed legs, including the insects, scorpions, crustaceans and spiders.

Autotroph - Any organism that is able to manufacture its own food. Most plants are autotrophs, as are many protists and bacteria. Autotrophs may be photoautotrophic, using light energy to manufacture food, or chemoautotrophic, using chemical energy.

Benthos - A group of organisms, most often invertebrates, that live in or on the bottom in aquatic habitats (such as clams that live in the sediments) which are typically immotile or of limited motility or range.

Biomass - The quantity of living matter, expressed as a concentration or weight per unit area.

Biota - The flora and fauna of a region.
Bivalve - Mollusk with two shells connected by a hinge (i.e. clams, oysters).

Bloom - A population burst of phytoplankton that remains within a defined part of the water column

Brackish - Somewhat salty water, as in an estuary.

Carnivore - Literally, an organism that eats meat. Most carnivores are animals, but a few fungi, plants, and protists are as well.

Cephalopod - A member of the group of mollusks that includes octopuses, squid, nautiluses and cuttlefishes.

Chlorophyll - A pigment contained in plants that is used to turn light energy into food. Chlorophyll also gives plants their green color.

Cilia - a tiny projecting thread, found with many others on a cell or microscopic organism, that beats rhythmically to aid the movement of a fluid past the cell or movement of the organism through liquid

Class - Subdivision of a phylum containing a group of related orders.

Coliform bacteria - A group of bacteria primarily found in human and animal intestines and wastes. These bacteria are widely used as indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) bacteria. *Escherichia coli* (E. coli) is one of the fecal coliform bacteria widely used for this purpose.

Consumer - Any organism which must consume other organisms (living or dead) to satisfy its energy needs.

Copepod - A type of small planktonic crustacean. Copepods are a major group within the mesozooplankton, and are both important grazers of phytoplankton and food for fish.

Crustaceans - The class of aquatic Arthropods including copepods, isopods, amphipods, barnacles, shrimp, and crabs which are characterized by having jointed appendage and gills.

DDT - A group of colorless chemicals used as insecticides. DDTs are toxic to man and animals when swallowed or absorbed through the skin.

Detritus - Accumulated organic debris from dead organisms, often an important source of nutrients in a food web.

Detrivore - Any organism, which obtains most of its nutrients from the detritus in an ecosystem.

Diatoms - Microscopic algae with plate like structures composed of silica. Diatoms are considered a good food source for zooplankton.

Dinoflagellate - Algae of the order Dinoflagellata.

Dissolved Oxygen - Microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. Dissolved oxygen is necessary for healthy lakes, rivers, and estuaries. Most aquatic plants and animals need oxygen to survive. Fish will drown in water when the dissolved oxygen levels get too low. The absence of dissolved oxygen in water is a sign of possible pollution.

Diurnal - Active during daylight.

Diversity - An ecological measure of the variety of organisms present in a habitat.

Ecology - The study of interrelationships between living things and to their environment.

Ecosystem - All the organisms in a particular region and the environment in which they live. The elements of an ecosystem interact with each other in some way, and so depend on each other either directly or indirectly.

Effluent - The discharge to a body of water from a defined source, generally consisting of a mixture of waste and water from industrial or municipal facilities.

Emissions - Refers to pollution being released or discharged into the air from natural or man-made sources. Pollutants may be released directly into the air from a structural device (i.e., smokestack, chimney, exhaust pipe) or indirectly via volatilization or dispersal (i.e., aerosol spraying).

Endangered - A species that is in immediate danger of becoming extinct and needs protection to survive.

Endemic species - A species that is restricted in its distribution to a particular locality or region.

Environment - The place in which an organism lives, and the circumstances under which it lives. Environment includes measures like moisture and temperature, as much as it refers to the actual physical place where an organism is found.

Erosion - The disruption and movement of soil particles by wind, water, or ice, either occurring naturally or as a result of land use.

Estuarine species - A permanent resident of an estuary. Also called a resident species.

Estuary - A semi enclosed body of water that has a free connection with the open sea and within which seawater (from the ocean) is diluted measurably with freshwater that is derived from land drainage (i.e. the Chesapeake Bay). Brackish estuarine waters are decreasingly salty in the upstream direction and vice versa. The ocean tides are projected upstream to the fall lines.

Eutrophic - Describes an aquatic system with high nutrient concentrations. These nutrient concentrations fuel algal growth. This algae eventually dies and decomposes, with reduces the amount of dissolved oxygen in the water.

Exotic Species - Any introduced plant or animal species that is not native to the area and that may be considered a nuisance.

Extinct species - A species, which has disappeared from existence due to either natural or human-induced means (opposite of extant).

Filter feeder - An organism that filters food from the environment via a straining mechanism (such as gills)(i.e. barnacle)

Food chain / food web - The network of feeding relationships in a community as a series of links of trophic levels, such as primary producers, herbivores, and primary carnivores. Includes all interactions of predator and prey, along with the exchange of nutrients into and out of the soil. These interactions connect the various members of an ecosystem, and describe how energy passes from one organism to another.

Gastropod - the largest and most successful class of mollusks (phylum Mollusca), containing over 35,000 living species and 15,000 fossil forms. Most gastropods have a one piece shell (univalve), however in some, such as slugs and nudibranchs there is no shell at all. Gastropods have a well defined head, with one or two sensory tentacles and a mouth. They travel by using a single large muscular foot.

Habitat - The place and conditions in which an organism lives.

Herbivore - Literally, an organism that eats plants or other autotrophic organisms. The term is used primarily to describe animals.

Hermaphroditic - An organism having both sexes: a plant or animal having both male and female reproductive organs and secondary sexual characteristics.

Hydrological - The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hypoxic - A condition where only very low levels of oxygen are present.

Indigenous Species - A species that evolved on the North American continent, was present at the time of European Colonization, and is resident within the Chesapeake Bay basin without human manipulation.

Impervious - Surfaces that will not allow things to pass through. Such as hard surfaces that do not allow water to pass through.

Intertidal - The area of shore located between high and low tides.

Introduced Species - Species, which have been intentionally or inadvertently brought into a region or area. Also called exotic species.

Invertebrate - Animals which lack a backbone and include such as squids, octopuses, lobsters, or shrimps, crabs, shellfishes, sea urchins and starfishes.

Keystone species - A predator at the top of a food web, or discrete subweb, capable of consuming organisms of more than one trophic level beneath it.

Larva - A discrete stage in many species, beginning with zygote formation and ending with metamorphosis.

Littoral zone - The intertidal area, also known as the splash zone.

Macro-organism - An organism visible without the aid of a microscope.

Mammal - Any of a large class called Mammalia; warm blooded, usually hairy vertebrates whose offspring are fed with milk secreted by the mammary gland.

Marine - Refers to the ocean.

Marsh - An emergent wetland that is usually seasonally flooded or wet, and often dominated by one or a few plant species.

Micro-organism - An organism requiring magnification to see/study (microscopic).

Micron - A unit of measure equal to one thousandth of a millimeter

Migratory - Describing groups of organisms, which move from one habitat to another on a regular or seasonal basis.

Mollusk - The invertebrate phylum, which contains bivalves (i.e. oysters), gastropods (i.e. snails), and squids.

Molt - To shed the exoskeleton (outer covering) or prior to new growth (i.e. blue crab).

Native Species - Species, which have lived in a particular region or area for an extended period of time.

Nekton - Organisms with swimming abilities that permit them to move actively through the water column and to move against currents (i.e. fish, crabs).

Neritic - A part of the pelagic zone, which extends from the high tide line to the bottom.

Niche - A general term referring to the range of environmental space occupied by a species.

Nitrogen - (N) is used primarily by plants and animals to synthesize protein. Nitrogen enters the ecosystem in several chemical forms and also occurs in other dissolved or particulate forms, such as tissues of living and dead organisms.

Nocturnal - Active only at night.

Nonpoint Source - A diffuse source of pollution that cannot be attributed to a clearly identifiable, specific physical location or a defined discharge channel. This includes the nutrients that runoff the ground from any land use - croplands, feedlots, lawns, parking lots, streets, forests, etc. - and enter waterways. It also includes nutrients that enter through air pollution, through the groundwater, or from septic systems.

Nutrients - Compounds of nitrogen and phosphorus dissolved in water, which are essential to both plants and animals. Too much nitrogen and phosphorus act as pollutants and can lead to unwanted consequences - primarily algae blooms that cloud the water and rob it of oxygen critical to most forms of aquatic life. Sewage treatment plants, industries, vehicle exhaust, acid rain, and runoff from agricultural, residential and urban areas are sources of nutrients entering the Bay.

Omnivore - Literally, an organism that will eat anything. Refers to animals that do not restrict their diet to just plants or other animals.

Parasite - A plant or animal, which lives on or in an organism of another species from which it derives its nutrition and/or protection; usually without benefit to the host and often with harmful effects.

Pelagic - The open ocean, excluding the ocean bottom and shore.

Perennial - A term used in botany used to describe plants that live for more than two growing seasons. Such plants either die back after each season, as some herbaceous plants do, or grow continuously, as some shrubs do.

Pesticides - A general term used to describe chemical substances that are used to destroy or control insect or plant pests. Many of these substances are manufactured and do not occur naturally in the environment. Others are natural toxics that are extracted from plants and animals.

pH - Measure of the acidity or basicity of water (-log10 of the activity of hydrogen ions in water).

Phosphorus - (P) A key nutrient in the Bay's ecosystem, phosphorus occurs in dissolved organic and inorganic forms, often attached to particles of sediment. This nutrient is a vital component in the process of converting sunlight into usable energy forms for the production of food and fiber. It is also essential to cellular growth and reproduction for organisms such as phytoplankton and bacteria. Phosphates, the inorganic form is preferred, but organisms will use other forms of phosphorus when phosphates are unavailable.

Photic zone - Layer of a body of water that receives ample sunlight for photosynthesis (usually less than 100m).

Photosynthesis - The process by which plants convert carbon dioxide and water into carbohydrates and oxygen. The carbohydrates are then available for use as energy by the plant or other consuming organisms. (CO_2+ H_2O +SUNLIGHT= $C_6H_{12}O_6$ + O_2). This process is also referred to as "primary production."

Phytoplankton - Plankton are usually very small organisms that cannot move in dependently of water currents. Phytoplankton is any plankton that is capable of making food via photosynthesis.

Plankton - Small or microscopic algae and organisms associated with surface water and the water column.

Point Source - A source of pollution that can be attributed to a specific physical location; an identifiable, end of pipe "point". The vast majority of point source discharges for nutrients are from wastewater treatment plants, although some come from industries.

Polychlorinated Biphenyl (PCB) - a chemical compound composed of a bi-phenyl group and chlorine atoms. PCBs are toxic to aquatic organisms as well as humans

ppt - Parts per thousand (used as a measurement of salinity).

Predator - Organism, which hunts and eats other organisms. This includes both carnivores, which eat animals, and herbivores, which eat plants.

Prey - Organism hunted and eaten by a predator.

Primary Producers - organisms, such as algae, that convert solar energy to organic substances through the molecule, chlorophyll. Primary producers serve as a food source for higher organisms.

Proboscis - long or tubular mouthparts of certain insects, worms, and spiders, used for feeding, sucking, and other purposes. Can also be the long flexible snout of some mammals.

Raptor - A bird of prey (i.e. osprey, eagle, hawk)

Red tide - A dense outburst of phytoplankton (usually dinoflagellates) often coloring water red brown.

Roe - Fish eggs, especially while still massed in the ovarian membrane; called caviar

Salinity - A measure of the salt concentration of water. Higher salinity means more dissolved salts. Usually measured in parts per thousand (ppt).

Salinity regime - A portion of an estuary distinguished by the amount of tidal influence and salinity of the water. The major salinity regimes are, from least saline to most saline:

- **Tidal Fresh** –salinity between 0 and 0.5 parts per thousand (ppt). These areas are at the extreme reach of tidal influence.
- **Oligohaline** –salinity between 0.5 and 5 ppt. These areas are typically in the upper portion of an estuary.
- **Mesohaline** –salinity between 5 and 18 ppt. These areas are typically in the middle portion of an estuary.
- **Polyhaline** –salinity between 18 and 30 ppt. These areas are typically in the lower portion of an estuary, where the ocean and estuary meet.

Salt marsh - A coastal habitat consisting of salt-resistant plants residing in organic-rich sediment accreting toward sea level.

Scavenger - An opportunistic animal that feeds on decaying plants and animals or scraps of food abandon by other animals.

Sediment - matter that settles and accumulates on the bottom of a body of water or waterway.

Sessile - Immobile because of an attachment to a substrate (i.e. oysters).

Shellfish - An aquatic animal, such as a mollusk (e.g. clams, oysters, and snails) or crustacean (e.g. crabs and shrimp), having a shell or shell-like external skeleton (exoskeleton).

Spat - Juvenile, newly attached oysters (i.e. oyster spat).

Spawn - To release eggs and/or sperm into water.

Species - A population or group of populations that are in reproductive contact but are reproductively isolated from all other populations.

Substrate - "Supporting surface" on which a sessile organism lives and grows. The substrate may simply provide structural support, or may provide water and nutrients. A substrate may be inorganic, such as rock or soil, or it may be organic, such as wood.

Subtidal - Submerged, not exposed at the lowest tide.

Sustainability - The ability to continue existing.

Stratification - The formation, accumulation, or deposition of materials in layers, such as layers of fresh water overlying higher salinity water (salt water) in estuaries.

Swim Bladder - an organ regulating the buoyancy in most teleost (bony) fishes.

Terrestrial - Living on land, as opposed to marine or aquatic.

Threatened - A species that is likely to become endangered if not protected.

Tides - Periodic movement of water resulting from gravitational attraction between the earth, sun, and moon.

Tributary - A body of water flowing into a larger body of water.

Trophic Level - Layer in the food chain in where one group of organisms serves as the source of nutrition of another group of animals.

Turbidity - The decreased clarity in a body of water due to the suspension of silt or sedimentary material.

Understory - Just beneath the canopy, this layer of the forest is composed of small trees and shrubs. As older trees die, they leave a gap in the canopy, which younger trees quickly grow to fill.

Vertebrate - Animals with a backbone including fish, amphibians, reptiles, birds, and mammals.

Wastewater - Water that has been used in homes, industries, and businesses that is not for reuse unless treated by a wastewater facility.

Water clarity - Measurement of how far you can see through the water. The greater the water clarity, the further you can see through the water.

Watershed - a region bounded at the periphery by physical barriers that cause water to part and ultimately drain to a particular body of water.

Wetland - Low areas such as swamps, tidal flats, and marshes, which retain moisture.

Zooplankton - a community of floating, often microscopic animals that inhabit aquatic environments. Unlike phytoplankton, zooplankton cannot produce their own food, and so are consumers.

Bibliography

Adams, Michael Henry, 2002, *Harlem Lost and Found: An Architectural and Social History; 1765 - 1915,* Monacelli Press, New York.

Braus, Judy, ed., 1989, *Ranger Rick's Nature Scope: Wading Into Wetlands,* National Wildlife Federation, McGraw Hill, New York.

Editorial Staff, 1992, *Project Wild Aquatic Education Activity Guide,* Council or Environmental Education, Project Wild, Gaithersburg, MD.

Haynes, James, M., Frisc, Norman, J., 1993, *An Illustrated Guide to Hudson River Fishes,* Center for Applied Aquatic Science and Aquaculture, Department of Biological Sciences, SUNY College at Brockport, NY.

Hunken, Jorie, 1993, *Botany for All Ages: Discovering Nature Through Activities for Children and Adults,* Second Edition, The New England Wildflower Society, Globe Pequot Press, Old Saybrook, CT.

Kesselbaum, Alan S., Slattery, Britt Eckhardt, 1995, *WOW!: Te Wonders of Wetlands; An Educator's Guide,* Environmental Concern, St. Michaels, MD & Te Watercourse, Bozeman, MT.

Lauber Patricia, 1995, *Who Eats What?: Food Chains and Food Webs,* Let's-Read-and-find-Out-Science Series, Stage 2, Harper Collins, New York.

Mitchell, Mark K., M.S., Stapp, William B., Ph. D., 1996-7, *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools,* Eleventh Edition, Kendall/Hunt Publishing Co., Dubuque, IA.

Nelson, Dennis, Dir., 1995, *Project Wet Curriculum & Activity Guide; K - 12,* Council for Environmental Education, Project Wet, Bozeman, MT.

Parker, Steve, 1988, *Eyewitness Books: Pond & River,* Alfred A. Knopf, New York.

Parker, Steve, 1990, *Eyewitness Books: Fish,* Dorling Kindersley, New York.

Pfeffer, Wendy, 1996, *What's It Like to be a Fish?,* Let's-Read-and-Find-Out-Science Series, Harper Collins, New York.

Ramis, Kenneth G., 1996, *Guide to Microlife*, Franklin Watts/Grolier, Danbury, CT.

Reid, George, K., 2001, *Pond Life,* Golden Guides, St. Martin's Press, New York.

Stanne, Stephen P., Panetta, Roger G., Forist, Brian, E., 1996, *The Hudson: An Illustrated Guide to the Living River,* Hudson River Sloop Clearwater, Inc., Rutgers University Press, New Brunswick, NJ.

Taylor, Barbara, 1992, *Look Closer: River Life,* Dorling Kindersley, Inc., New York.

Thatcher-Hurd, Edith, 1962, 2000, *Starfish,* Revised Edition, Let's-Read-and-Find-Out-Science Series, Harper Collins, New York.

Weir Roberts, Janet, Huelbig, Carole, 1996, *City Kids and City Critters!: Activities for Urban Explorers,* Houston Arboretum & Nature Center, McGraw Hill, New York.

Zim, Herbert S., 1989, *Seashore Life,* Golden Guides, St. Martin's Press, New York.

Web Resources

American Rivers
www.americanrivers.org

Beczak Environmental Education Center
www.beczak.org

Chesapeake Bay Program
www.chesapeakebay.net

Coastal Research and Education Society of Long Island
www.cresli.org

Cornell University Hydroecology & Fish Biology
http://www.dnr.cornell.edu/hydro2/hydro2.htm

DEC Hudson River Estuary Management Action Plan
http://unix2.nysed.gov/edocs/encon/hud_plan.htm

GE's "Statement" Website
www.hudsonvoice.com

GE, PCB's and the Hudson River, article
http://www.multinationalmonitor,org/mm2001/01july-august/julyaug01corp1.html

The Hudson River Foundation
www.hudsonriver.org

The Hudson River Museum
www.nrm.org

The Hudson River Sloop Clearwater
www.clearwater.org

The Institute of Ecosystems Studies
www.ecostudies.org

Meadowlands Environment Center
http://www.hmdc.state.nj.us/ec/index.html

Microsoft Encarta Dictionary, Encyclopedia, Thesaurus
www.encarta.com