ESTUARY ESSENTIALS

Concepts

- Definition of estuary
- Differing densities of fresh and salt water
- The salt front
- Reasons for the abundance of life in estuaries

Introduction

The Hudson River is an estuary — a body of water, partially enclosed by land, where salty ocean water is diluted by fresh water running off the land. The manner in which salt and fresh water come together in estuaries helps to make them very productive environments.

Students often assume that the density of a particular substance is the same throughout that substance. They might well expect the densities of salty ocean water and fresh river water to be the same. This activity shows that salt water is denser than fresh water, and offers a demonstration of why that density difference is an important factor contributing to the high productivity of estuaries like the lower Hudson River.

Expect this activity to take approximately 20-30 minutes of class time.

Materials

Each **student** (or small group of students) should have:

- 2 small wide-mouthed jars or plastic tumblers (8 oz. peanut butter jars work well)
- 1 medicine dropper
- 1 copy of student "Estuary Essentials" lesson

The **teacher** should have the following on hand:

- 1-2 quarts of fresh water
- 1-2 containers of ground black pepper
- 1-2 quarts of colored salt water - "ocean water" - prepared using the following:
    - 1-2 quart jars (mayonnaise jars or juice bottles, for example)
    - 1 cup of salt per quart of water (pickling or kosher salt works best)
    - 20 drops of food coloring per quart of water (dark colors -green, blue, red - are best) While this solution can be prepared ahead of time, mixing it in front of the class effectively engages students' interest.

Procedure

Begin by discussing the definition of an estuary, and ask students where the salt water and fresh water in the Hudson estuary have their source (the Atlantic Ocean and rain or snow falling in the Hudson's watershed). Explain that this activity will explore how salt and fresh water behave when they meet in the Hudson, and show why this behavior is important to estuaries' production of living things.

Point out (or mix while students watch) the salty "ocean water" and the fresh water. It is best not to fill their small containers with water until they are actually ready to use it. At that point fill one of the small containers one-third full of colored salt water, the other one-third full of clear fresh water.

The teacher can now let the students follow the lesson plan on their own, or lead them through it. In either case, these pointers should be helpful:

1. Add the colored solution slowly and gently, not with forceful squirts.
2. Don't swirl the solution or stir it with the droppers.
3. Placing a white card or piece of paper behind the jar will make it easier to see what happens when the colored water is added.
4. After the students have created their salt fronts, place about one quarter to one half teaspoon of pepper in each container. The pepper may not sink readily; tap the sides of the jar or gently push particles under the water's surface with a finger.
5. Don't expect all the pepper to line up at the salt front. Many particles will sink right through. But after two or three minutes, a fair number of particles will be suspended in or on the denser salt water layer.

Discussion

This demonstration shows the distribution of salt and fresh water from surface to bottom of the Hudson (though in the River the layers are less distinct due to tidal mixing). The salt front also moves north and south, marking the reach of ocean water upstream. Its location is determined by the flow of fresh water into the Hudson. Typically the salt front is furthest south in spring, when melting snow and rain bring large amounts of fresh water into the River, and furthest north in early fall, after the drier summer months. While there is considerable variation based on the amount and timing of precipitation, the front would usually be south of the Tappan Zee in early spring and at Beacon/Newburgh in early fall.

Estuaries rank among the most productive of all ecosystems on the planet, on a par with lush tropical forests and more productive than rich, fertilized croplands. Many marine species have life cycles geared to take advantage of this productivity, and we in turn take advantage of it through fishing. Roughly two-thirds of commercially-caught finfish are dependent on estuaries at some point in their life cycles; ninety percent of our shellfish catch is dependent on estuaries.

Further explorations

1. Incorporating the scientific method into this activity

As outlined here, this lesson is a demonstration rather than an experiment. Experimental controls can be set up for different parts of the procedure. Most obvious might be ascertaining whether salt or food coloring in the "ocean water" sample is responsible for its greater density. To set up a control, students will need two more jars and labels (or masking tape) to identify the contents of their containers. You will need one or two additional quart jars, which should be filled with water as were the others. Add 10 drops of food coloring to the fresh water in these jars. One of the students' additional jars should be one third full of clear fresh water, the other one third full of colored fresh water. (They should now have four jars: two with clear fresh water, one with colored salt water, and one with colored fresh water.) Have the students add the colored fresh water to the clear in the same manner used with the colored salty water. Compare the results. Is there a density difference due to the presence of food coloring?

2. Another illustration of density

To further explore the concept of density as it relates to salt and fresh water, have students fill a small container with fresh water and place an egg in the water. By carefully stirring salt into the water and increasing its density, they should make the egg float. Some students may be able to relate that phenomenon to their own experiences swimming in fresh and salt water. It's of great importance to deep draft, ocean-going ships travelling the Hudson to Albany. These ships will not float as high in less dense fresh water, and must be loaded taking that into account; otherwise their increasing draft might put them aground.

Resources

Anderson, Norman D. *Investigating Science in the Swimming Pool and Ocean.* McGraw-Hill Book Company, New York: 1978. Many activities exploring water, its properties, and its living organisms; of particular relevance are instructions for making a simple hydrometer which measures saltiness of water, along with suggested activities using the instrument.

Arnov, Boris. *Water: Experiments to Understand It.* Lothrop, Lee, & Shepard Books, New York: 1980. A wealth of simple demonstrations illustrating many physical properties of water; activities well-suited for elementary age students.

WATER POLLUTION CLEANUP

Concepts

- Types of water pollution in the Hudson River
- Techniques of cleaning polluted water
- Alternatives to waste disposal in waterways

Introduction

While many students are aware that the Hudson is polluted, few think about this in more than cursory fashion. When asked what forms this pollution takes, a fair number can't suggest anything beyond trash, garbage, and litter. In this exercise students will learn what types of pollution are found in the Hudson as they see analogous "pollutants" dumped in a jar of clean water.

The class then addresses pollution cleanup through a problem-solving activity. The "polluted" sample is presented to them along with an assortment of filters, funnels, containers, and implements that might be of use in cleaning it up. Students are given a limited amount of time to restore the water to its former clear state. While attempting to do this, they discover methods of cleaning water akin to those used in waste treatment and water supply systems. Also made apparent is the difficulty of dealing with certain substances once they're discharged into waterways like the Hudson.

This activity is best done in small groups, with no more than six students per group, and in a room equipped with a sink and running water. While a fair amount of material must be collected in advance, it is all readily and cheaply obtainable - and the results are well worth the effort.

Expect this activity to take 40-50 minutes of class time.

Materials

Each **small group of students** should have:

- 1 copy of "Water Pollution Cleanup" student worksheet
- 1 pen or pencil
- 1 wash basin or dish pan
- 1 piece of screening 6" square
- small amount of cheesecloth or aquarium filter fiber
- 1 small sponge
- 1 or 2 eyedroppers
- 1 or 2 spoons
- 1 empty quart jar
- 1 quart jar half full of clean water

- 3/4 cup of filter sand (used in swimming pool filters); clean, well-rinsed beach sand is also suitable
- 1 container for wastes removed during cleanup process (yogurt or cottage cheese containers, quart size, work well)
- 1 or more funnels, medium to large size (a suitable funnel can be made by cutting the bottom off a small plastic soda bottle)
- 1 tablespoon of alum (optional - obtain from a drugstore or chemistry teacher)

The teacher should have the following on hand:

- measuring spoons
- adhesive labels, masking tape, or grease pencils to mark jars
- quart jars half-filled with clean water; as many as there are groups of students
- "pollutants" (listed with the real pollutants they represent)
  - 3 tablespoons of vegetable oil (petroleum)
  - 2 tablespoons of leaf litter (sewage, organic wastes)
  - 1 teaspoon of sand and/or mud (grit and sediment)
  - 5 drops of dish detergent (could represent phosphates, detergents, or chemicals generally)
  - 1 drop of food coloring (toxic chemicals)
  - assorted items of trash - torn-up paper, styrofoam, bottle caps, etc. (litter, trash)
  - 1 teaspoon of vinegar (acid rain - optional; it's difficult to measure how well it's been removed)

Procedure

Before the class period

Assemble the required materials prior to presenting the activity to the class, placing each group's equipment in their wash basin for quick distribution. Prepare enough "polluted" water samples for all but one of the small groups by putting the indicated pollutants in the jars half full of water. The last sample will be prepared in front of the class. More theatrical impact can be achieved by keeping these samples out of sight until the time comes to clean them up.

Introducing the lesson

Ask the students to list the types of substances which pollute the Hudson (or other streams or lakes). As answers are offered, write them down on a chalkboard. Variation is possible, and leading suggestions from the teacher may be required. The list should eventually include the following: trash, sewage, toxic chemicals, other chemicals (including detergents), sand and silt, acid rain*, and petroleum.

Taking the remaining sample of clean water, tick off each item listed on the board, and add the analogous "pollutant" from the list above. Cap it, shake it up, and announce that students will have twenty minutes to try to restore this "polluted" sample to its original clear state. Pass out the cleanup materials to small groups of students, then list the items that should be in each wash basin, assuring that each group has all their materials.

Before handing out the polluted samples, give each group five minutes to discuss the exercise and come up with a written plan for cleanup. A recorder should be elected to write it out on the attached student worksheet.

The cleanup task

While the students should be free to develop their own cleanup techniques, the following ground rules should be outlined:

1. All pouring should be done over the wash basin to avoid messy and disruptive accidents.
2. The only clean water available to students is the half filled jar included with their cleanup equipment. They are not to use clean water from a faucet or other source. Encourage them to think hard about how this limited amount of clean water should be used.
3. Waste removed from the sample should be collected in the appropriate container.

* While rain falling in the Hudson Valley can be quite acidic, the River is buffered by salt water and by limestone in its freshwater tidal reaches; a neutral to slightly basic pH of 7 to 7.5 is thus maintained in its tidewater length. While adding vinegar to the sample is therefore optional, do not minimize acid rain as a problem — the lower Hudson is simply fortunate in its geologic setting.

4. The person selected as recorder should write down each step taken by the group as they try to clean the sample.
5. At the end of the activity, each group should have at least one half bottle full of "cleaned" sample to compare with the results obtained by other groups.

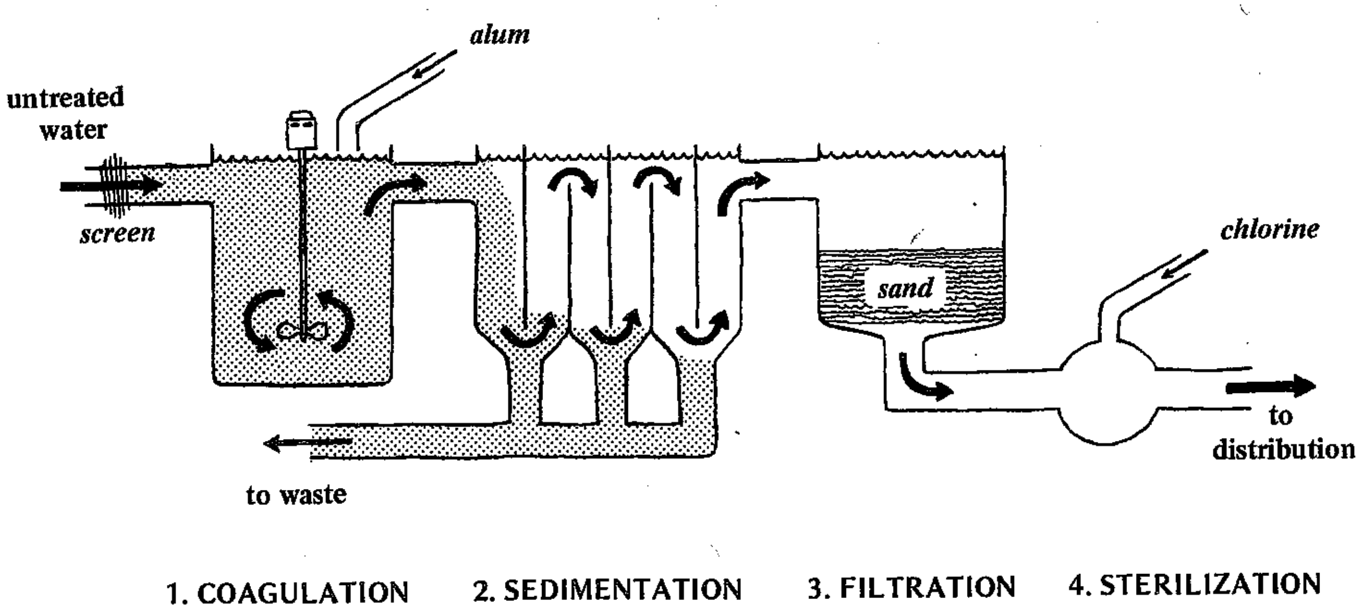
While the students try to clean their samples, visit each group to check their progress, answer questions, and offer suggestions. Avoid giving too much direction, but do encourage them to think before acting on their ideas.

When twenty minutes (it could be less if students have exhausted the possibilities) have passed, have each group label its jar of "cleaned" water and bring it to the front of the room. All other materials should be placed in the basins and collected, but don't spend time cleaning or organizing now; it's best to move right into the discussion while students are attentive. (One note about cleaning afterwards: don't put used filter sand down sink drains — it could clog them up; dispose of it in a wastebasket.)

Discussion

Begin by asking a spokesperson from each group to describe briefly how they tried to clean their sample. **Relate students' methods to real-life techniques used by water treatment plants.** Such plants are operated by several communities along the Hudson, the largest being the city of Poughkeepsie, that take their drinking water from the River. As it enters such a plant, water passes through screens which remove large objects and debris. Alum is added as the water enters large settling tanks; it causes tiny particles of sediment to bind together, forming larger masses which sink readily to the bottom. Water drains from the top of these tanks and enters sand filter beds, which remove any remaining suspended solids. The final step is the addition of chlorine to kill bacteria. Students usually don't take advantage of settling as a cleanup tool, and chlorination obviously isn't available to them; otherwise they typically use similar methods.

Steps in Municipal Water Treatment



Ask students which pollutants were hardest to remove. They should have been able to get rid of almost all the solid material — trash, grit, and leaf litter "sewage solids" — using the filter mediums provided. Since soap suds and oil rise to the surface, it is possible to skim with the spoons, suck with the eyedroppers, and blot with the sponge to remove most of these pollutants. Each of these techniques has its counterpart in real-life cleanup of oil spills. Only one effective method of dealing with the food coloring is available to the class — dilution. Many students will realize that this technique is perhaps the best use of their available clean water. It's also the technique most widely used by polluters discharging wastes into streams.

Does dilution get rid of pollution? Make note of the fact that only one drop of food coloring was added. Polluters often claim that small amounts of wastes dumped in a volume of water as large as the Hudson River do not pose real problems. However, bioaccumulation (also called biological magnification) in the food chain will concentrate toxic chemicals to high levels in animals at the top of the chains. Bald eagle, pelican, and peregrine falcon populations have suffered due to this phenomenon. In the Hudson, the waste discharge of one polluter — the General Electric Company — totalled only forty pounds per day of PCBs over a twenty-five year period, yet that discharge has threatened drinking water supplies, closed a major commercial fishery for striped bass, and made it dangerous to eat large amounts of fish caught in the River. Dilution is not a good solution for many sorts of wastes.

Some students assume it's possible to clean an entire river by running it through some sort of filter system. Point out that this isn't practical. **The only way to restore and maintain clean water is to require polluters to control what they put into our rivers and lakes.** While there are laws requiring this, they are not well-enforced, making cleanup harder.

Note also the large amount of waste produced by the cleanup efforts. Even with effective cleanup, such material will still need safe disposal somewhere. This is a particular problem with toxic materials. Where possible, manufacturing processes which require less poisonous and long-lasting chemicals should be substituted for those using toxic materials which may eventually work their way into the environment. And in many cases manufacturers can recycle and reuse wastes instead of throwing them away.

Much of this activity's value lies in encouraging teamwork in dealing with the cleanup exercise. In most cases, the most cooperative groups will also be the most organized and successful. Pollution is everyone's problem and everyone must work together if we are to succeed in the fight for a cleaner, healthier environment.

Further Explorations

1. Visit a water treatment or sewage treatment plant

Many municipal treatment plants will provide tours for local school groups. Be sure to brief students beforehand on what they will see, as the plants can be noisy and personnel are not necessarily prepared to explain the equipment and processes at the students' cognitive level.

Resources

Andrews, William A., ed. *A Guide to the Study of Environmental Pollution.* Prentice-Hall, Inc., Englewood Cliffs, NJ: 1972. A high-school level text and activity guide with many clearly described field and laboratory studies, quite a few of which can be adapted for younger students.

Miles, Betty. *Save the Earth: An Ecology Handbook for Kids.* Alfred A. Knopf, Inc., New York: 1974. Discusses the ecological problems of land, air, and water pollution in the world today, including projects that illustrate these problems and possible solutions to them; great book for elementary grades.

Stanne, Steve & Meg Clark. *Cleaning Up the Hudson: Hopeless Cause or Cause for Celebration?* Hudson River Sloop Clearwater, Inc., Poughkeepsie, NY: 1984. This booklet describes current environmental issues along the Hudson in language suitable for sixth grade and up; explains bioaccumulation of toxics, water pollution control laws, effects of dredging and filling the River, and other concerns.

PLACE NAMES IN THE HUDSON VALLEY

Concepts

- Unusual sounding names may have meaning in another language.
- Studying place names can provide information about an area's history.
- Immigrants from many nations settled in the Hudson Valley and its place names reflect this diversity.

Introduction

This lesson uses place names on nautical charts to explore the diverse origins of settlers in various places along the Hudson River. It points out to students the variety of clues that can be used in piecing together regional or local history. As such, the exercise also provides an introduction to historical research, and gives some sense of the value of maps in that process.
Expect this lesson to take approximately thirty minutes of class time.

Materials

Each student should have:

- 1 copy of the student "Place Names in the Hudson Valley" lesson
- a copy of each of these charts: Kingston, Peekskill, Castleton-on-Hudson, and Barrytown
- a pencil
- 4 crayons, colored pencils, or watercolor felt-tip markers

Procedure

The lesson can be read individually by students, or as a class exercise under the teacher's guidance. Frequent matching of written information to examples on the charts is required. Questions to be answered by the class or by individual students are set in **boldface** type.

Discussion

This activity was designed to be broadly applicable in the Hudson Valley region. Try to mention relevant examples of local place or street names in the students' community, showing that history didn't just happen somewhere else.

Further explorations

1. The stories behind the names

Some names, while not necessarily of great historical significance, exude mystery or compel curiosity — Murderers Creek in the town of Athens or Mystery Point in the Highlands, for example. Integrate language arts with this historical topic by having students make up a story which explains a certain place name. Anthony's Nose, a mountain in the Highlands, would be an excellent subject. The students' explanations of the name could then be compared to Washington Irving's colorful tale in his Knickerbocker History of New York.

2. How are places named today?

New streets, shopping malls, and housing developments require names. Prepare a list of such features recently constructed in your community, and compare their names with more long-standing ones. Why were they given their particular names? Do these reasons bear any similarity to the likely origins of the older names the students studied?

Resources

Gekle, William. *A Hudson Riverbook.* Wyvern House, Poughkeepsie, NY: 1978. Good readable reference book, with plenty of interesting historical tidbits and Hudson Valley lore. From the same author and publisher also comes The Lower Reaches of the Hudson (1982), with more of the same.

Keller, Allan. *Life Along the Hudson.* Sleepy Hollow Restorations, Tarrytown, NY: 1976. Excellent resource book on Hudson Valley history. Longer and more thorough than Gekle's books, though less colorful.

McNeer, May. *The Hudson, River of History.* Garrard Publishing, Champaign, IL: 1962. Dated, but a good overall history written for elementary age children.

While there are many other fine histories of the Hudson, be sure to check the bulletins, booklets, and pamphlets put out by local historical societies. They are often the most useful sources of information about place names.

READING NAUTICAL CHARTS

Concepts

- Nautical charts show physical features underneath and along the shores of water bodies.
- Nautical charts show artificial structures designed and/or useful for aiding navigation.
- The topographical and artificial features shown on charts are located very precisely to insure the safety of ships and boats which depend on them.

Introduction

Nautical charts offer an excellent means of teaching map reading. The relatively large scale of charts allows easy recognition of local features and permits precise orientation by pinpointing buoys, landmarks and coastline features. Decoding the symbols on charts is also fun for students, especially when plotting a safe passage for a real or imaginary boat.

The information presented on charts is relevant to many topics of history and social studies. Most obvious is the Hudson River as highway. Charts give a picture of the working environment of modern commercial river traffic — the destinations, dangers, and advantages of transporting goods along the River.

The vital role played by the River in the history of the Hudson Valley and New York State, including subjects such as transportation, patterns of settlement, and events of the Revolutionary War, can also be made clearer by using charts.

In addition to teaching a great deal about local history, the process of decoding the symbols on a chart and orienting oneself on the River is challenging and fun, offering students a new perspective on their surroundings.

Expect this activity to take 45-60 minutes of class time. With younger groups it might best be done in two shorter time periods, doing the worksheet section in the second one.

Materials

Each student should have:

- a copy of the student "Reading Nautical Charts" lesson
- a copy of each of these charts: Kingston, Peekskill, Castleton-on-Hudson, and Barrytown
- a pencil

Procedure

It is best to go through the lesson (up to the worksheet) with the students. Frequent matching of written information with examples on the charts is required. The questions to be asked are set in boldface type. The worksheet can be done by individual students on their own.

Discussion

We were not able to reproduce our sample charts in color. Information is easier to interpret on the full color originals, and it's very helpful to be able to show students the real thing. Check the Further Explorations section below for information on obtaining charts.

This lesson covers some of the most important and obvious features of charts, but curious students may ask about others. Nautical Chart #1 - U.S. Nautical Chart Symbols and Abbreviations is available from the address given in the Further Explorations section below. While it's exhaustive and a little intimidating, it will explain almost all information shown on charts.

Further explorations

1. Adapt the lesson for charts covering your locale; post actual full-color charts on bulletin boards.

Charts can be obtained at selected marine supply stores, or by mail order from: **Distribution Branch (N/CG33), National Ocean Service, Riverdale, Maryland 20737**; their phone is (301)436-6990. Nautical Chart Catalog #1, listing charts covering the Atlantic and Gulf Coasts, is available free of charge. A single chart currently costs $6-7, but prices are subject to change; call for information. Three charts cover the Hudson from New York City to Troy: **#12343** - New York (George Washington Bridge) to Wappinger Creek; **#12347** - Wappinger Creek to Hudson; **#12348** - Coxsackie to Troy. Chart #12327 covers all of New York Harbor, but a wide range of larger scale charts covers specific portions of that area. Charts of the State Barge Canal System, including the Mohawk and portions of the Hudson above Troy, are listed in Catalog #4 - Great Lakes and adjacent waterways.

2. Field Trips

Kingston Lighthouse - Call the Hudson River Maritime Center in Kingston for information about tours of this lighthouse and the Center's exhibits: (914)338-0071.

Tarrytown Lighthouse at Kingsland Point Park - A wide variety of historical and environmental Hudson River programs are available here; for information call Westchester County Department of Parks, Recreation, and Conservation: (914)285-2652.

Resources

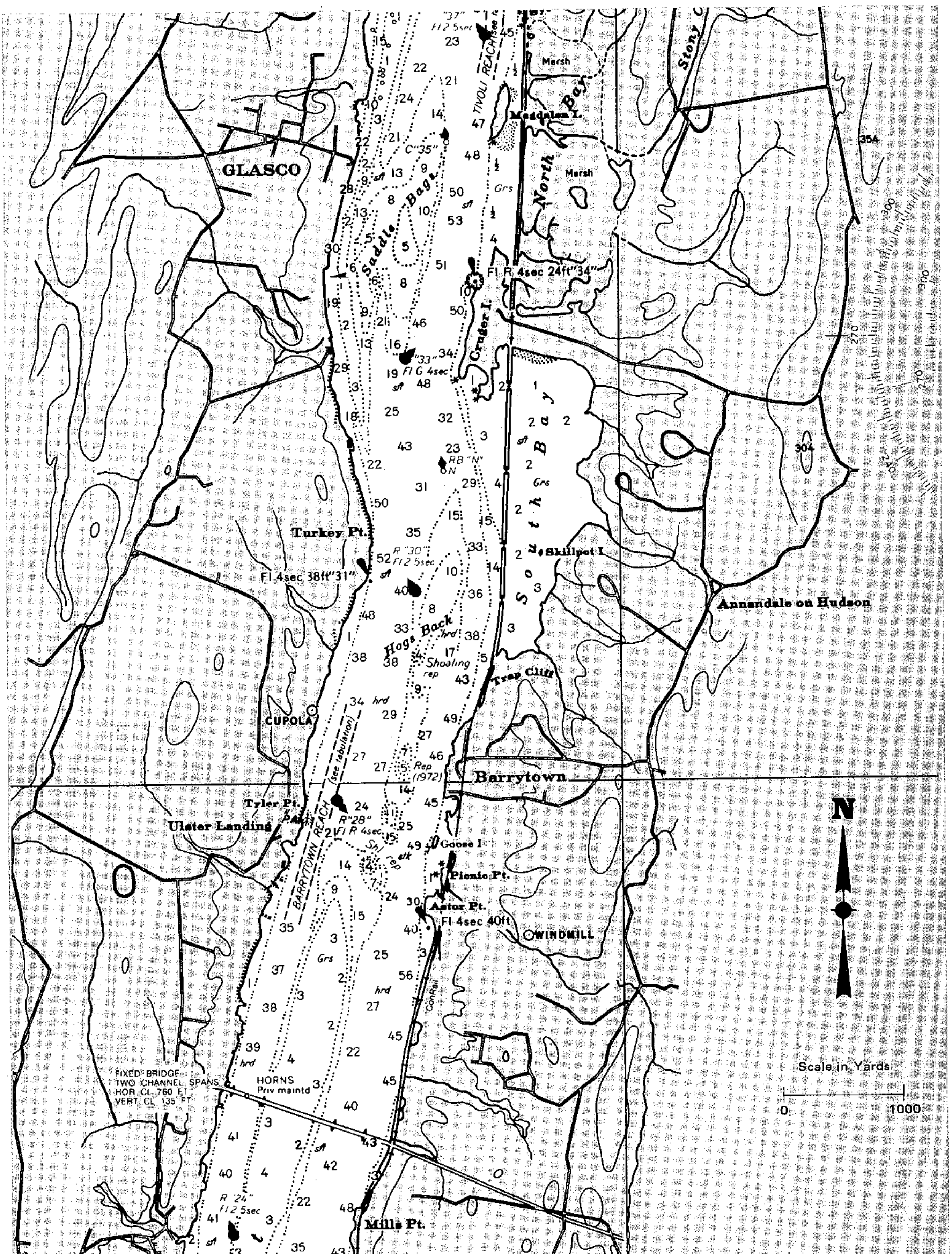
Slide Show

Tankers & Tugboats, Cars & Corn: Shipping on the Hudson River. 80 slides with written script. Covers history of shipping on River, present commercial traffic, and navigation along the Hudson. Available on a loan basis from Clearwater: (914)454-7673

Books

Glunt, Ruth. *Lighthouses and Legends of the Hudson.* Library Research Associates, Monroe, NY: 1975. Good history of Hudson River lighthouses and their keepers. Interesting tidbits about River characters and events. Suitable for seventh grade and up.

Wilke, Richard. *The Illustrated Hudson River Pilot.* Three City Press, Albany: 1974. Nautical information for every stretch of the River. An excellent teacher resource for followups to the charts lesson.


GLASCO
Saddle Bags
Tivoli Reach
Magdalen I.
North Bay
Stony Cr
Marsh
Cruger I.
South Bay
Skillpot I
Turkey Pt.
Hogs Back
Shoaling rep
Trap Cliff
Annandale on Hudson
CUPOLA
Barrytown
Tyler Pt.
Ulster Landing
BARRYTOWN REACH (see tabulation)
Goose I
Picnic Pt.
Astor Pt.
WINDMILL
ConRail
FIXED BRIDGE
TWO CHANNEL SPANS
HOR CL 760 FT
VERT CL 135 FT
HORNS
Priv maintd
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Scale in Yards
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N
Fl 4sec 38ft "31"
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R "30" Fl 2 5sec
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"37" Fl 2 5sec
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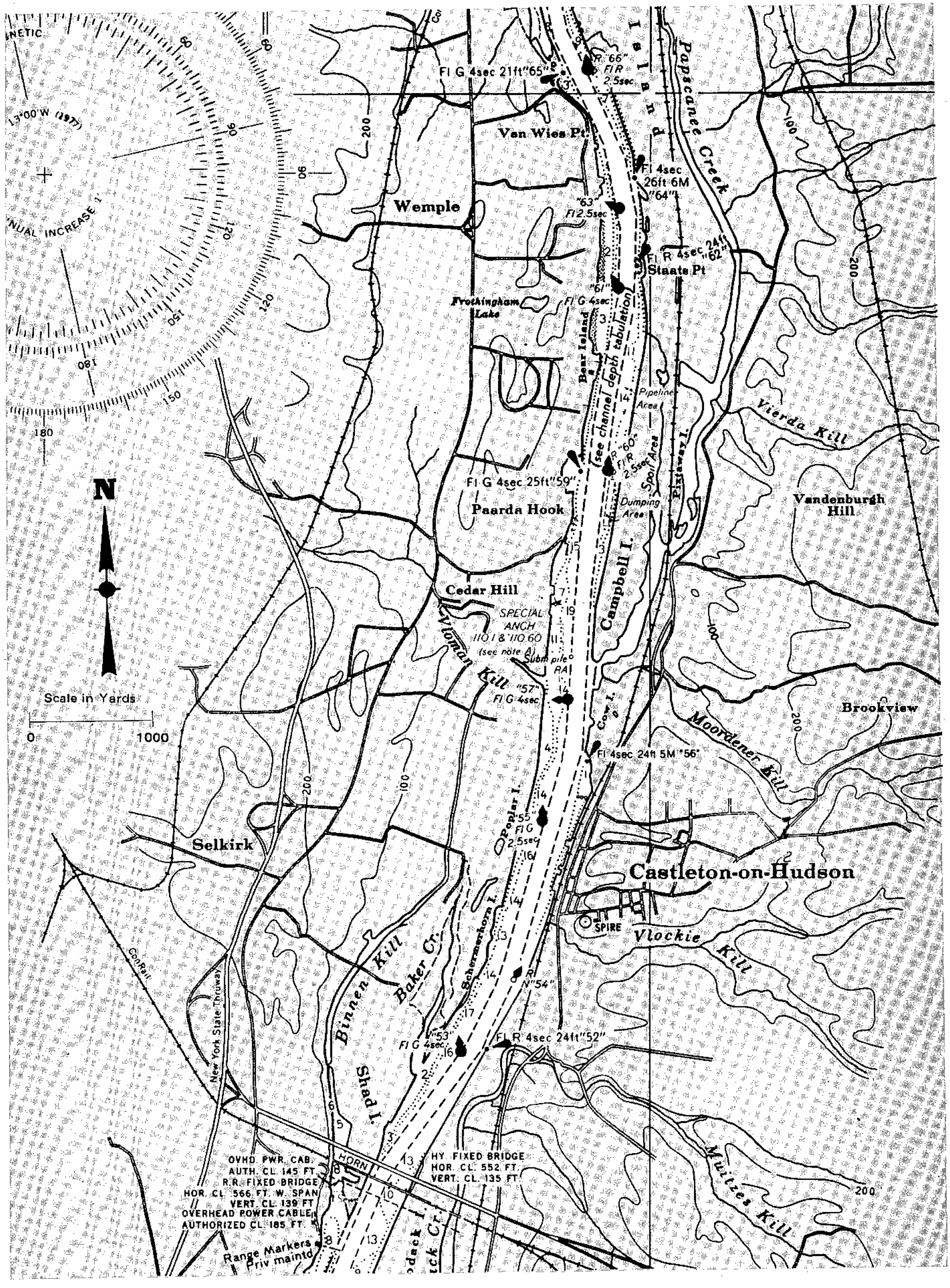
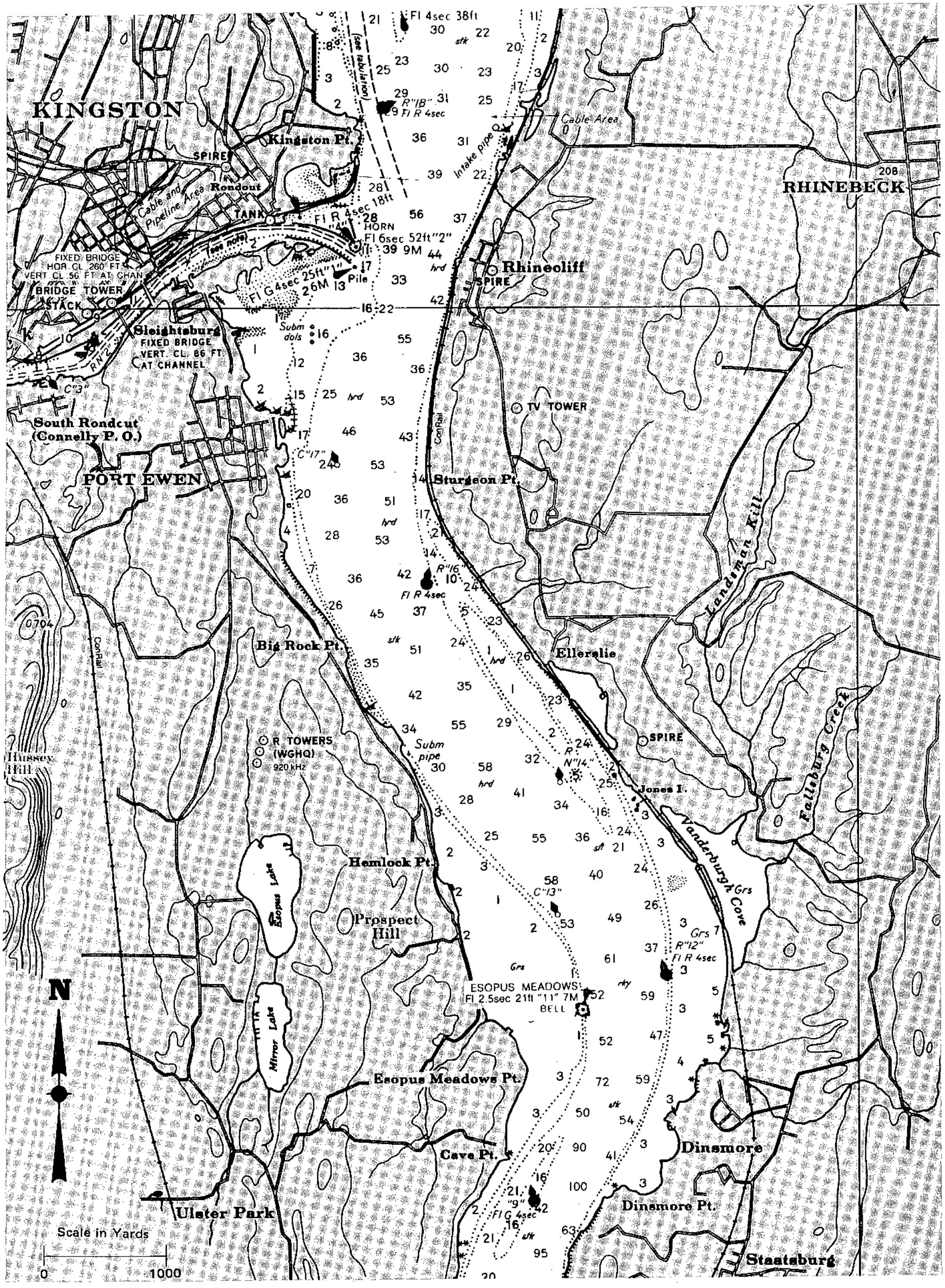
RB "N"
Rep (1972)

Barrytown



Castleton-on-Hudson


KINGSTON
Kingston Pt.
Rondout
RHINEBECK
Rhinecliff
Sleightsburg
South Rondout (Connelly P. O.)
PORT EWEN
Sturgeon Pt.
TV TOWER
Big Rock Pt.
Ellerslie
R TOWERS (WGHQ) 920 kHz
Jones I.
Vanderburgh Cove
Landsman Kill
Fallsburg Creek
Hussey Hill
Hemlock Pt.
Esopus Lake
Prospect Hill
Mirror Lake
ESOPUS MEADOWS Fl 2.5sec 21ft "11" 7M BELL
Esopus Meadows Pt.
Cave Pt.
Dinsmore
Dinsmore Pt.
Ulster Park
Staatsburg
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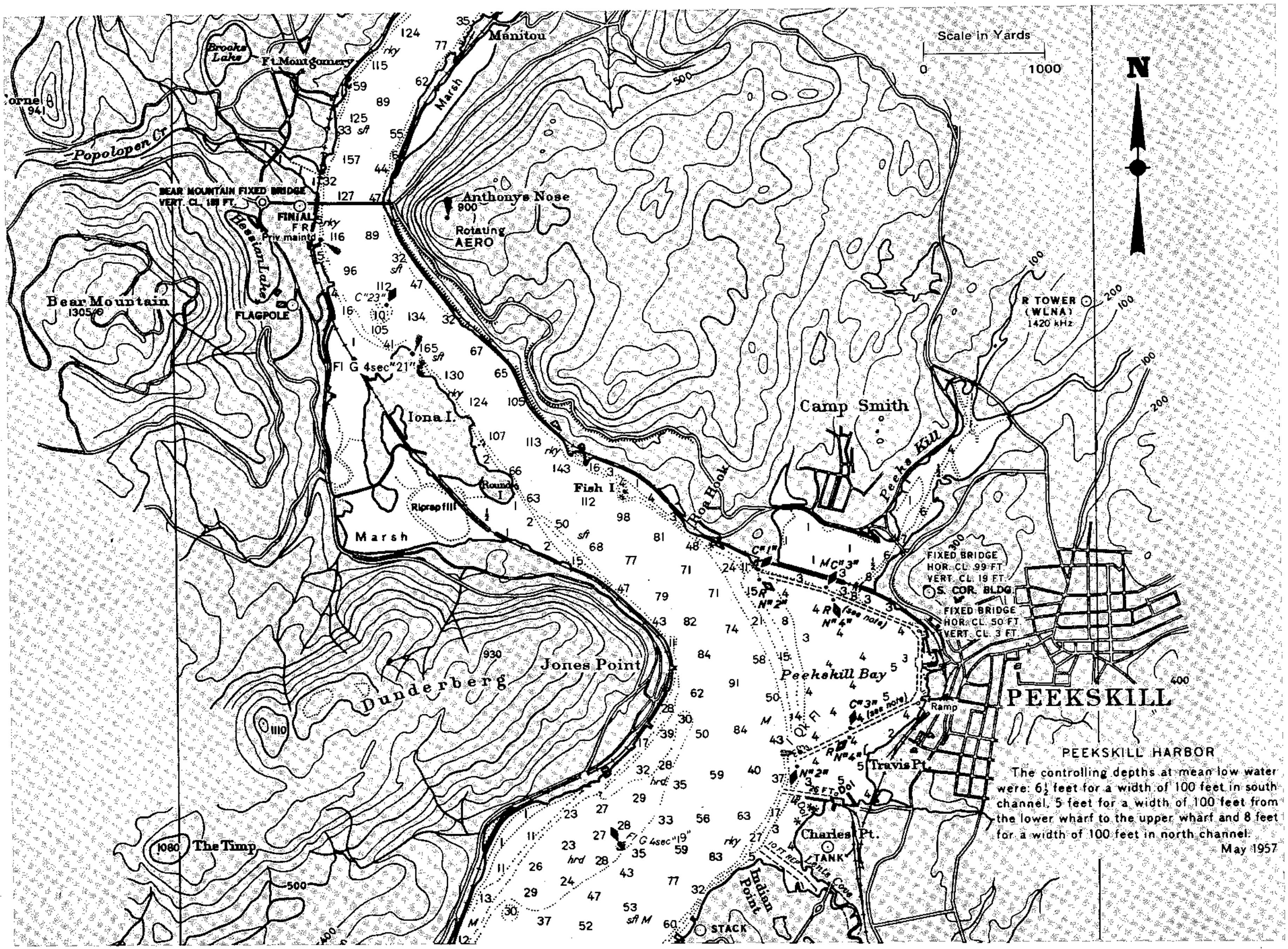
Kingston


Scale in Yards
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Manitou
Ft. Montgomery
Brooks Lake
Popolopen Cr.
BEAR MOUNTAIN FIXED BRIDGE
VERT. CL. 155 FT.
FINIAL
Hessian Lake
FLAGPOLE
Bear Mountain
1305
Anthonys Nose
900
Rotating
AERO
Marsh
Iona I.
Roundo I.
Fish I.
Fl G 4sec "21"
C "23"
Dunderberg
930
Jones Point
1110
The Timp
1080
Camp Smith
Peeks Kill
Hook
R TOWER
(WLNA)
1420 kHz
FIXED BRIDGE
HOR. CL. 99 FT.
VERT. CL. 19 FT.
S. COR. BLDG.
FIXED BRIDGE
HOR. CL. 50 FT.
VERT. CL. 3 FT.
PEEKSKILL
Peekskill Bay
Ramp
Travis Pt.
Charles Pt.
TANK
Indian Point
STACK
Fl G 4sec "19"
PEEKSKILL HARBOR
The controlling depths at mean low water were: 6½ feet for a width of 100 feet in south channel, 5 feet for a width of 100 feet from the lower wharf to the upper wharf and 8 feet for a width of 100 feet in north channel.
May 1957

Peekskill