
PIPELINE DREDGE
LOCK
DAM
OPEN HOPPER BARGES
Mike's LUMBER MILL
COASTAL PORT
TANK BARGES
TOWBOAT
RIVER PORT
COVERED DRY CARGO BARGES
DECK BARGE
BREAK BULK SHIP
CONTAINERSHIP
CRUISE SHIP
TUGBOAT
HOPPER DREDGE
HARBOR
OIL TANKER
SCHNEIDER OIL
OIL
Water Table
FRESH WATER
SALT WATER
NAVIGATION: Traveling the Water Highways!
GRADE SCHOOL EDITION
US Army Corps of Engineers

NAVIGATION is travel or transportation over water. Many different kinds of boats and ships are used on rivers and oceans to move people and products from one place to another.

Navigation was extremely important for foreign and domestic trade and travel in the early days of our country before cars, trucks, trains, and airplanes were invented. In those days, rivers were used as "roads" to connect inland settlements to river and coastal ports. Communities established at these commercial ports became important economic, cultural, and social hubs in the development of our Nation.

Many of the products we use and eat today are still transported by vessels on deep oceans and relatively shallow rivers or inland waterways. Towboats push barges (labeled in red) loaded with products such as grain, coal, and petroleum up and down rivers to loading and unloading facilities. Activities at a deep-water coastal port might include the loading or unloading of large commercial ocean-going vessels with lumber, oil, or cargo in large containers. Ocean-going vessels (labeled in yellow) maneuver in deep coastal harbors with the help of tugboats.

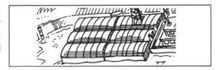
Navigation activities in the United States take place at more than 400 ports and along more than 25,000 miles of waterways. Some of the ports and waterways making up the extensive navigation network in this country are shown on the map below. Most rivers in the western part of the United States are not used for commercial navigation. Some of these rivers are used instead for recreation, irrigation, and generation of electricity. Shallow harbors or rivers are made safe for navigation by dredging or the construction of locks and dams.

Ports and Navigable Waterways of the United States

River Vessels:

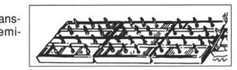
The most common way of transporting products on rivers is by TOW. A tow consists of one TOWBOAT and one or more BARGEs. Towboats push different kinds of barges, depending on the cargo. Three of the four basic types of barges are shown below. The fourth type is a DECK barge, which carries almost any kind of equipment, materials, or products that can be tied down and do not need protection from the weather.

COVERED DRY CARGO barge: Carries bulky solid cargo, such as dry cement, fertilizer, and farm products (corn, wheat, and soybeans) that need protection from the weather.



OPEN HOPPER barge: Holds bulky products, such as sand, gravel, or coal, that do not need protection from the weather.

LIQUID CARGO (TANK) barge: Transports liquid products such as chemicals, petroleum, oil, and molasses.



Ocean-Going Vessels:

Many products are traded with other countries by using deep-water ocean ports. Products that come into the country are called imports and those that are shipped to other countries are called exports. Trucks, trains, tows, and pipelines transport products into and out of ocean ports. Some of the large, ocean-going vessels in the deep-water harbor are shown below.

CONTAINERSHIP: Transports products stored in 20- to 45-foot-long containers that are stacked inside the ship and outside on the deck. Some ships carry as many as 5,000 containers.

TANKER ship: Holds chemicals, petroleum products, oil, and other liquids.

BREAK BULK ship: Carries bulky cargo such as lumber, packages of fertilizer, and boxes of fruit. Break bulk cargo is usually loaded and unloaded on portable platforms ("pallets").

Dredging:

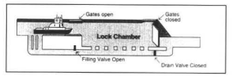
Sediment (gravel, sand, and silt) is deposited naturally in a harbor or river channel when a river slows down. Accumulated sediment reduces the channel depth and can make the waterway unsafe for navigation. Mechanical and hydraulic dredges are used to deepen and widen channels filled with sediment and deposit the sediment in an approved location. Mechanical dredges shovel or scoop up bottom materials and place them on a barge or scow. The two hydraulic dredges shown on this poster use pumps to remove a mixture of water and sediment ("slurry") from the channel bottom. The HOPPER DREDGE is an ocean-going vessel used to dredge sediment from the bottom of a deep-water channel or coastal harbor. Dredged material is stored in "hopper bins" inside the ship before disposal in the open sea or other location.

PIPELINE DREDGE: Vessel commonly used to dredge sediment from the bottom of shallow rivers or calm coastal waters. Dredged material is pumped from the river or ocean bottom and flows through a floating pipeline to shore. The dredged material commonly is used to restore eroded beaches.

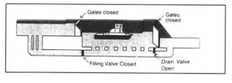
Locks and Dams:

Dams are built on shallow rivers to hold back water and form deeper navigation "pools." Most pools in the United States are maintained at a constant minimum water depth of 9 feet for safe navigation. Dams make it necessary for river vessels to use a series of locks to "step" up or down the river from one water level to another. The three steps in the "LOCKING THROUGH" process are shown below.

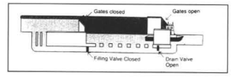
For a boat going downstream, the lock is first filled by opening the filling valve. The drain valve and upstream and downstream gates are closed, so the level of the water in the chamber rises to the upstream level. The upstream gate opens and the boat moves in.



To lower the boat, the gates are closed behind it, the filling valve is closed, and the drain valve is opened. The higher water in the lock chamber drains to the downstream level within minutes.



The downstream gate is then opened and the boat moves out on the lower water level. The process is reversed for a boat going upstream.



ACTIVITY
Comparing Different Modes of Transportation

Introduction

Transportation of domestic cargo by barge is relatively slow, but it is efficient and cost effective for moving large amounts of goods from one place to another. A comparison of the cargo capacities of a barge, jumbo hopper rail car, and large semitrailer truck is shown below.

Objectives -- Students will:

1. Calculate equivalent cargo capacities and ton-miles of traffic.
2. Compare cargo capacities of barges, trains, and trucks.

Materials

1. Pencil and paper.
2. Calculator (optional).

Teacher Preparation

1. Display the poster "Navigation: Traveling the Water Highways" several days before conducting this activity.
2. Discuss the different ways that people and cargo travel, emphasizing the importance of navigation to our Nation's economy.

Interpretive Questions

Use the tonnage information above to answer the following questions:

1. How many jumbo hopper rail cars would be needed to carry the same weight of coal as one barge? (Answer: 15); How many trucks would be needed to carry the same weight of coal as one barge? (Answer: 58).
2. It can be seen from the comparison above that the cargo capacities of barges, rail cars, and trucks differ greatly. The speed at which these different vehicles travel also varies. Tows travel at about 5 mph by river. A train moves along a railroad track at approximately 30 mph. Trucks traveling in a convoy usually travel at about 55 mph. Assuming a distance of 1,700 miles between St. Paul, Minnesota, and New Orleans, Louisiana, how many hours would it take for a barge, truck, and train to travel the distance? How many days? (Answers: barge: 340 hours, 14+ days; truck: 31 hours, 1+ days; train: 56–57 hours, 2+ days).
3. One "ton-mile" equals 1 ton of cargo moved a distance of 1 mile. How many ton-miles of traffic are produced by transporting 1,500 tons (one full barge) a distance of 1,700 miles from St. Paul to New Orleans? (Answer: 2,550,000 ton-miles).
4. One hundred jumbo hopper cars join together to form a "unit train." How many tons of grain can a unit train carry? (Answer: 10,000 tons).

Poster Series

This poster is part of a series of water-resources education posters developed through the U.S. Geological Survey's Water Resources Education Initiative, a cooperative effort between public and private education interests. Partners in the program include the U.S. Geological Survey, Bureau of Reclamation, and the U.S. Fish and Wildlife Service of the U.S. Department of the Interior; the National Oceanic and Atmospheric Administration; the U.S. Environmental Protection Agency; the U.S. Army Corps of Engineers; the Nebraska Groundwater Foundation; and the National Science Teachers Association.

The other posters in the series are entitled "Water: The Resource That Gets Used & Used & Used for Everything!", "How Do We Treat Our Wastewater?", "Wetlands: Water, Wildlife, Plants, & People!", "Ground Water: The Hidden Resource!", "Water Quality: Potential Sources of Pollution", "Hazardous Waste: Cleanup and Prevention", "Watersheds: Where We Live", and "Oceans--Coastal Hazards: Hurricanes, Tsunamis, Coastal Erosion". The posters in the series are designed to be joined to create a large wall mural. A schematic of the wall mural is displayed on this panel. The gray shaded spaces represent the posters listed above. The black shaded space represents this poster.

OCEANS	WATERSHEDS	HAZARDOUS WASTE
WETLANDS	WATER USE	WASTEWATER TREATMENT
NAVIGATION	GROUND WATER	WATER QUALITY

Water-resources topics of the posters are drawn in a cartoon format by the same artist. All poster are available in color. The poster entitled "Water: The Resource That Gets Used & Used & Used for Everything!" is available in color and black-and-white. The reverse sides of the color posters contain educational activities: one version for children in grades 3–5 and the other for children in grades 6–8. The black-and-white poster is intended for coloring by children in grades K–2.

ACTIVITY
Kentucky River Map and Profile

Introduction

Locks and dams are necessary structures for safe commercial and recreational travel on rivers with shallow water. On the adjacent panel is a map (aerial) view of the Kentucky River from south of Frankfort to Carrollton, Kentucky. Along the river are black T-shaped symbols showing the locations of the four sets of locks and dams currently used by commercial vessels. Most of the cargo carried on the Kentucky River is sand, gravel, and crushed rock that is pushed upstream in open hopper barges. Next to the map of the river is a profile, or side view, of the Kentucky River. The profile shows what the river, riverbed, dams, and navigation pools look like in cross section. The dams are numbered 1–4 on the map and profile.

Objectives -- Students will:

1. Develop skills in reading maps and graphs.
2. Learn to correlate a map view with the same location in profile.
3. Apply math skills to practical situations.

Materials

1. Map and profile of the Kentucky River.
2. Pencil and paper.

Teacher Preparation

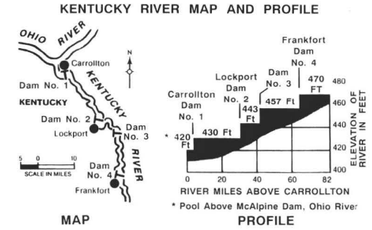
1. Display the poster "Navigation: Traveling the Water Highways" several days before conducting this activity.
2. Discuss the importance of locks and dams to commercial and recreational navigation. Explain the locking through process to students (see adjacent panel).

Interpretive Questions

Use the map and river profile below to answer the following questions.

1. On the profile of the river are numbers written horizontally and vertically. What do the numbers 0 to 82 represent on the horizontal axis? (Answer: number of miles from the mouth of the river); What do the numbers 400 to 480 represent on the vertical axis? (Answer: elevation in feet above sea level).
2. What is the approximate distance between the mouth of the river at Carrollton and Dam No.4? (Answer: 68 river miles); between Lockport and Frankfort? (Answer: 38 river miles).
3. What is the difference in elevation between the pools behind Dams 2 and 4? (Answer: 27 feet).
4. In which direction does the Kentucky River flow? (Answer: north).
5. If a tow of coal barges is traveling 5 mph and each locking through takes 30 minutes, how long will it take to start at mile 82 and travel to Carrollton? (Answer: 18.4 hours); If you have to be at the coal terminal at Carrollton between 10:00 a.m. and 12:00 p.m. on a Tuesday, when would you have to leave? (Answer: between the hours of 3 p.m. and 5 p.m. on Monday); How many locks would you pass through? (Answer: 4 locks); What is the elevation change from start to finish? (Answer: approximately 50 feet); How many miles will the trip cover? (Answer: 82 miles); Would the trip take less time by plane? (Answer: yes); Why or why not? (Answer: a plane flies in a straight line and travels faster).
6. The Kentucky River looks like a winding snake from above. What makes it look so wiggly? (Answer: many bends in the river); Does the Ohio River look as crooked as the Kentucky River? (Answer: no); On which river do you think it would be easier to navigate a large tow? Why? (Answer: the Ohio River, because it is wider and straighter.)

KENTUCKY RIVER MAP AND PROFILE



DEFINITIONS

Barge	- Long, unpowered, flat-bottomed boat used to transport cargo on water; pushed or pulled by a powered boat.
Dam	- Barrier built across a river to create a pool of water for navigation, flood control, water supply, or power generation.
Domestic	- Within the United States.
Dredge	- Machine equipped with a scooping or suction device used in deepening and widening harbors and waterways.
Harbor	- Sheltered part of a water body deep enough to provide anchorage for ships or boats.
Lock	- Walled navigational structure to allow raising or lowering vessels from one water level to another.
Locking through	- Using a navigation lock to "step" up or down on a river.
Port	- Region or city having a natural or artificial harbor with equipment, facilities, warehouses, and berths for ships taking on or discharging cargo or passengers.
Sediment	- Solid material (gravel, sand, and silt) that settles to the bottom of a river.
Towboat	- Powerful boat with a flat bottom and flat front used to push barges on rivers and other calm waterways.
Tugboat	- Powerful boat with V-shaped bottom and rounded front used to pull barges on open water or maneuver ships in ports.
Vessel	- Boat or ship intended for navigation on water.

ORDERING INFORMATION

Copies of all the posters in the series (see Poster Series Panel) can be obtained at no cost from the U.S. Geological Survey. Write to the address below and specify the poster title(s) listed on the Poster Series panel, and grade level(s) desired. The poster entitled "Water: The Resource That Gets Used & Used & Used for Everything!" is also available in black-and-white, intended for coloring by children in grades K-2. In addition, the poster entitled "Water: The Resource That Gets Used & Used & Used for Everything!" with activities intended for grades 3-5 is available in Spanish.

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U.S. ARMY CORPS of ENGINEERS

The U.S. Army Corps of Engineers is responsible for the operation and maintenance of the Nation's waterways to ensure efficient and safe passage of commercial and recreational vessels. The Corps' navigation projects play an integral role in the Nation's economy by providing efficient means by which commercial shippers can economically transport foreign and domestic products.

U.S. GEOLOGICAL SURVEY (USGS)

The USGS provides the Nation with reliable, impartial information to describe and understand the Earth. This information is used to minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; enhance and protect the quality of life; and contribute to wise economic and physical development. The USGS proudly serves the Nation in providing "science for a changing world."