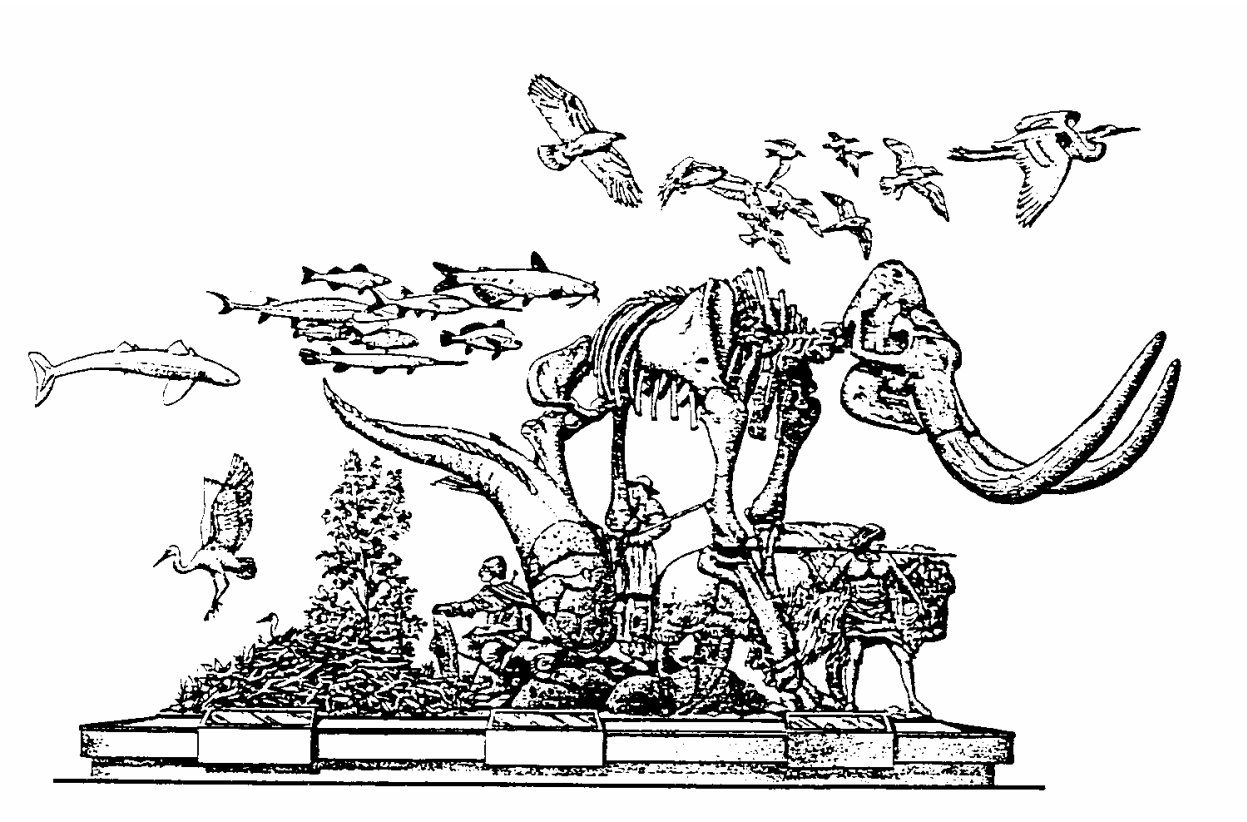
Educator's Handbook



Falls of the Ohio State Park

Clarksville, Indiana

Investigating the Falls of the Ohio

An Educator's Handbook

Resources and Activities for Before, During and After Your Visit

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Mission Statement

The mission of the Falls of the Ohio State Park is to provide opportunities for education and recreation while protecting the resources.

Mission Statement for the Interpretive Services of the Indiana Department of Natural Resources, Division of State Parks and Reservoirs:

The mission of the Interpretive Services is to provide information and offer interpretive experiences with Indiana's natural and cultural resources to visitors, staff and a diverse public.

Mission Statement for the Interpretive Services at the Falls of the Ohio State Park:

The Falls of the Ohio State Park interpretive services will focus on geology / paleontology, the Ohio River environment, archaeology and the history of Clarksville.

Vision Statement for the Falls of the Ohio State Park Interpretive Services:

We will strive to be leaders in providing innovative, effective interpretation at the Falls of the Ohio. We will instill an awareness and appreciation of the rich natural resources and cultural heritage in as many individuals as possible. All activities will be conducted in compliance with the regulations of the Department of Natural Resources and the National Wildlife Conservation Area.

Aerial view of the Falls of the Ohio (U. S. Army Corps of Engineers Photo)

Introduction

Thank you for your interest in the Falls of the Ohio State Park. This handbook was designed as a guide to help you and your students have a safe, positive learning experience during your visit to the Falls of the Ohio - a place that can serve as your *ultimate* outdoor classroom!

The Interpretive Center offers a variety of programs and mediums through which persons may experience the Falls on many levels. We can guide you through your first visit or provide an up-to-the-minute river condition report for your 1000th!

The pre-visit, on-site visit and the post-visit activities in this Handbook are designed to encourage each person to "experience" the Falls with all of their senses. You may use any activities you choose - or create your own. We are always seeking *new* educational activities to share! If you have an activity, tell us about it.

We hope that each person leaves the Falls with a better understanding of both the natural and cultural history which makes the Falls of the Ohio so unique. Ideally, we hope that each person leaves with a desire to learn even more.

For additional information or to schedule an indoor, outdoor, or teacher training program call (812) 280-9970 or write to:

Falls of the Ohio State Park
201 W. Riverside Drive, Clarksville, IN 47129-3148

A class explores the fossil beds. We offer an outdoor fossil lab May – Nov. 15.

Interpretive Center

The Falls of the Ohio Interpretive Center is a 16,000 square foot facility. It contains –

• 2,000 square foot exhibits gallery (described below)
• An award-winning 14 minute movie about the 400-million year history of the Falls area
• A new movie about the Kentuckiana connection to the Lewis and Clark expedition (shown at 1:00pm and 3:00pm and other times by request)
• Kids Corner - an activity area for preschool to first grade children
• Coral reef and Ohio River fish aquariums
• Classroom-library used for student labs, teacher in-service programs and public programs
• Gift shop that features educational items related to the Falls area
• Restrooms
• River and wildlife observation rooms
• Temporary exhibit gallery, changing three times per year. Themes alternate between geology, life science-nature and history-prehistory. (The schedule is made two to three years in advance and is in printed in our annual program brochure printed every January.)

Exhibit themes include:

• Geology & paleontology
• Modern and ancient coral reefs
• Flora and fauna at the Falls
• Archaeology
• History at the Falls, including local industry and commerce from the 17th century to today
• Human changes at the Falls
• Surveying and mapping
• Process that led to the establishment of the Falls of the Ohio National Wildlife Conservation Area and Indiana State Park

The Interpretive Center at the Falls of the Ohio State Park

Important information for Educators

While there is no fee to enter the State Park, there is an entrance fee to the Interpretive Center: $4 for adults and $1 for children 2 to 18. *Prices are subject to change*. Teachers and chaperons are admitted free of charge at a 1:5 ratio for grades 3 and below; 1:10 ratio for grades 4 and above. We can provide an "Educator's Guide" with additional important information. Please call or e-mail us.

We suggest that groups allow a minimum of one hour to tour the building. This would include time for the orientation theater and other video presentations in the exhibit gallery. Grade-specific activity sheets are provided to all groups. We have a general activity sheet (our most popular) and thematic (i.e. geology). Students are expected to use ours, or sheets created by the teacher, to promote an educational focus. Activity sheets reduce student horseplay significantly! We discourage last-minute decisions to visit the park because we are often heavily booked. Feel free to tell us how your visit fits into the curriculum – we can tweak our programming to cover topics your students are investigating.

The Virtual Park: www.fallsoftheohio.org

The Falls of the Ohio State Park has been on the worldwide web since 1998. We are proud of the content of our "virtual park," which contains:

- information about the park & museum
- virtual field trip on the fossil beds
- photo gallery
- links to other fossil sites on the worldwide web
- many of our park brochures are on-line
- activities from the Field Paleontology Institute
- Falls Fossil Festival, with a list of guest speakers, teacher workshops and activities (the current year's schedule is posted by the spring)
- E-mail addresses to contact park interpretive naturalists
- Link to the Falls of the Ohio Lewis & Clark Bicentennial Committee web site
- list of fossil collecting sites in the area

You are welcome to inquire about a reservation by e-mail, but we will contact you by telephone to make final arrangements. Please put your phone number in your e-mail text!

Programs and Services

Please refer to the "Educator's Guide" for the most up-to-date information about classroom programs, hikes, in-service, and other programs and services offered by the interpretive naturalists at the Falls of the Ohio. If you do not have a copy, please call (812) 280-9970, and we will send you one. We recommend all teachers bringing a group for the first time, to visit the Interpretive Center for a free hour-long orientation *before* bringing their group. We have found that an orientation will reduce the risk of problems from confusion or miscommunication. If you live more than a hour away, we can send you an agreement form, in place of attending the orientation. Orientations are scheduled by reservation on Thursdays from 4 to 5 PM or anytime on Saturday. We welcome inquiries about special needs and are always looking for ways to help your class.

We do ask that educators please read the "Educator's Guide" carefully before bringing groups to the Park. Following the guidelines and suggestions will make the visit a pleasant and memorable learning experience. **All group visits must be reserved in advance!** Interpretive naturalist-led programs are not available to groups without advance reservations. These programs are free with museum admission. If you intend to bring your group to the fossil beds without visiting the Interpretive Center, *a reservation is required*. This allows us to coordinate groups so one will not interfere with another.

Weekend programs are designed to meet the needs of our visitors and educational groups. Special cultural arts programs and other events are scheduled throughout the year. Call to find out what is happening or check the park web site: www.fallsoftheohio.org.

Museum-to-Go and other kits for loan

Fossils Museum-to-Go trunk
Contains two boxes (5 trays) of fossils of every major phyla found at the Falls of the Ohio. Includes a binder with suggested activities.

Zebra Mussel / Invasive Species Trunk
Uses zebra mussels to illustrate some problems created as a result of human activity in aquatic ecosystems. Includes labs, demonstrations, games, research, etc.

River Ecology Trunk
Developed by the U. S. Department of Fish and Wildlife, it contains activities and resources to enhance life science education in the classroom.

Computer-based Learning Lab
Through a Toyota TAPESTRY grant Marilyn Bowman created a comprehensive activity trunk that uses technology for water quality testing, transpiration rates in plants as well as an orienteering activity for the "willow woods" at the Falls of the Ohio State Park.

Summer Institutes and Educator Workshops

Park interpretive naturalists provide teacher training in the areas of geology, paleontology, biology, archaeology, and environmental sciences. These programs are usually offered each summer:

Field Paleontology Institute (3 days)
Advanced Field Paleontology Institute (1 day)
Project Archaeology (2 days)
Probing the Falls (1 day)
Project Wild or **Project Aquatic** (1 day)
Hoosier Riverwatch (2 levels, 1 day each) – Sponsored by INDR
Evolution: Investigating the Evidence (1 day)

Call for more information or check the park web site in mid January.

Project Archaeology – Summer Educator Workshop

The Clarksville Riverfront Foundation offers several week-long summer school programs which are coordinated by individual schools. If you would like to get your school involved, contact the Foundation at (812) 283-4999. A stipend is provided to instructors.

Field Paleontology Institute participants look for fossils at Liter's Quarry.

Kids Corner

Constructed in 2001, Kids Corner is an area designed for children pre-K through grade one. Due to the small size of this area, groups are scheduled approximately 15 children at a time. As with other programs, use of the Kids Corner by groups is reserved in advance. Activities are tied to these themes: fossils, the river, different ways to travel and nature. Children can work with puzzles, make rubbings of fossils, build a bridge over the Ohio River, pilot a "steamboat," play with toy animals, listen to stories, have a puppet tell a story and more.

Children build a bridge in the Kids Corner

Resource Library

One of the best kept secrets at the Interpretive Center is our resource library. Opened during regular Center hours, it contains a modest collection of books relating to the park themes (fossils & geology, birds & nature, coral reefs, regional history, river history, interpretation, etc.) As a general rule, materials cannot be "checked out" - they must be used in-house. In addition to books and magazines, we maintain files covering a lot of topics. We have a brochure on our resource library that we can send upon request.

Introduction to the Falls of the Ohio

Natural History

The history of the Falls of the Ohio reaches back millions of years, leaving us with a wealth of natural wonders and resources to explore. They include 400 million year old Devonian fossil beds, a variety of flora and fauna including over 265 species of birds and 125 species of fish, habitats and interesting geological formations such as sculpted limestone, natural arches and small waterfalls.

The formation of the Falls fossil beds dates back to the middle of the Devonian Period (in the Paleozoic Era) between 408 - 360 million years ago. At that time a shallow sea cut diagonally across the eastern half of the North American continent from New York through Kentucky south and west over Texas. The Appalachians and the Great Plains were dry land.

The continental sea was teeming with a variety of marine life including fish, echinoderms, trilobites, brachiopods, bryozoans, sponges and corals. The skeletal remains (mostly calcium carbonate) settled on the sea floor, steadily burying older layers of sediment. Over time the sedimentary rock limestone was formed, which preserved the fossils.

During the remainder of the Paleozoic Era, this area was alternately under a sea, swamps or intermittently exposed as dry land. During the Mesozoic Era (the "Age of Dinosaurs"), the area was dry land (with dinosaurs everywhere). The evidence of dinosaurs was not preserved, because there were no rocks formed in the area during the Mesozoic. Land was eroding away, as it is today.

Millions of years later during the Pleistocene epoch, glaciers advanced from the north. Over a period of two million years, they helped form the present day Ohio Valley. The last glacial advance (the Wisconsin glaciation) ended about 10,000 years ago. The last glaciers pushed south stopping short of the Falls before melting. This melt water, coupled with millions of tons of loose rock filled the river valley and shaped the river we call the Ohio. Since the end of the glaciation, an estimated 100 feet of glacial outwash and 20 feet of limestone have been removed.

The Devonian limestone extends to the north beyond Indianapolis, Indiana, and southeast to the Cumberland plateau. It may be found in northern and central Ohio and swings into Canada and over to western New York. During the Devonian, the North American and African continental plates were not far apart. Fossils similar to those at the Falls can also be found in Morocco, in northwest Africa.

These fossil beds are considered to be among the largest naturally occurring laterally exposed Devonian coral beds in the world. Over 300 species of fossils have been identified at the Falls, many of which are type specimens, being discovered and described from the Falls for the first time.

The fossil beds are only one natural resource at the Park. There are over 270 species of birds recorded, including shore birds, wading birds, and song birds. There are several endangered species which visit the Falls - the American Bald Eagle, the Osprey, two species of Night-Herons and the Peregrine Falcon. Cormorants, herons, gulls, geese, ducks, egrets, loons and kingfishers may be seen.

The Falls have been used as a fishing area for thousands of years. Some 125 species of fish have been reported. Some of the largest are catfish, weighing over 100 pounds. Three of the oddest fish, the long-nose gar, the paddlefish (spoonbill "catfish") and the shovel-nose sturgeon resemble prehistoric fish.

Other fauna which may be seen at the Falls include mammals like the fox, white tail deer, beaver, eastern cottontail, gray and fox squirrels, muskrat, opossum, and raccoon. Reptiles including turtles, lizards and non-poisonous snakes may be rarely seen. Invertebrates including river mussels, snails, and a variety of aquatic and airborne insects can be observed.

Flora at the Falls include both native and non-native species. Evening primrose, prairie mimosa, monkey flower, wood sage, bittersweet nightshade and tickseed sunflower may be seen blooming at various times. Trees include the eastern cottonwood, sycamore, black willow, honey locust, silver maple and Osage orange. Other plants include star cucumber vine, sumac, trumpet creeper and bind weed.

The flora and fauna flourish at the Falls in a variety of habitats including river, stream, wetland, mudflat, sandbar, marsh, prairie, rock, and woodland. These diverse habitats co-exist in a concentrated area that has been altered both by man and nature.

The diversity of the natural resources at the Falls provides an unlimited opportunity for study and simple enjoyment of a "natural" area rich in bio-diversity.

Cultural History

The cultural history of the Falls is both rich and varied. The first human habitation of the Falls reaches back about 12,000 years ago when the Paleo-Indian lived in the area. These early peoples were nomadic, following animal migrations and seeking raw materials such as high quality flint. They probably hunted mammoths, mastodons and other ice age mammals that are now extinct.

The Archaic people lived between 10,000 - 3,000 years ago. They were semi-nomadic tribes who moved seasonally to gather wild plants, to fish, and to hunt and trap animals. They produced tools such as adzes, axes, the compound spear (atl-atl), and baskets. The native figure in the lobby exhibit represents this group.

The Woodland Culture developed in the region 2,000 - 1,000 years ago. They cultivated crops, established small villages with regional variations, buried their dead ceremoniously, used bows and arrows, and developed pottery techniques. Extensive trade networks were established. Large mound and earthwork complexes were built during this period.

Late Prehistoric Cultures flourished between 1,000 and 300 years ago. They developed maize agriculture, as part of adapting to a floodplain environment. These cultures developed into "chiefdoms" with complex political and social systems. Large "towns" were developed by building large platform mounds around a central plaza. These "towns" were often surrounded by a stockade.

Evidence of permanent settlements at the Falls of the Ohio by prehistoric peoples is considerable. Development of the cities around the Falls has destroyed many of these prehistoric sites. Construction of the levee following the 1937 flood heavily altered or destroyed sites near the Falls. Numerous prehistoric sites in the Louisville area have been destroyed by filling swamps and lakes. More recent development has destroyed more. Still, there is an abundance of evidence that people lived in the Falls area.

The first documented European occupation of the Falls occurred in 1778 when George Rogers Clark, with a group of militia and their families, established a settlement on Corn Island near present day Louisville. It was from here, he launched his successful military campaign in the Northwest Territories. Some have suggested, though not confirmed, that Robert LaSalle visited the Falls in the late 1600's. Daniel Boone may have passed through in 1771.

After George Rogers Clark completed his military career and settled near the Falls, the area began to develop rapidly. Clark and his men were granted land in the area and Clark surveyed the town of Clarksville, Indiana. A representation of a cabin was assembled at his home site in 2001. In 1803, George Rogers Clark's younger brother, William Clark, with his partner, Meriwether Lewis and the Corps of Discovery, began their famous exploration of the Louisiana Purchase near Mill Creek below the Falls. Look for a variety of events and exhibits between 2003 and 2006 for the bicentennial commemoration.

An interpreter talks to visitors at the cabin reconstructed at the George Rogers Clark home site at the Falls of the Ohio State Park

Several famous people visited and lived near the Falls. In the early 1800's, Henry Clay and Humphrey Marshall fought a duel at Silver Creek. John James Audubon lived in the Falls area from 1807-1810, where he completed many bird paintings.

Other famous dignitaries who visited the Falls include Presidents James Monroe, William Henry Harrison, Abraham Lincoln, and Herbert Hoover (also a geologist). Visiting literary figures include Charles Dickens, Mark Twain, and Walt Whitman. Mike Fink, the legendary "riverman," visited. Big Jim Porter, the "Kentucky Giant," ran a tavern on Shippingport Island (at that time a thriving community).

As navigation and commerce expanded on the Ohio River, the need for controlling the depth and flow of the river increased. To circumvent the dangerous rapids at the Falls of the Ohio, the Portland canal with locks was dug over several years and completed in 1830. Over the years, it was enlarged to handle bigger steamboats. The first dam on the Ohio River was constructed beginning in 1868. Due to frequent interruptions by high water and runaway barges, the dam was not completed until 1881.

The Ohio River Canalization Project was created to improve river navigation. A series of dams were constructed to control the river flow. The wickets consisted of 58 dams made of wood and metal which had to be raised and lowered individually by manual labor. The dam at the falls was number 41. Wicket construction began in 1885 and was completed in 1929. A decision was made to replace the

wickets with a series of mechanized locks and dams. Currently, 20 locks and dams help maintain water levels throughout the entire Ohio River system. Two wicket dams, dams #52 and #53, are slated to be replaced by a new dam near the mouth of the Ohio. The McAlpine Dam at the Falls of the Ohio was completed in 1964, replacing the aging wooden wickets. The locks and dams on the Ohio are operated and maintained by the Army Corps of Engineers, who are responsible for controlling the water level in the river.

In 1982, after immense effort by groups and individuals, 1404 acres of the Falls were designated a National Wildlife Conservation Area administered by the Army Corps of Engineers. In 1990, a section of the area became the Falls of the Ohio State Park, administered by the Indiana Department of Natural Resources, Division of State Parks. The state park designation gave impetus to the construction of the Falls of the Ohio Interpretive Center, a 16,000 square feet, 5.1 million dollar visitor exhibit complex. Between 2000 and 2003 another 76 acres of wetlands were added to the Falls of the Ohio State Park near the George Rogers Clark home site. Its primary use is a nature preserve, since it floods frequently.

Falls of the Ohio in the year 1600
Giant mural in the lobby of the Interpretive Center

FASCINATING FOSSILS

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to identify the major types of fossils found in the Devonian Period: Corals, bryozoans, echinoderms, trilobites, brachiopods, bivalves, cephalopods, and gastropods.

MATERIALS:

Pictures of fossils on overhead transparencies, slides or PowerPoint
Samples of fossils

PROCEDURE:

1. Present pictures or specimens of the fossil types that are found at the Falls of the Ohio. (A fossil kit is available from the park and may be reserved by calling (812) 280-9970. It is available for pick-up only and cannot be shipped.) Have the students examine the fossils. Introduce the discussion of the characteristics of the fossils by asking the students if they have ever seen any creatures that look like these. Ask students if anyone has a shell collection. The students may compare present day shells to the ancient fossilized specimens.

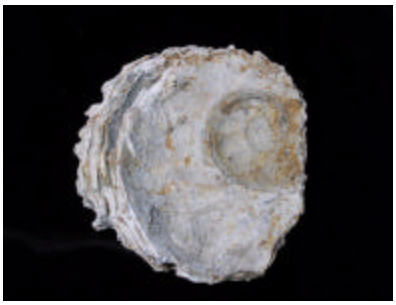
2. Have students notice the shapes, sizes, lines of growth, and colors of the shells and fossils. Note the colors if you have real fossils, too.

3. Present the names characteristics of the major types of fossils they will see at the Falls and in your collection. (Brochures of these fossils are available at no charge from the park.) The following fossils are listed by rank abundance at the Falls of the Ohio.

Corals – Corals are small animals that live in colonies. They have soft bodies and build homes by taking calcium carbonate out of seawater. Many Silurian and Devonian corals found in our area look like honeycomb. In fact, species have a variety of shapes. In addition to honeycomb, some resemble a wasp nest, fan, links in a chain, organ pipes, tubes, etc. The horn coral, commonly found at the Falls, is a single animal whose skeletal structure may resemble a cow or bison horn, or a small tusk.

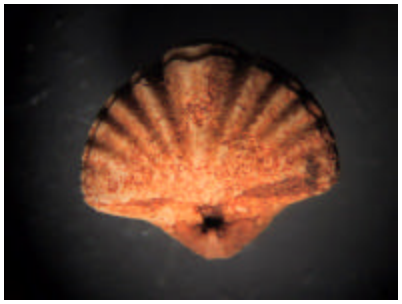
Enallophrentis - a Devonian horn coral

Sponges (Stromatoporoids) These colonial organisms have thin layers of calcium carbonate. They have various shapes, sometimes resembling petrified cow patties. Colonies can be tiny encrustations over corals and shells or they can be mounds six feet across and a foot thick. The largest fossil at the Falls is a stromatoporoid sponge colony over 100 feet long.



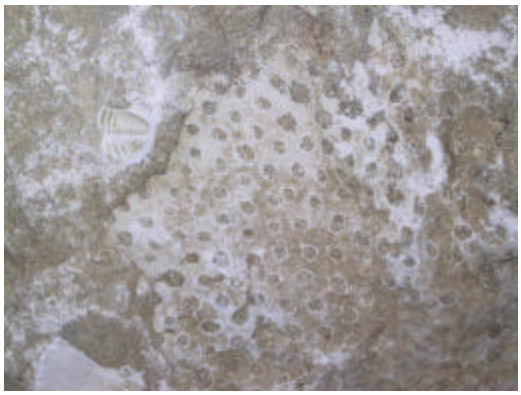
A Devonian stromatoporoid with a snail mold

Brachiopods - These marine animals have to shells called valves. The top and bottom valves do not look the same. They have bilateral symmetry – the left and right sides are mirror images of each other.



Brevispirifer - a Devonian brachiopod

Echinoderms - There are two types of echinoderms found at the Falls: crinoids (sea lilies) and blastoids. Both lived attached to the sea floor on stalks (columns). Both had a body made of tiny plates (although blastoid plates were fused, while crinoids were held with ligaments). Their skeletons were composed of calcite. The crinoid columns are usually what people see. They are sometimes called "Indian beads" because there are holes in the center and they can be strung into a necklace or bracelet.



Coscinium – a Devonian bryozoan

Bryozoans – Superficially, they are similar in appearance to corals. These tiny creatures lived in colonies where each individual was attached to its neighbors. The colony contained dozens, hundreds or thousands of individuals each less than a millimeter long. They had tentacles for feeding and most had calcite skeletons. The colony grew by budding new individuals. Some colonies grew in flat sheets, others in upright positions looking like bushes or nets.

Gastropods – Also called snails, they have coiled shells: flat spiral, upward like a screw, or a combination. Some have many coils visible, while in others only the last coil is visible.

Bivalves – Although they may look similar to brachiopod, they are not. The bivalves (also called pelecypods or clams) have two shells, but the top and bottom are identical in shape. Each shell is asymmetric; they are not mirror images on the right and left sides. Fossil bivalves look much like modern day species.

Trilobites – These small creatures crawled along the bottom of the sea. Some spiny ones may have been able to swim or glide short distances. Some could roll up in a ball in a defensive posture. They had a three part segmented body – with a cephalon (called the head, even through it contained other internal organs), the thorax (containing the gills and intestines) and pygidium (tail).

Dawsonoceras – a Silurian cephalopod

Cephalopods – These animals have a shell like the chambered (or pearly) nautilus. It is a spiral shell with each segment a little bigger that the last, the animal living in the last one. (Many fossil cephalopods are straight or gently curved rather than coiled.) The older chambers could be filled with gas or water to adjust the buoyancy while swimming. This allowed the animal to rise or fall as it moved. The creature inside is similar to a squid.

4. Have students make a notebook with drawings and identification notes about each type of fossil.

5. Have students bring their notebooks and record the various fossil types that they find while exploring the fossil beds. They can draw a picture and describe where they made the observation.

EXTENSIONS/EVALUATIONS:

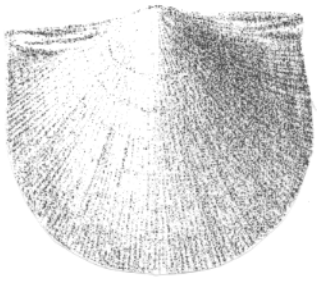
6. Have students take rubbings of fossils for their notebooks. Look for a fossil with a distinctive texture that they can feel. (A lot of fossils won't work.) Place a page out of their notebooks over the fossil and rub across the page with the side of a crayon or charcoal pencil.

7. Have students identify four different types of fossils ground at the Falls. Describe what they may have looked like and whether they swam, crawled or were attached to the sea floor.

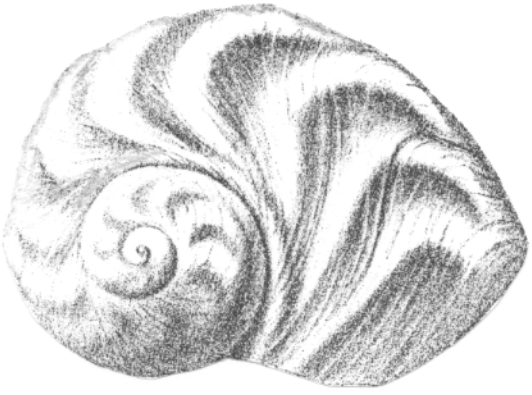
8. Attend a Falls Fossil Festival in mid September. Participate in a hike on the fossil beds or dig into the Liter's Quarry "Fossil Piles." Find out about the festival at the web site: www.fallsoftheohio.org, or call (812) 280-9970.

Fossil Shells ID Sheet
Brachiopods and Mollusks

Pleuronotus
Flat spiral snail



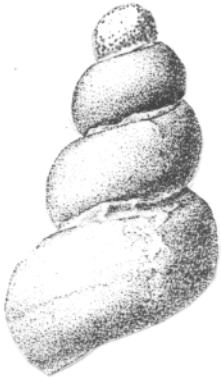
Megastrophia
brachiopod



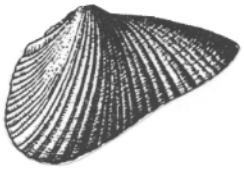
Turbonopsis
Turban-snail

"Atrypa"
brachiopod

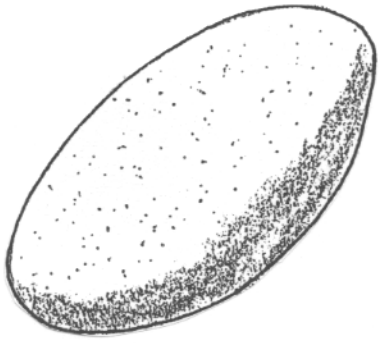
Brevispirifer
brachiopod



Paleozygopleura
Tall spiral snail

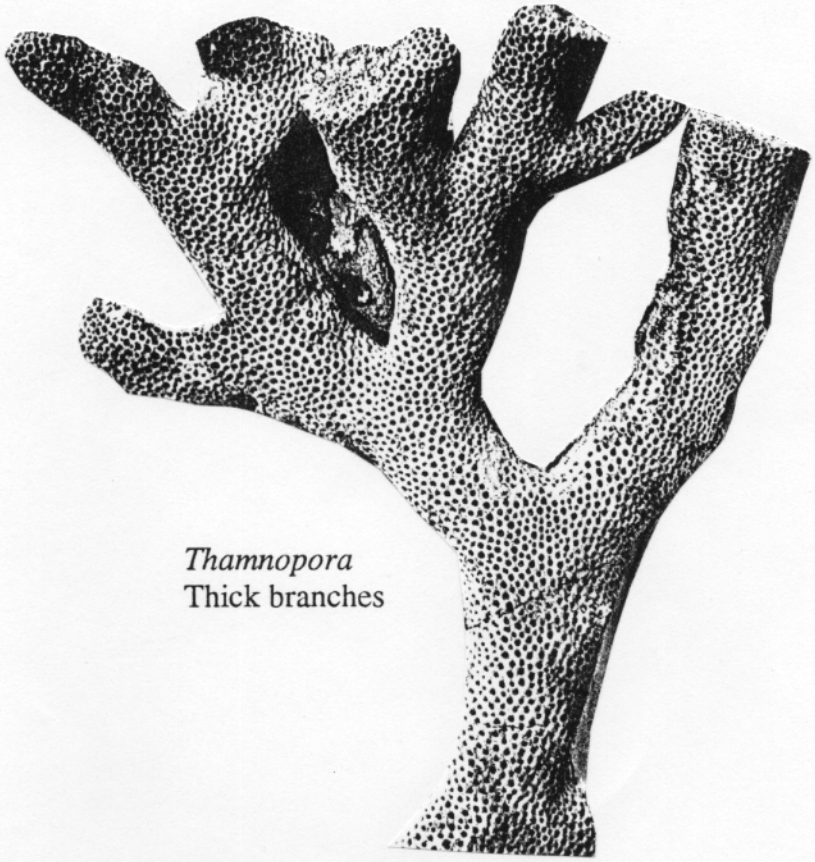


Hippocardium
Rostroconch
(only extinct class of mollusks)



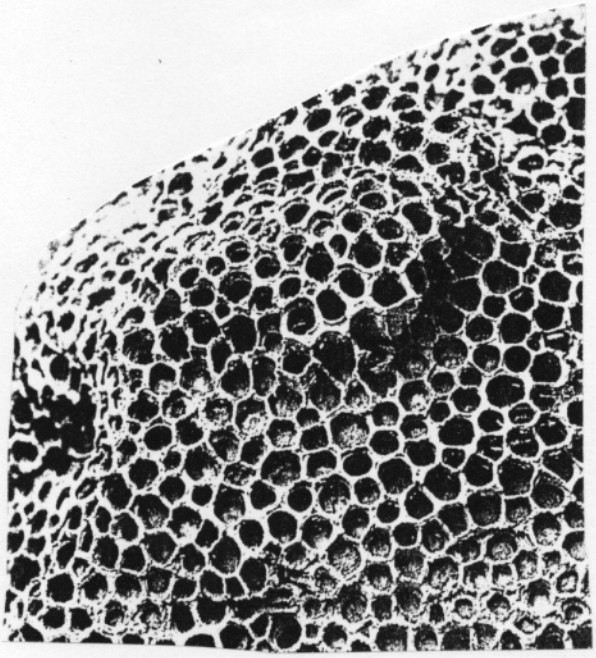
Modiomorphia
Clam

Branching and Honeycomb Coral ID Sheet



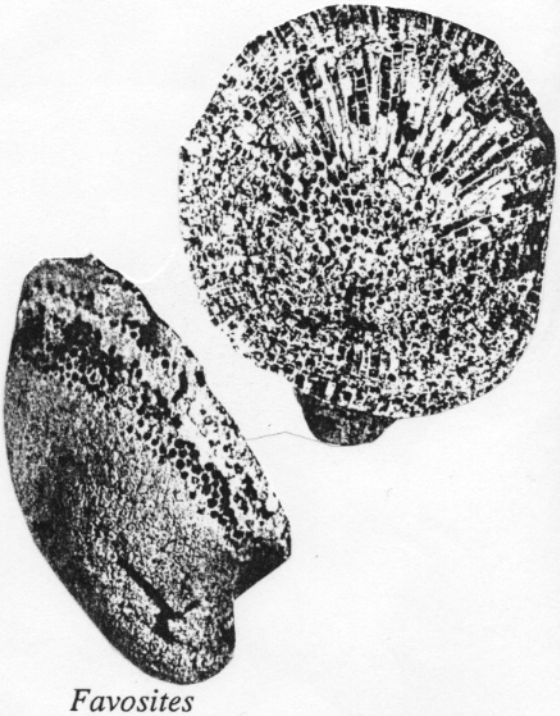
Thamnopora
Thick branches

Alveolites
Thin branches



Pleurodictyum
"Wasp Nest" Coral

Favosites
"Honeycomb" Coral

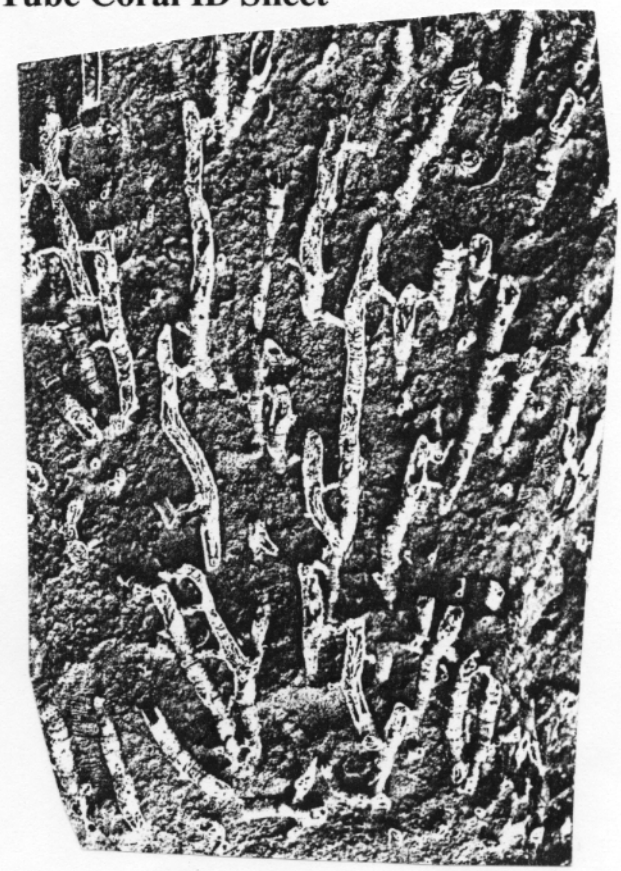


Favosites
"Knee Cap" Coral

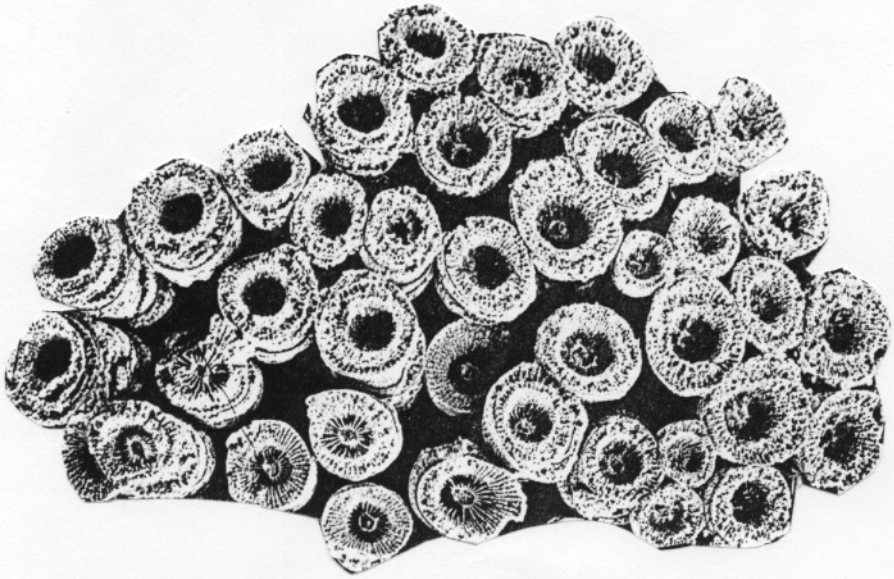
Pipe Organ and Tube Coral ID Sheet

Aulocystis
Encrusting tube coral

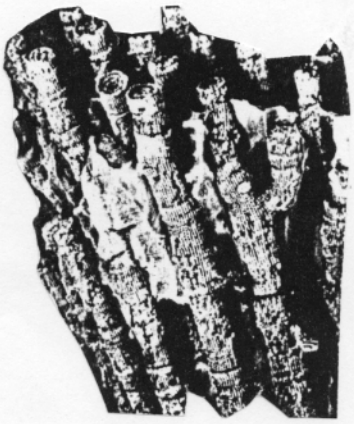
Syringopora
Thin tubes



Syringopora
Thick tubes

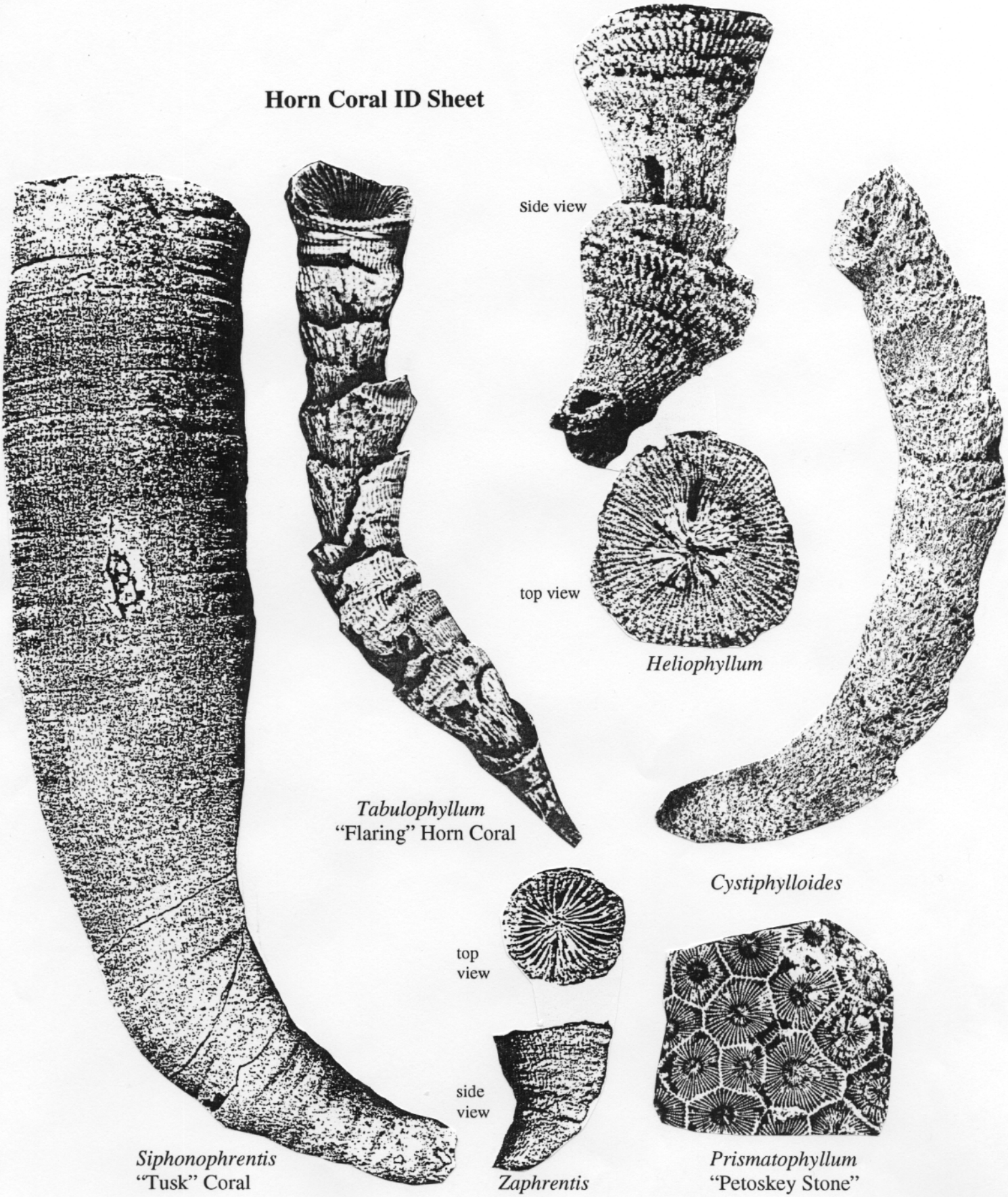


Eridophyllum
Large "Pipe Organ" Coral



Acinophyllum
Small "Pipe Organ" Coral

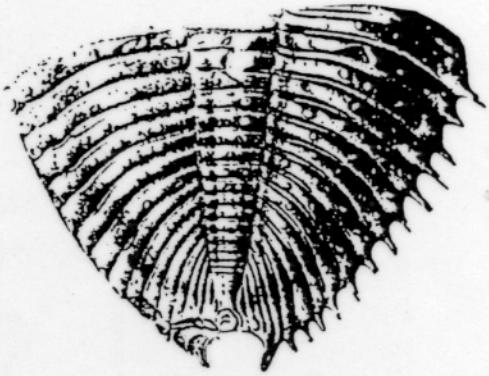
Horn Coral ID Sheet



Misc. Fossil ID Sheet

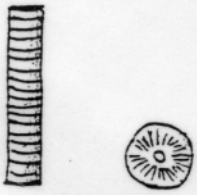
Phacops

Crassiproteus



Coronura

Trilobite tails



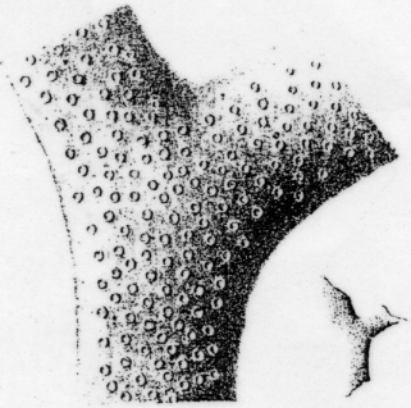
Side view top view

Crinoid column

Blastoid
Eleacrinus

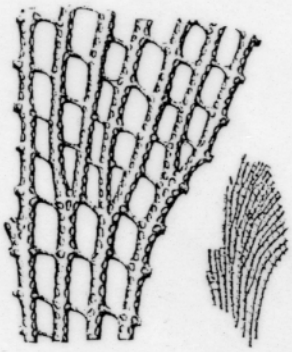
Stromatoporoid
Sponge

Echinoderms



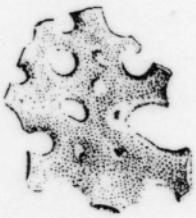
magnified view regular size

Cystodictya



magnified view regular size

Fenestella



regular size

Coscinium

Bryozoans

DESIGN YOUR OWN FOSSIL

GRADE LEVEL: K - 3

OBJECTIVE:

Students will be able to describe how fossils are formed.

MATERIALS:

Plaster of Paris
Plastic containers such as margarine tubs
(one container for each child)
Small shells of various types (two or three for each child)
Petroleum jelly
Water

PROCEDURE:

1. Mix up a batch of plaster of Paris that is rather stiff. Fill the containers half full of the plaster mix.

2. Distribute shells and containers with plaster of Paris and small amount of petroleum jelly to each student.

3. Direct students to coat the shells with petroleum jelly and press them into the plaster of Paris. Set the containers aside for a day or two until the plaster has set.

1) *Fossil trilobite* Phacops

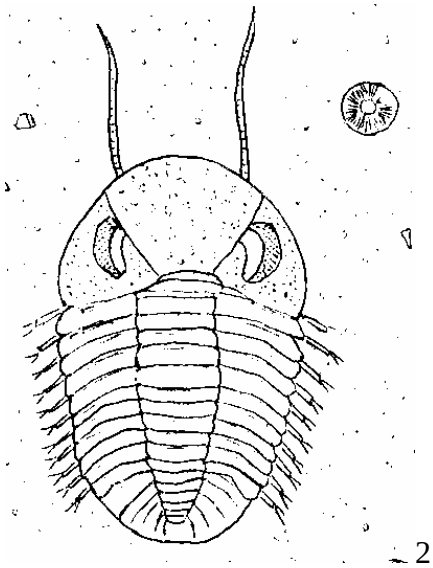
4. When the plaster has set have the students reclaim their containers and carefully remove the shells. The shells will have left depressions or molds of their shape in the plaster. Explain that fossils leave impressions in the sand and clay at the bottom of the sea where they once lived and this is what we are finding at the Falls in the fossil beds. We also are finding the shells of the animal or the hard bony parts of the animal. (Student may be directed to paint the mold of shells so that they show up better.)

5. Show students pictures or overheads of some of the fossils that they will find at the Falls (crinoid stems, brachiopods, trilobites, corals, clams, snails, etc.) or borrow the fossil "Museum to Go" kit from the park.

6. Distribute paper and crayons or chalk and direct the students to draw an undersea picture of the animals and plants as they may have looked when they were alive.

EXTENSIONS/EVALUATIONS:

7. Make fossil rubbings at the fossil beds. Students need paper such as newsprint to spread over the protruding fossil and a crayon or piece of chalk to rub across the paper to get an imprint of the fossil on the paper. Find the name of their fossil and print it under the rubbing. The finished products can be displayed in the classroom.



2) Phacops *trilobite reconstructed as living*

CASTS AND MOLDS

GRADE LEVEL: K - 3

OBJECTIVE:

Students will be able to explain the difference between casts and molds of fossils.

MATERIALS:

Play dough or modeling clay, one piece per student

Rocks containing fossils and impressions of fossils.

PROCEDURE:

1. Distribute one piece of clay and one fossil rock to each student.

2. Have the students find fossils in or on the rocks and cover them with the clay to make an impression. When they remove the clay they will have either a cast or a mold of the fossil.

3. Explain the difference between casts and molds. A fossil cast is the shape of the fossil sticking out of the fossil rock. If there is a depression where a fossil was set in the rock this is a mold. (To remember the difference, think of the jello mold - you pour the jello into the mold.) The clay will produce the opposite configuration. It will make a cast from a mold and a mold from a cast. Students will probably have at least one of each.

4. Describe the different types of fossils to the students: clams, snails, corals, sponges, and crinoids. Ask the students if they know what the animals looked like when they were alive. Have students draw pictures of their ideas.

EXTENSIONS/EVALUATIONS:

5. Have the students identify the fossils in the diorama at the Falls Interpretive Center. Have them compare their pictures to the scientist's conception.

6. Have students identify casts and molds on the fossil beds. Have them bring along some clay and make a cast or mold of something they haven't seen before.

Internal cast of the snail Paleozygopleura

Internal mold of the snail Paleozygopleura *lined with quartz*

EARTH'S TIME

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to explain the progression of events and natural and cultural history over time that produced the fossils and the Falls of the Ohio.

MATERIALS:

Large sheets of paper six feet in length
Historical biography of the Falls
Crayons and pencils

PROCEDURE:

1. Draw a center line along the length of the paper. Divide the line into three sections representing the three eras, Paleozoic, Mesozoic and Cenozoic. The Paleozoic era should be the largest, at least half of the paper.

2. Divide eras into periods. (See chart on next page.) Start with the end of the Precambrian, which was the largest, about seven times longer than all the other periods put together. The following list has the names and millions of years that they span.

3. Indicate the important creatures or developments found in each period.

4. Make special note of the time of the formation of the fossil beds and the creatures that were living then. (Devonian Period 408 to 360 million years ago during the Paleozoic era.)

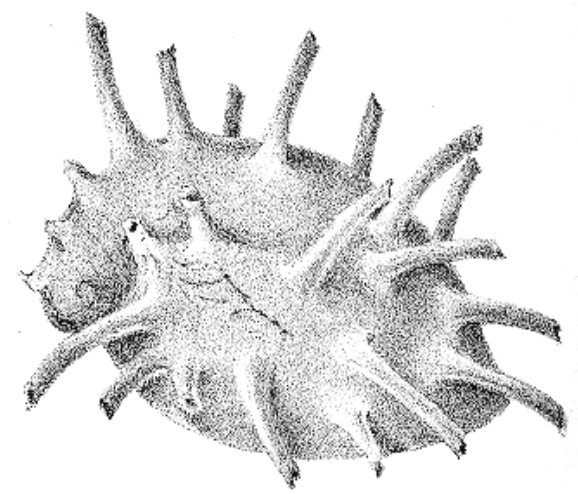
EXTENSIONS/EVALUATIONS:

5. Have students create a time line for their life span, eighty or ninety years. Have them mark special eras, babyhood, childhood, teenage, adulthood, old age. Have students determine which era are the longest? Shortest? Ask students what important things have happened to them and what they expect will happen in their lifetime personally, locally, and globally? How does their life span compare to the earth's life span?

6. How can you manage your life and insure your healthy quality of life? How can you insure the survival of the earth and its health? Design a plan of action for both cases.

7. Do the matching test activity that is with this lesson. The information can be found in the exhibits at the Falls Center.

Answers to *Falls Time Line* activity on page 12: 1, 6, 4, 3, 11, 9, 2, 12, 5, 7, 10, and 8.



Platyceras dumosum – *a spiny snail*

Triceratops – a "spiny" Cretaceous dinosaur

Geologic Time

Era	**Period**	**Began (years ago)**	What happened?
Precambrian		4.6 billion	Origin of Earth
	Archean Eon	3.8 billion	First bacteria
	Proterozoic Eon	2.5 billion	One celled organisms
	Vendian "Period"	700 million	Multicellular organisms
Paleozoic	"Early Life"		Rise of Exoskeleton
	Cambrian	570 million	Sudden abundance of shelly life
	Ordovician	505 million	Rise of corals, jawless fish
	Silurian	438 million	Earliest land plants and animals
	Devonian	408 million	First amphibians & forests
	Mississippian	360 million	Abundant crinoids, coal forests
	Pennsylvanian	320 million	First reptiles, abundant insects
	Permian	286 million	Largest extinction recorded
Mesozoic	"Middle Life"		Rise of the Dinosaurs
	Triassic	248 million	First dinosaurs & mammals
	Jurassic	213 million	First birds
	Cretaceous	144 million	First flowering plants, extinction of dinosaurs, ammonites, etc.
Cenozoic	"Recent Life"		Rise of Mammals
	<u>Epochs</u>		
	Tertiary		Mammals diversify
	<u>Paleocene</u>	66 million	
	<u>Eocene</u>	55 million	
	<u>Oligocene</u>	38 million	
	<u>Miocene</u>	25 million	
	<u>Pliocene</u>	5 million	
	Quaternary		Humans appear
	<u>Pleistocene</u>	2 million	Ice Age
	<u>Holocene</u>	10 thousand	Spread of *Homo sapiens*

Earth's Time Activity

A Falls of the Ohio Time Line

Match the persons, events, and things in the left column with the correct number indicating time sequence. Number 1 is the oldest and 12 the most recent.

Coral patch reef	_____
George Rogers Clark at Clark's Point	_____
Paleo-Indians	_____
Wisconsin glaciation	_____
Wickets	_____
Portland Canal	_____
Dinosaurs	_____
Falls becomes a State Park	_____
Louisville founded	_____
John James Audubon at the Falls	_____
Penn Central (ConnRail) railroad bridge built	_____
First Steamboats on the Ohio River	_____

Model of Devonian corals and sponges in the diorama at the Interpretive Center

BUILDING GLACIERS

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to explain the impact the glaciers had on the land that they covered.

MATERIALS:

Sand or loose soil
Cardboard box 12" x 24" or a cat litter tray
Brick or cinder block
Match sticks or small twigs to represent trees and plants

PROCEDURE:

1. Distribute materials to each group of students.

2. Have the students create a landscape in the box with hills and valley, trees and shrubs.

3. Have the students place a brick or cinder block on the landscape. After a few minutes remove the brick and measure the depression created in the landscape. This is called compaction and happens in nature when something very heavy like a glacier pushes down on the land.

Glaciers covering North America

4. Replace the brick in the sand and slowly push the brick across the landscape from one end to the other. What happens as the brick is being pushed? (Soil and 'trees' are pushed out of the way, the ground is leveled and the soil piles up in front of and on either side of the brick.)

5. You have formed a model of a terminal moraine that is a pile of sediment where the glacier stopped moving forward. Lateral moraines were formed along the side of the glacier as it moved forward just as they did when the brick was pushed along the landscape. Have students find a map showing the end moraines in Indiana. How wide were they? Find information from the Indiana Geological Survey's web page: http://igs.indiana.edu/

EXTENSIONS/EVALUATIONS:

6. Have students find out how many glacial ages have occurred in Indiana? When was the last one? When is the next one expected?

7. Have the students mark the times of the glacial ages on their time line chart.

8. Have students look at a glacial map of Indiana. What would happen to a north flowing river as glaciers moved south across the state?

Comparing a glacier to Louisville

PREHISTORIC PEOPLE

GRADE LEVEL: K - 3, 4 - 8

OBJECTIVE:

Students will become aware of life on the continent of North America before the United States was formed.

MATERIALS:

Stories of Native Americans
Shoe boxes
Modeling clay
Scraps of material
Art Paper
Potting soil or sand
Toothpicks
Popsicle sticks

PROCEDURE:

1. Discuss the life of the Native Americans before 1600 A.D. Include types of food, shelter, clothing, occupations, tools and toys.

2. Read some accounts of what Native American children learned as they grew up. (Many stories can be found in the library. Choose one appropriate to your grade level.)

3. Arrange the students in small groups of four or five. Have each group of students make a diorama depicting life along the Ohio River about four hundred years ago. Include houses, landscape, tools, boats and other important items used by the Native Americans.

Bone fish hooks - Archaic B.C. 4000 - 700

4. Display the dioramas and have students tell a story using describing what is going on.

EXTENSIONS/EVALUATIONS:

5. When the students visit the Falls of the Ohio Interpretive Center, compare their dioramas to the ones in the museum.

6. Research the kinds of toys that the Native Americans children played with. Make your own and try them out.

7. List the type of artifacts that archeologists might encounter in the following Native American sites:

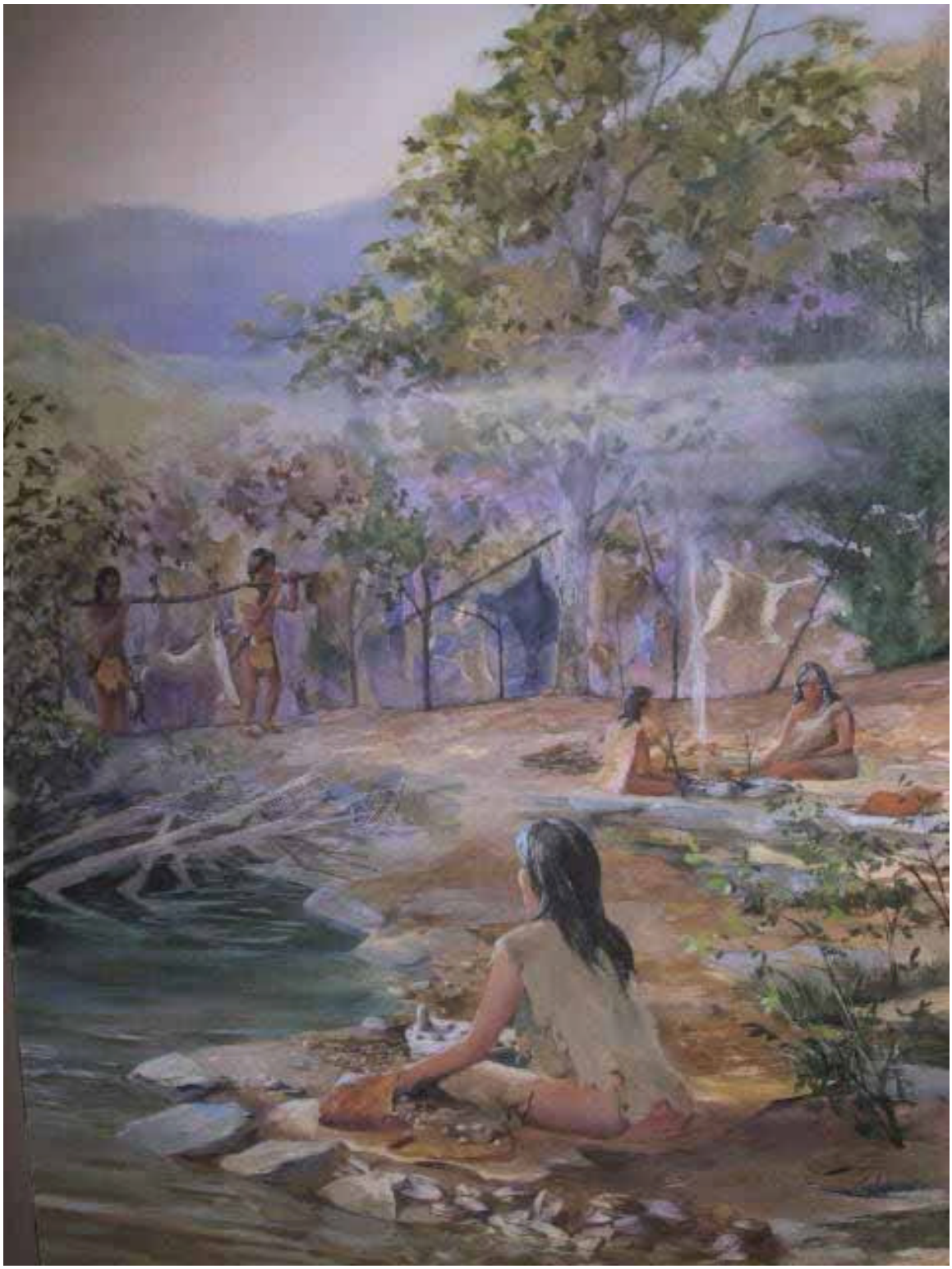
Flint Knapping area
Food Preparation area
Burial sites
Sleeping areas

8. Make a chart comparing the type of items we throw away with the items Native Americans might throw away.

9. Research the laws pertaining to archaeology in your state.

10. Have a flint knapper demonstrate how projectile points were made (for older students).

Diorama of Native American village: Mississippian – A.D. 1000 – 1650



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THE HUNT FOR THE HISTORY

Grade Level: 4 - 8

OBJECTIVE:

Students will discover how different the Falls area was in the early1800's. Students will be able compare that time to our present day life and be able to decide in which time they would prefer to live.

RESOURCES:

The Public library
The Falls of the Ohio Interpretive Center
The Filson Historical Society
The U.S. Army Corps of Engineers
Indiana Historical Bureau
Kentucky Historical Society
The Internet

SUGGESTIONS TO THE TEACHER:

Research could be done in teams. Students could pick a topic that interests them. Reports could be done in written form or done as an art project (drawings, diorama, mini-plays, stories). At the end of the activity ask the students which time period they prefer to live in (then or now) and why.

PROCEDURES:

Assign students research projects on an aspect of life in the late 18th to early 19th century.

1. Look at a map of the Falls during the Late 1700's. (Map is included at the end of this lesson.) Compare with a modern map of the Louisville area and determine the major differences between the area then and now.
Locate Corn Island (adjacent to Louisville) on the 1796 map. This seven acre island was where the first fort in this area was built. It no longer appears on maps of the Falls area. Have the students find out what happened to Corn Island.

2. The map shows Fort Steuben in Jeffersonville, Indiana. There is an un-named fort in Louisville – what is its name? Research how many forts were built at the Falls, when, and what were their names.

3. Look up information on the canal. When was it built? How did people get around the Falls of the Ohio before the canal was constructed?

4. Research log cabins. Build models of them and find out how the settlers heated them, how they cooked their food, how many rooms they had, where they got their water for drinking, cooking, bathing and washing their clothes.

Small model of a pioneer cabin at Interpretive Center

5. Find the names of some of the steamboats that traveled the Ohio in the 1800's. The "New Orleans" was the first steamboat on the Ohio. Research its history. Write a ship's log or a diary of the events that might have happened while traveling on the river.

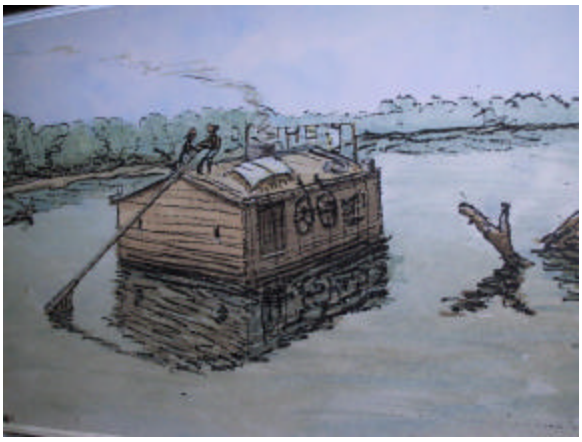
6. What is a "Buffalo trace" How did it get its name?

7. How did people, livestock and cargo get across the river before there were bridges? When was the first bridge built in this area? Where was it?

8. Find out about the grist mills that the settlers built along the streams that ran into the Ohio River and answer the following questions: What was ground up in the grist mill? How is this done today? What powered the grist mill? Did these mills cause any pollution? Why couldn't the settlers just go to the store like we do to get what they needed? What type of businesses were here in the1800's?

Model of a Grist Mill in the Interpretive Center exhibit gallery

9. What would it be like to live on a flatboat or a keelboat like the ones the settlers used coming down the Ohio River to settle in Indiana or Kentucky? Encourage students to read and write about the topic and answer the following questions in their stories. Where would you sleep on the boats? Where would you get food? What do you think they did with garbage and waste materials? Did they bring any animals with them? Where did they keep them?



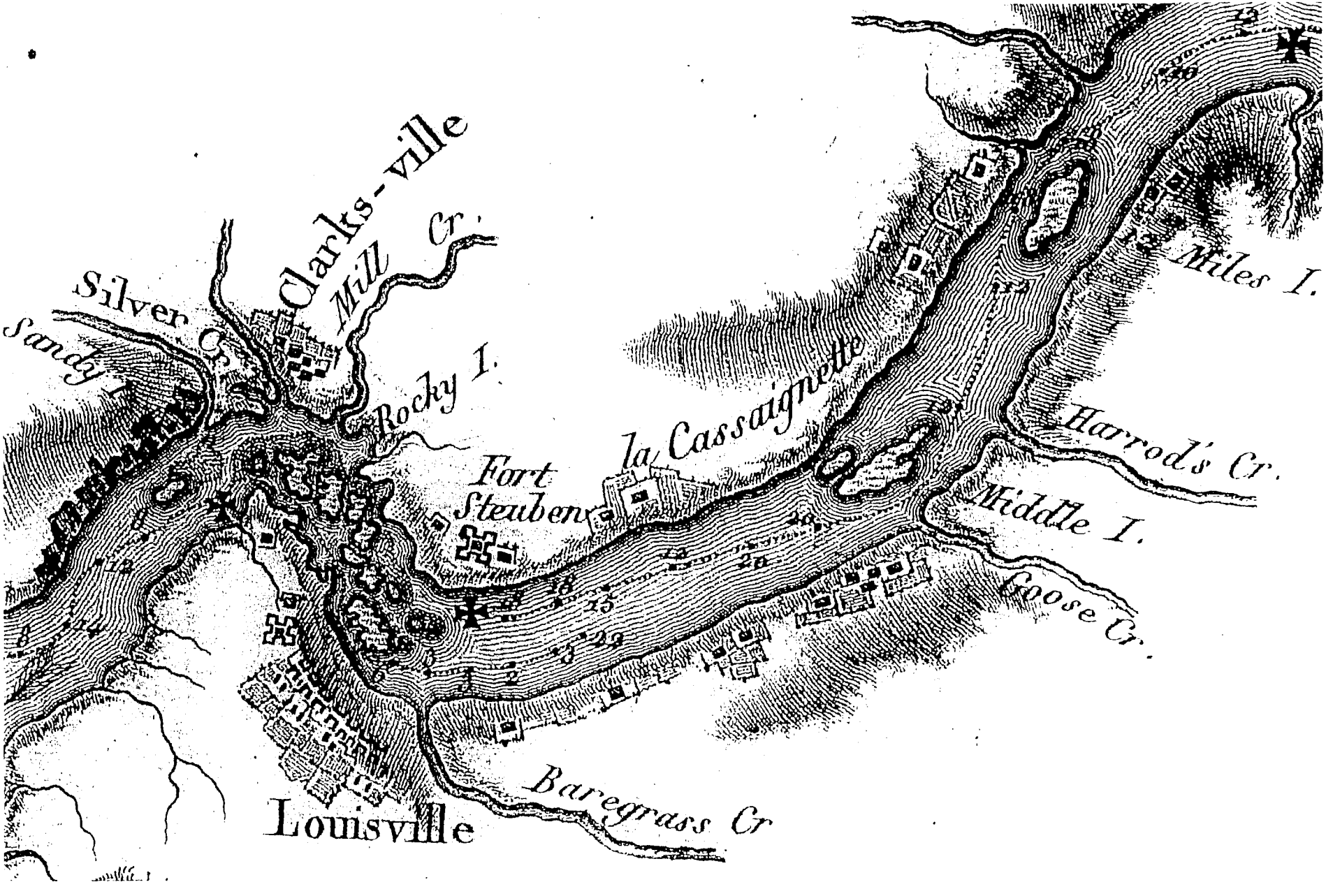
Keelboat on the river

10. Assign the students partners to report on the famous people that are connected to the Falls of the Ohio in some way and are part of the exhibits in the park Interpretive Center. Some of them are listed below.

John James Audubon
George Rogers Clark
William Clark
James Hall
Meriwether Lewis
Prince Madoc
William A McAlpine
Constantine Rafinesque
Sacajawea
Tecumseh

Constantine Rafinesque – An Early Naturalist

James Hall – A prolific paleontologist of the 19th century



1796c George Collot

MAKE A RIVER

GRADE LEVEL: 4 - 6

OBJECTIVE:

Students will learn how the Ohio was carved over time. They will get an understanding of how we each impact water quality.

MATERIALS:

Diatomaceous Earth (pool filter material) 10 lbs.
Plastic or aluminum tray (kitty litter size or 12" x 24" x 4" is good)
Blue and red food coloring
Paper cups (3 per group)
Water
Aerial photos of rivers and river deltas
Book or block one to two inches thick

BACKGROUND TEACHER INFORMATION:

The Ohio River was not always there. About 387 million years ago, much of Indiana and surrounding states lay submerged under a warm tropical ocean. Huge fish called arthrodires swam around in the marine environment. After a vast period of time that included the uplift and erosion of the Appalachian Mountains to the east and a more recent "ice age" to the north, the river was formed. It was created when glaciers blocked the flow of north-flowing rivers. These rivers backed up and flooded until they breached valley walls. Eventually they carved into the landscape creating the path that is now the Ohio River. The Teays (pronounced Tays) River was the pre-Pleistocene river drained parts of eastern U.S. similar to the Ohio, except it included parts of Michigan and northern Illinois and excluded Tennessee and Alabama.

Today the Ohio River stretches some 981 from Pittsburgh, Pennsylvania to Cairo, Illinois. About 10% of the U.S. population lives in the Ohio River basin.

Rivers are never in a straight line. They meander and curve back and forth always finding the path of least resistance as they flow toward sea level.

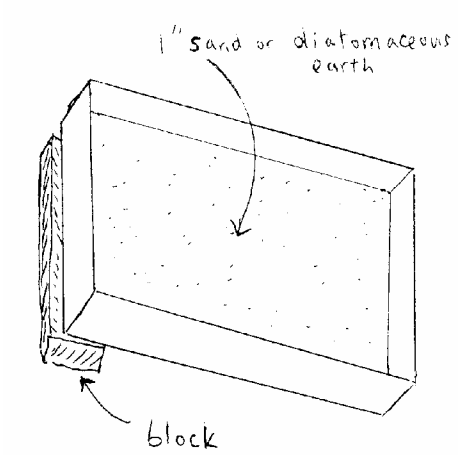
PROCEDURE:

The following investigation can be a bit messy. It is a good idea to put down newspapers on the desks and tables.

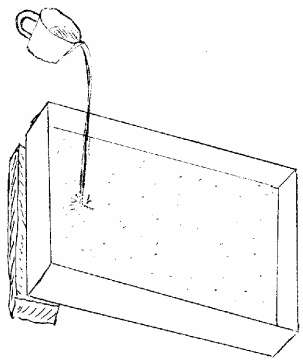
1. Each group needs: tray with enough diatomaceous earth to cover the bottom one inch deep, one paper cup with water, one paper cup with blue water, and one paper cup with red water.

2. Have students pack the sand into the tray about one inch deep. Add some clean water to help pack down the sand. The sand represents land without rivers.

3. Next, have one student tilt the tray up with a book or wood block to create a slight slope. (See illustration below.)



4. To create the river, have a student slowly drip the blue water onto a spot at the highest end of the tray. (See below.) It is important to pour the water at the same spot rather than moving



around. Remind the students that water always flows by gravity to reach sea level. The low end can represent sea level. The water will move the sand in a meandering (curving) path. Continue to pour water until a "river" has covered the length of the tray. Ask students to describe the river's appearance. Examine aerial photos of rivers and river deltas. Do they see any similar features?

5. The second part of the investigation demonstrates how water quality is effected by outside factors. A watershed is the land on both sides of a river and all of the water stored in the soil. Rain, wastewater and any other liquids that cannot be absorbed by the land is filtered by the soil before it gets into streams. A lot of water is stored in the soil. Other is stored in the sand and gravel in the river's flood plain – called the aquifer. This is the water that we find when we drill a well.

We all play a role contributing to the water quality of the Ohio River. Any wastewater or other substance that we allow to get into the water pollutes it; makes it unfit to drink; unfit for fish to live in and unfit for other animals to use.

Take the red-colored water and pour it from a different spot on the tray. Where did the red water go? What color is the water at the vase of the river you just created? What happens when the red water flows into the river? The color change represents the now polluted water. Ask students to name some things that can pollute our waters/ Any foreign substance that goes into the water can be a pollutant. For example, if you change the oil in your car and don't dispose of it properly, the oil could end up in the river. Other pollutants include animal waste from feedlots, chemical run-off from fertilizers and spills from ruptured pipelines.

EXTENSIONS:

Follow-up this investigation with a visit to your local water company.

Check out the Louisville Water Company web site at www.louisvillewater.com/home.htm, click on the "Funzone" to learn more about the Ohio River and drinking water.

Aerial view of the Falls of the Ohio

A historical photo showing a paddlewheel towboat pushing its load on the Ohio River before the age of the diesel engine.

River bends at the old lock and dam 46, one of the old wicket dams at Owensboro, Kentucky (ca. 1930). (All images on this page are courtesy U. S. Army Corps of Engineers)

WHAT'S IN *YOUR* WATER?

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to determine the properties of water using test kits for pH, hardness, dissolved oxygen, copper, iron and chlorine, and will be able to determine if the water is able to sustain life.

MATERIALS:

Water samples from Louisville, the Ohio River, Indiana, pond water, rainwater, well water. Water test kit such as La Mott's Tap Water Tour.

PROCEDURE:

1. Have students form groups of four or five and distribute water samples and test materials to groups. Give each group one type of water but run all of the tests on it (hardness, pH, dissolved oxygen, copper, iron, chlorine.)

2. Explain the procedures for obtaining the results of the tests. (In the Tap Water Tour kit the students drop a tablet into a small amount of the water and watch for a color change.)

3. Have the students make predictions about the water. Which water sample will have the highest pH? Which water sample will have chlorine in it? Will the rain water be the softest? Which type of water will be the hardest?

4. After doing the tests and recording the results have the students create a chart showing the results from their water sample.

5. Results may vary but tap water should be neutral, while rain water may be the most acid (i.e. have the highest pH.) Tap water should test positive for chlorine for it is added to kill harmful bacteria that may be in the water. Spring water or pond water may be the hardest having the most dissolved minerals in it.

6. Since all animal and plant life depend on oxygen to sustain life, water is tested to see if there is enough dissolved oxygen in it for the plants and animals that live in it. According to the test results, which water sample had the most dissolved oxygen in it? How does oxygen get dissolved the water? Why is it important for the Ohio River to have enough dissolved oxygen in it? The pond, the river and the rainwater should have lots of dissolved oxygen in it. Oxygen near the surface of the water gets absorbed and dissolved in it. The more the surface of the water is exposed to air the more oxygen it absorbs. The Ohio River supports much plant and animal life and therefore needs much dissolved oxygen. It also has a very large surface area to absorb the oxygen.

EXTENSIONS/EVALUATIONS:

7. Read *The Magic School Bus at the Waterworks* by Joanna Cole to the students. It presents an entertaining lesson in how water is purified and delivered to our homes.

8. Have children construct an aquarium where they have to test the temperature and acidity and oxygen levels for the fish. Have the students keep a daily chart so they can see the fluctuations in chemical content of the water.

9. Have the students draw a diagram of how the water gets from the river to their house.

10. Take the students to a water treatment plant to observe the process used to treat water so that it is pure enough to drink. The Louisville Water Company has an excellent facility.

11. Have students write a story pretending that they are a water droplet and describe their trip through the water treatment plant.

FLOATING YOUR BOAT

GRADE LEVEL: K - 3

OBJECTIVE:

Students will understand how the shape of a boat determines how well it floats and how much it can safely carry.

MATERIALS:

Pans of water (plastic dishpans are an excellent choice)
Aluminum foil
Marble chips, marbles, plastic chips or pennies

PROCEDURE:

1. Inform the students that they are to make boats from the aluminum foil and float them in the water and test them for being able to carry cargo.

2. Divide the students into small groups of three or four. Place one pan of water on newspapers in the midst of each group. Dispense one square of aluminum foil to each child. Allow them to work on designing different types of crafts to float in the water.

Flatboat on the Ohio River

3. Have the students test their boats for their ability to float and not take on water.

4. Supply each group with small items to place in the boats as cargo. Marble chips, marbles, pennies, plastic chips all work well. Have students find out which boat holds the most cargo without sinking.

5. Have students display their boats and have them discuss which models held the most cargo. Have the students tell which shape will be best for moving cargo up and down the river. (Large flat- bottomed boats can carry the most cargo like the barges we see on the river.)

EXTENSIONS/EVALUATIONS:

6. Have the students build their own barge or river boat and research the history of ship building in Indiana.

7. Have the students write a story about the "Great Steamboat Race".

8. Take the students on a field trip to visit the McAlpine Locks. Besides watching the operation of the locks, the students can become familiar with the history of the river canal and the building of the locks from the display in the visitor center. [Note that there is limited access during construction of the new 1,200-foot lock chamber.

Delta Queen steamboat

BUILDING BRIDGES

GRADE LEVEL: 4 - 8

OBJECTIVE:

The students will be able to explain the important concepts in building bridges by explaining their own bridge construction.

MATERIALS:

Soda straws (100 per group)
Straight pins
Masking tape

PROCEDURE:

1. Arrange the students in groups of four.

2. Position the tops of two desks two feet apart.

3. They will construct a bridge between two desks. The only materials they may use are soda straws, pins and tape. The finished product must be able to bear the weight of one book without falling down. If they construct a solid floor on their bridge then it should be able to stand the weight of model cars crossing it.

4. Compare the structures of each group when they are finished - width, height, suspension, pillars, and whatever other features they included.

5. Where did they get their ideas? What bridges have they seen that inspired their design? Let students choose the best design of the ones they have built. Have them decide which is the best for weight-bearing.

EXTENSIONS/EVALUATIONS:

6. Visit the Falls exhibit of the bridges and locks and dams. Have students report on the need for and use of the bridges and the lock and dam system on the Ohio River.

7. Let them debate the problem of where to put another bridge across the Ohio River between Kentucky and Indiana at Louisville.

8. Research different designs of covered bridges.

9. Research bridge designs and find out which designs are most appropriate in different sites.

10. Obtain photos of bridges across the Ohio River between Pittsburgh and Cairo, Illinois. Let students vote on the design they prefer.

11. Compare the new Natcher Bridge with the older bridge in Owensboro, Kentucky. Note the differences and similarities.

ConnRail Bridge at the Falls:
The first bridge over the Ohio River – 1870.

Something Fishy

GRADE LEVEL: K - 3, 4 - 8

OBJECTIVE:

Students will be able to trace the life cycle of fish and be able to identify common species found in the Ohio River e.g. bass, walleye, catfish, gar, and other forms of life such as crayfish, clams and snails.

MATERIALS:

Posters of Fish commonly found in fresh water streams
Handout with fish identification points
Overhead of fish identification points
The Magic School Bus On the Ocean Floor, by Joanna Cole
Art Paper
Crayons, markers, or watercolors

PROCEDURE:

1. Explain the markings on several kinds of fish as seen in the poster. (Posters from the fish and wildlife service are excellent.) Some of the common fish that students may recognize are the large mouth bass, walleye, gar and catfish.

2. Use the overhead to show different kinds of shapes, mouths, coloration, and breeding habits.

3. Direct students to work in groups to create their own underwater scene and add other living creatures and plants that are present in fresh water streams and rivers like the Ohio. Students who have gone fishing or investigated ponds and streams on their own will have many contributions. Crayfish, freshwater clams, mussels, and snails are important additions.

4. Students can share their work with the class explaining what they have included and why.

5. Discuss what fish eat and the food chain in the water. Large fish eat smaller fish, insects and plants. Medium size fish eat smaller fish, insects and plankton (microscopic plant and animal life). Minnows and mussels eat plankton. Crayfish are scavengers. Snails are herbivores and scavengers.

6. Read *The Magic School Bus on the Ocean Floor*, by Joanna Cole to the students. The book explains the life of fish and sea creatures that are common to both salt water and fresh water.

7. Explain the life cycle of fish from egg, to fry, to adult. (Fry are young fish.) Fish continue to grow larger as long as they live and have a good food supply. Ask students if they are familiar with any life cycle pattern of fish. Some students may be familiar with the life cycle of the salmon that swims upstream to lay its eggs as an adult.

8. Add a life cycle to their picture of river life.

Short-nose Gar in the Ohio River aquarium at the Interpretive Center

EXTENSIONS/EVALUATIONS:

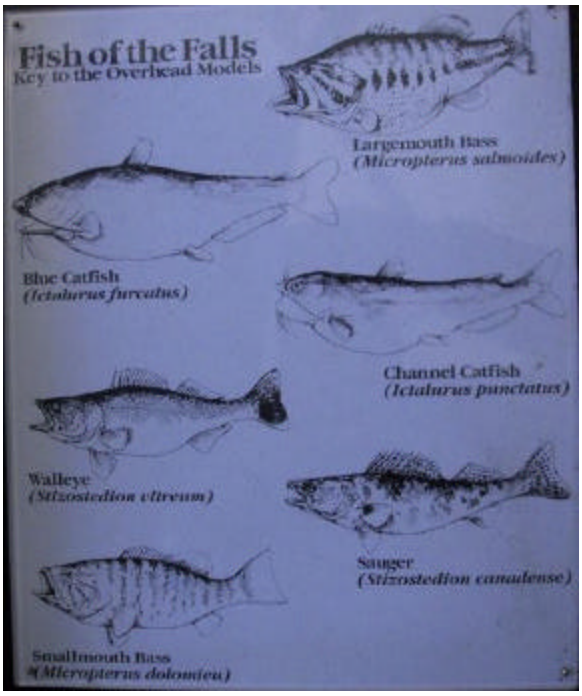
9. Have students examine a fish model or a real fish to learn its parts.

10. On a visit to the Falls of the Ohio ask one of the fishermen what kinds of fish they are catching. Explore the shallow water to see what kind of animal life you can find. (Crayfish and minnows should be common.) Do not keep specimens out of water very long and put them all back in their environment as soon as possible.

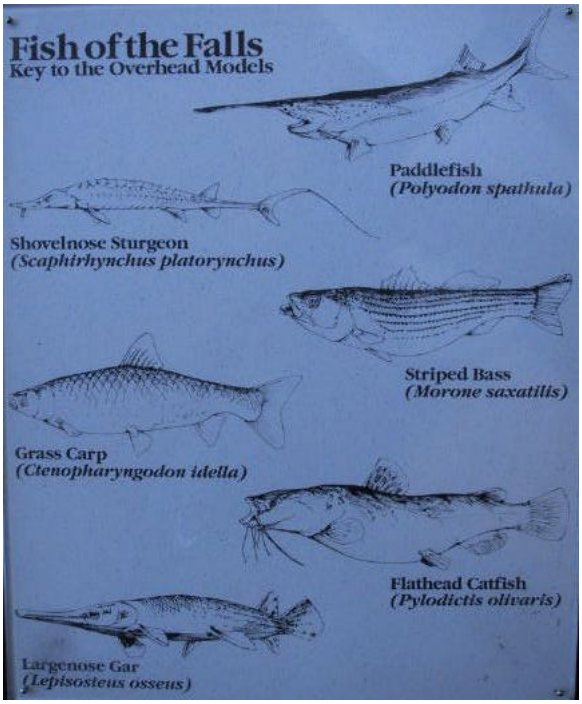
11. Take the students on a fishing trip. The Falls of the Ohio is an easily accessible place. Record the number and kinds of fish caught, their length, weight and markings.

12. Go to a pond and have students compare the ecosystems of the pond to the river. Direct them to make charts of the different kinds of living things found in both systems.

Ohio River Fish in Interpretive Center Lobby



Fish identification for the taxidermy mounts in the lobby (shown on the left).



Something Fishy

Adaptation	Advantage	Examples
Mouth		
sucker shaped mouth	feeds on very small plants and animals	sucker, carp
elongate upper jaw	feeds on prey it looks down on	spoonbill, sturgeon
elongate lower jaw	feeds on prey it sees above	barracuda, snook
duckbill jaws	grasps prey	muskellunge, pike
extremely large jaws	surrounds prey	bass, grouper
Body Shape		
torpedo shape	fast moving	trout, salmon, tuna
flat bellied	bottom feeder	catfish. sucker
vertical disk	feeds above or below	butterfly fish, bluegill
horizontal disk	bottom dweller	flounder, halibut
hump backed	stable in fast moving water	sockeye salmon, chub, razorback sucker, coho salmon
Coloration		
light colored belly	predators have difficulty seeing it from below	most minnows, perch, tuna, mackerel
dark upper side	predators have difficulty seeing it from above	bluegill, crappie, barracuda, flounder
vertical stripes	can hide in vegetation	muskellunge, pickerel, bluegill
horizontal stripes	can hide in vegetation	yellow and white bass, snook
mottled	can hide in rocks and on bottom	trout, grouper, rockbass, hogsucker
Reproduction		
eggs deposited in bottom	hidden from predators	trout, salmon, most minnows
eggs deposited in nests	protected by adults	bass, stickleback
floating eggs	dispersed in high numbers	striped bass
eggs attached to vegetation	stable until hatching	perch, northern pike, carp, muskellunge,
live bearers	high survival rate	guppies

Spotted Grouper

ZEBRA MUSSEL INVASION

GRADE LEVEL: 4 - 8

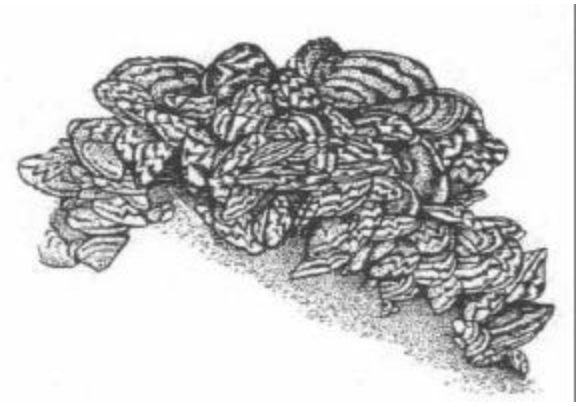
OBJECTIVE:

The student will come to understand the danger of introducing an invasive species into an ecosystem.

BACKGROUND FOR TEACHER:

When the Falls of the Ohio State Park Interpretive Center opened in 1994, there were few zebra mussels to be found in the waters of the Ohio around Louisville. It did not take long for this invasive species to wreak havoc on the Ohio River ecosystem. Today there are large numbers of zebra mussel shells that can be found on the fossil beds. (Please note that it is illegal in Indiana to have in your possession any native or non-native mussel or clam shell.)

To learn more about zebra mussels, teachers are invited to check out the Falls "Ecotrunk" on Zebra Mussels which contains excellent resource materials explaining the life cycle of the Zebra Mussel and the dangers they bring to the Ohio River ecosystem. The "Ecotrunk" also contains materials and activities such as the one given below that can be done in your classroom and demonstrate the dangers of the zebra mussel.



Zebra mussels

"DON'T HAVE A CLUE" STORY PROCEDURES:

1. Divide the students into cooperative learning groups. Each group will carry out the entire activity.

2. Give each group a copy of the story, "What happened to Lake Michigan?" and the related questions.

3. Distribute one or more fact cards to each member of the group, and request that they keep them face down for the time being.

4. Read aloud the story "What Happened to Lake Michigan?" At the end of the story direct the students to take turns reading the questions to their group.

5. Have the students silently read their fact cards. If their fact card answers the question they will raise their hand and share the fact card with the group when called upon.

6. Have one student in the group be the recorder and write down the answers to the questions. Students may use all available information from the cards as well as outside knowledge that can be substantiated.

7. Conduct a class discussion on each question allowing each group to contribute its answers. Try to have the class come to a consensus about the answers to the questions.

8. Give each student a copy of the questions so that they can record the answers decided upon by the class.

Fact Card 3.2

An adult zebra mussel filters approximately one liter of water per day.

Don't Have a Clue

Fact Card 3.2

During dusk and dawn, the water is full of shadows. In this environment, walleye can hide and attack their prey. Many people no longer fish for walleye during the day.

Don't Have a Clue

Fact Card 3.2

Due to increased water clarity, sunlight penetrates the water causing increased growth in vegetation.

Don't Have a Clue

Fact Card 3.2

When zebra mussels die, they wash up on the shoreline and begin to decay.

Don't Have a Clue

Fact Card 3.2

A zebra mussel was found in Lake St. Clair in 1988. They reproduce rapidly. One female mussel can produce 30,000 to 100,000 eggs per year.

Don't Have a Clue

Fact Card 3.2

Because they find their prey by sight and chase them down, smallmouth bass like clear water.

Don't Have a Clue

Fact Card 3.2

Walleye generally are found in murky water where they can hide and attack their prey.

Don't Have a Clue

Fact Card 3.2

Walleye, who have eaten more small fish than were being produced, have diminished their current food source.

Don't Have a Clue

DON’T HAVE A CLUE STORY

Read by teacher

What Happened to Lake Michigan?

Melanie had grown up near Chicago, and she had spent most of her summers sailing, swimming, and fishing in Lake Michigan. Melanie moved away from Chicago in 1980. In 1993, she and her husband, Mike, moved back to her home town, where the moved into a condominium high above Lake Michigan’s impressive shoreline. Melanie noticed the water in the harbor was much clearer than when she was a child. She was surprised to see a lot of plant life in the water that she had never observed before.

One day while they were sailing, Melanie told mike that, when she was in high school, she remembered boats coming in and out of the harbor filled with walleye and smallmouth bass. As Melanie was remembering the good old days with Mike, they passed her family’s favorite vacation spot, a secluded beach where they camped every summer, and they noticed a nasty odor. Melanie and Mike also noticed that the only boats they saw on the lake were sailboats and yachts – no fishing boats.

On their return trip home they stopped at Fred’s Fresh Fish Shop to purchase, what else, fresh fish. Melanie was disappointed to learn from Fred, a local fisherman, that he did not have any walleyes left.

He informed her that the local fishing industry had gone through many changes. At this time, the only fresh fish he had was fish shipped in from elsewhere.

What Happened to Lake Michigan?

1. Why was the lake much clearer when Melanie returned in 1993?

2. What factors could have caused the increase in vegetation?

3. An odor was observed on the beach. What could have caused it?

4. Who or what could have been responsible for the decreased number of walleye?

5. What changes has the local fishing industry gone through?

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Don't Have a Clue

BIRDS OF A FEATHER

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to identify birds common to the Falls of the Ohio area.

MATERIALS:

Posters of birds common to the Ohio Valley Bird identification books
Bird watching area

PROCEDURE:

1. Introduce the bird poster and have students identify common birds from the poster. Students should be familiar with robins, blue jays, cardinals, sparrows and crows, to name some from their own experience.

2. Explain how we identify birds by their colors, shapes, sizes, type of tail, wing bars, type of feet, type of bill or beak, how they fly and what they eat. The bird identification book will show the important characteristics of the particular species of birds.

3. Observe some real birds at a school bird feeder and/or at the Falls Wildlife Observation room. Identify the birds. What characteristics are used for species determination?

4. Observe birds from a distance, such as the observation deck of the Interpretive Center. Have students identify the birds that are flying above the water. Determine which birds are hunting for aquatic life and which are hunting for insects. On a good day they will see herons, osprey and cormorants, gulls, ducks and bank swallows.

5. Start a journal listing of the types of birds that they see, where, when and how many.

EXTENSIONS/EVALUATIONS:

6. Choose a bird that is of interest to a student and write a life history of the bird. Include the following information: where the bird lives and nests, if it migrates and where, what it eats, how it raises its young, what kind of nest it builds and any other interesting facts.

7. Research the laws concerning owning live raptors and migratory birds or their feathers.

8. Invite a state or federal fish and wildlife officer to discuss laws about birds and help them identify ways of helping the migratory birds.

9. Invite a member of the Audubon Society or Beckham Bird Club to help students identify birds and perhaps get involved with a bird population census.

10. Participate in the winter "Backyard Bird Count" sponsored by the National Audubon Society.

Turkey Vulture – from exhibit panel on the deck of the Interpretive Center

Osprey – *from exhibit panel on the deck of the Interpretive Center*

Answers to activity on following page : 1-I, 2-G,
3-A, 4-F, 5-D, 6-C, 7-B, 8-E, 9-H

Birds of a Feather Activity

The following birds are found at the Falls. What do they eat?

Match the bird to its food.

__ 1.) Cardinal

__ 2.) Cormorant

__ 3.) Heron

__ 4.) Hummingbird (Ruby-throated)

__ 5.) Kingfisher (Belted)

__ 6.) Mallard Duck

__ 7.) Osprey

__ 8.) Peregrine Falcon

__ 9.) Woodpecker (Downy, Hairy, Piliated, etc.)

A. Nabs fish, frogs, insects

B. "Dive bombs" for fish

C. Dabbles for insects, plants

D. Dives in head first for fish

E. Grabs small birds out of the air

F. Flower nectar

G. Paddles underwater for fish

H. Grubs

I. Seeds

Double Crested Cormorants perched on a submerged tree at the Falls of the Ohio

Great Blue Herons search for fish in The rapids at the Falls of the Ohio

TREES AND NATURE

GRADE LEVEL: 4 - 8

OBJECTIVE:

Students will be able to identify common trees and flowers found at the Fall of the Ohio and recognize the ecological niche that supports their existence.

MATERIALS:

Paper suitable for rubbings of leaves and bark
Charcoal pencils or large crayons
Overheads or charts of leaf characteristics
Overheads or charts of flower characteristics
Hand lenses (magnifying glasses)
Tree and flower identification books

PROCEDURE:

1. Individually or in small groups, have students "adopt" a tree for this project. Keep the group in a relatively small area so that everyone is not out of site.

2. Make rubbings of the bark and leaves.

3. Have children use the tree books to identify the leaf samples.

Maple leaves

4. Discuss how leaves are identified by their shape, color, size, margins, and venation. Have students describe the bark pattern of their "adopted" tree.

5. Hike the Woodland Loop Trail, identifying the trees along the way. What differences are observed between the trees in the upper woodland and those in the lower woods along the riverbank.

EXTENSIONS/EVALUATIONS:

6. Have students use the flower books to identify the samples of flowers and weeds.

7. When exploring the riverbank area, note how the roots anchor the tree to the ground.

8. Display the rubbings of bark and leaves at school. Make sure they are correctly labeled.

9. Have the students write a poem or a story about nature at the Falls.

10. Have students draw a picture of one of the trees or flowers in the park.

Aster

GLOSSARY

Archaic culture - Semi-nomadic people who lived between B.C. 8,000 - 1,000 moved seasonally to hunt, fish and forage. The people used tools (adzes, axes, etc.) and developed regional variations in their culture.

Archaeologist - A person who studies remains of past cultures, both prehistoric and historic.

Archaeology – The study of past lifeways, cultures, and cultural processes through the investigation of material remains left behind by humans.

Arrowhead – A general term for projectile points used for hunting by Native Americans. It includes spear and arrow points.

Artifact – Any object made, used or modified by humans.

Atlatl – A device for extending the range of a spear (see illustration above).

Avian - Relating to birds.

Biostrome – A layer or layers composed primarily of skeletons of organisms. It can be of limited or considerable geographic extent.

Blastoid (illustrated above) – A member of the phylum Echinodermata, Class Blastoidea that is characterized by a globular-shaped body with fused plates on a stalk. Fed with tentacles called brachioles.

Brachiopod - A marine invertebrate animal with a soft body and two shells that are symmetrical from left to right, not top to bottom. They were fixed by a pedicle muscle and could not move. Brachiopods are abundant in the fossil record, but are uncommon in the ocean today.

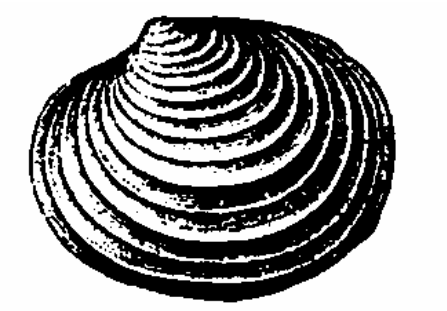
Brevispirifer gregarius - A species of Devonian brachiopod that is so common at the Falls, it forms a layer and one of the zones of the fossil beds. The layer may contain 10,000 shells per cubic foot.

Bryozoa - A phylum of colonial animal that builds an exoskeleton. Some bryozoans build colonies that superficially resemble corals. Individual members of the colony are microscopic. Some resemble netting or lace.

Calcium Carbonate - The chemical compound that makes the minerals calcite and aragonite. Calcite forms chalk, limestone, and marble. Aragonite forms the exoskeletons of most modern shell forming organisms.

Celt – A ungrooved stone ax used for wood cutting (illustrated above).

Chert - A sedimentary rock composed of quartz (silicon dioxide). It occurs in various colors. Prehistoric peoples used chert to make projectile points, scrapers, drills and other tools. Its origin is unknown.



Clam - Any of a variety of bivalve mollusks. They have a soft body and the two halves of the shell are held together by a pedicle muscle. (Devonian clam *Paracyclas* illustrated above.)

Colonial Coral - A growth habit of coral where individual animals live in adjacent tubular chambers.

Corals - A marine invertebrate, usually a colonial organism, that lives in an exoskeleton made of calcium carbonate. Corals live symbiotically with alga that builds the skeletal structure by protecting the algae from predators.

Coral Zone - A layer of rock at the Falls containing abundant corals (shown above).

Crinoid - A member of the phylum Echinodermata, Class Crinoidea, which usually have a stalk composed of circular plates (the column), a body composed of calcite plates held together by ligaments consisting of a cup and arms with small tentacles (pinnules), and a holdfast or grapple to anchor it to the sea floor.

Culture – A system of shared, learned, symbolic human behavior for adaptation for our natural and social environment.

Dam – A structure built to block movement of water on a river or stream.

Devonian - The period of geologic time between 408 -360 million years ago, marked by the dominance of fishes and the first amphibians. The limestone layers at the Falls of the Ohio were deposited during the middle of the Devonian Period.

Dunkleosteus - A Devonian fish which reached 10 meters in length characterized by exterior bony plates and sharp cutting jaws which lacked teeth. A member of extinct fish called arthrodires. (Shown above)

Ecology - A branch of biology that looks at the interrelationships between organisms and their environments.

Epoch - A subdivision in geologic time. Pleistocene is an epoch of the Quaternary Period.

Era - A subdivision of geological time consisting of the divisions: Precambrian, Paleozoic, Mesozoic and Cenozoic. The Devonian period falls within the Paleozoic Era.

Exoskeleton - The hard outer covering, or shell, protecting the soft organs of an organism.

Extinct – An organism that no longer exists in living form.

Falls - A drop in a river or stream over a rock ledge creating cascading water.

Fauna - Animal life which occupies a particular area.

Finger Coral - A slang name for small, finger-like corals in the coral zone at the Falls.

Flatboat - A steerable raft made of wood with sides and sometimes a shelter in the center. Flatboats were used by families and traders for river travel.

Flora - Plant life which occupies a particular area.

Fossil - Any evidence of pre-existing plant or animal life preserved in rock, generally older than 10,000 years.

Geological Time - the total time the earth has existed, estimated to be 4.5 billion years. It is subdivided into eons, eras, periods, epochs, ages and smaller units. (See page 10, this *Handbook*.)

Glacial boulder - A large rock transported by ice some distance from its source, and deposited in an area of melting ice.

Glacial outwash – An assortment of sand, pebbles, cobbles, and boulders (usually non-stratified) that remain as melting glaciers recede from an area.

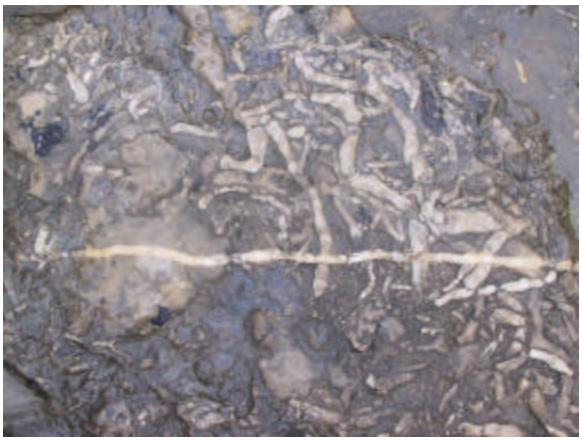
Glacier – A large mass of moving ice. Ice has to be a minimum of 100 feet thick to move from its own weight. Formed by the accumulation of more snow than melts / sublimates during warmer months.

Horn Coral - A common name for solitary corals of the Order Rugosa, characterized by an internal radial pattern of vertical partitions called septae. Some species are shaped like a cow's horn or cornucopia.

Historic Time - Time usually measured form the time of recorded history or when Europeans first had contact with native people.

Igneous rock - Rock formed from molten magma (deep within the earth) or lava (on the surface). Occurs at the Falls in the glacial outwash. Examples include granite, basalt, rhyolite, and diorite.

Invertebrate - An animal without a backbone.



Joint - A linear fracture in rocks without lateral or vertical movement formed from stresses in the earth's crust. It may be filled with a mineral like calcite (as shown above).

Limestone - A sedimentary rock composed of calcium carbonate that is formed from the exoskeletons of marine invertebrates or chemical precipitation in seawater.

Locks - A man-made "water elevator" built on a canal and used to raise and lower boats to different levels. The McAlpine Locks on the Portland Canal at Louisville are one of 21 locks in the Ohio River System (see above).

Long hunter - A person who hunted and trapped in the wilderness, exploring and surveying areas while trading with the natives.

Mammoth - An ancestral elephant, with sharply curved tusks, which lived during the Pleistocene epoch. They preferred open woodlands and meadows where it could graze on grasses and other plants. There is a skeleton in the Interpretive Center lobby.

Marine – Oceanic, salt water environment.

Mastodon - An ancestral elephant similar to the mammoth, with shorter straighter tusks. Preferred woods where it would browse on trees. Also called a mastodont.

Mineral - A natural, solid, inorganic chemical compound. Rocks are mixtures of minerals.

Metamorphic rock - Rock which has been altered by heat and pressure (i.e. granite to gneiss, limestone to marble). Found at the Falls in glacial outwash. Gneiss is shown above. Other examples include quartzite and greenstone.

Mississippian culture - (A.D. 1,000 - 1650) - A native culture which lived throughout the mid-Mississippi valley and most of the Southeast. This culture lived in large villages, built houses, developed an economy based on agriculture, practiced religion, and created high levels of art.

Mollusks - A group of invertebrates that include snails, clams, squid and slugs. They consist of a soft body, most with an exo-skeleton (shell) exterior. Its shape depends upon where it lives.

Mussel - A bivalve mollusk found in fresh, brackish or sea water. Today they are commonly used as food. Their shells are used to make buttons.

Oil Shale - A type of shale rich in hydrocarbons (petroleum residue). With treatment, small amounts of the hydrocarbons can be released as oil.

Organism - Any living, individual plant or animal.

Paleo-ecology – The study of prehistoric life by reconstructing the ecosystem based on geological evidence.

Paleo-Indians - (40,000? - 8,000 B.C.) - A culture thought to have entered America via the Bering Strait land bridge between the last two Ice Ages. Current evidence leads to the possibility that some could have come to the Americas on boats. They were nomadic tribes that foraged and hunted in order to survive. Local sites date back to B.C. 12,000.

Paleontology - The study of prehistoric life in their geological context.

Plate Tectonics - The geological theory, with solid proof of evidence, that the earth's crust is composed of moveable plates above the mantle, that slide along over or under one another.

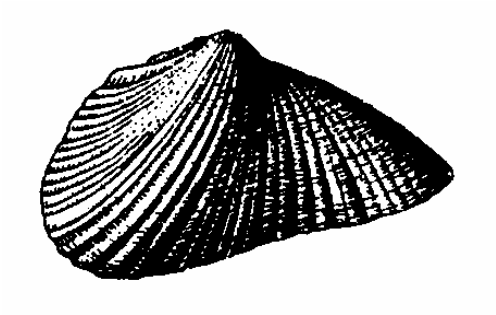
Portage - To carry boats and cargo over land between navigable waterways.

Prehistoric - Before the time of recorded (written) history.

Provenience – The horizontal and vertical location of an artifact at a site.

Rapids – Water flowing over small ledges of rock.

Rock - A mixture of two or more minerals, or an aggregate of a single mineral.



Rostroconch – A peculiar marine mollusk in the Class Rostroconchia, the only extinct mollusk class in the fossil record. Characterized by a single valve that wrapped around the mollusk. (*Hippocardia* is illustrated above.)

Sandstone - A Type of sedimentary rock formed from sand-sized particles cemented together by calcium carbonate or other minerals.

Sediment - Loose rock particles of any size – from microscopic clay to giant boulders.

Sedimentary Rock - Rock formed from sediments deposited by water, wind or ice. Examples include limestone, sandstone, siltstone and shale.

Shale – A sedimentary rock composed of compacted clay particles (i.e. mud).

Snail - A gastropod having a spiral shell. The animal typically lives in the last and largest whorl or section of the shell. The animal pokes its head out of the shell and moves on a fleshy foot that also protrudes from the shell. (*Turbinopsis* snail model illustrated above.)

Specimen – Any object of nature used in study. They are not made by humans. Examples include fossils, rocks, shells, insects.

Strata - (Singular - stratum) Layers of rock or sediment, usually laid down horizontally.

Stratification - The arrangement of rocks or sediment in distinct layers due to the action of water or wind.

Tectonics - Relating to the forces that cause earthquakes, mountain building, ocean trenches and volcanoes.

Trilobite - A group of extinct arthropods related to crabs, spiders, and insects. Trilobites had segmented exoskeletons divided into three lobes or sections. (Specimen shown above is an enrolled *Odontocephelaus* from the fossil beds.)

Weathering – The process by chemical or mechanical means that breaks down rock into products that are stable under conditions at the earth's surface.

Wicket - A gate (usually wooden) built into a dam which regulates water flow. The McAlpine dam at the Falls replaced the old wicket dam #41 in 1964.

Woodland culture - (B.C. 1,000 - A.D. 1,000) - A culture which began settling into villages and increasing their dependence upon agriculture. They developed complex social systems, used the bow and arrow to hunt game, stored food in ceramic vessels, and built mounds.

Zone – A layer of rock defined by its dominant fossils or minerals. At the Falls there is the coral zone, *Amphipora* zone, *Brevispirifer* zone, Brachiopod – Bryozoan zone and *Paraspirifer* zone.

The National Science Education Standards

This is an edited version from the National Academy of Science's Science Content Standards, for grades 5 – 8 with items selected that are tied to Falls of the Ohio State Park exhibits and interpretive programs. To find out which standards apply to your grade, check out this web site: http://www.nap.edu/readingroom/books/nses/html/overview.html#content

Content Standard D:

As a result of their activities in grades 5-8, all students should develop an understanding of

- Structure of the earth system
- Earth's history
- Earth in the solar system

Developing Student Understanding

A major goal of science in the middle grades is for students to develop an understanding of earth and the solar system as a set of closely coupled systems. The idea of systems provides a framework in which students can investigate the four major interacting components of the earth system--geosphere (crust, mantle, and core), hydro-sphere (water), atmosphere (air), and the biosphere (the realm of all living things). In this holistic approach to studying the planet, physical, chemical, and biological processes act within and among the four components on a wide range of time scales to change continuously earth's crust, oceans, atmosphere, and living organisms. Students can investigate the water and rock cycles as introductory examples of geophysical and geochemical cycles. Their study of earth's history provides some evidence about co-evolution of the planet's main features--the distribution of land and sea, features of the crust, the composition of the atmosphere, global climate, and populations of living organisms in the biosphere.

By plotting the locations of volcanoes and earthquakes, students can see a pattern of geological activity. Earth has an outermost rigid shell called the lithosphere. It is made up of the crust and part of the upper mantle. It is broken into about a dozen rigid plates that move without deforming, except at boundaries where they collide. Those plates range in thickness from a few to more than 100 kilometers. Ocean floors are the tops of thin oceanic plates that spread outward from mid-ocean rift zones; land surfaces are the tops of thicker, less-dense continental plates.

Because students do not have direct contact with most of these phenomena and the long-term nature of the processes, some explanations of moving plates and the evolution of life must be reserved for late in grades 5-8. As students mature, the concept of evaporation can be reasonably well understood as the conservation of matter combined with a primitive idea of particles and the idea that air is real. Condensation is less well understood and requires extensive observation and instruction to complete an understanding of the water cycle.

The understanding that students gain from their observations in grades K-4 provides the motivation and the basis from which they can begin to construct a model that explains the visual and physical relationships among earth, sun, moon, and the solar system. Direct observation and satellite data allow students to conclude that earth is a moving, spherical planet, having unique features that distinguish it from other planets in the solar system. From activities with trajectories and orbits and using the earth-sun-moon system as an example, students can develop the understanding that gravity is a ubiquitous force that holds all parts of the solar system together. Energy from the sun transferred by light and other radiation is the primary energy source for processes on earth's surface and in its hydrosphere, atmosphere, and biosphere. By grades 5-8, students have a clear notion about gravity, the shape of the earth, and the relative positions of the earth, sun, and moon. Nevertheless, more than half of the students will not be able to use these models to explain the phases of the moon, and correct

explanations for the seasons will be even more difficult to achieve.

Guide to the content Standard

Fundamental concepts and principles that underlie this standard include

Structure of the Earth System

• Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

• Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

• Some changes in the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.

• Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.

• Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.

• Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

• Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

Earth's History

• The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

• Fossils provide important evidence of how life and environmental conditions have changed.

• Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist. [From Life Sciences Standard C]

Earth in the Solar System

• The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.

The following is a sample from the Indiana Academic Standards document posted at **www.indianastandards.org**.

Grade 4

Overview

The Indiana Academic Standards for Science contain six standards. Each standard is described below. *Age-appropriate concepts listed underneath each standard specifically tied to the Falls of the Ohio State Park and its interpretive programs are available upon request. Please let us know which grade you teach.* These ideas build a foundation for understanding the intent of each standard.

Standard 1

The Nature of Science and Technology

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the other. This first standard draws portraits of science and technology that emphasize their roles in the scientific endeavor and reveal some of the similarities and connections between them. In order for students to truly understand the nature of science and technology, they must model the process of scientific investigation through inquiries, fieldwork, lab work, etc. Through these experiences, students will practice designing investigations and experiments, making observations, and formulating theories based on evidence.

Standard 2

Scientific Thinking

There are certain thinking skills associated with science, mathematics, and technology that young people need to develop during their school years. These are mostly, but not exclusively, mathematical and logical skills that are essential tools for both formal and informal learning and for a lifetime of participation in society as a whole. Good communication is also essential in order to both receive information and disseminate it; to understand others' ideas as well as have one's own ideas understood. Writing, in the form of journals, essays, lab reports, procedural summaries, etc., should be an integral component of students' experiences in science.

Standard 3

The Physical Setting

One of the grand success stories of science is the unification of the physical universe. It turns out that all natural objects, events, and processes are connected to each other. This standard contains recommendations for basic knowledge about the overall structure of the universe and the physical principles on which it seems to run, with emphasis on the Earth and the solar system. This standard focuses on two principle subjects: the structure of the universe and the major processes that have shaped the planet Earth, and the concepts with which science describes the physical world in general — organized under the headings of *Matter and Energy* and *Forces of Nature*. In Grade 4, students learn that the properties of rocks and reflect the processes that formed them. They investigate force and energy.

Standard 4

The Living Environment

People have long been curious about living things — how many different species there are, what they are like, how they relate to each other, and how they behave. Living organisms are made of the same components as all other matter, involve the same kinds of transformations of energy, and move using the same basic kinds of forces. Thus, all of the physical principles discussed in Standard 3 ? The Physical Setting, apply to life as well as to stars, raindrops, and television sets. This standard offers recommendations on basic knowledge about how living things function and how they interact with one another and their environment. In Grade 4, students learn that all organisms need energy and matter to live and grow.

Standard 5

The Mathematical World

Mathematics is essentially a process of thinking that involves building and applying abstract, logically connected networks of ideas. These ideas often arise from the need to solve problems in science, technology, and everyday life; problems ranging from how to model certain aspects of a complex scientific problem to how to balance a checkbook.

Standard 6

Common Themes

Some important themes pervade science, mathematics, and technology and appear over and over again, whether we are looking at ancient civilization, the human body, or a comet. They are ideas that transcend disciplinary boundaries and prove fruitful in explanation, in theory, in observation, and in design. A focus on *Constancy and Change* within this standard provides students opportunities to engage in long-term and on-going laboratory and fieldwork, and thus understand the role of change over time in studying the Physical Setting and the Living Environment.

Kentucky Science Standards

Relevant academic expectations and content statements related to the Falls of the Ohio State Park and its interpretive programs are available upon request. Please let us know which grade you teach.

The *Core Content for Science Assessment* contains three parts: (1) Conceptual Understandings of Physical, Life, and Earth/Space Science; (2) Scientific Inquiry; and (3) Applications/Connections, the understanding of the nature and utility of science. Thus, all aspects of achievement in science will be assessed. Inquiry and applications/connections skills will be assessed only in the context of physical, Earth/space, and life sciences content.

Test questions will not merely determine whether students have memorized information. They will assess students' understanding and knowledge of science and their ability to reason and use problem-solving skills developed through inquiry and the application of scientific concepts to real-life situations. Elementary students are assessed on their basic understanding of concrete concepts and the simple relationships among them. As students progress from elementary through high school, the concepts studied become more abstract, and students make more connections among concepts. Assessment items reflect this increasing complexity, the expectation of students' deeper understanding of concepts, and the development of sophisticated skills.

Conceptual Understandings

Students need solid knowledge and understanding of physical, life, and Earth/space science concepts if they are to apply science to everyday life. Understanding science implies that students integrate many types of knowledge, including the concepts of science, relationships between concepts, reasons for these relationships, ways to use ideas to explain and predict natural phenomena, and ways to apply ideas. The physical, life, and Earth/space science content statements delineate the content of science in the three widely accepted divisions of science. The content statements focus on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

Scientific Inquiry

Students in all grade levels and domains of science should have the opportunity to use scientific inquiry and develop the ability to think and work as scientists. Scientific inquiry refers to the ways scientists study the natural world and propose explanations based on evidence. Inquiry includes making observations; posing questions; examining sources of information; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results. Test questions may assess students' understanding of scientific inquiry.

Applications/Connections

The Applications/Connections part is organized into three categories. Science and technology includes a study of the abilities associated with technological design, the similarities between inquiry and technological design, and the idea that technological solutions have benefits and consequences. Science in personal and social perspectives includes a study of the concepts of population growth; natural resources; environmental quality; and natural and human-induced hazards. History and nature of science includes a study of the concepts of science as a human endeavor, the nature of scientific knowledge, and historical perspectives of science.

Test items that show connections to science and technology may include examples of how technological advances contribute to the advancement of scientific theories and concepts. Questions may assess students' understanding of how science is continuously revised and evaluated by society and the reciprocity between science and technology. Test items may reflect personal and social perspectives such as students' understanding of relationships among populations within communities or the interactions among people, society, and scientific challenges. Test items may also show connections to historical or cultural perspectives of science. Students' understanding of the human dimensions of science, the nature of scientific knowledge, and the role of science in society may be assessed.

Brochures Available

The park offers a number of free brochures. General interest brochures are helpful for planning a visit or basic information about the park and the fossil beds. Specialized brochures are available for visitors with a deeper interest in the subjects. Many are posted on our web site.

General interest:

Park Brochure - with a map and general information
Discovering Fossils - illustrates the most common fossils on the upper and lower fossil beds
Highlights of the Interpretive Center - a map of our museum with general information about our facility
What is a Patch Reef? - interprets diorama in exhibit gallery and provides insight as to the nature of the geology of the fossil beds
Are Fossils Important? - examines the "value" of fossils and lists places to get fossils identified

Special interest:

Birds at the Falls of the Ohio - a checklist of the 270 (+/-) species of birds reported at the Falls
Ancient Shells at the Falls of the Ohio, Part I: Brachiopods - describes brachiopods and lists species found at the Falls
Ancient Shells at the Falls of the Ohio, Part II: Mollusks - describes snails and clams and lists species found at the Falls
Corals at the Falls - describes this dominant fauna found at the Falls and lists the identified species
Crinoids and Blastoids at the Falls of the Ohio - describes these echinoderms and lists species found at the Falls
Trilobites at the Falls of the Ohio - describes trilobites and lists species found at the Falls
Resource Library - describes the library holdings, policies and how to use it

References and Suggested Reading

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