American Museum of Natural History

# WATER : $H_2O$ = Life

## EDUCATOR'S GUIDE

amnh.org/education/water

INSIDE:

- Suggestions to Help You **Come Prepared**
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# ESSENTIAL Questions

**This exhibition explores where water occurs on Earth, how it's used, and how we can become better stewards of our water planet. You can use the essential questions below to connect the exhibition's educational themes to your curriculum.**

## Why is water essential to all life?

Life started in water, and the properties of water drove the course of its evolution. About two-thirds of the human body is water. Every living organism needs water to survive. Space probes look for signs of water on other planetary bodies to determine whether they are, or might have been, home to life as we know it.

- **Water is crucial to all ecosystems.** Along with temperature, the presence or absence of water determines what lives where on Earth and in what quantities. Species have adapted exquisitely to an amazing variety of freshwater and marine habitats. The ocean is home to the largest known diversity of life on the planet. Ingenuity enables our species to live in environments that range from very wet to very dry.

## How does water shape the planet and regulate its climate?

Water covers more than two-thirds of the Earth's surface, an abundance that is unique in our solar system. It continuously changes from one form to another as it moves through the crust, oceans, and atmosphere in a vast process known as the "water cycle." The oceans store heat in great quantities. By storing and transporting heat, as ocean currents and atmospheric vapor, water is an extremely important modifier and driver of climatic patterns.

- **Earth system processes are made possible by the unique physical and chemical properties of water.** The water molecule ($H_2O$) is very stable, is an excellent solvent, and requires a lot of energy to change temperature and states. These properties are the basis of the fundamental connection between life and liquid water. Water exists in three states on Earth: liquid (clouds, rivers, and aquifers), gas (water vapor), and solid (ice, snow, glaciers, and icebergs). Unlike most substances, water is less dense in its solid form than in its liquid form.

**Tropical cyclones like Katrina, above, are fueled by heat released when moist air rises and the water vapor it contains condenses.**

## How is water distributed across the planet?

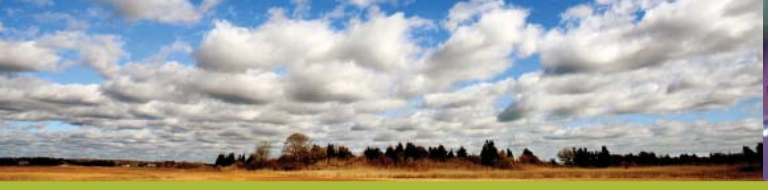
Earth's water is a finite resource. The availability of water on land varies due to weather patterns, evaporation rates, and other factors. Most water is contained in the oceans. Less than 3% of all water on Earth is fresh, and less than one-third of that is liquid.

**Drip irrigation systems like this one use tubes or pipes on or under the soil to deliver water. This low-pressure method is efficient and loses less water to evaporation than other forms of crop irrigation.**

- **Water fuels the growth of human settlements.** Access to water has shaped the distribution and spread of homes, farms, and cities across millennia. People live along coastlines, rivers, and lakes because water is useful for food, sanitation, transportation, power, and many industrial processes. Where fresh water is not readily available, people have used many technologies to collect and carry it. Its value and beauty make water a potent symbol in many cultures.
- **Freshwater and marine systems are fragile and susceptible to human misuse.** Rivers, lakes, and groundwater can be depleted or polluted, making them unavailable or unsuitable for life. Oceans are under threat from chemical pollution, overfishing, sedimentation, habitat destruction, and other factors. All species, including humans, live "downstream"—all living things use water already used by others. Billions of people live without safe water and sanitation, and global thirst is growing along with the world's population.

## How can we be better stewards of our water planet?

We need to use water more efficiently, conserve where possible, protect water quality, and make informed decisions to balance competing demands among species. While the world's aquatic systems have a limited capacity to absorb waste, they can be resilient. Actions we take today can revitalize and sustain this precious resource.



## USEFUL TERMS & CONCEPTS

**"the commons":** any resource—like the oceans and the water we drink—that is shared by a group of people and should be preserved for future generations

**conservation:** the sustainable use of natural resources

**desalination:** removing salt, especially from seawater

**ecosystem services:** benefits obtained from intact ecosystems, such as water purification, waste breakdown, and oxygen production

**grey water:** wastewater from showers, sinks, and washing machines (not toilets)

**groundwater:** fresh water that is stored under Earth's surface in aquifers, layers of sand, gravel, or porous rock; groundwater supplies springs and wells

**pesticides:** any substance intended to kill unwanted organisms, especially insects. They can remain in the food web and water supply, with unintended consequences.

**reclaimed water:** sometimes called recycled water, this is former wastewater that has been treated and purified for reuse rather than discharged into a sewer or drain.

**surface water:** fresh water found on Earth's surface, such as rivers, lakes, and reservoirs

**sustainable:** meeting current needs without losing the ability to meet future needs

**virtual water:** the volume of water required to produce a commodity or service

**wastewater:** water, including sewage, that has been used in homes, industries, or businesses and cannot be reused unless it is treated

**water cycle:** the continuous movement of water between the atmosphere, the land, and the sea

**water ethic:** the concept that humans must protect the quality and availability of water for all the species that depend on it, now and in the future

**water footprint:** the total volume of fresh water used to produce the foods and services consumed by an individual or community

**water stress:** the combination of high human population and low water supply

**waterborne disease:** a disease caused by microorganisms (such as protozoa, viruses, bacteria, and intestinal parasites), and which is directly transmitted by drinking contaminated water

**watershed:** all the land drained by a single river system. Large watersheds like the Mississippi River basin contain thousands of smaller watersheds.

**wetland:** shallow, often intermittently wet habitat, such as a swamp or marsh. Wetlands help filter water, absorb the force of storms and tides, and provide habitat for countless species.

## COME PREPARED

### Plan Your Visit

- Find information on field trips, reservations, lunchrooms, and more at **amnh.org/education/plan**.
- Look inside this guide and the grade-specific inserts it contains for activities and discussion questions to use before, during, and after your visit.
- Visit **amnh.org/education/water** for an in-depth description of the exhibition, activities, book and web lists, and more.

### Making the Most of Your Visit

**Teaching in the Exhibition**
Designed for an educator leading a small group of students, this section of the guide provides an overview of each area of the exhibition and points out highlights. It also suggests guiding questions to spark an inquiry process in which students ask questions, make observations, and propose explanations.

**Self-Guided Exploration**
You may wish to have your students explore the exhibition independently using one of the strategies below. The evidence and questions they gather can serve as springboards for follow-up discussions and further research.

- **Museum worksheets:** The inserts provide black-and-white reproducibles that you can distribute.
- **Make your own worksheets:** You can adapt the information and questions in the Teaching in the Exhibition section.
- **Map of the exhibition:** You may wish to distribute copies of the *Water: $H_2O$ = Life* map to the class in advance of your visit. Ask students to choose an area of the exhibit that they find particularly interesting, and to write several questions about it. During your visit, have students look for information across the whole exhibition that helps answer these questions, as well as record new questions that come up.

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Your visit to the *Water: $H_2O$ = Life* exhibition can be correlated to the National Science Education Standards listed below. Grade-specific NYC Scope & Sequence units are listed on the inserts. Visit **amnh.org/education/water** for a full listing of relevant NYS Science Core Curriculum Standards, NYC Scope & Sequence, National Curriculum Standards for Social Studies, and NYC Mathematics Standards.

**National Science Education Standards**

**All grades** A: Science as Inquiry, Abilities necessary to do scientific inquiry; A2: Understanding about scientific inquiry; E: Science and Technology, Identify a problem and propose a solution, communicate problems, design, and solution
**K–4** C1: The characteristics of organisms; C2: Life cycles of organisms; C3: Organisms and environments; D1: Properties of earth materials; E1: Abilities of technological design; E2: Understanding about science and technology; F1: Characteristics and changes in populations; F2: Types of resources; F3: Changes in environments; F4: Science and technology in local challenges
**5–8** B1: Properties and changes of properties in matter; C1: Structure and function in living systems; C3: Regulation and behavior; C4: Populations and ecosystems; C5: Diversity and adaptations of organisms; D: Earth and Space Science, Structure of the Earth System; F: Population, Resources and Environments
**9–12** C1: Interdependence of organisms; C3: Behavior of organisms; F1: personal and community health; F2: Population growth; F3: Natural resources; F4: Environmental quality; F5: Natural and human-induced hazards; F6: Science and technology in local, national, and global challenges; G1: Science as a human endeavor; G2: Nature of scientific knowledge

# Teaching IN THE EXHIBITION

**The *Water: $H_2O$ = Life* exhibition is designed to engage all learning styles through hands-on and digital interactives, videos, wall panels, models, specimens, and live animals. This guide divides the exhibition into eight numbered areas, which correspond to the map and to the text below. Each area is supported by an overview, highlights to explore, and guiding questions.**

## 1. Life in Water

All life needs water. This area showcases some unexpected groupings of animals and plants—such as the **wood frog**, **orchid**, **tardigrade**, **kangaroo rat**, **albatross**, **diatom**, and **mud-skipper**—that gather, store, and use water in unique ways.

### Exploration:

- **Models and specimens:** Students can compare and contrast the way different plants and animals have adapted to extreme environments such as the driest deserts, the hottest water, and the saltiest seas.

### Guiding Questions:

- What would you have to do to be able to live in an environment where all the water was hot or salty?
- Many plants and animals can't live in the extreme conditions depicted here. What physical features enable some organisms to survive where others can't?

**Some species never drink! Kangaroo rats get all the water they need from the food they eat.**

## 2. Blue Planet

Water shapes our planet. This area focuses on the extraordinary $H_2O$ molecule, water's dynamic role in Earth processes, and where fresh water is abundant or scarce around the world.

### Exploration:

- **Touchable water cycle sculpture:** Students can use their senses to explore water as a liquid, a vapor, and a solid, and can then describe their experience.
- **Science on a Sphere:** Students can watch visualizations on this globe suspended in midair, and consider how water is distributed around the world. Ask students to find their homes on the globe and compare their local water availability to that of other places.

### Guiding Questions:

- What are the unique characteristics of water?
- Where is fresh water found?
- What human activities are possible because of the physical properties of water?

## 3. Water Works

Humans put water to work. This area discusses where fresh water is found, how we collect it, who uses how much, and how it contributes to almost everything we produce and consume.

### Exploration:

- **How We Use the World's Water interactive:** With the help of these wall-sized graphs, students can analyze how water is used around the world, who uses more of it, and why.
- **Virtual Water quiz show:** Students can play the game for surprising information about how we use water—and how much! Ask students to list two facts that surprise them.
- **Stories of dams around the world & Removing a Dam interactive:** Students can look at these wall panels and lift the lever on the interactive. Ask them to consider the problems that dams solve and create.
- **Getting Groundwater interactive:** Students can turn the crank to pump water from the well and explore water delivery from an aquifer.

### Guiding Questions:

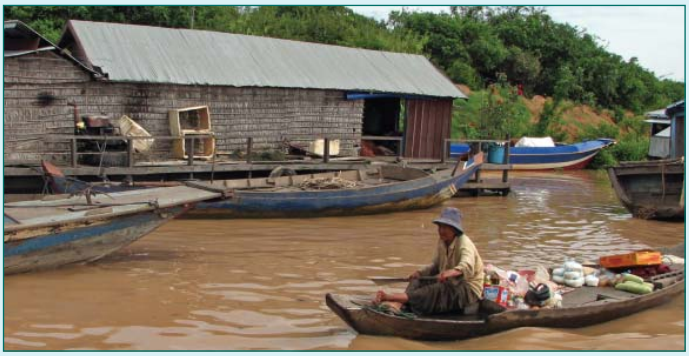
- What do humans use water for?
- How do we put water to work?
- How does technology help us use water more efficiently?
- Why are some technologies less efficient than others?

## 4. Water Everywhere

Some places or seasons are extremely wet, others very dry. This area explores some of the wettest and iciest places in the world, how species (including humans) have adapted to these extremes, and how climate change is affecting them.

### Exploration:

- **Tonle Sap & Arctic ice cap displays:** These models of Cambodia's freshwater fishery and the North Pole give students the opportunity to explore how species adapt to



**During Cambodia's monsoon season, the Mekong River runs backwards and Tonle Sap Lake expands. Houses on floats move with the lake's edge.**



these environments, why they might be at risk, and the behaviors that are the cause. Ask students to come up with five questions about the animals and plants.

**Guiding Questions:**
- In what ways does life depend on water?
- How do Arctic species cope with rising temperatures?
- What are some of the many roles that water plays in cultural beliefs?

## 5. Not a Drop

Half of the world's fresh water can be found in only six countries. Over a billion people do not have access to safe drinking water. This area offers stories from some of the driest locations in the world and examples of technologies that collect and carry water.

**Exploration:**
- **Stories of water scarcity:** Stories about places such as northern India enable students to explore how gender and age affect access to water. Other panels show technologies that address water shortages in places that include Western Australia, Chile's Atacama Desert, and South Africa. Ask a few student volunteers to talk about times when water really mattered to them. Ask how their stories are different from—or similar to—stories in the exhibition.

**Guiding Questions:**
- How does access to water influence the way people live?
- How do people use technology to increase access to water?
- How does access to water affect women and children around the world?

**The marshlands of Mesopotamia, which cleaned the waters of the Tigris and the Euphrates, were drained during the 1991 Gulf War. They have responded well to reflooding by the native Ma'dan people.**

## 6. Healthy Water

Clean water and good health go hand in hand. This area explores where our drinking water comes from, what's involved in making it safe, and why clean water is so important.

**Exploration:**
- **Wetlands diorama & bottled water technology:** Students can observe these displays in order to compare natural and industrial ways to purify water.
- **Your Water On Tap interactive:** Students can explore drinking water sources, delivery methods, and wastewater treatment. Ask where the water goes when they flush a toilet.
- **Porous Rocks interactive:** Students can drip water through four rocks of varying porosity to explore how water finds its way underground.

**Guiding Questions:**
- What makes water clean or dirty?
- Where does our drinking water come from? Where does our dirty water go?
- How can we protect and conserve our drinking water?
- How is water stored and how does it move underground?

## 7. Restoring Ecosystems

More than any other resource, water exemplifies the ecological principle that all living things are connected. This area demonstrates how aquatic ecosystems are both fragile and resilient.

**Exploration:**
- **Mesopotamia, Mississippi Delta, & Mono Lake displays:** Students can examine stories from different places to see how local ecosystems have been severely damaged and what programs are now in place to restore them. Ask students to list which parts of the ecosystem are at particular risk, and why.

**Guiding Questions:**
- How have societies used water throughout history?
- How does water use in one area affect other regions?
- How do tidal wetlands protect us? How can we protect tidal wetlands?

## 8. Local Story

We are stewards of our water planet. This area features stories of New York residents who are taking action to protect the region's water.

**Exploration:**
- **What Can We Do? interactives:** Students can use these multimedia stations to discover how much water they use in daily activities. Have students suggest ways in which they could use less water. Ask students to consider making a specific change that would protect and conserve water in their daily lives.

**Guiding Questions:**
- What are some surprising ways to be more responsible about water use?
- What could you do to reduce water pollution around your home or school?

# BACK IN THE Classroom

## ACTIVITIES

**Animal Story** (K-8): Have students create a poster, story, or cartoon strip about an animal from the exhibition. Younger students can draw the animal's home and describe how it uses water. They can also include other living things that share the ecosystem. Older students can describe a day in the life of that animal based on its physical traits and its relationship to water. Request further research if needed.

**Write a Letter** (K-12): Have students write a letter to their families or local policy makers about what they learned in the exhibit and how they think their families or communities could conserve water.

**Water Conservation in School** (K-12): Ask students to survey how their school uses water and brainstorm conservation strategies (e.g. fixing leaks, using water fountains instead of bottled water). Encourage them to present the report to your principal.

**Watersheds** (3-12): Ask students to research their local watershed and water supply on the Environment Protection Agency website (**epa.gov/owow/watershed**). Sample questions: What is a watershed? What is "good" water? How is your water supply tested, cleaned, and treated? How can you protect local resources?

**Global Water Issues** (5-12): Have students describe and categorize water problems and solutions from around the world. Then quote Einstein: "We can't solve problems by using the same kind of thinking we used when we created them." Brainstorm new solutions. For inspiration, visit Cooper-Hewitt Museum's "Designing for the Other 90%" website (**other90.cooperhewitt.org**) and explore the Water section. As an extension, students can design and build their own water-related inventions.

**Bottled Water** (5-12): Brainstorm brands of bottled water with students and compile a list on the board. Then conduct a blind taste test that includes tap water and at least three brands of bottled water. Divide the class into teams, assign one brand to each, and ask teams to research how theirs is produced and marketed. Have students include the benefits and disadvantages of using plastic bottles. Ask them to compare the cost to that of orange juice and gasoline.

## DISCUSS THE EXHIBITION

**Build on what your students learned at the Museum with these conversation starters.**

- What did you learn about water that surprised you?
- How do your actions affect how much water you use? What future choices could you make to protect this valuable resource?
- How would your life change if you didn't have access to water? What would you be willing to give up?
- Who owns water? Who competes for it? Is water a public or private resource?
- Is clean water a human right?
- How can we balance human use of natural resources while still preserving them?

## ONLINE RESOURCES

- **Water for Educators:** amnh.org/education/water
  You'll find an in-depth description of the exhibition, activities, book and web lists, and more.
- **Water OLogy:** amnh.org/ology/water
  Younger students can explore interactives such as "Living on Ice" and find fun Stuff-to-Do activities.
- **Science Bulletins:** amnh.org/sciencebulletins
  Students can examine current research about water through videos and interactives.
- **Your Water On Tap:** amnh.org/education/waterontap
  Students can explore how drinking water is delivered and treated, and how wastewater and stormwater is processed.

**Who Owns Water?** (5-12): Divide the class into two teams, one representing corporations (for which water is a commodity to be bought and sold) and the other the people (for whom water is an inalienable individual and collective right). Have each team research its side of the issue. Ask them to debate "Who Owns Water?"


### Credits

***Water: $H_2O$ = Life*** is organized by the American Museum of Natural History, New York (www.amnh.org), and Science Museum of Minnesota (www.smm.org) in collaboration with Great Lakes Science Center, Cleveland; The Field Museum, Chicago; Instituto Sangari, São Paulo, Brazil; National Museum of Australia, Canberra; Royal Ontario Museum, Toronto, Canada; San Diego Natural History Museum; and Singapore Science Centre with PUB Singapore.

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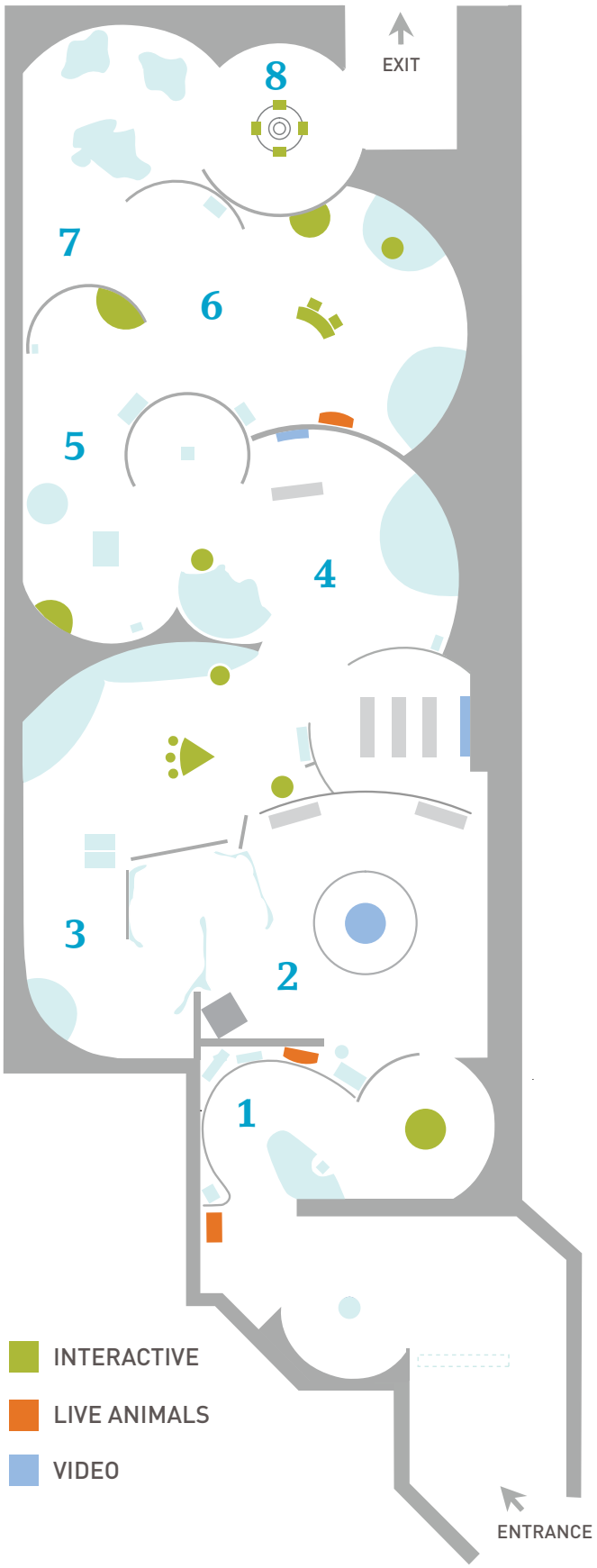
# Map OF THE EXHIBITION

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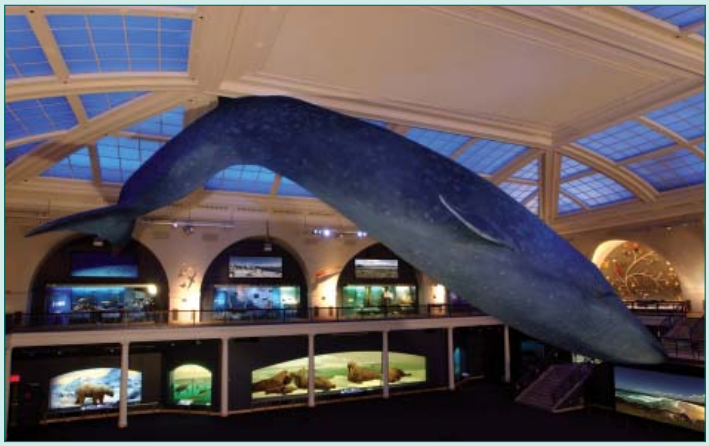
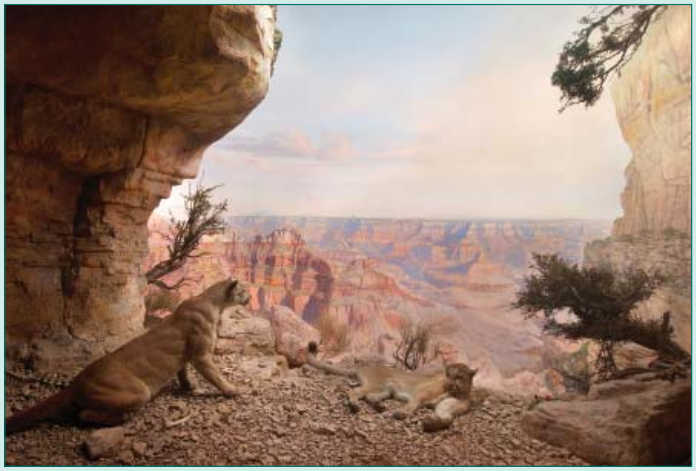
# Connections TO OTHER MUSEUM HALLS

**Continue your exploration of water throughout the Museum. Here are some good places to start looking:**



## Milstein Hall of Ocean Life (1st floor)

- **Ecosystem dioramas on the upper level:** Life began in water. Observe the extraordinary ways in which organisms have adapted to eight ecosystems that range from mangroves to deep-sea vents.
- **Trees of Life:** Almost every primary group of organisms is represented in the ocean. Look at the displays on either side of the entrance to see the diversity of marine organisms.



## Hall of North American Mammals (1st floor)

**Observe how water has shaped the landscapes depicted in the backgrounds of these dioramas:**

- **Mountain Goat:** Striped by debris from smaller glaciers on either side, this massive river of ice has gouged a channel through the rock.
- **Coyote:** Valleys like this one—with flat bottoms, steep walls, and waterfalls—are formed in the wake of alpine glacial erosion.
- **Mule Deer:** This ancient volcanic core resisted the erosive power of the water that created the plains around it.
- **Grizzly Bear:** The energy of the Yellowstone River sliced this canyon through the rocky uplift.
- **Mountain Lion:** The dramatic walls of the Grand Canyon were sculpted by the Colorado River.

## Gottesman Hall of Planet Earth (1st floor)

- **What Causes Climate and Climate Change?** This wall panel illustrates the fundamental role that water plays in energy transport around Earth.
- **Granite Traces:** Opposite the above wall panel is a large, touchable piece of granite (#10) with scratches called striations, made by glaciers.
- **Earth Cycles:** These panels show the integral role of water in the erosion process and in the carbon and rock cycles.
- **How Do We Read the Rocks?** Look at different kinds of rocks in this section of the hall for evidence of how water shaped them.

## Warburg Hall of New York State Environment (1st floor)

- **Life in the Water:** Observe a freshwater lake's cycle of nutrition and decay, and its seasonal cycle of water movement and distribution.
- **Glaciation:** An ice sheet once covered much of New York State. (What signs of glaciation can you find across the street on the rocks of Central Park?)

## Hall of Biodiversity (1st floor)

Panels and computer terminals behind the rain forest diorama describe the role of water in different ecosystems, related environmental issues, and what you can do to protect this vital resource.

## Margaret Mead Hall of Pacific Peoples (3rd floor)

These island populations are truly "water people." Look for examples of the skills and tools they have developed for a life that revolved around the Pacific Ocean.

## More Cultural Halls

Visit the halls of **Northwest Coast Indians** (1st floor), **South American Peoples** (2nd floor), **African Peoples** (2nd floor), and **Eastern Woodland Indians** (3rd floor), to compare and contrast the role of water in the daily life of these very different groups. Where did people settle? What artifacts can you find that involved the use of water in spiritual and practical life (such as fishing, cooking, navigation, and ornamentation)?