

Water Planet Educator Guide

Grade 6–Grade 12

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SCIENCES

Water is life, and as far as we know, life is impossible without it. Discover how water shapes life on Earth.

Welcome to the Water Planet where the focus is on water and the adaptations animals have for living in and out of water.

In this exhibit, students can explore the essential connections between life and water. This exhibit displays a variety of animals that live in water and have unique adaptations for reproducing, moving, feeding, sensing and defending themselves in their environments.

Through interactive stations in the exhibit, students can also explore the different properties of water found on Earth – fresh water, salt water, hot and cold water, surface and subsurface water, frozen, liquid and vapor forms – and how organisms are adapted to each.

Understanding the variety of animals that live in water, the habitats they live in, and Earth’s limited water resources sets the stage for fostering conservation awareness and environmental stewardship.

The following main themes are woven throughout Water Planet:

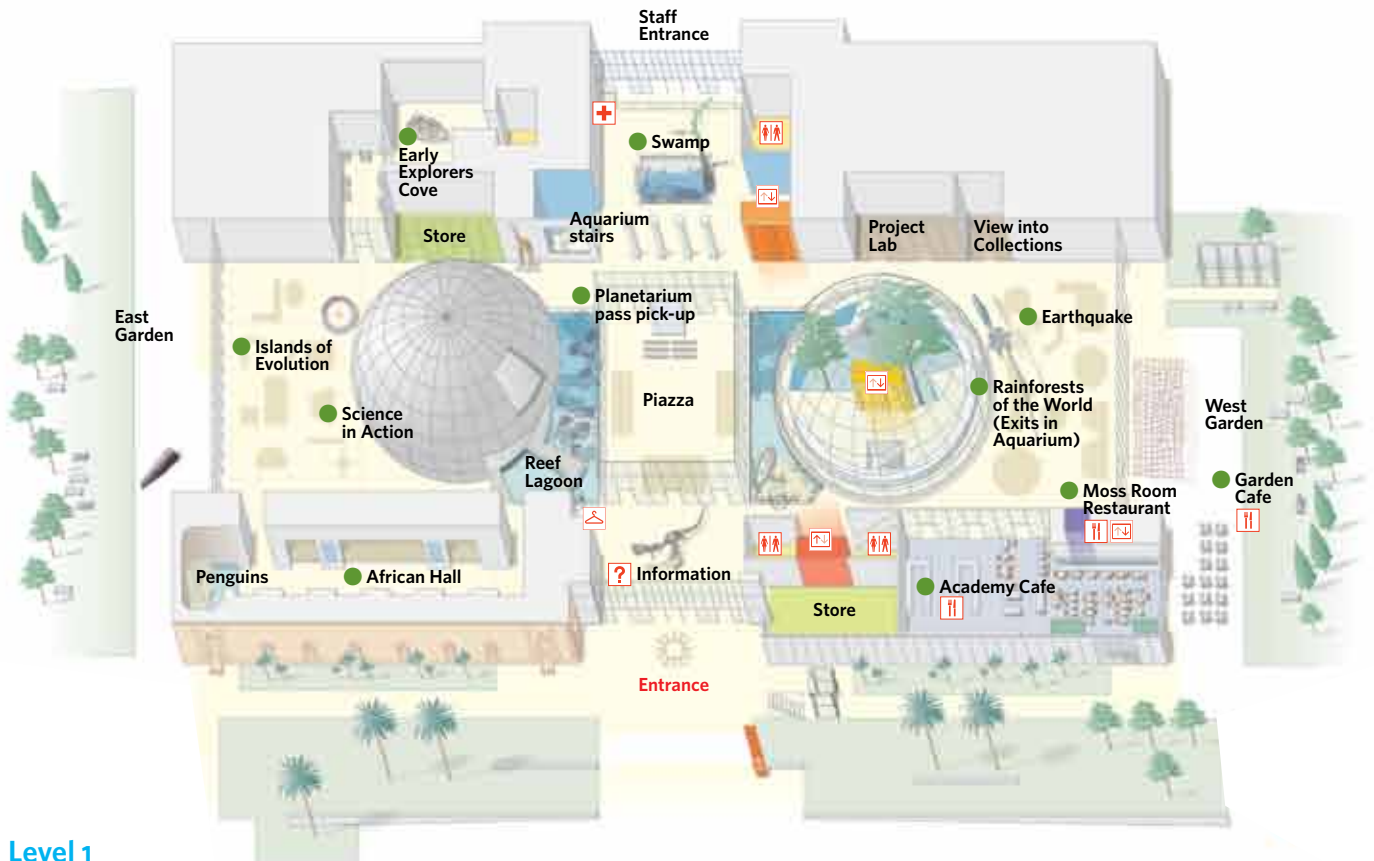
- » Water is essential to life
- » Water has unique properties
- » Animals are adapted for life in and out of water in several ways

Use this guide to:

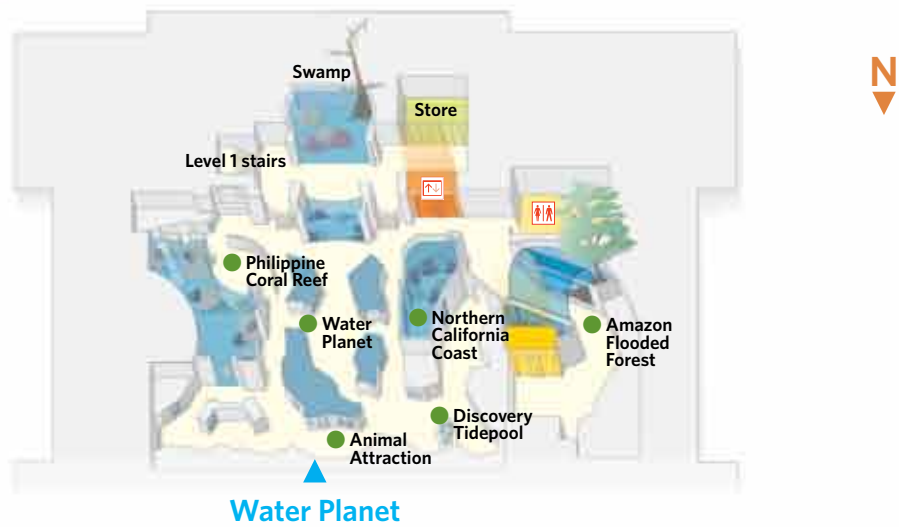
- » Plan your field trip to the California Academy of Sciences’ Water Planet exhibit.
- » Learn about exhibit themes, key concepts and behind-the-scenes information to enhance and guide your students’ experience.
- » Link to exhibit-related activities you can download.
- » Connect your field trip to the classroom.



California Academy of Sciences Map

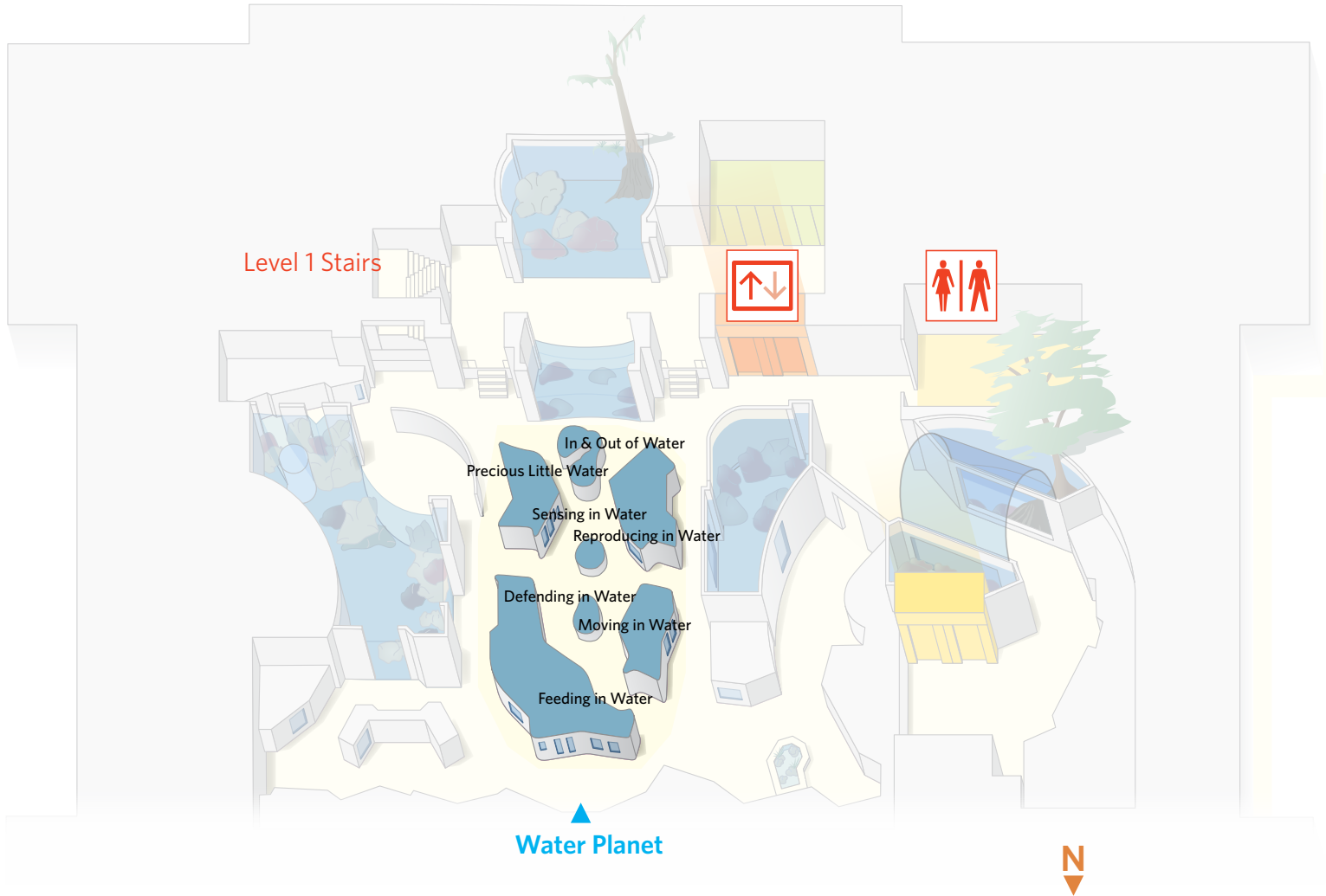


Level 1



Lower Level
(Aquarium)

Aquarium Map



The Water Planet exhibit consists of seven areas: Precious Little Water, In and Out of Water, Reproducing, Moving, Defending, and Sensing. You will encounter an abundance of organisms, as well as numerous interactive stations, video presentations, and information panels. Before you visit the exhibit, spend some time viewing the information on the Academy's website at www.calacademy.org to begin planning your visit.

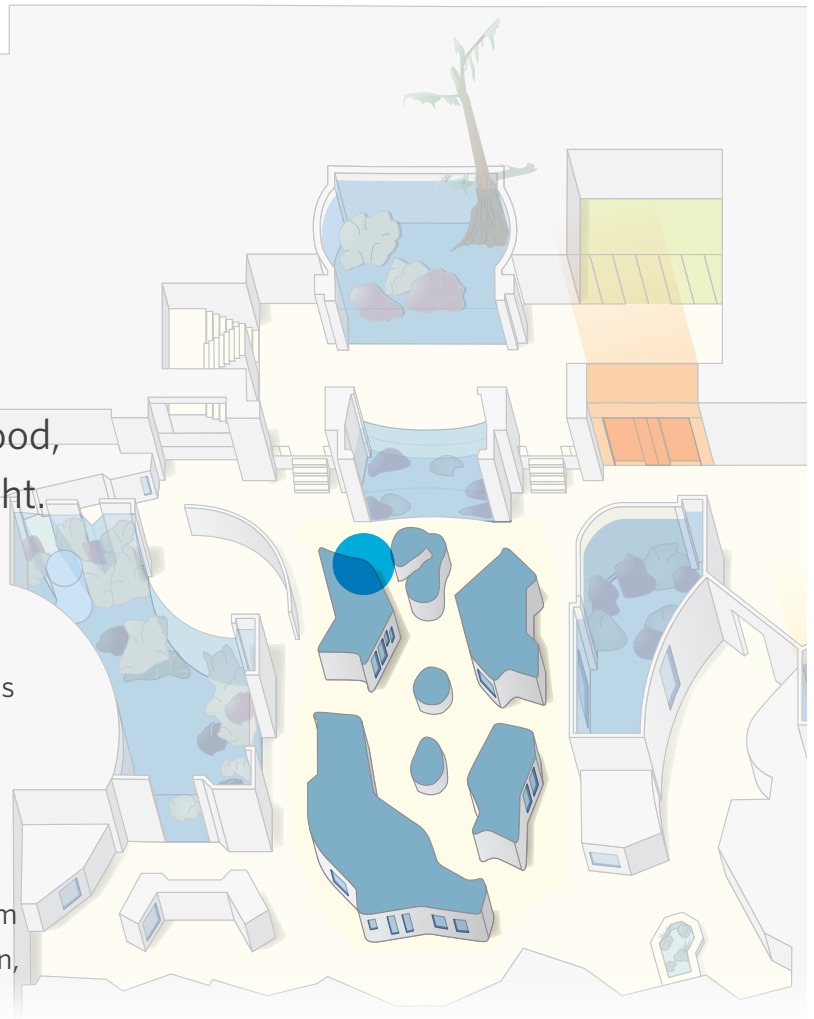


Precious Little Water

Where water is scarce, life seems impossible. Yet animals survive by storing water, getting water from food, resting in burrows or hunting at night. See how animals conserve water.

Main ideas:

- » Some animals are adapted to live in environments that don't have much water.
- » The lifestyles of many animals are adapted to seasonal availability of water or to being aquatic only during certain stages of their lives.
- » Many aquatic animals use gills to get oxygen from the water, but some get oxygen through their skin, or breathe air at the surface.



Take a closer look!

Explore these animals' adaptations for living in harsh environments with precious little water.

Mexican bearded lizard

Heloderma horridum

These venomous lizards make their home in abandoned mammal burrows, under rocks or in tunnels they have dug. Active primarily at dusk and after dark, bearded lizards escape the heat of the day by hiding in their homes.



Centralian carpet python

Morelia bredli

Pythons found in Australia, Asia and Africa are related to boas of the New World (the Americas). But while boas give birth to live young, pythons lay eggs. Females incubate their eggs by coiling around them. Most pythons have heat-sensing pits around their mouth, but black-headed and woma pythons do not.



Photo: © McDonald Wildlife Photography / Animals Animals

Photo: Brian Freiermuth © California Academy of Sciences

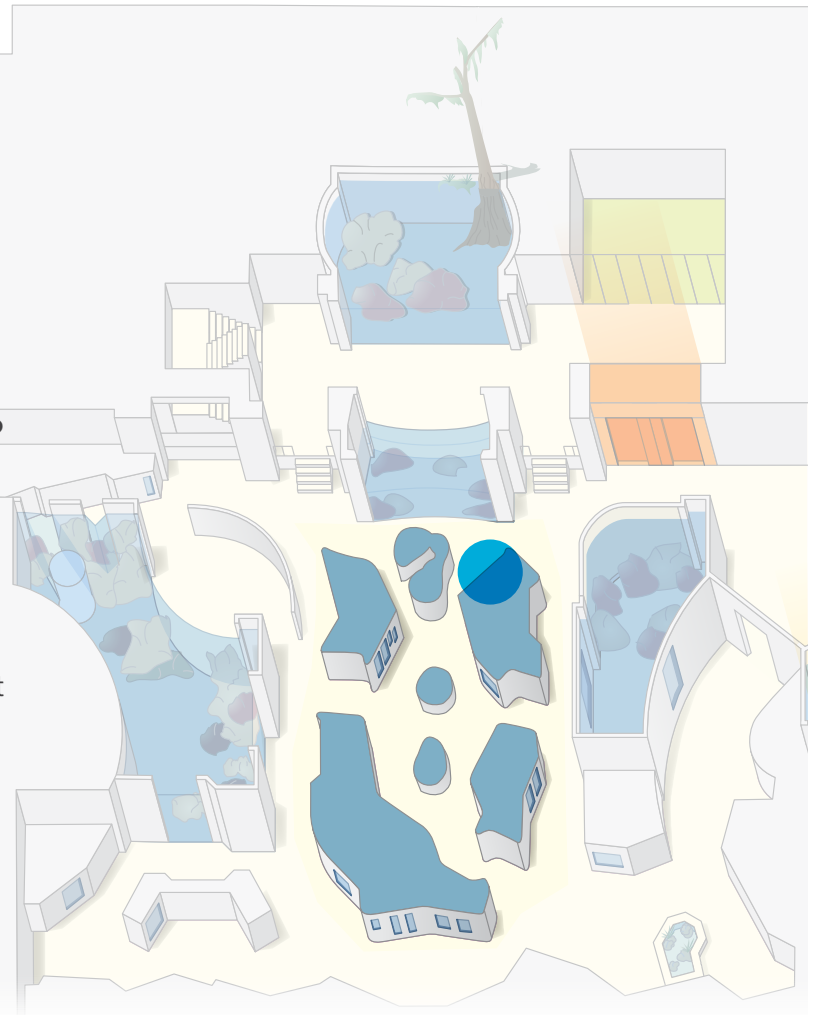


In and Out of Water

Living in water offers challenges. What happens when there's not enough oxygen or a pond dries up? Animals have unique strategies to survive in these conditions.

Main idea:

- » Some animals are adapted to live both in and out of water and can survive even when water is not available at certain times of the year.



Take a closer look!

Learn how these animals can survive when water is not always present.

Australian lung fish

Neoceratodus forsteri

Lungfish live in oxygen-poor pools. This fish has lungs and gulps air at the surface to supplement the air it takes in through its gills. One of these fish has been at the Steinhart Aquarium since 1938.



Redtail killifish

Nothobranchius guentheri

These fish live and spawn during the wet season, then die. When it is dry, their buried eggs survive until the rains return.



Photo: Susan Middleton © California Academy of Sciences

Photo: © Tom McHugh / Photo Researchers, Inc.

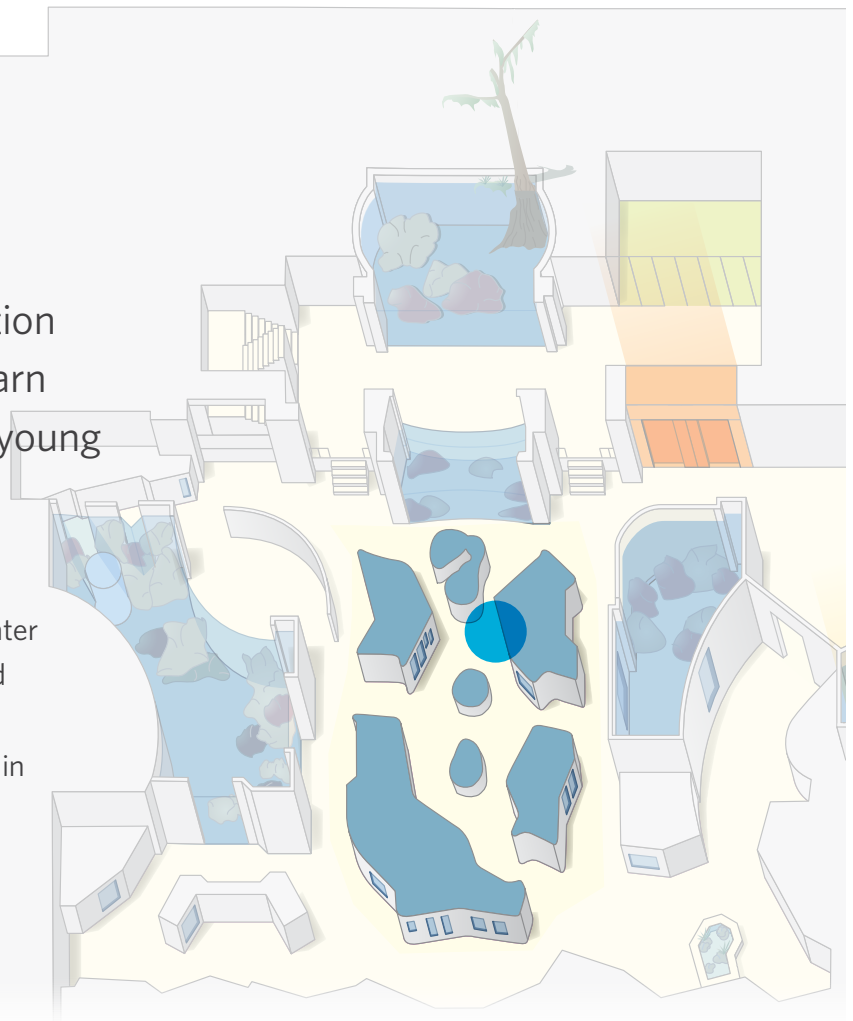
C. KEY CONCEPTS

Reproducing in Water

With water all around, reproduction can play out in unusual ways. Learn how aquatic animals mate, bear young and care for offspring.

Main ideas:

- » The presence, absence and fluctuations of water affect the timing of reproduction, location and behavior in all life forms.
- » Reproduction in aquatic organisms can occur in ways that are not possible on land.



Take a closer look!

Check out these animals to learn more about how they mate and reproduce in water.

Lined seahorses

Hippocampus erectus

Unlike any other animal, seahorses have true male pregnancy. The female deposits hundreds of eggs into the male's brood pouch, where they are then fertilized and nourished until the male contracts and the offspring emerge as fully developed miniature-sized seahorses.

Photo: Ron DeCloux © California Academy of Sciences



Janss' pipefish

Doryhamphus janssi

Like their seahorse relatives, males take on the parental duties. After successfully courting the female in an elaborate courtship dance, the female lays her eggs on a spongy brood patch on the male's underside.

Photo: Ron DeCloux © California Academy of Sciences



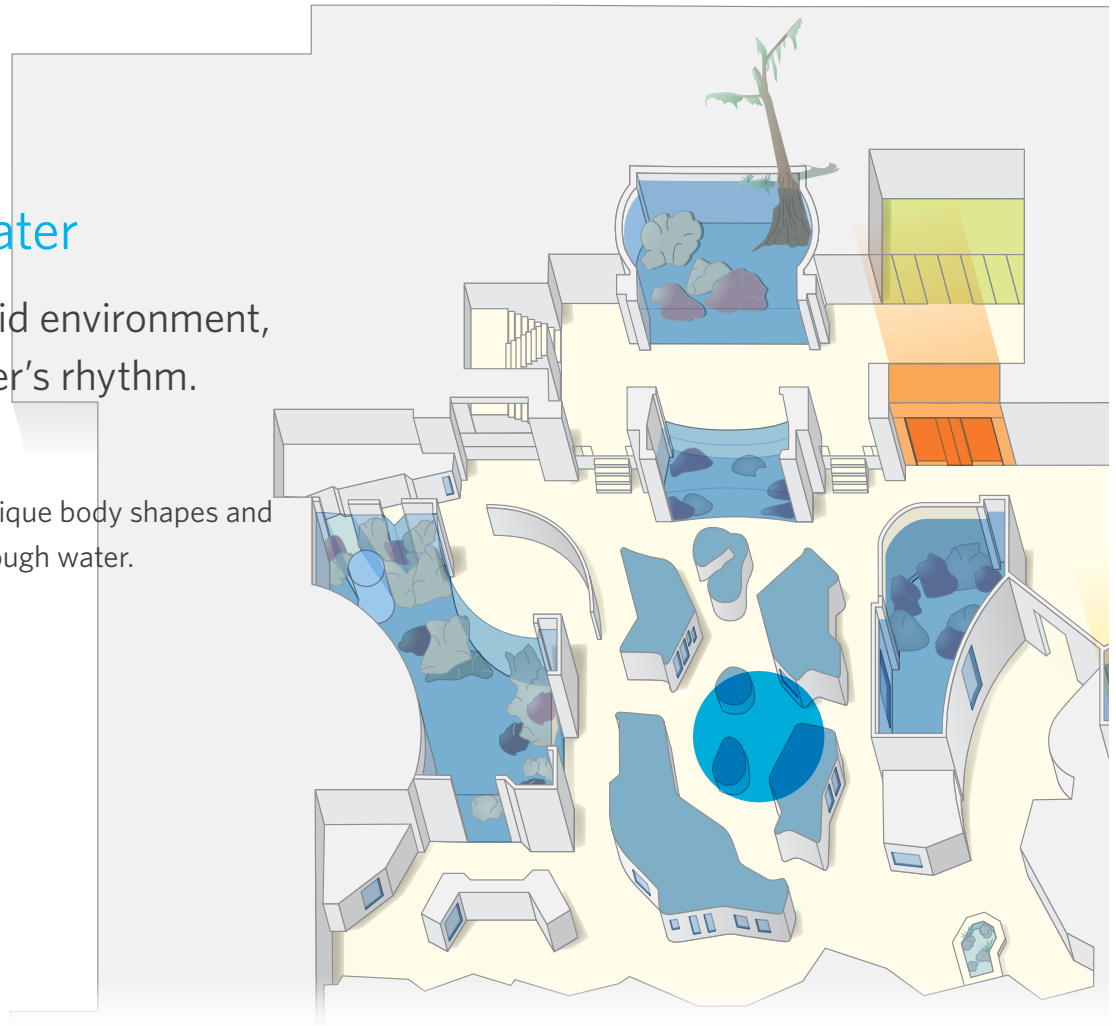
C. KEY CONCEPTS

Moving in Water

Immersed in a fluid environment, life moves to water's rhythm.

Main idea:

- » Aquatic animals have unique body shapes and methods for moving through water.



Take a closer look!

These animals have unique body shapes and methods for moving through water.

Shaw's cowfish

Aracana aurita

Can you see how the cowfish moves just its fins and tail to propel its rigid body? These fish aren't fast, but they can turn in place and stay balanced even in the roughest water.



Moon jelly

Aurelia sp.

Moon jellies swim weakly and drift with the currents. They use a fringe of cilia to sweep tiny plankton into their mouth located at the center of their transparent dome-shaped bells.



Photo: Ron DeCloux © California Academy of Sciences

Photo: Gerald and Buff Corsi © California Academy of Sciences

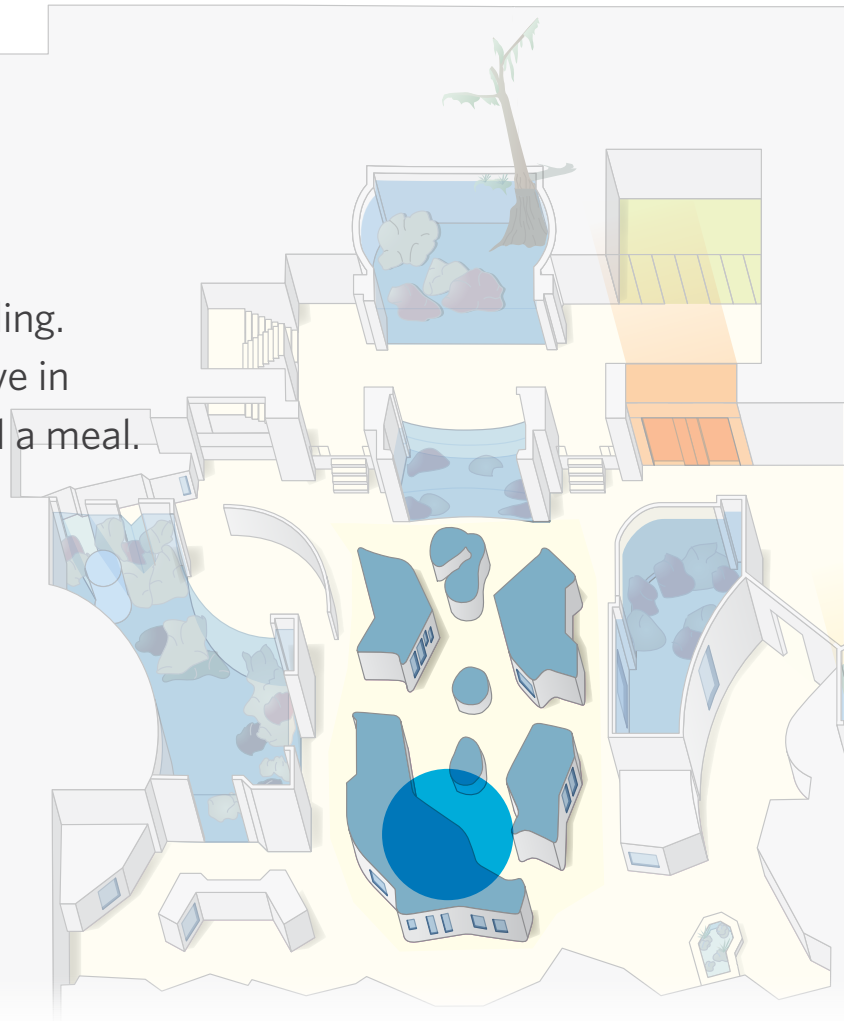
C. KEY CONCEPTS

Feeding in Water

Fangs and jaws are good for feeding. Filters work well too when you live in water. Discover how animals find a meal.

Main idea:

- » Aquatic animals feed in different ways, including filter feeding, which is unique to watery environments.



Take a closer look!

Explore ways these animals find and eat their food.

Paddlefish

Polyodon spatula

If you see a paddlefish open its mouth, it's breathing and eating. As water passes through the mouth, gills collect oxygen and tiny prey.



Photo: © Patrice Ceisel / Visuals Unlimited

Burmese vine snake

Ahaetulla fronticincta

This tree-dwelling snake dines on fish. Dangling from a branch over water, it watches and waits. When a fish gets close to the surface the vine snake plunges its head into the water and grabs a meal.



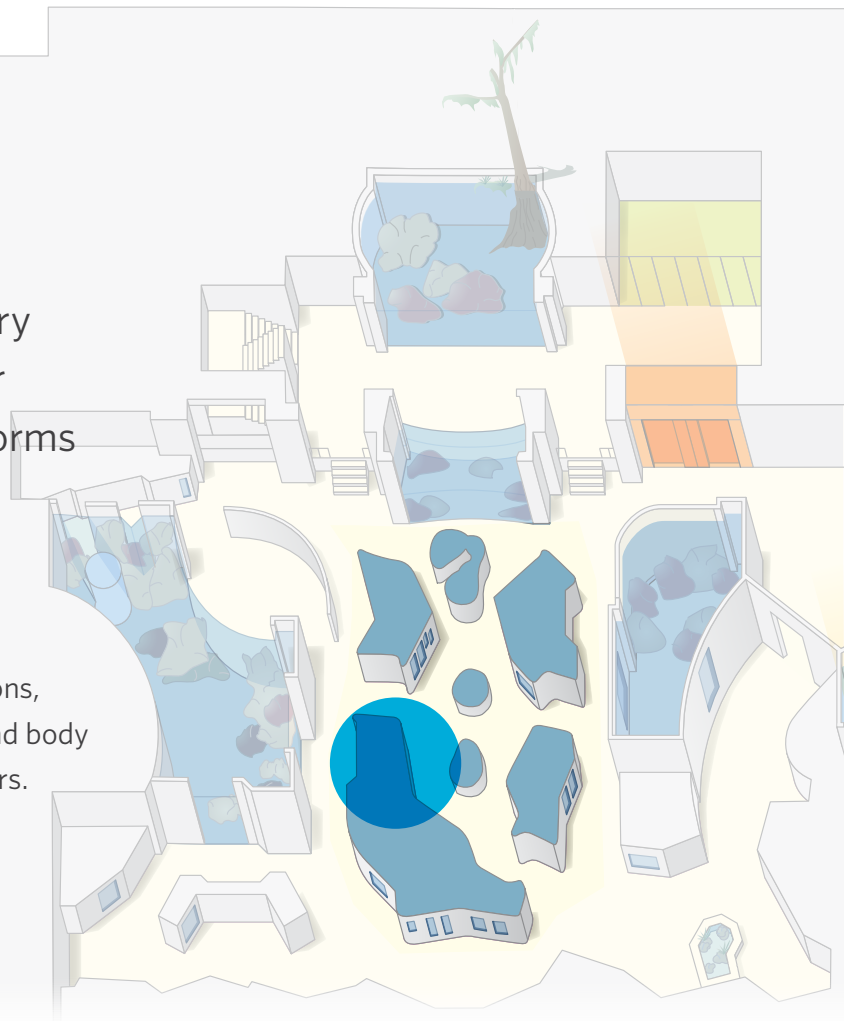
Photo: Dong Lin © California Academy of Sciences

Defending in Water

What's your defense when hungry animals are all around? Armor or camouflage? Look for different forms of defense.

Main idea:

- » Aquatic organisms have a variety of adaptations, including behavior, physical characteristics and body chemistry, to avoid becoming prey to predators.



Take a closer look!

These animals have many successful strategies to avoid being eaten by predators.

Feather duster worms

Sabellastarte sp.

These worms build protective tubes that are often buried in the mud or sand. When simple “eyes” on the “feathers” sense a predator, the worms quickly withdraw into their tubes.



Photo: Bart Shepherd © California Academy of Sciences

Glass catfish

Kryptopterus minor

This fish is like a living mirror—its clear body contains crystals that reflect light. In murky water, a predator sees mostly reflections, not this fish.



Photo: © Brian Bevan / Ardea

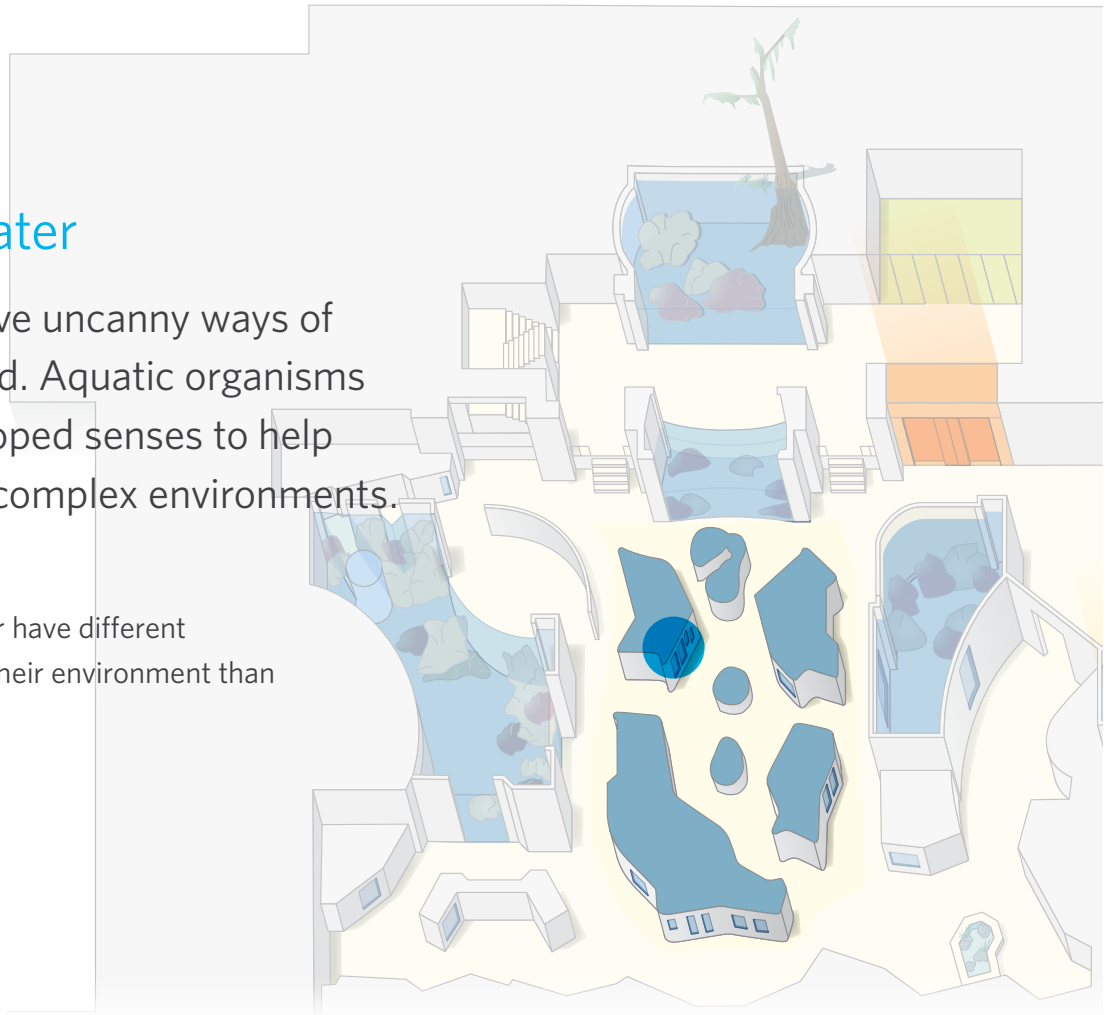
C. KEY CONCEPTS

Sensing in Water

These animals have uncanny ways of sensing their world. Aquatic organisms have highly developed senses to help them live in their complex environments.

Main idea:

- » Animals that live in water have different adaptations for sensing their environment than animals that live on land.



Take a closer look!

Observe the ways these animals sense their surroundings underwater.

Peacock mantis shrimp

Odontodactylus scyllarius

This visual hunter has eyes on stalks and can view its surroundings from a safe burrow. Each eye has stereovision and contains 16 color-vision pigments.



Photo: © Bruce Watkins / Animals Animals

Blind cave fish

Astyanax fasciatus

In the dark, this fish relies on its sense of smell and a lateral line along each side of the body that is sensitive to water-pressure changes.



Photo: © Paddy Ryan / Animals Animals

Guiding Questions and Answers

Use these questions to get the students thinking about animal adaptations.

- » **What different challenges do the snakes and other reptiles in *Precious Little Water* face in their environment compared to the rest of the animals on display?**

These reptiles live in dry environments, whereas all of the other animals on display live in or very near water. Reptiles that live in deserts or other dry environments still need water to survive and have unique adaptations to live there.

- » **What are some ways that animals cope with having little water?**

Animals that live in dry environments have adaptations that help them reduce water loss and survive with little available. Some of these are physical adaptations such as tough skin, special ways of storing water in their bodies, and excreting nitrogenous wastes in a solid form rather than as liquid urine. Many of these animals also have behavioral adaptations to conserve water such as avoiding the heat of the day in underground burrows and coming out at night when temperatures are cooler. Some animals don't need to drink water because they get all they need from the food that they eat.

- » **What do all animals need in order to survive, whether they live in water or on land? How does an aquatic environment influence those things?**

Animals must obtain energy, defend themselves, sense their environment, and reproduce whether they live in water or on land. Animals that live in water have special adaptations, such as filter feeding or jet propulsion, that allow them to get what they need to survive in an aquatic environment.

- » **What are some of the ways that organisms defend themselves in an aquatic environment? Are these unique to an aquatic environment?**

Aquatic animals use various strategies to protect and defend themselves, including teeth, stinging cells, quick escapes, mimicry, and camouflage. Many aquatic animals look like their surroundings and some, such as cuttlefish, can even change the color and patterns on their bodies! Some terrestrial animals use similar strategies to protect themselves from predators. For example, many insects mimic the vegetation they are found on.



Vocabulary

Adaptation	a physical characteristic or behavior that helps an organism survive and reproduce in its environment
Aquatic	associated with water, including oceans, rivers, lakes, and other bodies of water
Ectothermic	refers to animals whose body temperature is controlled externally, and usually depends on the temperature of their surroundings
Endothermic	refers to animals whose body temperature is controlled internally by metabolic or other processes
Lateral line	a sensory organ in fish used for detecting vibrations and pressure changes in the surrounding water— The lateral line is usually visible as a faint line running along each side of the fish.
Larva (plural larvae)	in many animals, an early stage of life that looks very different from the adult form
Terrestrial	associated with land



Science Behind the Scenes

Researching Damselfish Global Distributions

Have you ever observed fish in an aquarium and wondered where they live in nature?

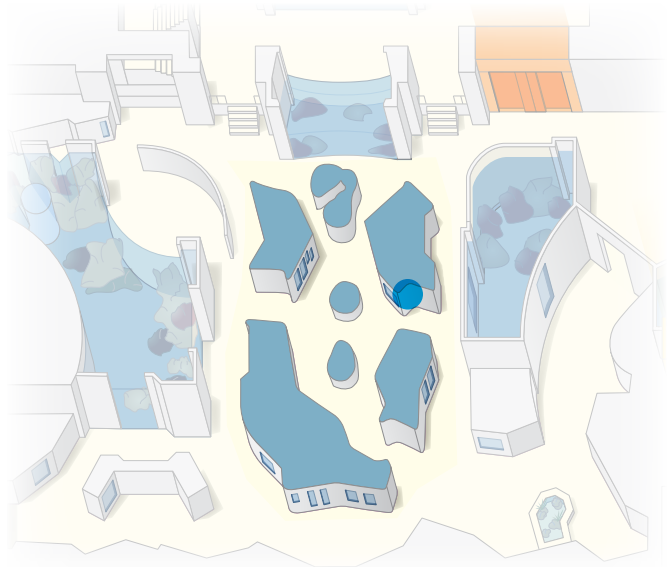


“Many reef fishes begin the first few months of their lives drifting in the ocean before settling down in a reef as a juvenile,” says **Dr. Luiz Rocha**, Assistant Curator and Follett Chair of Ichthyology at the California Academy of Sciences. “They can travel thousands of kilometers in their larval stage, feeding on plankton along the way.”

This is how a species of damselfish, blue green chromis (*Chromis viridis*) starts its life. Like some other fish, it lives in different habitats depending on what stage of life it is in. Scientists are studying this species right here at the Academy.

Dr. Rocha is trying to determine how fish species that travel long distances compare to species that don't. Species of fish that travel long distances tend to have fewer genetic differences than species that live in the same reef for their entire life.

In collaboration with other scientists, Dr. Luiz Rocha is learning more about how these fish are related to each other and where they live globally. He conducts research all over the world, sampling coral reef fishes from Hawaii to East Africa. It's hard work, but someone has to do it!



Damselfish (*Chromis viridis*)
John E. Randall



Damselfish (*Chromis viridis*)
John E. Randall



Damselfish (*Chromis viridis*)
Richard Ling



Specimen Spotlight

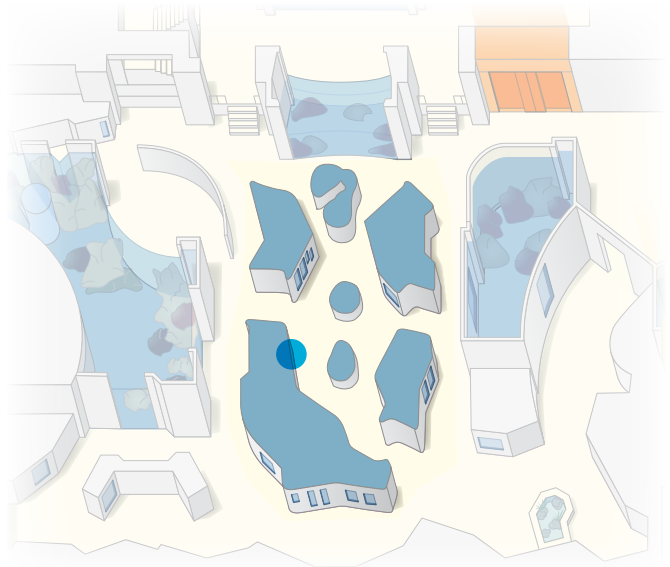
Dwarf Cuttlefish

Sepia bandensis

Finding the number of dwarf cuttlefish on display might be harder than you think! These amazing animals are masters of camouflage. Specialized cells called chromatophores allow cuttlefish to rapidly change the color and pattern of their skin to blend into their surroundings, like rocky or sandy sea bottoms or soft-coral.

While they are called “cuttlefish”, these animals are actually not fish, but are members of the class Cephalopoda, which means “head-foot”. Along with their close relatives the octopus and squid, cuttlefish can escape predators by forcing water out of their bodies to jet-propel themselves backward. Be sure to check out another member of the same class, the chambered nautilus, found in the Philippine Coral Reef Exhibit. Do you see any similar characteristics they share?

Native to Indo-Pacific waters, the dwarf cuttlefish on display are part of a captive-breeding program at the Academy’s Steinhart Aquarium. Behind the scenes, Aquarium biologists can raise hundreds of tiny hatchling cuttlefish at any given time. Establishing a stable breeding population of dwarf cuttlefish in captivity makes it easier for aquariums to showcase these remarkable animals without jeopardizing wild populations.



Richard Ross © California Academy of Sciences



Related Exhibits

Rainforests of the World

Expand your exploration of life and its connection to water in Rainforests of the World where your journey through this hot and humid environment begins on the forest floor and takes you through the different layers of a rainforest. Explore the diversity of plants and animals found in the tropical rainforests of Borneo, Madagascar, Costa Rica and the Flooded Amazon and discover how life there has adapted to the presence of abundant water and seasonal flooding typical of tropical rainforest ecosystems.

Philippine Coral Reef

Explore a tropical coral reef without getting wet in the stunning Philippine Coral Reef exhibit which focuses on the world's most diverse of marine ecosystems. The 25 foot deep, 212,000 gallon tank offers spectacular underwater views of reef algae and animals and focuses on their unique adaptations and ecological interactions.

California Coast

Dive into the underwater world of the northern coast of California which contains some of the world's richest temperate marine ecosystems. At the Discovery Tidepool in the California Coast exhibit, visitors can get up close and personal with animals of the rocky intertidal zone and learn about the adaptations they have for surviving the changing water conditions of daily high and low tides.

African Hall

Explore the wilds of Africa from its hot and dry deserts to high elevation rainforests and discover the adaptations plants and animals have for surviving in harsh conditions when water is scarce. African Hall offers an in-depth look into Africa's diverse and changing ecosystems showcasing iconic animals including lions and zebras. Five living dioramas include pancake tortoises, chameleons and the watery world of an entire colony of African penguins.



Suggested Activities to Download

Download these activities from our website to enrich your field trip experience.

» **At-Academy Activity:** [Living Fossils Scavenger Hunt](#)

<http://www.calacademy.org/teachers/resources/lessons/living-fossils-savenger-hunt/>

Through this scavenger hunt, students will observe examples of animals with evolutionarily primitive characteristics and record observations using drawings and words.

» **Connected Experience:** [Marine Invertebrate Anatomy](#)

www.calacademy.org/teachers/resources/lessons/marine-invertebrate-anatomy/

In this lesson, students will learn about invertebrate diversity and compare marine invertebrates' anatomy with that of humans'. The Connected Experience includes a classroom-based pre-activity, an at-museum scavenger hunt, and a post-activity to do back at school.

» **Anytime Lesson Plan:** [Buoyancy Bulls-Eye](#)

<http://www.calacademy.org/teachers/resources/lessons/buoyancy-bulls-eye/>

In this classroom activity, students will learn how organisms float, sink, or hover in water as they construct a neutrally buoyant scuba diver.

Be sure to review our teacher resources online!

www.calacademy.org/teachers/resources

- » **Pre-, during-, and post-visit activities:** short, lively activities to focus your class trip.
- » **Connected experiences:** Activity combinations that extend the museum visit into the classroom.
- » **Anytime lesson plans:** Full-period lessons to integrate into your yearly curriculum.



Bibliography

Want to find out more?

Here is a selection of additional resources to explore in the Academy's Naturalist Center or at your public library.

Naturalist Center staff can also answer any questions you have about this exhibit via email or phone. The Naturalist Center is located on the third floor of the Academy and is open Monday–Friday from 11AM to 4PM and Saturday–Sunday from 10AM to 5PM. 415.379.5494 / naturalist@calacademy.org

Books

- » **Deserts** by Michael George. Mankato, Minn.: Creative Education, 1992. Naturalist Center Juvenile GB612 .G46 1992
In almost coffee-table style, full color photos illustrate text about what deserts are like and what might live there.
- » **Did a Dinosaur Drink This Water?** by Robert E. Wells. Morton Grove, Ill.: A. Whitman, 2006. Naturalist Center Juvenile GB662.3 .W44 2006
A cartoon-style guide to the water cycle which emphasizes the fact that every living thing depends on water.
- » **Our World of Water: Children and Water Around the World** by Beatrice Hollyer. New York, N.Y.: Henry Holt and Co., in association with Oxfam, 2009. Naturalist Center Juvenile TD348 .H65 200947
Looks at how six children from different countries obtain and use water. Illustrates how water is essential to humans as well as the plants and animals we depend on.
- » **Seahorses** by Twig C. George. Minneapolis, MN: Millbrook Press, 2005. Naturalist Center Juvenile QL638.S9 G46 2005
Describes the unique anatomy and adaptations of seahorses and sea dragons, with great full-color photos of different species.
- » **Water Science** by Deborah Seed. Reading, Mass.: Addison-Wesley Pub. Co., 1992. Naturalist Center Juvenile QC920 .S38 1992
Comprehensive information about the water in our bodies and on our earth, with experiments and riddles to help kids really engage with the material.

Websites

- » **Fish with Fingers**
www.pbs.org/wgbh/evolution/library/03/4/1_034_03.html
A segment from PBS' evolution library which discusses the move from water to land. The evolution library has a great deal of multimedia material about adaptations.
<http://www.pbs.org/wgbh/evolution/library/01/index.html>
- » **Desert Ecology of Tucson, Arizona: Plant and Animal Adaptations to the Desert**
wc.pima.edu/Bfiero/tucsonecology/adaptations/adaptations_home.htm
Interactive information on different ways plants and animals survive in the desert. The larger site has some interesting information about desert ecology.
- » **Project Wet**
www.projectwet.org
Water education for teachers, students and parents on topics such as conservation, wetlands and ground water.



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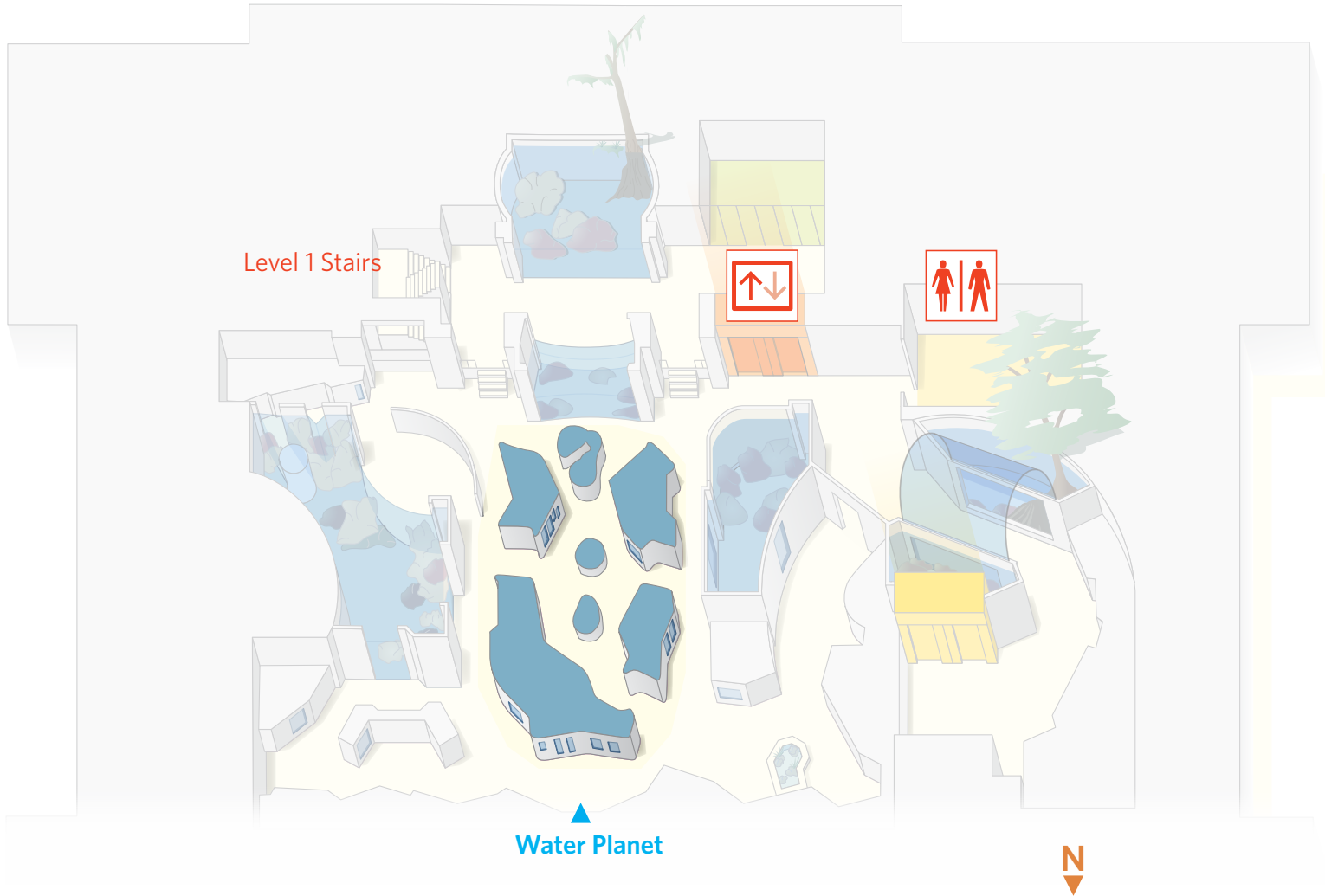
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Aquarium Map



Welcome to the Water Planet where the focus is on water and the adaptations animals have for living in and out of water.

Adaptation: *A physical characteristic or behavior that helps an organism survive and reproduce in its environment*

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