AMPHIBIANS

Powerpoint Script

2015

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Slide 1

AMPHIBIANS

Slide 2

What's so special about amphibians?

This presentation will review amphibian life cycles, physical characteristics, taxonomy, roles in ecosystems, and conservation issues. A short overview of amphibian species of Washington is also included.

Slide 3

Amphibian Life Cycle

Most people are probably familiar with the word "amphibious," which refers to the ability to live or function in water and on land, and is derived from Greek words "amphi" meaning "both" and "bios" meaning "life." "Amphibian" is the word for a class of animals, Amphibia, that literally live a double life – with a gilled, aquatic **larval** stage and, usually, an air-breathing, terrestrial adult stage.

Slide 4

"Alternative Lifestyles"

Some amphibians lead alternative lifestyles, that is, they don't spend part of their lives in water and part of their lives on land. Some species of amphibians are fully aquatic and spend their whole lives in the water and some species of amphibians are fully terrestrial, spending their whole lives on land.

Fully aquatic amphibians may or may not go through metamorphosis. Adult amphibians that do not go through metamorphosis are called "**neotenic"** adults, meaning that the adult amphibian retains some larval characteristics such as external gills. One example is the Cope's giant salamander (*Dicamptodon copei*) of western Washington, in which the larvae almost never metamorphose completely but rather live as neotenic adults. In some salamander species, such as Pacific giant salamanders (*Dicamptodon tenebrosus*), tiger salamanders (*Ambystoma tigrinum*) and Northwestern salamanders (*Ambystoma gracile*) in the Pacific Northwest, the larvae may or may not fully metamorphose into terrestrial adults depending on conditions.

Because the climate is so moist in western Washington, many species of salamanders are fully terrestrial, such as the Oregon slender salamander (*Batrachoseps wrighti*). Fully terrestrial salamanders in Washington are classified in the Plethodontidae family and are lungless. These salamanders lay their eggs on land in moist places and the young hatch as fully terrestrial juveniles, small versions of the adult form. This is referred to as direct development.

Slide 5

Ecothermic

A characteristic that amphibians and reptiles share is that they are ectothermic. Animals that are ectothermic are commonly referred to as "cold-blooded." While it is true that ectothermic animals do not have internal mechanisms to keep their blood warm (as do endothermic animals such as birds and mammals), this does not necessarily mean that their blood is cold.

Ectothermic animals rely on their external ("ecto") environment to control their body temperature. So the air, water, substrate or sunlight that an amphibian is exposed to will greatly affect the animal's internal temperature. Amphibians do have limited control over their body temperature, in that they can move short distances to different microclimates, such as sun, shade or moist areas. Their lack of ability to regulate their body temperature limits the range of habitats in which amphibians can survive. Few amphibians (or reptiles) live in extremely cold environments such as the arctic tundra or mountaintops.

Amphibians have some interesting ways of coping with freezing conditions:

- "antifreeze" in blood (usually a form of glucose) which protects the cells
- hibernation, often underground, or
- protective "cocoons" of shed skin and mucous.

Slide 6

Amphibian Eggs

Most amphibians hatch from eggs laid in water or in moist areas. Amphibian eggs, unlike reptile and bird eggs, lack protective shells to retain moisture. Thus, amphibian eggs must remain in water or in very moist areas so that they do not dry out. The eggs do, however, include a large yolk that serves to nourish the embryo and a gelatinous coating which supports the eggs, can stick the eggs to substrates such as plants, and protects the eggs from damage.

Like fish, amphibians usually lay their eggs in water in order to prevent the eggs from drying out. Some amphibians lay their eggs on land in moist areas. Most frog and toad eggs are fertilized externally. In this process, the female releases the eggs and then the male, who is on the female's back clasping her, releases sperm over the eggs. In amphibians, the clasping of the female by the male during fertilization is termed **amplexus**. One species of frog in the Pacific Northwest, the tailed frog (*Ascaphus truei*), employs internal fertilization by way of a modified **cloaca** (hence the name "tailed" frog), which the male uses to deposit sperm in the female.

In most salamanders, fertilization is internal. The male deposits a small packet of sperm, called a **spermatophore**, on the ground and the female salamander picks it up with her cloaca. In a few families of salamanders, the eggs are externally fertilized by the male as they are being laid by the female. Fertilization is also internal for the caecilians. Male caecilians posses an organ, called the **phallodeum**, which is used to deposit sperm inside the female.

Slide 7

Amphibian Skin

Most amphibians have smooth skin, composed of an inner dermal layer and outer epidermal layer of dead cells, which does not grow scales, hairs or feathers. Amphibians have very permeable skin, meaning liquids and gases can easily pass across the skin cells into the body. The skin is an important organ for amphibians. Adult amphibians breathe through their skin in addition to, and in some lungless species of amphibians, in place of, their lungs. (All of the fully terrestrial salamanders in Washington state are lungless.) Amphibians do not have diaphragm muscles to expand and contract their lungs, but use movements of their mouths for the intake and exhalation of air. Gas exchange through the skin supplements this shallow breathing.

Gland cells in the skin of amphibians produce mucus, which helps to keep the skin moist, enabling the passage of gases across the skin. Other gland cells in the skin produce poisons, ranging from mild to deadly (in only a few species), that provide defense against predators. Amphibians also rely on their skin to absorb water, as they do not usually drink water through their mouths. Because their skin is so permeable, amphibians are particularly vulnerable to environmental toxins.

Amphibians shed their skin, as do reptiles, but amphibians usually eat their shed skin so you don't see their skin sheds as you do with snakes. In contrast to amphibian skin, reptile skin is scaly, not permeable and not glandular.

Slide 8

Order Gymnophonia: Caecilians

Not a whole lot is known about caecilians, most likely due to their burrowing, nocturnal habits. Very few studies have been conducted in the wild on their behavior or breeding. Caecilians are legless amphibians that resemble worms, mainly due to the rings along their bodies that look like segments. These animals range in length from approximately 5 inches (12.5 cm) to approximately 4.5 feet (1.4 m). Caecilians usually lack tails, though some species have very short tails, and, in most species, the eyes are covered with skin or with bone and skin, thus rendering them useless for vision. Caecilians do, however, have a unique sensory organ: a tentacle located between the eye and the nostril on either side of the head. These tentacles are used as olfactory (smell) and tactile (touch) receptors.

Caecilians generally live underground, though some species are aquatic, in tropical areas of Mexico, Central and South America, sub-Saharan Africa, India and Southeast Asia. Most caecilians are thought to be predators, feeding on animals such as earthworms and, in some regions, small burrowing snakes.

Slide 9

Order Anura: Frogs and Toads

Anurans are the most widespread of all amphibians. They are found throughout the world (except for polar regions), with a very high diversity of species in the tropics.

Slide 10

Frog and Toad Characteristics

In frogs and toads, the larvae are tailed but legless, and the adults are tailless but have two pairs of legs, the hind legs being longer than the fore legs. Anurans' modes of locomotion, hopping or leaping, and the physical adaptations to do these actions, are characteristics that set this order of amphibians apart from the other two orders. Although there is no scientific distinction between frogs and toads, frogs generally have smooth skin, live in water and have very long hind limbs adapted for leaping; while toads usually have drier, warty skin; live on land and have shorter hind limbs that are better adapted for hopping.

Most frogs lay eggs in water or in moist places on land – these are the oviparous species. In most species, these eggs hatch into tadpoles, aquatic larvae that eventually metamorphose into adults. Tadpoles are usually herbivorous, but some species are carnivorous, eating a variety of small invertebrates and sometimes eggs or larvae of other amphibians. Adult frogs and toads are carnivorous.

Frogs, unlike caecilians and salamanders, possess vocal cords and are able to produce a variety of sounds. Given that, it is not surprising that frogs also possess eardrums and have much better auditory perception than caecilians or salamanders, which make only quiet clicking and squeaking sounds and lack eardrums. Male frogs often attract mates by calling and also warn other males to stay away with territorial calls. In some species, both males and females may emit distress calls when a predator apprehends them.

Slide 11

Order Caudata: Newts and Salamanders

Salamanders are set apart from other amphibians by the presence of a tail in all life stages and by two pairs of limbs of approximately equal size, with the exception of the Sirenidae family, which lack hind limbs.

These amphibians mainly inhabit northern temperate regions of the earth; in the Americas north of tropical Mexico, Europe, extreme northwestern Africa, and Asia north of the Himalayas; though one family, the Plethodontidae extends into Central and South America. The greatest diversity of salamander species occurs in North America, with the Pacific Northwest hosting a large number of species, some found nowhere else in the world. In some areas of the Pacific Northwest, up to eleven different species of salamanders may coexist.

Salamanders are adapted to cool, moist climates with many species being primarily nocturnal. Terrestrial species are commonly found under rocks, logs or leaves and aquatic species generally rest at the bottoms of streams or ponds under stones or in other protected areas. The activity level of these amphibians varies with the seasons, usually with one period of high activity, but this depends on the species. Salamanders generally prey on arthropods and other invertebrates, from small to large ones depending on the size of the salamander, but may also feed on other amphibians or on small snakes.

Slide 12

Some Amphibians of Washington

<u>Pacific treefrog</u>

- Probably most common frog in PNW
- Quite variable in color
- Sticky pads on toes for climbing
- Breed between Feb and June (depending on elevation)
- Males chorus loudly during breeding season

Slide 13

Red-legged frog

- Inhabit moist forests and forested wetlands
- lay eggs in cool, shaded ponds or edges of lakes

Cascades frog

- Inhabit mountain meadows and moist forests
- lay eggs in sunny ponds at high elevations

Slide 14

Northern leopard frog

- Listed as endangered in WA; found in eastern WA
- Many factors have potentially contributed to the decline in leopard frog populations in WA
    - habitat alteration
    - disease
    - agricultural chemicals
    - introduced fish and bullfrogs

Tailed frog

- Live in cool, fast-flowing streams – thus, external fertilization would be ineffective. Internal fertilization is a necessity
- Males have a tail that is a modified cloaca – used for internal fertilization
- The two tailed frog species (the coastal tailed frog and the Rocky Mountain tailed frog) are the only members of the family Ascaphidae and are considered the most primitive frogs in the world
- Tadpoles use mouths to suction themselves onto rocks

Slide 15

Western redback salamander

- Common salamanders in western WA.
- Inhabit forests, can be well away from water. Usually under rocks or logs.
- Salamanders – external fertilization, courtship ritual then male deposits spermatophore, female picks it up with her cloaca.
- Plethodon = family of lungless, terrestrial salamanders. Intake oxygen through skin and lining of mouth.
- Direct development – common in terrestrial species of lungless salamanders in the PNW – young complete metamorphosis while inside the egg. Hatch out as fully-formed (sexually immature) terrestrial juveniles.

Olympic torrent salamander

- inhabit cold, moving waters of mountainous areas of the Olympic peninsula

Slide 16

American bullfrog

An introduced species with big impacts!

In Washington state, and in other western states, a non-native species that is having major impacts on native amphibians (and other species) is the American bullfrog (*Rana catesbeiana*). Bullfrogs were introduced to the western United States from the eastern United States in the early 1900s. Bullfrog legs were sought after for food and the introduced bullfrogs were hunted as game. Bullfrogs are large frogs, up to 7 inches (17.5 cm) long or even longer, and are voracious predators, eating the young of other amphibians, reptiles, and even waterfowl. It is widely believed that in Washington state, bullfrogs have been a factor in the decline of western pond turtles (*Actinemys marmorata*), Oregon spotted frogs (*Rana pretiosa*) and possibly even northern leopard frogs (*Rana pipiens*).

Scientists are now also researching the potential role of American bullfrogs in the spread of the chytrid fungus. It has been found that American bullfrogs, which have also been introduced to many other countries around

the world, carry the chytrid fungus everywhere they are found, apart from Japan. Bullfrogs are not susceptible to the disease the fungus causes, but they do carry the fungus and may assist in its spread.

Slide 17

The role of amphibians in ecosystems

Amphibian larvae, by feeding on organic debris, aid in the decomposition of organic matter. Some larvae also feed on algae, controlling the growth and spread of the algae. Although they might not be commonly observed, amphibians are major players in many ecosystems. Amphibians are an important link in the food chain of many habitats – many of the larger vertebrates that eat amphibians do not eat invertebrates, so amphibians provide the link to transfer energy from invertebrates to larger vertebrates.

In the forests of the Pacific Northwest salamanders can be very densely distributed on the forest floor, in some cases having a total biomass greater than that of many other vertebrate animals in the forests. All of these salamanders consume a huge number of invertebrates.

Slide 18

Amphibians as indicators of ecosystem health

As described earlier, amphibians are particularly vulnerable to environmental toxins (such as chemicals in fertilizers, weed and pest killers and detergents) because their skin and eggs are so permeable. Amphibian eggs can dry out if water levels drop and the developing embryos can be affected by ultraviolet radiation. Due to these and other sensitivities, amphibians are often among the first animals to suffer if wetlands are altered. If amphibian populations in wetlands fail, it is in indicator that other animals that depend on wetlands may also be at risk if action is not taken to protect these habitats.

Many species of amphibians depend on wetlands to provide for their basic needs: food, water, air, shelter and space. As human activities have reduced and degraded wetlands, amphibians have become environmental indicators of just how much wetlands habitat and the living organisms that depend on them can handle.

Slide 19

Biomagnification

Biomagnification, or bioaccumulation, is one way that pollution can affect species. Biomagnification refers to the accumulation of chemical toxins in the fatty tissues of animals and the magnification of these toxins at each step up in the food chain. Pesticides and other toxins are stored in the fatty tissues of animals that inadvertently consume them and are passed up the food chain in higher and higher concentrations.

Illustration: The tadpoles in this illustration represent amphibian larvae. Fish consume the larvae and the toxins that the larvae have taken in with their diet of organic matter. Because the fish eat many larvae, they consume a high level of toxins. Great blue herons then consume the fish, receiving all of the toxins originally ingested by the amphibian larvae and concentrated in the fish.

Slide 20

What are they trying to tell us? Amphibian Population Decline

In 1989, amphibian scientists from across the globe came together for a meeting, the First World Congress of Herpetology, and realized that amphibian populations were in serious decline in many parts of the world. Since that time, scientists have conducted many studies on the various factors that may be contributing to the worldwide decline of amphibians.

The World Conservation Union (IUCN) status report on amphibian conservation in 2008 showed that 42% of the 6,260 known amphibian species are declining in population. 159 species are believed to already be extinct. This is the largest species extinction rate since that of the dinosaurs 65 million years ago.

Habitat destruction (of wetlands and forests) has been a major factor in the decline of many species. However, worldwide declines have also been documented in populations inhabiting areas not directly affected by human activity. Many scientists are actively researching this topic and attempting to understand what kinds of global

changes could be resulting in the disappearance of so many species of amphibians. Some of the contributing factors that have been identified include:

- introduced species
- global climate change (including increased UV-B radiation)
- diseases and pathogens (esp. chytrid fungus)
- environmental toxins, such as pesticides

It is most likely that some combination of these factors has mounted to an overall environmental problem for frogs and other amphibians. Factors that pose major threats to amphibian survival in some areas may not be present in other areas. So it is difficult to determine with certainty exactly why amphibian populations have been declining worldwide and what is causing so many frogs to be deformed. The fact that amphibians are suffering is an indicator of possible environmental problems that could affect other species, including humans.

Not one factor has been singled out as "the" cause of recent declines in amphibian populations, however a disease caused by a chytrid fungus has been implicated in numerous declines across the globe. In 1999, a new species of chytrid fungus was identified that infects and causes a fatal disease, called chytridiomycosis, in amphibians. Chytrid fungus is a rapidly spreading infectious disease that can prove lethal for many amphibians. Thus far, chytrid fungus has been identified in association with amphibian declines in frogs, toads, newts and salamanders on every amphibian-inhabited continent.

Chytrid fungus is the current focus of amphibian conservation, as it is the most pervasive disease currently affecting amphibians worldwide. The disease is thought to have originated in a South African species of frog, the African clawed frog (*Xenopus laevis*), and was initially spread by commercial trade in this species (for laboratories and pet stores). Following that initial spread, the disease may have dispersed via waterways and through direct contact between amphibians. Scientists are now studying how chytrid fungus can be controlled or how infected amphibians might be treated. In addition, the Association of Zoos & Aquariums (AZA) is calling on its members to participate in a global response to this unprecedented conservation crisis by raising public awareness and breeding endangered frog species in captivity for eventual release back into the wild. This is essential for the survival of many species and will buy time to respond to threats in the wild.

Chytrid fungus may be a potential threat to the Oregon Spotted Frog, an endangered species native to the Pacific Northwest. Also in the Pacific Northwest, UV-B radiation has been shown to affect the survival of embryos of several species, such as the western toad (*Bufo boreas*) and Cascades frogs (*Rana cascadae*). Other species, most notably the Pacific treefrog (*Pseudacris regilla*), are resistant to the damaging effects of UV-B radiation due to high levels of an enzyme that removes the defects caused by the radiation. So increasing levels of UV-B radiation hitting the earth due to thinning of the earth's ozone layer could be affecting the survival of some species of amphibians.

Slide 21

What you can do:

The following list provides some suggestions of opportunities for teachers and students to be engaged in amphibian conservation—these opportunities represent a range of actions, each of which contributes to addressing the threats facing amphibians in our own backyards and around the globe. Some of these suggestions are simple daily choices, other suggestions involve more time and commitment, but any of these choices or actions will help to ensure that the diversity of amphibians on our earth will survive into the future.

We encourage teachers to consider these actions and select one or two to start with that connect with your curriculum, the resources available to your school and to your and your students' interests. Every effort counts!

- Participate in wetlands habitat restoration
- Make schoolyards and backyards "frog friendly"
- Participate in FrogWatch or other monitoring programs
- Be a responsible pet owner
- Minimize pollution
- Raise amphibian awarenessRaise funds for amphibian conservation projects

As we learn about amphibians, their characteristics and their roles in the environment, we also become more aware of our own roles in the environment. What is the global decline of amphibians really telling us? What can we do about it? What choices can we make that will lessen our negative impacts on amphibians and the environment as a whole?

- Participate in wetlands habitat restoration

Participate in, or initiate, a wetland restoration project. Grants are often available for habitat restoration projects from state agencies, county departments or public utilities.

- Make schoolyards and backyards "frog friendly"

Native plants are important because by choosing plants already suited to the site conditions, little maintenance, chemical fertilizers, herbicides, or additional watering will be necessary for the plants to thrive. Also, according to the National Wildlife Federation, native plants may support 10 to 50 times as many species of native wildlife as non-native plants. Shelter boxes can help birds, bats and bees find the shelter they need to raise young or survive the winter.

Remember that due to western Washington's proximity to lakes, rivers and Puget Sound, your schoolyard and backyard habitat can affect local wetlands and marine habitats. Mulch is both a great fertilizer and weed deterrent. If you keep your plants healthy, they can survive minor plant damage from insects. Fertilizer, herbicides and pesticides can create huge problems for sensitive species such as amphibians.

- Participate in FrogWatch or other monitoring programs

Participate in National Wildlife Federation's FrogWatch program: www.frogwatch.org or look for other amphibian monitoring opportunities in your local area.

- Be a responsible pet owner

It's important to keep pets indoors. Wild animals frequently come into contact with pets allowed to run free. Millions of birds, small mammals, reptiles and amphibians are killed by cats and dogs. Pets can cause indirect and direct harm to wildlife, and can themselves be injured by wild animals.

Pet waste can be extremely harmful to all wildlife. Cat feces often contain a parasite that reaches waterways by storm runoff or through the sewer system. These parasites are ingested by filter feeders such as shellfish, which are in turn eaten by many different animals. This parasite causes toxoplasmosis, a disease fatal to birds, reptiles, amphibians and marine animals such as sea otters.

- Minimize pollution

Buying unbleached paper and using phosphate-free detergents are also important for improving water quality in urban areas. The manufacturing of bleached paper often results in the release of toxic chemicals into the waste stream. Phosphates encourage algal growth, which can suffocate aquatic life.

- Raise amphibian awareness

Educate yourself about the characteristics and habitat needs of local species of amphibians. By doing so, you can better understand how to lessen your own impact on these species.

Hold an Amphibian Awareness Fair for students and their parents (at school or in the community).

- Raise funds for amphibian conservation projects

Woodland Park Zoo, as a member of the Zoo & Aquarium Alliance of the Pacific northwest, is working collaboratively to save the Oregon spotted frog. Support this effort by making a donation to Woodland Park Zoo directed to Conservation/Education: https://www.zoo.org/donate.

Slide 22

Photo credits

VOCABULARY

Amplexus: mating embrace of amphibians. The male clasps the female either around the waist or chest during courtship and/or when the eggs are being released by the female and fertilized by the male.

Arthropod: the phylum, Arthropoda, of invertebrate animals characterized by a hard exoskeleton and jointed appendages. Arthropods include insects, spiders, millipedes, centipedes and crustaceans.

Brilles: transparent scales covering the eyes of snakes.

Carapace: the upper (dorsal) portion of a turtle's or tortoise's shell.

Carnivorous: refers to an organism that catches and consumes animals.

Cloaca: an internal receptacle that collects excretory and reproductive products. These products are passed through an opening of the cloaca called the vent or anus.

Crocodilian: a member of the order Crocodylia, which includes crocodiles, caimans, alligators and the gharial.

Detritus: matter (plant, animal or mineral) in the process of decaying or breaking down. Animals that feed on detritus eat decaying plant or animal matter.

Direct development: the process of development in which the young complete the larval stage within the egg (inside or outside the mother's body) and are born or hatch as fully-formed, small adults.

Ectothermic: dependent on the outside environment to regulate internal body temperature.

Estivation: a state of lowered body functions, such as metabolism and breathing, that occurs during hot, dry weather conditions.

Hemipenes: the paired copulatory organs of male snakes and lizards.

Herbivorous: refers to an organism that relies on plant matter for nutrition.

Herpetology: the study of reptiles and amphibians.

Jacobson's organs: a pair of small organs located in the roofs of the mouths of reptiles and amphibians that respond to chemical stimuli, such as smells and tastes. Also called vomeronasal organs.

Larval: refers to the early developmental stage of an animal that is physiologically unlike the adult form. The animal must complete metamorphosis before it takes on the adult form.

Metamorphosis: an abrupt change in physical form or structure that occurs between developmental stages (larval and adult) of some animals.

Neoteny: the retention of larval characteristics in the sexually mature, adult stage.

Oviparous: refers to animals in which the young develop in eggs that are laid and hatched outside the body of the mother. The eggs are laid before any significant development of the embryo has occurred. In amphibians, larvae may hatch from these eggs at any stage of development, from undeveloped larvae to fully metamorphosed, small adults (direct development).

Ovoviviparous: refers to animals in which the young develop in eggs that are carried within the body (or in some species of amphibians, in a skin pouch or on the back) of the mother. Nourishment is provided by a yolk, not directly from the mother. Eggs developed in this manner may hatch just before or immediately after exiting the mother's body. In amphibians, larvae may hatch from these eggs at any stage of development, from undeveloped larvae to fully metamorphosed, small adults (direct development).

Parthenogenesis: reproduction in which an unfertilized, often female, egg develops into adulthood. In some species, individuals produced through parthenogenesis are genetically identical to their mothers and to their parthenogenically-produced siblings. In other species, limited genetic rearrangement occurs.

Phallodeum: the copulatory organ of male caecilians.

Plastron: the lower (ventral) portion of a turtle or tortoise's shell.

Scute: a large, horny scale of a reptile, such as the plates of a turtle or tortoise's shell.

Spermatophore: a packet of sperm deposited by a male and taken into the reproductive tract by a female, as in external fertilization of salamanders.

Viviparous: refers to animals in which the young do not develop within eggs but are directly nourished by the mother inside her body and are born as fully-metamorphosed, small adults.

Vomeronasal organs: see "Jacobson's organs".