BACKGROUND INFORMATION FOR TEACHERS

WHAT IS HERPETOLOGY?

Herpetology is the scientific study of reptiles and amphibians. The name comes from the Latin root word "herp" which means "to creep." Reptiles and amphibians are not closely related (they last shared a common ancestor over 300 million years ago), but it is a historical convention to keep the two groups lumped together, despite their vastly different biologies. This educational kit covers only amphibians and their conservation.

WHAT IS AN AMPHIBIAN?

Amphibians are vertebrate animals that live part of their life cycle on land and part in the water. Their skin is permeable to oxygen and water, which allows them to breathe and absorb water through their skin. This skin is usually moist and mucous-covered. Most amphibians require water for reproduction through external fertilization (eggs are released into water, then sperm released into water nearby). The eggs are jelly-like and must remain moist to allow development of the larvae (in salamanders and caecilians) or tadpoles (in frogs and toads). Most amphibians undergo metamorphosis, or a dramatic change in body form. Tadpoles will lose their tails and gills, and grow four legs and lungs. Salamander and caecilian larvae will lose their gills and grow lungs, but otherwise do not change body shape. Alternatively, some amphibians develop directly from an egg to a juvenile stage that looks just like the adult, completely "skipping" the tadpole stage of development (Example: plethodontid salamanders, cocqui frogs).

Amphibians have multiple forms of respiration, depending on their life stage, as well as where they live:

- Gills: Fully aquatic amphibians breathe using gills, whether they are juveniles or adults.
- Lungs: Most adult amphibians live on land and breathe air via lungs.
- Skin (cutaneous respiration): Most amphibians have the ability to undergo respiration directly through pores in the skin. This requires the skin to remain moist. Some amphibians breathe only using this method (Example: plethodontid salamanders).
- Mouth (buccal breathing): Some adult frogs will undergo respiration via diffusion in/out of the capillaries in the mouth. This allows them to obtain oxygen while sustaining long/complicated calls to attract a mate.

Classification of Amphibians:

- Class Amphibia:
    - Order Caudata (salamanders): These are amphibians that have four limbs and a tail throughout their life. Some fully aquatic salamanders have reduced limbs or have lost one set of set of limbs (Example: sirens). Found in North and South America, Europe, and Asia.
    - Order Anura (frogs, toads): These amphibians also have four limbs. With the exception of one group of frogs (Family Ascaphidae), they do not have tails as adults. Their bodies are modified for jumping, with long back limbs. Note: toads are just a type of frog that are more adapted to an adult life on land and have warty skin. Found all over the world, except Antarctica.
    - Order Gymnophiona (caecilians): These are a little-known group of amphibians that live underground, have no limbs, and have greatly reduced eyes. Many people have mistaken them for worms. They are found only in moist, tropical areas of the world.

WHAT IS CAUSING WORLDWIDE AMPHIBIAN DECLINES?

The earth contains over 7,000 known species of amphibian, with approximately 30–40% that are threatened or endanger of extinction (see IUCN red list for more infomation: http://www.iucnredlist.org). This decline is the result of a combination of several threats to their existence (see also: http://amphibiaweb.org/declines/declines.html).

- Habitat change, reduction, or fragmentation – This is a problem worldwide, but particularly in the developing nations in tropical parts of the world, where amphibian diversity is high.
- Over-exploitation

    - Pet trade – This is a very lucrative business, particularly with the poison arrow frogs. Their trade is now controlled and restricted, but has not stopped.
    - Food – Historically, frogs all over the US were caught to be eaten for their muscular legs. Now, bullfrogs are often bred for this purpose, but that can still cause other problems (see Introduced Species below).
    - Education – Frog dissections! Most commonly, this is done on leopard frogs and bullfrogs, and includes mainly wild-caught individuals.
- Introduced species – Non-native species can have drastic effects on native species if they pose a competitive or predatory threat (Example: rainbow trout, bullfrogs)
- Climate change – Temperature changes can cause both direct and indirect effects on amphibians. Directly, it causes many frog species to breed earlier in the sprin, however, for those species that cannot breed earlier, they are quickly outcompeted for resources. Indirect effects can be seen in droughts, ponds drying more quickly (leaving less time to undergo metamorphosis), and more UV radiation. See also chytridomycosis below.
- Chytrid fungal disease – Chytridomycosis or "chytrid" is a fungal disease that infects mouthparts (in tadpoles only) and the skin of amphibians, making it more difficult to eat or undergo cutaneous respiration. In extreme cases, the skin thickens and comes off the body, which will not allow the amphibian to breathe through it or balance their water levels, leading to death. This is a contagious disease that can be spread from frog to frog in the water and even through human contact (i.e. through aquatic recreation activities). The chytrid fungus spread more readily in warmer climates, which means that increases in global temperature can facilitate disease spread to new, previously cold, parts of the globe.
    - There are two forms of virulent chytrid: *Batrachochytrium dendrobatis* (*Bd*) infects frogs and salamanders and *Batrachochytrium salamandrivorans* (*Bs* or Bsal) infects only salamanders. *Bd* has been found in amphibians on every continent, but has had the most drastic effects in North and South America; *Bs* is currently only found in Asia and Europe.
    - See also: http://amphibiaweb.org/chytrid/chytridiomycosis.html.
- Ranaviruses – These are a suite of *iridoviruses* that can infect all amphibians, plus other aquatic organisms such as fish and turtles. They are an envelope virus, but are able to infect hosts even without the envelope. Research indicates that they could remain viable in water, without a host, for up to one month. Frogs and salamanders are most susceptible to ranavirus while they tadpoles, larvae, or metamorphs. The symptoms include lethargy (which can lead to increased predation likliehood), hemorrhaging, and eventually death. See also: http://www.nwhc.usgs.gov/disease_information/other_diseases/ranavirus.jsp.
- Chemical contamination of water
    - Pesticides – Many pesticides contain neurotoxins that can affect more than just the target animal (insects). Herbicides, such as atrazine, contain an endocrine disrupter which can cause some amphibians to undergo reproductive pathway changes (feminization of males or hermaphroditism).
    - Heavy metals – Metals such as aluminum, lead, mercury, cadmium, silver, arsenic, etc. become prevalent in the water due to agricultural and industrial run-off. These can lead to deformities and low larval/tadpole survival.
    - Acids – A low pH in water can alter or halt development of the embryos in the eggs (because the eggs are jelly-like, anything in the water enters them). Also, heavy metals are dissolved in water more readily at low pH.
    - Nitrogen – Agricultural fertilizers are full of nitrogen products such as nitrate, nitrite, and urea. Studies have shown these chemicals to cause behavioral changes in frogs, such as reduced feeding and swimming, plus deformities.