44.2C: Temperature and Water

Temperature and water are important abiotic factors that affect species distribution.

Learning Objectives

• Describe species adaptations to temperature fluctuations and the availability of water

Key Points

• Temperature is a factor that influences species distribution because organisms must either maintain a specific internal temperature or inhabit an environment that will keep the body within a temperature range that supports their metabolism.
• Many species have developed adaptations, such as migration, hibernation, and estivation, to deal with temperature fluctuations in the environments in which they live.
• Water retention is vital to all living beings; adaptations have evolved within both terrestrial and aquatic species to minimize water loss.

Key Terms

• osmosis: The net movement of solvent molecules from a region of high solvent potential to a region of lower solvent potential through a partially permeable membrane
• estivate: to go into stasis or torpor in the summer months
• extremophile: an organism that lives under extreme conditions of temperature, salinity, etc; commercially important as a source of enzymes that operate under similar conditions
• **torpor**: a state of being inactive or stuporous
• **hibernation**: a state of inactivity and metabolic depression in animals during winter

## Temperature & Water as Abiotic Influences

### Temperature

Temperature affects the physiology of living things as well as the density and state of water. It exerts an important influence on living organisms because few can survive at temperatures below 0 °C (32 °F) due to metabolic constraints. It is also rare for them to survive at temperatures exceeding 45 °C (113 °F). This is a reflection of evolutionary response to typical temperatures. Enzymes are most efficient within a narrow and specific range of temperatures; enzyme degradation can occur at higher temperatures. Therefore, organisms must either maintain an internal temperature or inhabit an environment that will keep the body within a temperature range that supports metabolism. Some animals have adapted to enable their bodies to survive significant temperature fluctuations, as seen in hibernation or reptilian torpor. Similarly, some bacteria have adapted to survive in extremely-hot temperatures found in places such as geysers. Such bacteria are examples of extremophiles: organisms that thrive in extreme environments.

Temperature can limit the distribution of living things. Animals faced with temperature fluctuations may respond with adaptations, such as migration, in order to survive. Migration, the movement from one place to another, is common in animals, including many that inhabit seasonally-cold climates. Migration solves problems related to temperature, locating food, and finding a mate. In migration, for instance, the arctic tern (*Sternula paradisaea*) makes a 40,000 km (24,000 mi) round trip flight each year between its feeding grounds in the southern hemisphere and its breeding grounds in the Arctic Ocean. Monarch butterflies (*Danaus plexippus*) live in the eastern United States in the warmer months, but migrate to Mexico and the southern United States in the wintertime. Some species of mammals also make migratory forays: reindeer (*Rangifer tarandus*) travel about 5,000 km (3,100 mi) each year to find food. Amphibians and reptiles are more limited in their distribution because they lack migratory ability. Not all animals that can migrate do so as migration carries risk and comes at a high energy cost.

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**Figure (PageIndex(1)): Arctic tern**: The arctic tern is an example of a species that must migrate yearly to deal with temperature fluctuations that exist in the regions where it is found.
Some animals hibernate or estivate to survive hostile temperatures. Hibernation enables animals to survive cold conditions, while estivation allows animals to survive the hostile conditions of a hot, dry climate. Animals that hibernate or estivate enter a state known as torpor, a condition in which their metabolic rate is significantly lowered. This enables the animal to wait until its environment better supports its survival. Some amphibians, such as the wood frog (*Rana sylvatica*), have an antifreeze-like chemical in their cells, which retains the cells’ integrity and prevents them from bursting.

![Wood frog](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/44%3A_E…)  
**Figure 1**: Wood frog: The wood frog, like all other amphibians and reptiles, cannot migrate; as a result, the species survives extreme temperature changes through the antifreeze-like chemical found in their cells.

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### Water

Water is required by all living things because it is critical for cellular processes. Since terrestrial organisms lose water to the environment by simple diffusion, they have evolved many adaptations to retain water.

Examples of adaptations used by terrestrial and aquatic species include the following:

- Plants have a number of interesting features on their leaves, such as leaf hairs and a waxy cuticle, that serve to decrease the rate of water loss via transpiration.
- Freshwater organisms, surrounded by water, are constantly in danger of having water rush into their cells because of osmosis. Many adaptations of organisms living in freshwater environments have evolved to ensure that solute concentrations in their bodies remain within appropriate levels. One such adaptation is the excretion of dilute urine.
- Marine organisms are surrounded by water with a higher solute concentration than the organism and, thus, are in danger of losing water to the environment because of osmosis. These organisms have morphological and physiological adaptations to retain water and release solutes into the environment. For example, marine iguanas (*Amblyrhynchus cristatus*) sneeze out water vapor that is high in salt in order to maintain solute concentrations within an acceptable range while swimming in the ocean and eating marine plants.
Figure 1: **Marine iguanas**: Marine iguanas have a special, salt-secretion adaptation that allows them to minimize bodily water loss.