



## **WAVE on Wheels Outreach**

### **Penguin Presentation**

**Grades 9 – 12**

#### **Time requirement**

1 Hour

#### **Group size and grade**

Up to 50 students maximum

#### **Materials**

1 African Penguin

Penguin Artifacts Bin

Penguin Emergency Backpack

Penguin Pedestal

WAVE Tablecloth

#### **Goal**

Through a live penguin encounter, students will be excited, engaged, and educated about the wonders of aquatic life and the importance of conservation.

#### **Objectives**

1. Students will be able to list 5 adaptations a penguin has for aquatic life including a combination of internal and external body parts as well as behaviors.
2. Students will be able to define natural selection and discuss its effects on penguin adaptations.
3. Students will be able to list at least 5 species of penguin and identify that some penguins live in warm environments.

4. Students will be able to discuss biological factors relating to penguin population numbers, individual growth rates, and reproductive success.
5. Students will be able to discuss social behavior strategies among penguins.
6. Students will be able to discuss penguin conservation efforts as well as how they can help save penguins and other aquatic animals.
7. Students will be able to design and describe a method for monitoring and minimizing human impacts on penguin environments.

## **Theme**

Penguins are unique aquatic birds that play an important role in their environment.

## **Kentucky Core Academic Standards – Science**

### **HS. *Interdependent Relationships in Ecosystems***

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

### **HS. *Natural Selection and Evolution***

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

LS4.C: Adaptation

### **HS. *Human Sustainability***

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

ESS3.C: Human Impacts on Earth Systems

## **Background**

### ***Penguin Adaptations as Aquatic Birds***

Penguins fly differently than other birds: not in the sky, but underwater, and can swim up to 12 mph. Due to the small muscles at the base of their feathers, which bind them closely to their bodies, penguins are considered waterproof. To reinforce their waterproof coat, the feathers are covered in a waxy substance that repels water. This substance is secreted at the base of the tail and distributed throughout the coat during preening. Flighted birds have hollow, light-

weight bones that create a lighter body to increase flying ability. Penguins, on the other hand, have heavy, thick bones which are durable enough to withstand propulsion while swimming. Penguins, like other aquatic birds, also have webbed feet for better locomotion in the water.

Penguins have several unique adaptations that help them survive in their environment. Penguins are black on the back and white on the front, which is observed as a type of camouflage known as countershading. Countershading aids many aquatic animals, including sharks, as they are more difficult to see considering their light undersides blend in with the sunlight if a predator is looking up from below. If a predator is looking down from above, the darker upper body of the penguin blends in with the ocean depths which are black as sunlight completely dissipates. Penguins also have excellent eye sight for above and below water. They possess an extra eyelid, called a nictitating membrane, that functions similar to underwater swim goggles. Penguins are not just good swimmers, but also good divers. Emperor penguins hold the record of diving to depths of over 1,700 feet and holding their breath for more than 11 minutes. At these depths, the pressure on their body and internal organs is 40 times the amount of pressure at the surface. Studies have hypothesized that penguins avoid low-oxygen problems and nitrogen narcosis, where nitrogen painfully enters the blood, by diverting blood flow to only essential organs.

In recent years, the African penguin population has been in decline to the point of claiming the title as an endangered species. Many factors have contributed to the decline of the population, inhibiting growth and development. Examples include but are not limited to: guano depletion, as it has been collected for commercial exploitation, forcing the penguins to relocate their nesting sites; egg collection for human consumption; and shifting fish stocks, as overfishing continues to be a prevalent environmental issue. These various factors have affected the individual and population growth of the African penguin species. Being forced to adapt to alternate environments with the possibility of an alteration in their primary diet may also result in genetic variations within these individuals.

Penguins are among the most social species of bird. All 18 species live in large groups, or rookeries, that may include thousands of individuals. These large groups allow penguins to survive in the harshest environments as they huddle to stay warm. Large hunting groups and migration groups also reduced predation. Typically, at the first sign of danger, young members of the group are moved into the middle of the group giving them the most protection and greatest survival rates. Unlike elephants and many other social animals, penguins do not have a group leader for the colony. However, there is some evidence there are levels of dominance in the group. Within these large groups, individual family units are able to locate each other, as each penguin has a distinct vocalization. Family units spend much time together feeding, sleeping, and cooperatively preening. Since a penguin cannot reach all feathers on its body, a preening partnership allows all feathers to stay in prime condition and strengthens the social bond.

The African penguin is mostly a monogamous species, meaning they remain with one partner throughout their life, unless extenuating circumstances, such as predation, occur. They breed in colonies on rocky shores, which serve as strategic places to avoid predation, and return to the same breeding and nesting site each year. The African penguin has an extended breeding period which allows them to breed throughout the year, peaking in reproduction during various times depending on the region. Incubation of the eggs is a responsibility shared by both parents, a benefit that encompasses the shared conservation of energy and risk of predation for each other, but a constant level of protection for the offspring. Each parent is equipped with an incubation pouch to keep the eggs at a constant temperature. Eggs hatch asynchronous, or not at the same time, usually being about a day or two apart. A penguin hatchling grows very quickly, reaching full size in about two months; however, maturation with adult plumage does not occur until a year later. Parent penguins remain as a safeguard to their young for the first month of their life, after which they only remain dependent on their parents for food for a continued duration of two more months before becoming completely independent.

### *Penguin Diets*

African penguins are carnivorous birds which feed on a variety of fish, such as herring, anchovies, sardines, and occasionally smaller crustaceans and squid. Their tongues are armed with sharp, backward-facing barbs that prevent prey from escaping. They can eat about 1 pound of food per day, or about 15% of their body weight. With that in perspective, it's no surprise that an African penguin poops about every 20 minutes, or around 72 times a day.

### *Penguin Predators*

There are many predators that feed on African penguins, on land and sea. On the shore, snakes and mongooses hunt for penguin eggs, while leopards have been observed hunting adults. Marine predators include sharks, fur seals, orca, and the number one predator of penguins, leopard seals. A common misconception is that polar bears are also penguin predators. Polar bears are only found near the arctic circle or North Pole, whereas penguins remain in the Southern Hemisphere only. Therefore, these two animals would never come in contact with one another.

### *The Role of the Penguin in the Ecosystem*

Because of their dual environments of both land and sea, penguins play an important role in the oceanic and terrestrial ecosystems. Over various regions of diverse climates, penguins serve as a source of prey for leopard seals, sharks, and orcas in the water and foxes, mongoose, and leopards on land. Penguins are also predators themselves, affecting populations of various fish, crustaceans, and squid. Penguin feces provide nutrients to the oceanic and terrestrial land, as microorganisms and bacteria feed upon the wastes they provide. A few burrowing species of penguin also disrupt the ground, directly effecting the landscape.

### *Natural Selection*

Penguin ancestry appears to date back 36 million years to a species known as *Idadyptes salasi*. This mega-penguin stood over 5 feet tall with a beak over 7 inches long. Attachment points for neck muscles are also large, suggesting it used its powerful neck for spearing prey. Since this large bird was alive during a warmer climate, its discovery goes against the general rule that as climatic conditions get warmer, species tend to evolve a smaller body size. It has also created some confusion about the movement of penguin populations around the equator millions of years ago. Another penguin-like species from the past was the great auk. Auks are penguin-like seabirds found in the Northern Hemisphere. There are 22 species of auks, including the Atlantic puffin and the extinct great auk. Members of the auk family fill an ecological role similar to penguins in the southern hemisphere. However, they are not closely related as auks are more closely related to gulls. These similarities are due to convergent evolution where unrelated species adapt similar traits as a result of adapting to similar environments and niches.

Many wonder how and why the Blackfoot penguin, otherwise known as the African penguin, came to Africa. Penguins originally migrated to Africa about 30 million years after they had already populated Australia, Antarctica, and South America. Remains of ancient penguins suggest a larger diversity than the single species that exists in Africa today. Specific distinctions in bone comparisons lead scientists to conclude that three separate species of penguin colonized Africa three separate times, with the prior two species eventually becoming extinct, with reason to believe that sea-level had a part to play in their extinction. Because penguins like to breed on small, rocky islands, nesting sites may have been lost as lowering sea levels resulted in a connection between the islands and the mainland.

### *Species of Penguin*

Throughout the southern hemisphere there are 18 types, or species, of penguin. The largest penguin species is the emperor penguin reaching heights up 45 inches. This large size has allowed the species to adapt to frigid temperatures of -40 degree Fahrenheit. The smallest penguin is the fairy, or little blue, penguin only reaching 13 inches in height. The small size may have been an adaptation to less food intake, warmer climates, or an increase ability to hide and seek shelter. Of the 18 species, 7 live in warm weather environments including the African black-footed penguin. Warm weather penguins lack feathers on the lower leg, while cold weather penguins have feathers down to their feet. Warm weather penguins also have a bald patch on their head which serve as a release point for heat.

### *Food Web Connections*

As with most predators, penguins play a critical role in their ecosystem as a top down control mechanism for the environment's food web. Apex predators consume tertiary and/or secondary consumers, which consume primary consumers, which consume producers, which produce energy from the sun through photosynthesis. The main source of energy for all ecosystems initiates from the sun in the form of solar energy. Through the process of

photosynthesis, plants convert this energy into oxygen and glucose. Because of this conversion, green plants, some bacteria, and algae are labeled as producers. An animal, such as an herbivorous fish, who consumes the plant, is known as a primary consumer, because it receives the energy from the plant which converted the energy from the sun. The penguin who eats the fish that feeds on the plant which converted the sunlight is known as a secondary consumer, hence a process that directly related back to the sun as the primary energy source. An apex consumer is the top of the food chain or web with few to no natural predators at adult size such as an orca, shark, or leopard seal.

### *Penguin Conservation*

Unfortunately, the African penguin species is endangered, which means there has been a 50-70% decline in population reduction rates. Current reasons for the reduction in recent years are over-fishing, oil pollution, and the collection of guano and eggs. Predation also serves as a factor, considering the observation of the African penguin's newest predator, the leopard seal. Hope lies in the protection of this species under the classification of the endangered status. Breeding grounds are preserved as national parks or nature reserves, and guano and egg collections have been outlawed. Still, penguins may be caught as bycatch in other fisheries, accidentally drowning in nets. Increased pressure of fishery competition can also have an indirect yet negative effect on penguin species. As more prey items are harvested from the oceans, fewer food resources are left for tertiary consumer predators, which in turn begin hunting new prey, such as penguins. In a direct manner, over-fishing takes prey straight from penguins, as they are predators themselves, turning the situation into a condition of limiting resources. A limiting resource is an environmental condition that limits the growth, abundance, or distribution of an organism or a population of organisms in an ecosystem. Recall the fact that an adult penguin may consume 15% of its body weight daily, and an African penguin weighs about 8 pounds. Therefore, an African penguin consumes on average 438 pounds of food per year. An average human, weighing significantly larger, may reach 1,000 pounds annually.

The WAVE Foundation's Aquatic Conservation Fund supports a variety of organizations whose chief mission is to protect natural resources and environments. SANCCOB (Southern African Foundation for the Conservation of Coastal Birds) is a non-profit organization whose primary objective is to reverse the decline of seabird populations through the rescue, rehabilitation, and release of ill, injured, abandoned and oiled seabirds – especially endangered seabirds like the African penguin. Over the past 50 years, this organization has treated more than 95,000 seabirds and has confirmed that the oil spill response actions alone have increased the African penguin population by 19%. The fund has also supported The Punta San Juan Project—Protecting One of the World's Largest Colonies of Humboldt Penguins. This project has introduced a variety of environmental changes to support local seabirds including adding cement artificial nests on the

outskirts of breeding colonies. The project also collects annual survey data on population numbers, egg counts, and successful birth counts. Information about other penguin research projects are available from the Penguin Taxon Advisory Group (TAG).

## **Vocabulary**

Asynchronous – Lack of temporal concurrence; absence of synchronism.

Conservation – The study of the loss of Earth’s biological diversity and ways this loss can be prevented.

Convergent evolution - The process whereby organisms (who are not closely related) independently evolve similar traits as a result of adapting to similar environments or ecological niches.

Fusiform – Torpedo shaped, tapering at both ends.

Guano – Penguin feces or poop

Limiting factor – A factor present in an environment that controls a process, particularly the growth, abundance or distribution, of a population of organisms in an ecosystem.

Monogamous – The condition of having only one mate during a breeding season or during the breeding life of a pair.

Natural selection - Process by which organisms that are better adapted to their environment tend to survive longer and reproduce more succeeding generations than those individuals that are less well adapted.

Niche - The place or function of a given organism within its ecosystem.

Nitrogen narcosis - An effect on the brain of gaseous nitrogen that occurs to SCUBA divers and potentially diving animals including pain, drowsiness, and/or drunkenness

Oviparity - producing eggs that mature and hatch after being expelled from the body

Photosynthesis - process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water.

Reproduction – The production of offspring by a sexual or asexual process.

Rookery - A breeding place or colony of gregarious birds

## **Extension Activities**

Project WILD Activities. Please contact your state Project WILD coordinator for more information. See <http://projectwild.org/KentuckyCoordinator.htm> (for Kentucky) or <http://www.projectwild.org/ProjectWILDCoordinators.htm> (for other states).

- Back from the Brink – Students will (1) explain the reasons for the decline of certain wildlife species and describe methods used in species recovery, (2) describe the effects of the decline and recovery of wildlife on people and the environment, (3) analyze issues surrounding the decline and recovery of wildlife species and examine strategies to resolve those issues, and (4) describe the importance of an environmentally literate citizen base to the success of the recovery project.

- Bird Song Survey – Students will identify and describe the importance of bird counting as one means of inventorying wildlife populations.
- Can Do! – Students will (1) identify a problem involving wildlife in their community, (2) suggest and evaluate alternative means by which to either solve the problem or at least improve the situation, (3) successfully undertake the project, and (4) analyze and describe the process by which they successfully solved the problem or improved the situation.
- Know the Legislation: What’s in It for Wildlife? – Students will (1) describe the legislative process in which a bill becomes law, (2) identify points when private citizens can have an effect on the legislative process, and (3) evaluate the effectiveness of the legislative process from the perspective of the students’ personal experience.
- Turkey Trouble – Students will (1) define and give examples of exponential and linear growth rates in wildlife populations, and (2) describe factors that affect and limit growth of wildlife populations.
- We’re in This Together – Students will (1) identify environmental problems of concern to both people and wildlife, and (2) generalize that people, domesticated animals, and wildlife are subject to similar environmental problems.
- Wildlife Issues: Community Attitude Survey – Student will (1) assess the values held by various groups and individuals regarding a selected issue, and (2) distinguish between beliefs, values, and attitudes.
- Wildlife Research – Students will (1) identify reasons for research related to wildlife, (2) evaluate appropriate kinds of research related to wildlife, and (3) design and conduct a wildlife research project.

Penguin Watch - <http://www.penguinwatch.org/>

### **Resources**

Project Wild <http://www.projectwild.org>

Project Wet <http://www.projectwet.org>

Project Learning Tree <http://www.plt.org>

<http://www.arkive.org/african-penguin/spheniscus-demersus/>

<http://marinebio.org/species.asp?id=646>

<http://www.arkive.org/african-penguin/spheniscus-demersus/>

<http://www.mysticaquarium.org/animals-and-exhibits/species-of-the-month/652-african-penguin>

<http://a-z-animals.com/animals/african-penguin/>

[http://ecos.fws.gov/tess\\_public/profile/speciesProfile;jsessionid=354BAD592C2D8B57025B388561F112C0?spcode=B0FM](http://ecos.fws.gov/tess_public/profile/speciesProfile;jsessionid=354BAD592C2D8B57025B388561F112C0?spcode=B0FM)

<http://education.nationalgeographic.org/media/endangered/>

[http://www.simtech.net/upload/Newsletter16\\_2.pdf](http://www.simtech.net/upload/Newsletter16_2.pdf)