Indiana Dunes Education

National Park Service
U.S. Department of the Interior

Indiana Dunes National Park
Education Department

Secrets of Succession

Summary:

Follow the legacy of early dunes' scientist Henry Chandler Cowles and hike on the beach over foredunes and through forests. By exploring diverse ecosystems, students will discover the forces that shape the dunes and produce this unique succession of plants.

Objectives: students will be able to

1. Describe the plant and animal species which characterize each successional stage of the dunes.
2. Name three ways in which plants and animals in the dunes change the environment, allowing other plants and animals to succeed them.
3. Explain the affect of human and natural erosion on the process of succession.
4. Relate the abiotic measurements to trends in biological communities.
5. Define succession, humus, community, disturbance, adaptation, and glacier.

What to expect on during your trip:

1. Group arrives at the West Beach unit.
2. A brief introduction is given, and the moderate to strenuous hike begins. Some flexibility is possible to accommodate physical ability. Let rangers know beforehand if your group has any special needs or requirements.
3. Students will be engaged in exploration activities to learn about the special features in the dunes throughout the 1.5 to 2 hour hike.

Setting:

West Beach is located in Portage, Indiana; Porter County on County Line Road. The Succession Trail is about 1 mile long and includes walking in sand and on flights of stairs. Restrooms and picnic shelters are available at this site. Other hiking trails are available for use in this area if a group wishes to hike on their own before or after the program.

Grade:

5^{th} – 12^{th} grade.

Ratio of students to ranger:

30 or less is ideal; we will try to accommodate larger groups within reason due to staffing levels. Please provide one adult chaperone for every ten students for safety purposes.

Safety Issues:

Poison ivy, slivers on boardwalks, seasonal heat or cold, safety on stairs and dunes. Some adults and children may have difficulty walking the trails and climbing the dunes. Bring sunscreen, insect repellant and lots of water when hiking any of the park's trails. Students should dress for the weather and wear shoes suitable for hiking.

Background Information:

Geology: The first dunes of Indiana were formed approximately 15,000 years ago when the last of the Ice Age glaciers swept down from the north. As the climate warmed, the movement of the glacier was halted, and a glacial deposit called a moraine was formed. This moraine acted as a dike holding back the water of the melting glacier forming what is now Lake Michigan. Waves, wind and plants have all combined to bring sand to the southern and eastern shores of Lake Michigan and begin the dune building process. The process of dune building that began over 15,000 years ago is still continuing today. Through the dynamic process of succession, a variety of biological communities succeed one another on the dunes of West Beach. Each community changes the physical and biological environment making conditions suitable for the next community.

The shoreline of the new lake first stood at 640 feet elevation, but this was only temporary. The increasing influx of meltwater from the ice to the north soon caused the lake to breach its morainic dam near what is now the southwest part of Chicago. As water passed out of the opening in the moraine and down the Des Plaines and Illinois valleys, the level of ancestral Lake Michigan fell. A new, lower lake level was established when the down-cutting of the Des Plaines River was stabilized by a boulder-rich zone with the Valparaiso Moraine. The new lake level, which stabilized at 620 feet was also only temporary. When the boulder field near southwest Chicago was breached, the lake began to lower again until a third level at 605 feet was reached. This resulted because the down cutting of the Illinois River and its tributaries virtually ceased when the river reached bedrock. This third lake level was to be the last stage of ancestral Lake Michigan.

By this time, the glaciers had completely left the Lake Michigan Basin. A new drainage was opened at the Straits of Mackinac, to the north, which was lower than the outlet at Chicago and continues to be the principal drainage of the lake up to the present.

Geologists refer to the three lake levels of ancestral Lake Michigan as the following:

1. Glenwood at 640 feet elevation
2. Calumet at 620 feet
3. Tolleston at 605 feet.

At each of these lake stages, beaches and their accompanying foredunes are preserved. The transition to modern day Lake Michigan was a gradual one involving numerous rises and falls of the lake level. Even today the lake level is not fixed, as can be seen by a two to three foot rise during the past several years. The average level of Lake Michigan over the past 100 years is about 578 feet above sea level.

Succession: Sand dunes start as bare sand, then become dunes with grass helping to hold them in place. Over time, shrubs and trees are able to take root. As more time passes, a full forest, also called a climax forest, is able to grow at the back edge of a dune system. The change in ecosystems that takes place over time is called succession.

During succession, a series of changes occurs in the ecological community that inhabits a region. Succession happens because the activities of living organisms and abiotic factors change the conditions of a region so that it becomes more inhabitable by a different group of organisms. In sand dunes, an example of the changing communities is beach, foredune, interdunal pond, forested back dune. If marram grass takes root on a beach, its roots will begin to trap sand, causing small dunes to form. This then sets the stage for additional plant and animal life to inhabit the dunes. A progression of plant communities is found on the dunes along the south shore of Lake Michigan.

Moving from beach to oak forest in the dunes, the amount of sunlight decreases. This is due to the community plant composition. Near the lake, sun-tolerant cottonwoods and grasses are found. In the oak forest are found shade-tolerant oak, witch hazel, and other broad-leaved trees and shrubs. Sunlight, evaporation, and transpiration decrease from beach to oak forest, while the amount of moisture available to the soil increases. Since there is a greater quantity of organic material in the soil progressing from beach to oak forest, the soil is more capable of holding moisture.

The vegetation controls the amount of sunlight striking the ground. As the plants grow, they create shade, which modifies the light and moisture conditions on the ground.

Trees are sometimes observed with unusual bent or twisted growth patterns resulting from their competition for available sunlight.

Dune grasses have adapted ways to reproduce and spread. They may have underground runners and the ability to shoot up new stems to prevent sand burial. Others produce enormous quantities of seeds which travel by wind. In the foredunes, a greater part of the plant is underground. This enables plants to capture and hold sand in place to build dunes.

Prerequisite Classroom Activities:

Prior to your visit to Indiana Dunes National Lakeshore, please take a moment to read through the information listed below. We suggest that you do one or more of the described activities with your class in order to prepare them for the lessons and experiences they will have during their field trip. If there is a special topic or area that you want the ranger to cover during the presentation, please contact the park's scheduling office, and every effort will be made to accommodate your request.

Activity 1: Practice data collection with your group to prepare them for their field experience at the park. Use data such as height, shoe size, hair color, eye color, etc. After recording the data, break into small groups to summarize their findings. Each group should present their conclusions orally to the class.

Activity 2: Use field guides around the school to become familiar with using them. Research the organisms listed on the **attached student data sheet** and try to determine any special adaptations those organisms might have to help them survive in the five different successional stages of the dunes.

Activity 3: Ask each student to dig up and bring into class a plant from his or her yard along with a small amount of the soil from which it came. Make sure to dig up the roots as well as the other plant parts. Study the various parts of the plant and especially notice the roots. Students should describe the soil sample. Discuss how different soil types require different root structures for plants.

Activity 4: Study various soil types common to your area. Soil surveys of your county should be available from your local soil conservation service office. These provide detailed soil descriptions, aerial photos and many other types of information. Pay particular attention to information pertaining to soil formation. You may want to allow some freedom to allow the students to find their town or their house on the photos.

Activity 5: Students examine a map or atlas of the world and find other areas which have sand dunes. Compare the differences and similarities between these areas and the southern shore of Lake Michigan. Have students work in groups to research a park and present their findings to the class. Beginning in the United States, students can research the differences and similarities between our Indiana dunes with those found at the following national parks:

- Sleeping Bear Dunes National Lakeshore—www.nps.gov/slbe
- Great Sand Dunes National Monument and Preserve—www.nps.gov/grsa
- White Sands National Monument—www.nps.gov/whsa
- Pictured Rocks National Lakeshore—www.nps.gov/piro
- Cape Cod National Seashore—www.nps.gov/caco

Vocabulary:

ABIOTIC – Non living.

ADAPTATION – Change in an organism or its parts that fits it better for the conditions of its environment.

CLIMAX COMMUNITY - The final, most mature and stable community (sere) possible under existing environmental conditions.

COMMUNITY - A group of plants and animals which thrive and work together in a specific area.

ECOSYSTEM - Interacting communities and abiotic components

GLACIER - A sheet of moving ice which lasts through the yearly dry period. Continental glaciers, such as the one which produced Lake Michigan, were a mile thick and covered Indiana Dunes 12,000 years ago. When they melted, this formed the shoreline of ancient Lake Chicago (present day Lake Michigan).

HABITAT – The place or environment where a plant or animal normally or naturally lives and grows

MORAINE - Rock material of variable size deposited in a ridge by retreating glaciers at their sides (lateral moraine – Sleeping Bear Dunes) or front (terminal moraine – Indiana Dunes area).

PRIMARY SUCCESSION - The change in vegetation and animal life over time which naturally occurs as one community is replaced by others. Primary succession begins on barren soil.

SECONDARY SUCCESSION - The change in vegetation and animal life in a community which occurs after a human disturbance or a major event such as a fire, flooding, or volcanic event. Secondary succession occurs on formerly vegetated areas.

SERAL STAGE - A community in a successional series. The entire sequence of communities is known as a sere.

SUCCESSION - The changes in vegetation and animal composition over time through which one population or community is replaces by others in the same location. The process produces a sequence in community types from pioneer stages to a mature or climax community, unless the process is interrupted. The process of succession is often interrupted.

Extension or Follow-up Activity

Class reflection paper or writing sample:

Ask each student to write a short essay, letter or story about what they learned on their field trip to Indiana Dunes National Lakeshore. Rangers love receiving mail from their students. Send the ranger the packet of essays from your class (or a copy of them), and your ranger will send your class a certificate from the dunes. Send your essays to:

Indiana Dunes National Lakeshore
1100 N. Mineral Springs Road
Porter, IN 46304
Attn: Your ranger's name or just Education Department

If you are using this essay as a class assignment for a grade, we would like to suggest that each essay contain the following elements. Use the rubric below to score them.

* The name of the park and the location of their field trip—for example:
Douglas Center, Indiana Dunes National Park

* Three facts they learned on the field trip about the habitats of the dunes.

* A brief explanation of why Indiana Dunes is unique and therefore a national park.

* At least two things the student can do to help take care of his or her national park.

* Fill in the blank of this statement and provide an explanation:

I would like to learn more about _____ at Indiana Dunes.

*** For advanced groups, add the following element:

Tell the park rangers if you would like to bring your families and friends to the dunes and, if so, what would you do here and where would you go.

Assessment:

Grading for Class reflection writing assignment:

Writing and organization- **4 points** the writing sample is very well written and organized by the elements provided. It has a strong introduction, middle and conclusion. **3 points** the writing sample is well written and organized by the elements provided. It includes an introduction, middle and conclusion. **2 points** the writing sample is choppy and is not well organized. It lacks an introduction or conclusion. **1 point** the writing sample is very short and unorganized.

Grammar & Spelling- **4 points** Mistakes in spelling and grammar are minor or non-existent. **3 points** Mistakes in spelling and grammar are minimal—about 4-5. **2 points** mistakes in spelling and grammar are numerous—5-10. **1 point** mistakes in spelling and grammar are more than 10.

Facts and content- **4 points** the writing sample demonstrates the student's learning on the dunes program and includes three or more facts provided by the park staff. **3 points** the writing sample demonstrates the student's learning and includes only two facts provided by the park staff. **2 points** the writing sample does not demonstrate much learning and only includes one fact provided by the park staff.**1 point** the writing sample does not demonstrate any learning and does not include any facts provided by the park staff.

National Park Service theme - **4 points** the writing sample clearly demonstrates the student's understanding of the role of the NPS in preserving the dunes by explaining why Indiana Dunes is such a unique treasure.**3 points** the writing sample mentions the NPS and its role in preserving the Indiana Dunes. **2 points** the writing sample mentions the NPS and Indiana Dunes. **1 point** the writing sample does not mention anything about the NPS or its role at Indiana Dunes

Stewardship- **4 points** the writing sample lists three things the student can do to assist in taking care of the Indiana Dunes. **3 points** the writing sample lists two things the student can do to assist in taking care of the Indiana Dunes. **2 points** the writing sample lists one thing the student can do to assist in taking care of the Indiana Dunes. **1 point** the writing sample does not list anything about what the student can do to take care of the Indiana Dunes.

Indiana Content Standards:

5th Grade: Science

Earth and Space Science

- **5.ESS.3** 2016 - Investigate ways individual communities within the United States protect the Earth's resources and environment.

Life Science

- **5.LS.1** 2016 - Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- **5.LS.2** 2016 - Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

6th Grade: Science

Life Science

- **6.LS.1** 2016 - Investigate and describe how homeostasis is maintained as living things seek out their basic needs of food, water, shelter, space, and air.
- **6.LS.2** 2016 - Describe the role of photosynthesis in the flow of energy in food chains, energy pyramids, and food webs. Create diagrams to show how the energy in animals' food used for bodily processes was once energy from the sun.
- **6.LS.3** 2016 - Describe specific relationships (predator/prey, consumer/producer, parasite/host) and symbiotic relationships between organisms. Construct an explanation that predicts why patterns of interactions develop between organisms in an ecosystem.
- **6.LS.4** 2016 - Investigate and use data to explain how changes in biotic and abiotic components in a given habitat can be beneficial or detrimental to native plants and animals.
- **6.LS.5** 2016 - Research invasive species and discuss their impact on ecosystems.

7th Grade: Science

Earth and Space Science

- **7.ESS.1** 2016 - Identify and investigate the properties of minerals. Identify and classify a variety of rocks based on physical characteristics from their origin and explain how they are related using the rock cycle. (i.e. Sedimentary, igneous, and metamorphic rocks)
- **7.ESS.2** 2016 - Construct a model or scale drawing (digitally or on paper), based on evidence from rock strata and fossil records, for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
- **7.ESS.4** 2016 - Construct an explanation, based on evidence found in and around Indiana, for how large-scale physical processes, such as Karst topography and glaciation, have shaped the land.

8th Grade: Science

Life Science

- **8.ESS.2** 2016 - Create a diagram or carry out a simulation to describe how water is cycled through the earth's crust, atmosphere and oceans. Explain how the water cycle is driven by energy from the sun and the force of gravity.
- **8.LS.5** 2016 - Explain how factors affecting natural selection (competition, genetic variations, environmental changes, and overproduction) increase or decrease a species' ability to survive and reproduce.

High School Biology

Interdependence

- **B.3.1** 2016 - Use mathematical and/or computational representation to explain why the carrying capacity ecosystems can support is limited by the available energy, water, oxygen, and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- **B.3.2** 2016 - Design, evaluate, and refine a model which shows how human activities and natural phenomena can change the flow of matter and energy in an ecosystem and how those changes impact the environment and biodiversity of populations in ecosystems of different scales, as well as, how these human impacts can be reduced.
- **B.3.3** 2016 - Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions and identify the impact of changing conditions or introducing non-native species into that ecosystem.

Energy Transfer

- **B.2.3** 2016 - Use mathematical and/or computational representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **B.2.4** 2016 - Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Earth and Space Science

The Solid Earth

- **ES.5.3** 2016 - Construct a model that demonstrates the difference between weathering, erosion, transportation of material, deposition, and new soil and sedimentary rock formation. Differentiate between types of physical and chemical weathering.
- **ES.5.5** 2016 - Create a timeline detailing the processes that have occurred in Indiana to create mostly sedimentary bedrock. Explain how changing sea levels, climate, and glaciation have shaped Indiana geology.

Environmental Science

Flow of Matter and Energy

- **Env.2.1** 2016 - Describe how matter cycles through sources and sinks and how energy is transferred. Explain how matter and energy move between and within components of an environmental system.
- **Env.2.3** 2016 - Recognize and explain that the amount of life any environment can support is limited by the available energy, water, oxygen, nutrients and minerals, and by the ability of ecosystems to recycle organic materials from the remains of dead organisms.
- **Env.2.6** 2016 - Understand and describe how layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. Recognize that by burning these fossil fuels, people are passing stored energy back into the environment as heat and releasing large amounts of matter such as carbon dioxide and other air pollutants.

Environmental Policy

- **Env.4.2** 2016 -Understand that environmental policies/decisions have negative and positive impacts on people, societies, and the environment.

Natural and Anthropogenic Resource Cycles

- **Env.8.1** 2016 - Demonstrate a knowledge of the distribution of natural resources in the U.S. and the world, and explain how natural resources influence relationships among nations.
- **Env.8.2** 2016 -Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit.

Illinois Content Standards:

5th Grade: Science
Energy

- **5-PS3-1** 2017 - Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

From Molecules to Organisms: Structures and Processes

- **5-LS1-1** 2017 - Support an argument that plants get the materials they need for growth chiefly from air and water.

Ecosystems: Interactions, Energy, and Dynamics

- **5-LS2-1** 2017 - Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Earth and Human Activity

- **5-ESS3-1** 2017 - Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Middle School: Science
From Molecules to Organisms: Structures and Processes

- **MS-LS1-5** 2017 - Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Ecosystems: Interactions, Energy, and Dynamics

- **MS-LS2-1** 2017 - Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- **MS-LS2-2** 2017 - Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- **MS-LS2-3** 2017 - Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- **MS-LS2-4** 2017 - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations

- **MS-LS2-5** 2017 - Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Earth's Systems

- **MS-ESS2-2** 2017 - Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- **MS-ESS2-4** 2017 - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

Earth and Human Activity

- **MS-ESS3-3** 2017 - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*
- **MS-ESS3-5** 2017 - Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

HIGH SCHOOL Life Sciences

Ecosystems: Interactions, Energy, and Dynamics

- **HS-LS2-1** 2017 - Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- **HS-LS2-2** 2017 - Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **HS-LS2-3** 2017 - Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- **HS-LS2-4** 2017 - Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **HS-LS2-5** 2017 - Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- **HS-LS2-6** 2017 - Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions; but changing conditions may result in a new ecosystem.
- **HS-LS2-7** 2017 - Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

- **HS-LS2-8** 2017 - Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Biological Evolution: Unity and Diversity

- **HS-LS4-5** 2017 - 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.
- **HS-LS4-6** 2017 - Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*

Earth and Space Sciences

Earth and Human Activity

- **HS-ESS3-1** 2017 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ESS3-2** 2017 - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*
- **HS-ESS3-3** 2017 - Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- **HS-ESS3-4** 2017 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
- **HS-ESS3-5** 2017 - Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
- **HS-ESS3-6** 2017 - Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.