



## ECOSYSTEMS: Interactions, Energy, and Resilience

This lesson plan was created by Prof. Katie Hinde, Arizona State University, using Next Generation Science Standards and explanations from the National Academies of Sciences, Engineering, and Medicine. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13165>.

**Core Idea 2 LS2A-C Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.**

The Lesson Plan is designed to add a “real world” example for constructing a food web for a specific ecosystem based on 2022MMM combatants in WILD North America Division, using the species lists for Federal Public Lands: <https://irma.nps.gov/NPSpecies/Search/SpeciesList> and is designed to take 60-90 minutes depending on if teachers include a group collaboration on food webs after students create their own individual food web.

[Linked Worksheets](#) (dimensions account for standard paper margins) (editable after download)  
[Linked Presentation Sliddeck](#) (editable after download)

### LEARNING OBJECTIVES:

At the end of this assignment, students will be able to

- Explain different ecosystem roles within a food web
- Interpret and apply principles of food webs to real species in real ecosystems.
- Illustrate the complex relationships among 12 or more species within a food web
- Compare and contrast intact/recovered ecosystems with disturbed ecosystems
- Describe interactions and dynamics in ecosystems in relation adult and immature individuals
- Navigate to Federal Public Lands species lists to select and extract key information

There are 7 different species (Black Bear, Wolf, Cougar, Coyote, Bighorn Sheep, Elk, and Marmot) each species is matched to a specific park/public land and has a 3-page worksheet packet.

Each student group is assigned a species and then constructs two food webs for that species in two specific geographic locations within the US National Park System. This is designed as a group project so that students can divide tasks and bring more species into the food webs and compare and contrast food webs in which large carnivores are absent or rare.

The paired slideshow enables educators to present key information about ecosystems, food webs, major groups of mammals, and the role of large predators within systems. The slide show further describes the activity step-by-step to students.

### **Teachers may consider modifying the lesson to incorporate**

- more specific sleuthing of plants, insects, birds, reptiles, and fish within the park ecosystem
- narrow research to species adapted to specific river, lake, forest, plains, desert or systems;
- visit the website of their specific park (<https://www.nps.gov/findapark/index.htm>) to find specific threats, monitoring, and mitigation practices Park Staff are implementing to address climate change, look-up information about the cultural resources of the park, Indigenous land stewardship and traditional ecological knowledge (TEK; [www.nps.gov/subjects/tek/description](http://www.nps.gov/subjects/tek/description)), and/or abiotic aspects of the natural systems within the park, human impacts and climate change within the specific park.
- visit the “Climate Change And Your National Parks” at [www.nps.gov/subjects/climatechange](http://www.nps.gov/subjects/climatechange) to explore which effects of climate change are impacting their park: advancing spring onset, sea level change, and wildland fire.

## **BACKGROUND**

Excerpted from: National Academies of Sciences, Engineering, and Medicine. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13165>.

### **Interdependent Relationships in Ecosystems**

- i. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- ii. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- iii. Growth of organisms and population increases are limited by access to resources.

### **How and why do organisms interact with their environment and what are the effects of these interactions?**

Ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment. As with individual organisms, a

hierarchical structure exists; groups of the same organisms (species) form populations, different populations interact to form communities, communities live within an ecosystem, and all of the ecosystems on Earth make up the biosphere. Organisms grow, reproduce, and perpetuate their species by obtaining necessary resources through interdependent relationships with other organisms and the physical environment. These same interactions can facilitate or restrain growth and enhance or limit the size of populations, maintaining the balance between available resources and those who consume them. These interactions can also change both biotic and abiotic characteristics of the environment. Like individual organisms, ecosystems are sustained by the continuous flow of energy, originating primarily from the sun, and the recycling of matter and nutrients within the system. Ecosystems are dynamic, experiencing shifts in population composition and abundance and changes in the physical environment over time, which ultimately affects the stability and resilience of the entire system.

Ecosystems are ever changing because of the interdependence of organisms of the same or different species and the nonliving (physical) elements of the environment. Seeking matter and energy resources to sustain life, organisms in an ecosystem interact with one another in complex feeding hierarchies of producers, consumers, and decomposers, which together represent a food web. Interactions between organisms may be predatory, competitive, or mutually beneficial. Ecosystems have carrying capacities that limit the number of organisms (within populations) they can support. Individual survival and population sizes depend on such factors as predation, disease, availability of resources, and parameters of the physical environment. Organisms rely on physical factors, such as light, temperature, water, soil, and space for shelter and reproduction. Earth's varied combinations of these factors provide the physical environments in which its ecosystems (e.g., deserts, grasslands, rain forests, and coral reefs) develop and in which the diverse species of the planet live. Within any one ecosystem, the biotic interactions between organisms (e.g., competition, predation, and various types of facilitation, such as pollination) further influence their growth, survival, and reproduction, both individually and in terms of their populations.

**By End of 12th Grade:** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

### **How do matter and energy move through an ecosystem?**

Animals acquire matter from food, that is, from plants or other animals. The chemical elements that make up the molecules of organisms pass through food webs and the environment and are combined and recombined in different ways. At each level in a food web, some matter provides energy for life functions, some is stored in newly made structures, and much is discarded to the surrounding environment. Only a small fraction of the matter consumed at one level is captured by the next level up. As matter cycles and energy flows through living systems and between living systems and the physical environment, matter and energy are conserved in each change.

The carbon cycle provides an example of matter cycling and energy flow in ecosystems. Photosynthesis, digestion of plant matter, respiration, and decomposition are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

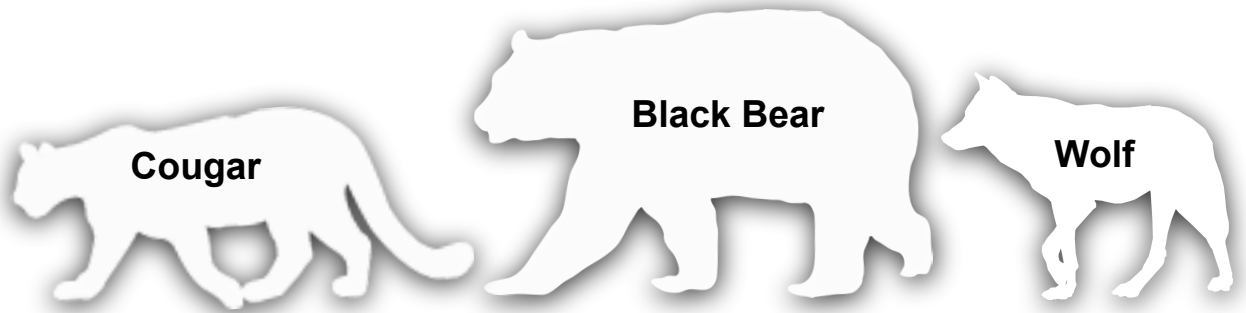
**By the end of 12th Grade:** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web, and there is a limit to the number of organisms that an ecosystem can sustain.

### **What happens to ecosystems when the environment changes?**

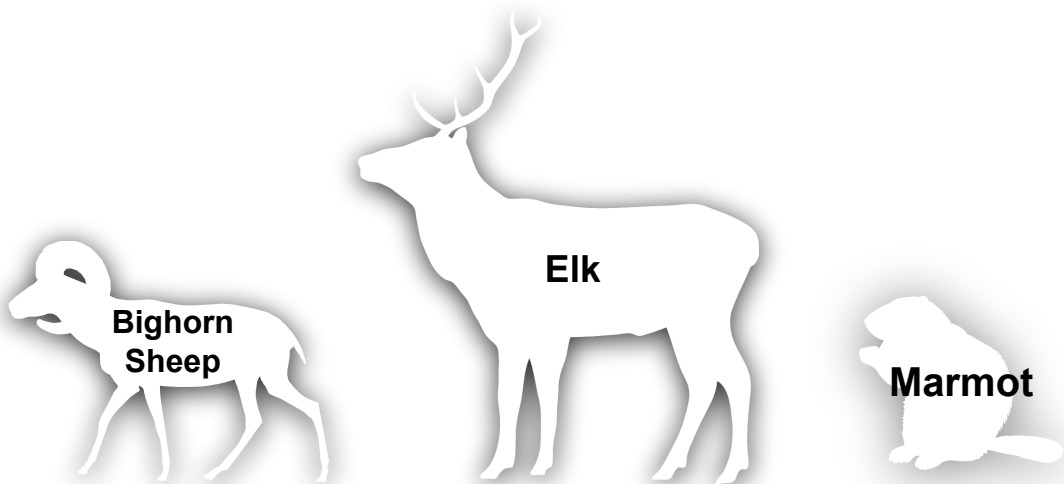
Ecosystems are dynamic in nature; their characteristics fluctuate over time, depending on changes in the environment and in the populations of various species. Disruptions in the physical and biological components of an ecosystem—which can lead to shifts in the types and numbers of the ecosystem’s organisms, to the maintenance or the extinction of species, to the migration of species into or out of the region, or to the formation of new species (speciation)—occur for a variety of natural reasons. Changes may derive from the fall of canopy trees in a forest, for example, or from cataclysmic events, such as volcanic eruptions. But many changes are induced by human activity, such as resource extraction, adverse land use patterns, pollution, introduction of nonnative species, and global climate change. Extinction of species or evolution of new species may occur in response to significant ecosystem disruptions.

Species in an environment develop behavioral and physiological patterns that facilitate their survival under the prevailing conditions, but these patterns may be maladapted when conditions change or new species are introduced. Ecosystems with a wide variety of species—that is, greater biodiversity—tend to be more resilient to change than those with few species.

**By the end of grade 12.** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.



## **March Mammal Madness Combatants & Ecosystem Interactions**



**Worksheets  
for High School Life Sciences  
Designed as a Group Activity  
Unique Versions for 7 Different Species**



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Hot Springs National Park

The 2022 March Mammal Madness WILD North America **BLACK BEAR** is from Hot Springs National Park in Arkansas. The park and its surrounding mountains exhibit a south-central United States pine-oak-hickory forest ecosystem. Within this system, black bears are omnivores, eating both plants and animals. Working in a group go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Black Bear in the park ecosystem.

- 1) Select your park (Hot Springs National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, black bears are omnivores, eating both plants and animals. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Black Bear in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
Date \_\_\_\_\_  
Class \_\_\_\_\_  
Teacher \_\_\_\_\_

In each park, there are dozens of mammal species. You'll notice there are many different species of small rodents that eat plants, and many different species of small carnivores that eat the rodents (and bats that eat insects) but far fewer species of large and very large mammals. (You can also select "vascular plant" species in the park, and you'll see many times more plant species than the number of mammal species).

**FOR EACH PARK, draw a food web diagrams:**

- 1) Write a title "Food Web: <Insert 1st Park Title>" and "Food Web: <Insert Yellowstone Nat'l Park>" above the appropriate food web.
- 2) Include the **Black Bear** and the other animals from the tables for each park.
- 3) Add arrows and labels to illustrate what species eat what species and what species compete with what species in each diagram. Write a figure description explaining what the diagram shows.
- 4) Next to each animal in each diagram, include an A, C, U or R to indicate if the species is abundant, common, uncommon, or rare.

After completing your two diagrams of food webs in the two park ecosystems, think about the interactions among species they show. **Answer the following questions:**

- A) Does the Black Bear have a different or similar community of carnivore competitors in Hot Springs and Yellowstone National Parks? Explain your answer by describing both Presence/Absence and Abundance of other large carnivores.
- B) In a Black Bear's daily life, how might the differences of the food web between Hot Springs National Park and Yellowstone National Park affect the Black Bear's behavior?
- C) Imagine a Black Bear mama has just left her hibernation den with her young cubs. Are there different dangers to her cubs in Hot Springs National Park than in Yellowstone National Park? How do you think this could affect her behavior?





Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Superior National Forest

The 2022 March Mammal Madness WILD North America **WOLF** is from Superior National Forest in Minnesota and a boreal forest ecosystem. Within this system, wolves are carnivores, cooperatively hunting large herbivores. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Wolf in the park ecosystem.

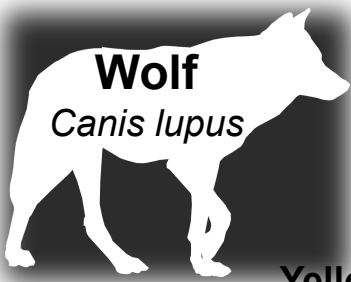
- 1) Select your park (**Voyagers National Park** bc Superior Forest isn't in the database), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, wolves are carnivores, cooperatively hunting large herbivores. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Wolf in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):





Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

Teacher \_\_\_\_\_

## Santa Monica Mountains National Recreation Area

The 2022 March Mammal Madness WILD North America **COUGAR** is from the Santa Monica Mountains National Recreation Area in California. This public land and its surrounding mountains have many different ecosystems, including oak woodlands, valley oak savannas, coastal sage, and chaparral. Within this system, cougars are an apex predator hunting and eating many different mammals. Working in a group go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Cougar in the park ecosystem.

- 1) Select your park (Santa Monica Mountains National Recreation Area), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, cougars are an apex predator hunting and eating many different mammals. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the Cougar in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
Date \_\_\_\_\_  
Class \_\_\_\_\_  
Teacher \_\_\_\_\_

In each park, there are dozens of mammal species. You'll notice there are many different species of small rodents that eat plants, and many different species of small carnivores that eat the rodents (and bats that eat insects) but far fewer species of large and very large mammals. (You can also select "vascular plant" species in the park, and you'll see many times more plant species than the number of mammal species).

**FOR EACH PARK, draw a food web diagrams:**

- 1) Write a title "Food Web: <Insert 1st Park Title>" and "Food Web: <Insert Yellowstone Nat'l Park>" above the appropriate food web.
- 2) Include the **Cougar** and the other animals from the tables for each park.
- 3) Add arrows and labels to illustrate what species eat what species and what species compete with what species in each diagram. Write a figure description explaining what the diagram shows.
- 4) Next to each animal in each diagram, include an A, C, U or R to indicate if the species is abundant, common, uncommon, or rare.

After completing your two diagrams of food webs in the two park ecosystems, think about the interactions among species they show. **Answer the following questions:**

- A) Does the Cougar have a different or similar community of carnivore competitors in the Santa Monica Mountain Recreation Area and Yellowstone National Parks? Explain your answer by describing both Presence/Absence and Abundance of other large carnivores.
- B) In a Cougar's daily life, how might the differences of the food web between Santa Monica Mountain Recreation Area and Yellowstone National Park affect the Cougar's behavior?
- C) Imagine a Cougar mama has a litter of cubs. Are there different dangers to her cubs in Santa Monica Mountain Recreation Area than in Yellowstone National Park? How do you think this could affect her behavior?



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Bighorn Canyon National Recreation Area

The 2022 March Mammal Madness WILD North America **BIGHORN SHEEP** is from the Bighorn Canyon National Recreation Area in Wyoming and Montana. This public land has multiple ecosystems including high desert juniper and sagebrush, montane forest, and great plains of prairie grasses and wildflowers. Within this system, bighorn sheep are herbivores that eat plants and stay vigilant for predators. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the bighorn sheep in the park ecosystem.

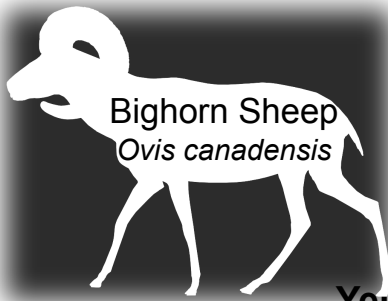
- 1) Select your park (Bighorn Canyon National Recreation Area), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, bighorn sheep are herbivores that eat plants and stay vigilant for predators. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the bighorn sheep in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

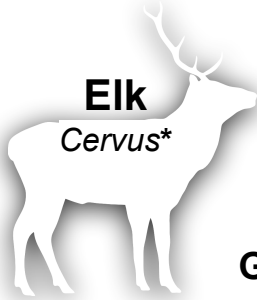
List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):







Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Great Smokey Mountains National Park

The 2022 March Mammal Madness WILD North America **ELK** is from the Great Smokey Mountains National Park in Tennessee. Five forest types within the park support over 1,500 species of flowering plants and at least 4,000 non-flowering varieties. Within this system, elk are herbivores that eat plants. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the elk in the park ecosystem.

- 1) Select your park (Great Smokey Mountains National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):

\*Elk species and subspecies designations are not always used consistently among scientists & wildlife managers



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Yellowstone National Park

The 2022 March Mammal Madness WILD North America **ELK** is from the Great Smokey Mountains National Park in Tennessee. Five forest types within the park support over 1,500 species of flowering plants and at least 4,000 non-flowering varieties. Within this system, elk are herbivores that eat plants. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the elk in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

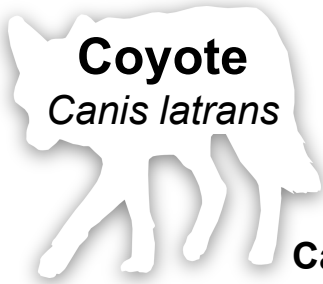
List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):

\*Elk species and subspecies designations are not always used consistently among scientists & wildlife managers





Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Cayuhoga Valley National Park

The 2022 March Mammal Madness WILD North America **COYOTE** is from Cuyahoga Valley National Park in Ohio. The Park includes forest and grassland, as well as river and wetland ecosystems. Within this system, coyote are omnivores eating a mix of plants and smaller prey. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the coyote in the park ecosystem.

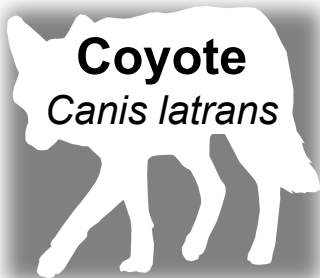
- 1) Select your park (Cayuhoga Valley National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Class \_\_\_\_\_  
 Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, coyote are omnivores eating a mix of plants and smaller prey. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the coyote in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



# Yellow-Bellied Marmot

*Marmota flaviventris*

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

Teacher \_\_\_\_\_

## Great Basin National Park

The 2022 March Mammal Madness WILD North America **MARMOT** is from Great Basin National Park in Nevada. The area includes desert, sagebrush scrub, and forest ecosystems. Within this system, marmots are herbivores, eating plants, and staying vigilant for predators. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the badger in the park ecosystem.

- 1) Select your park (Great Basin National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



# Yellow-Bellied Marmot

*Marmota flaviventris*

Name \_\_\_\_\_

Date \_\_\_\_\_

Class \_\_\_\_\_

Teacher \_\_\_\_\_

## Yellowstone National Park

Within this system, marmots are herbivores, eating plants, and staying vigilant for predators. Working in a group, go to [irma.nps.gov/NPSpecies/Search/SpeciesList](http://irma.nps.gov/NPSpecies/Search/SpeciesList) and look up other mammal species that live alongside the badger in the park ecosystem.

- 1) Select your park (Yellowstone), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables below. Make sure the species is currently confirmed to be in the park from the "Occurrence" column
- 3) Note if the species is Abundant (A), Common (C), Uncommon (U), or Rare (R) next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			

List any Rodent, Rabbit/Hare, or Hoofed Mammal Primary Consumers that were historically present that are no longer (although not all historically present species will always be listed):

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

List any Secondary, Tertiary, or Apex Consumers that were historically present that are no longer (although not all historically present species will always be listed):



# ECOSYSTEMS: Interactions, Energy, and Dynamics



## March Mammal Madness Combatants & their Ecosystems!



# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Interdependent Relationships in Ecosystems

- A. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- B. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- C. Growth of organisms and population increases are limited by access to resources.



Sourced from <https://doi.org/10.17226/13165>. Image by Robert Jensen

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Interdependent Relationships in Ecosystems

Ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment.

For example, plants through photosynthesis turn sunlight into energy, get nutrients from soil, and collect water from soil and air to maintain cellular functions.



Sourced from [Physio.org](https://www.physio.org); Margo Matusz; Stefan Tancor; Sigi M. Basky; Barak; Chae Seonho; An Ignorant About CC BY 4.0

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Interdependent Relationships in Ecosystems

As with individual organisms, a hierarchical structure exists;

- 1) Groups of the same organisms (species) form populations
- 2) Different populations interact to form communities
- 3) Communities live within an ecosystem
- 4) All of the ecosystems on Earth make up the **biosphere**.

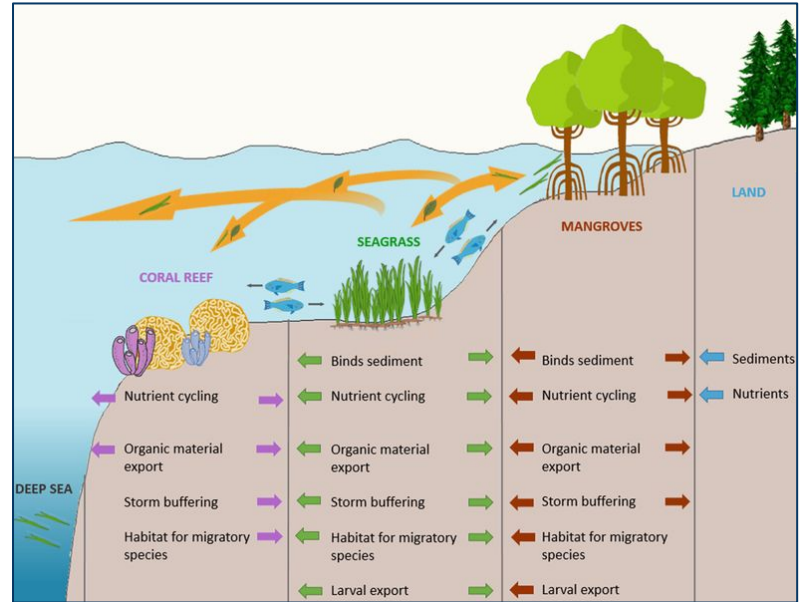


Illustration from Physiologic: Margo Meluso, Steven Towner, Sigmund, Binky Barnes, Chase Sorenson, An Ignorant Artist CC-BY



# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Interdependent Relationships in Ecosystems

Within a community food web, animals have traits that help them get their food- vision and smell help animals find and identify food; mouths, teeth, and/or beaks can help animals get and break down their food, and animals' organs digest food.

Animals also have traits to avoid becoming someone else's food- predator detection, escape, & defense.

In Kgalagadi Transfrontier Park in the Kalahari desert in South Africa, Botswana, and Namibia, the lion as predator is using physical traits of claws, strength, & teeth after a behavioral predator tactic of ambush



while the eland is using physical traits of hard hooves, strength, and behavioral tactic of anti-predator kicking to try and escape.



Silhouettes from Physiology: Margo Moulton, Steven Troner, Sigm M. Bailey, Barbara, Chris Sorenson, An (Source: Alamy.com)

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Interdependent Relationships in Ecosystems

Within a community food web in addition to getting things from “lower on the food chain” and avoiding species “up the food chain,” there can be **competition for resources with other organisms** that eat the same things.

For example, monkeys and megalabats in the same ecosystem are often eating the same fruits; both coyotes and bobcats often hunt rodents and rabbits.

## Baltic Sea Food Web

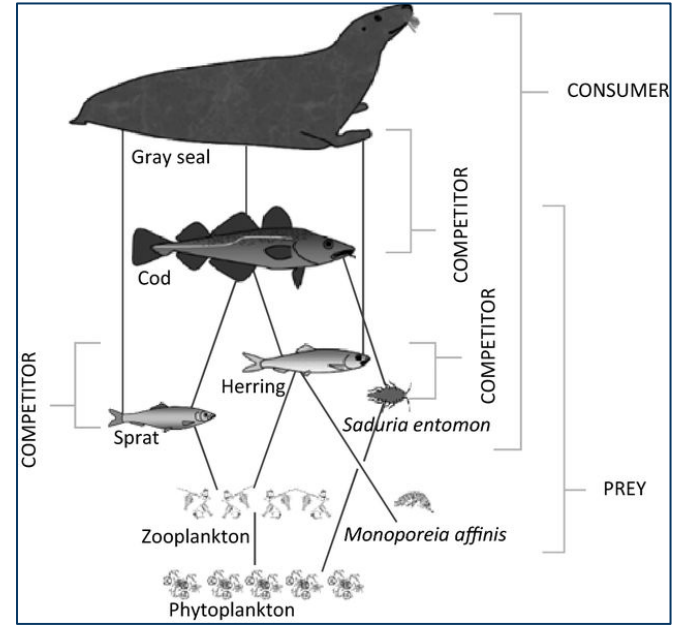


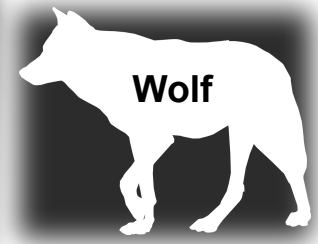
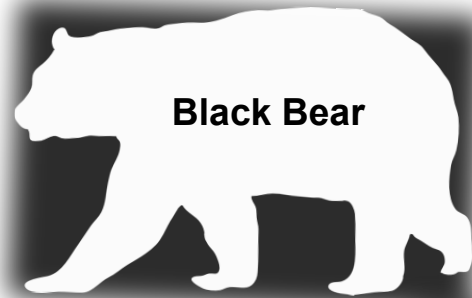
Illustration from PhyloPic.org: Margo Mearns, Steven Triller, Sigmund, Blake Bonker, Chris Sorenson, An Ignorant Artist CC-BY



# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America

The WILD North America Division in the 2022 Tournament features species populations that live in specific Federal Public Lands, including National Parks, National Forests, and Recreation Areas.



Silhouettes from PhyloPic.org: Margo Motta; Steven Troner; Sage M. Basky Barnes; Chase Bennett; An Ignorant Artist CC BY-SA 4.0

# AMERICA'S PUBLIC LANDS

Public lands are areas of land and water that today are owned collectively by U.S. citizens and managed by government agencies.

Across the country, more than **640 million acres** are parks, forests, preserves, and historic sites that are open to the public.

Lands can be protected for recreation and conservation, preserved for their cultural significance, for wildlife, and the intrinsic value of the ecosystem.



Most federal public lands are managed by four agencies: National Park Service, Forest Service, Bureau of Land Management, and Fish and Wildlife Service within the Department of the Interior

# The World's FIRST National Park

March 1, 2022 is the 150th Anniversary of the founding of Yellowstone National Park

Yellowstone National Park was established to preserve and protect the scenery, cultural heritage, wildlife, geologic and ecological systems and processes in their natural condition for the benefit and enjoyment of present and future generations.



# The World's **FIRST** National Park

**March 1, 2022 is the 150th Anniversary of the founding of Yellowstone National Park**

Yellowstone serves as the core of the Greater Yellowstone Ecosystem, **one of the last and largest nearly intact natural ecosystems on the planet.**

Yellowstone has the most active, diverse, and intact collections of combined geothermal features with over 10,000 hydrothermal sites and half the world's active geysers.





# The World's FIRST National Park

Based on the park's location at the convergence of the Great Plains, Great Basin, and Columbia Plateau, **27 Native American Tribes** have historic and modern connections to the land and its resources.

Since at least 10,000 years before Yellowstone became a national park, Native Americans lived, hunted, fished, gathered plants, quarried obsidian, and used thermal waters for religious and medicinal purposes and continue cultural practices in Yellowstone.

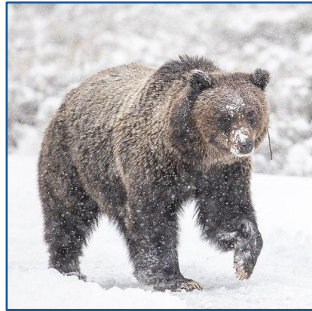
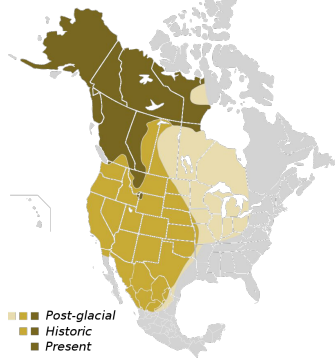
**For over 10,000 years before colonization, people existed in balance within the Yellowstone Ecosystem**

Nez Perce tribe members & NPS Rangers during a commemoration of the Nez Perce Trail.

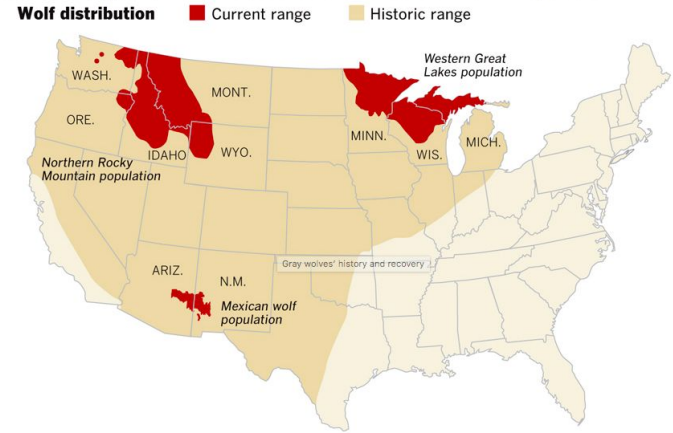
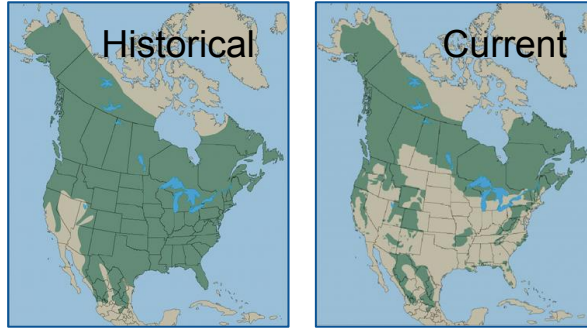


# Ecosystem Disturbances

## Grizzly Bear Historical & Today's Distribution



## Black Bear Distribution





# Ecosystem Disturbances

The loss of major predators in forest ecosystems has allowed game animal populations to greatly increase, **limiting the growth of young trees and reducing biodiversity.**

Densities of large mammalian herbivores were six times greater in areas without wolves

Loss of major predators contributes to deforestation and results in less carbon sequestration, a climate change concern.



# Ecosystem Interactions

Large predators can help maintain native plant communities by keeping large herbivore densities in check, allow small trees to survive and grow, reduce stream bank erosion, and contribute to the health of forests, streams, fisheries and other wildlife.



[Loss of predators affecting ecosystem health](#)

Image: Neal Herbert



# Ecosystem Interactions

Combinations of predators, such as wolves and bears have important interactions for maintaining ecosystem balance:



"Wolves can provide food that bears scavenge, helping to maintain a healthy bear population," said Robert Beschta, professor emeritus at OSU, "The bears then often prey on young moose, deer or elk - in Yellowstone more young elk calves are killed by bears than by wolves, coyotes and cougars combined."

# Yellowstone Wolf Recovery Program

Late 1800s–early 1900s: predators, including wolves, are routinely killed in Yellowstone.

1926: The last wolf pack in Yellowstone is killed

1974: The gray wolf is listed as endangered; recovery is mandated under the Endangered Species Act.

1975: The long process to restore wolves in Yellowstone begins.

1991: Congress appropriates money for wolf recovery.

1995 and 1996: 31 gray wolves from western Canada relocated to Yellowstone.

**1995 and 1996: 31 gray wolves from western Canada relocated to Yellowstone.**

2008-Present Day: Repeated de-listing & re-listing of wolves as endangered species



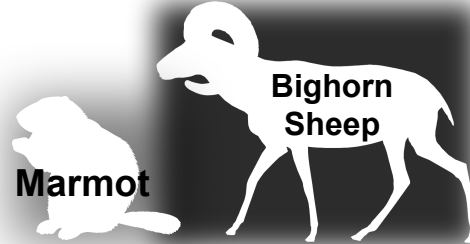
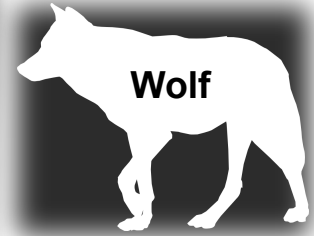
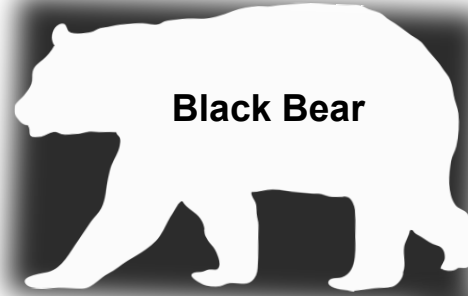
**Current population of wolves in Yellowstone: 89**

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America

The WILD North America Division in the 2022 Tournament features species populations that live in specific Federal Public Lands, including National Parks, National Forests, and Recreation Areas, but many of these areas have **impacted ecosystems**.

In this activity, students research the specific ecosystems of the combatant and the other mammal species in their ecosystem and compare these to the more intact/recovered ecosystem of Yellowstone National Park.



# ECOSYSTEMS: Interactions, Energy, and Dynamics

**CARNIVORES:** cougars, wolves, coyotes, otters, badgers, bears, foxes, bobcats, weasels

**HOOFED MAMMALS:** elk, deer, bison, bighorn sheep, moose

**BUNNIES:** rabbits, hares, pika

**RODENTS:** mice, rats, beavers, marmots, squirrels, lemmings

Scientific Term

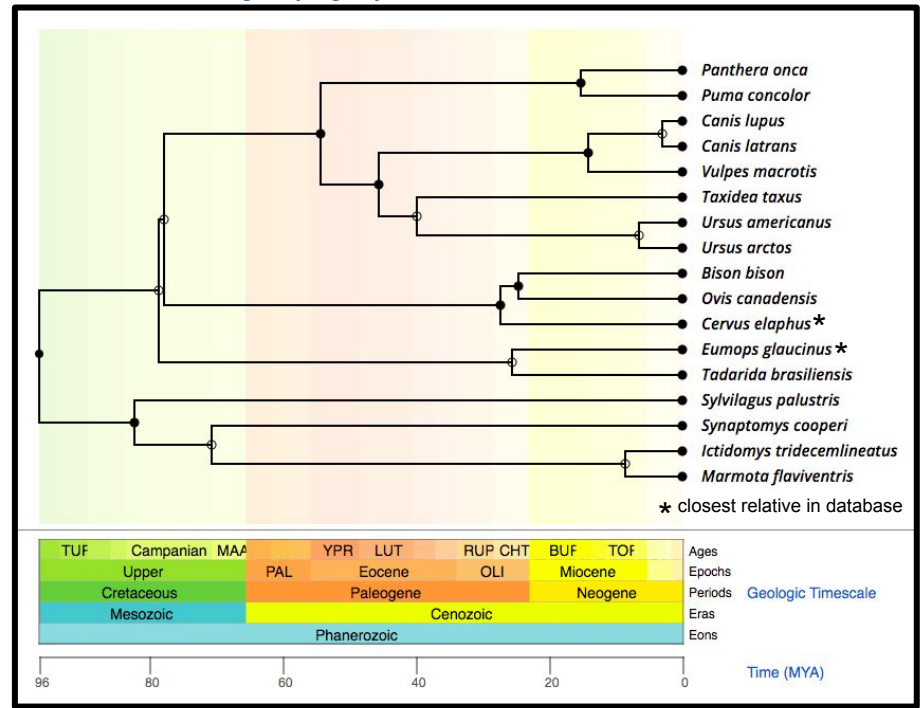
**CARNIVORA**

**ARTIODACTYLA**

**LAGOMORPHIA**

**RODENTIA**

TimeTree.org Phylogeny of WILD North America Division 2022





# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Scientific Term

### **CARNIVORA**

**Large** bear, cougar, wolf,  
**Medium** coyote, otter, badger, fox, bobcat,  
raccoon, skunk, fisher  
**Small** weasel, stoat, ferret, mink, pine martin

### **ARTIODACTYLA\***

**Extra Large** bison, moose  
**Large** elk, deer, bighorn sheep, mountain goat,  
pronghorn

### **LAGOMORPHIA**

**Medium** rabbit, hare, cottontail  
**Small** pygmy rabbit, pika

### **RODENTIA**

**Medium** beaver, marmot, porcupine,  
**Small** mice, rats, squirrels, woodrat, chipmunks,  
flying squirrel, voles



Bobcat with Ground Squirrel



Ground Squirrel with Grass

\*Hoofed Mammals are typically Large-Extra Large in North America

Top Image by Alan Schmierer  
Bottom Image by Brocken Inaglori

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America

**NPSpecies**  
Information on Species in National Parks  
Part of IRMA

National Park Service  
U.S. Department of the Interior  
Natural Resource Stewardship and Science

Home Search Parks Reports Add-Edit Help Contact Us

Home > Search > Get a Park Species List [ Log On ]

### Search for a Park Species List

**Search Criteria**

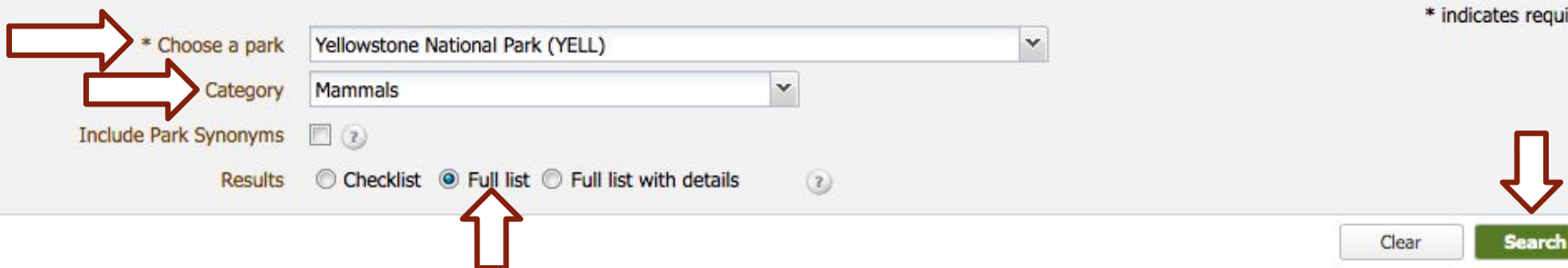
\* Choose a park  \* indicates required

Category

Include Park Synonyms

Results  Checklist  Full list  Full list with details

Clear Search



Website URL: <https://irma.nps.gov/NPSpecies/Search/SpeciesList>

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America

Results

Restore default sort order sorted by Category Sort, Order, Family, and Scientific Name Download Report/PDF

Order	Family	Scientific Name	Common Names	Record Status	Occurrence	Nativeness	Abundance
Artiodactyla	Antilocapridae	<i>Antilocapra americana</i>	antelope, pronghorn	Approved	Present	Native	Common
Artiodactyla	Bovidae	<i>Bison bison</i>	bison, buffalo	Approved	Present	Native	Abundant
Artiodactyla	Bovidae	<i>Oreamnos americanus</i>	mountain goat, Mountain Goat, Ro...	Approved	Present	Non-native	Uncommon
Artiodactyla	Bovidae	<i>Ovis canadensis</i>	bighorn sheep, Bighorn Sheep	Approved	Present	Native	Uncommon
Artiodactyla	Cervidae	<i>Alces alces</i>	Eurasian Elk, moose	Approved	Present	Unknown	Uncommon
Artiodactyla	Cervidae	<i>Alces alces shirasi</i>	Yellowstone moose	Approved	Present	Native	Uncommon
Artiodactyla	Cervidae	<i>Cervus elaphus</i>	Rocky Mountain Elk	Approved	Present	Native	Abundant
Artiodactyla	Cervidae	<i>Odocoileus hemionus</i>	mule deer, Mule Deer	Approved	Present	Native	Abundant
Artiodactyla	Cervidae	<i>Odocoileus virginianus</i>	white-tailed deer, White-tailed Deer	Approved	Present	Unknown	Uncommon
Carnivora	Canidae	<i>Canis latrans</i>	Coyote	Approved	Present	Native	Abundant
Carnivora	Canidae	<i>Canis lupus</i>	Gray Wolf, Wolf	Approved	Present	Native	Common
Carnivora	Canidae	<i>Vulpes vulpes</i>	Red Fox	Approved	Present	Unknown	Common
Carnivora	Felidae	<i>Lynx canadensis</i>	Canada lynx, Canadian Lynx, lynx	Approved	Present	Native	Rare
Carnivora	Felidae	<i>Lynx rufus</i>	Bobcat	Approved	Present	Native	Uncommon

Page 1 of 1 Displaying 1 - 78 of 78

# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America



- 1) Select your park (Hot Springs National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables. Make sure the species is currently confirmed to be in the park from the “**Occurrence**” column
- 3) Note if the species is **Abundant (A)**, **Common (C)**, **Uncommon (U)**, or **Rare (R)** next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

PRIMARY CONSUMERS			
Body Size	Small	Medium	Large
Order	Rodentia	Lagomorph or Rodent	Artiodactyla
Species Common Name			
Species Common Name			
Species Common Name			



# ECOSYSTEMS: Interactions, Energy, and Dynamics

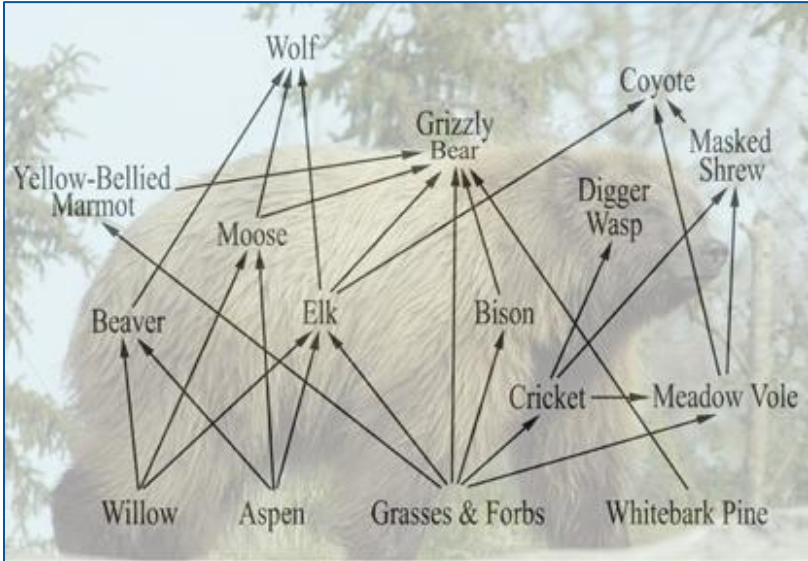
## Ecosystems of 2022 March Mammal Madness Combatants in WILD North America



- 1) Select your park (Yellowstone National Park), category (Mammals), click circle for full list. The list will have dozens of species, many with familiar names
- 2) Find species and fill in species common names that match the criteria to complete the tables. Make sure the species is currently confirmed to be in the park from the “**Occurrence**” column
- 3) Note if the species is **Abundant (A)**, **Common (C)**, **Uncommon (U)**, or **Rare (R)** next to their common name.
- 4) Cross out the remaining box(es) if there are fewer than 3 species that meet the criteria in each table column

SECONDARY, TERTIARY, & APEX CONSUMERS			
Body Size	Small	Medium	Large/XL
Order	Carnivora	Carnivora	Carnivora
Species Common Name			
Species Common Name			
Species Common Name			

# ECOSYSTEMS: Interactions, Energy, and Dynamics



# ECOSYSTEMS: Interactions, Energy, and Dynamics

## Further Reading for Interested Students

- [Assessing the Ecological Health of the Greater Yellowstone Ecosystem](#)
- [Traditional Lands Maps](#)

## Additional Slides for expanding the assignment:



Silhouettes from PngKing.com; Margo Maluco, Steven Towner, Sage M. Bailey Barnes, Chase Scoville, An Ignorant Abroad CC BY 3.0

# ECOSYSTEMS: Interactions, Energy, and Dynamics

**Climate Change**

Home   Our Strategy ▾   **Understand the Science** ▾   Adapt to Change ▾   Mitigate the Cause ▾   Share the Story ▾   Our Program

**Effects in Parks** ▶

- Recent Climate Exposure ▶
- Bird Response to Climate Change
- Park Visitation and Climate Change
- Eastern Forest Vulnerability
- Advancing Spring Onset
- Sea Level Change
- Wildland Fire

*NPS.gov / Home*

## Climate Change

The National Park Service is responding to the challenges of climate change by protecting imperiled species, enhance visitor infrastructure, and protect our parks for the benefit of all visitors.

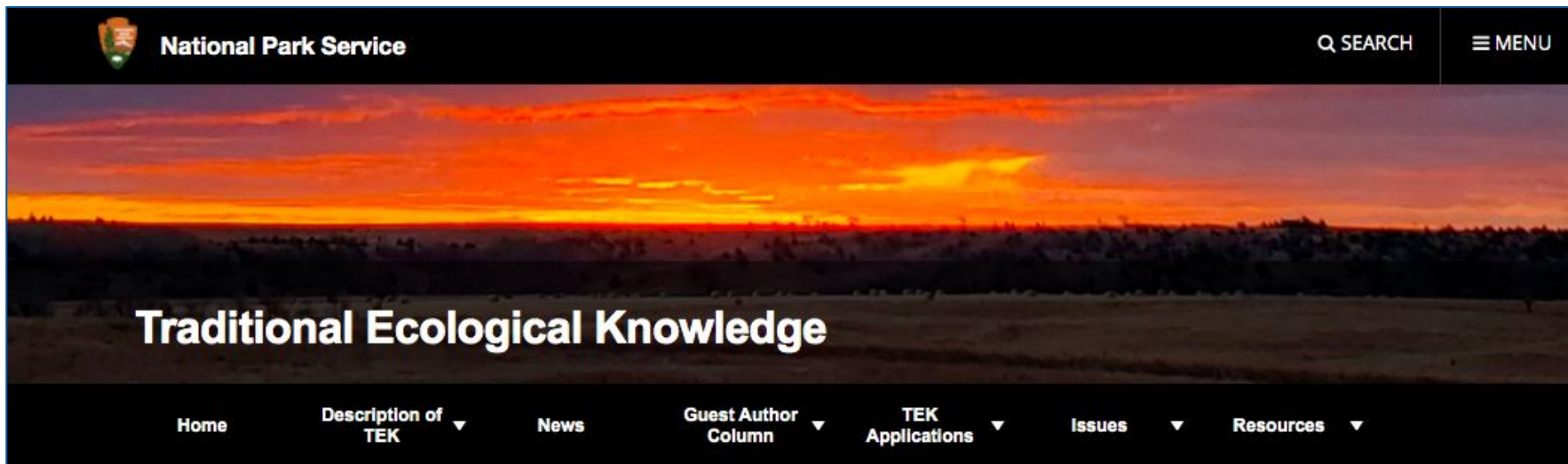
But as human activity drives rapid changes to our modern climate, the National Park Service is rising to the challenge with a comprehensive strategy that

## Parks

Efforts to restore ecosystems, recover from the impacts it brings to our parks.

Life Science Core Concepts sourced from the National Academies of Sciences, Engineering, and Medicine. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13165>.

# ECOSYSTEMS: Interactions, Energy, and Dynamics



“Traditional Ecological Knowledge (TEK) is the on-going accumulation of knowledge, practice and belief about relationships between living beings in a specific ecosystem that is acquired by Indigenous people over hundreds or thousands of years through direct contact with the environment, handed down through generations, and used for life-sustaining ways. This knowledge includes the relationships between people, plants, animals, natural phenomena, landscapes, and timing of events for activities such as hunting, fishing, trapping, agriculture, and forestry. It encompasses the world view of a people, which includes ecology, spirituality, human and animal relationships, and more. TEK is also called other names, such as Indigenous Knowledge and Native Science.”