

FOCUS QUESTIONS

- How do apex predators influence their ecosystems?
- What are the implications for a species with a large geographic range when its habitats become fragmented?
- What important ecological processes can be restored by building and maintaining corridors that connect fragmented habitats?

WILDHOPE EDUCATOR GUIDE

OVERVIEW

"When I was a young kid, I would go in the forest with my father, sometimes my grandfather, and they would tell me stories about the jaguar." "We have a sense of pride that this apex predator is still with us, but the jaguar is losing its home." Ray Cal, Wildlife Ecologist, Runaway Nature Reserve, Belize

In *Jaguar Passage* we learn that the Jaguar is the largest cat in the Americas and, as the region's apex predator, it functions to keep other animal populations under control. However, human expansion has caused forest habitat loss and fragmentation throughout the jaguar's historical range, reducing their populations and eroding the important impact they have on their ecosystem and its processes. Fortunately, wildlife ecologist Ray Cal and conservation biologist Emma Sanchez are part of a team of organizations that are working to photograph, collar, and track jaguars to learn more about their movements. The large team also works to purchase, restore, and protect habitat that allows jaguars to move more freely and safely throughout their range.

KEY CONCEPTS

- Habitat loss and fragmentation: Over the last 100 years a combination of logging, clearing for agriculture, and urbanization has reduced jaguar habitat throughout the Americas by 50% of its original area and much of the remaining jaguar habitat is fragmented. For example, a recent study from the Atlantic Forest of Brazil found that 85% of the jaguar's habitat there has been lost with only half of what remains still in good condition.
- Apex predators: Animals that are at the top of their food chains and have no natural predators of their own are known as apex predators. Jaguars are the primary apex predator of the tropical forest ecosystems of South and Central America and by way of multiple food web pathways they play a crucial role in maintaining the biodiversity and ecosystem processes throughout the habitats they occupy.
- Ecosystem ecology: Understanding how living organisms interact with each other and their physical environment within a specific natural system is essential for reversing and restoring the Earth's degraded habitats and the essential functions they provide for wildlife.
- Corridor ecology: Wildlife have many reasons for needing to travel across large swaths of land but human activity has removed that ability by fragmenting large contiguous ecosystems into small isolated island habitats while also bisecting the fragments with roads and highways which create dangerous barriers to animal movement. Corridor ecology studies how and why animals move throughout the Earth's landscapes and how we can restore this essential ecosystem process.
- Biodiversity: Habitat fragmentation has created barriers to the movement of wildlife across landscapes which reduces the genetic diversity and health of isolated populations. Many species that find themselves in small isolated patches are unable to maintain large enough populations and species with more fragmentation are at greater risk of extinction. For example, nearly 30% of mammal species, including jaguars, are globally at risk of extinction and habitat fragmentation is a primary driver of this risk.
- Genetic diversity: The small populations of jaguars that remain in the Americas are often isolated from each other. This isolation puts them at risk of genetic drift which can cause the random loss of genetic diversity. Connecting these populations with habitat corridors can help restore gene flow throughout the greater jaguar range.



• Conservation biology: The practice of conservation biology recognizes the intrinsic value of the Earth's natural diversity of organisms. Conservation biology works to understand how the natural world operates, how humans affect nature, and how we can use collective scientific and cultural knowledge to conserve Earth's biological diversity. Restoring and maintaining wildlife corridors can protect some of the natural migration patterns of animals like jaguars. The ability to move safely among fragments can ensure access to resources as well as maintain gene flow among populations.

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BACKGROUND

The jaguar (*Panthera onca*) is the largest cat species in the Americas and plays a crucial role as an apex predator throughout its range where it helps maintain the structure and function of tropical forest ecosystems. Jaguars are primarily found in dense rainforests like the Amazon but historically they could be found from the Grand Canyon of Arizona all the way south to the grasslands of Argentina. Jaguars are solitary and territorial animals with males occupying larger ranges than females. They are considered opportunistic predators and their diets can include over 85 different species of animals, ranging from deer and capybaras to caimans and turtles. Jaguars require large, contiguous habitats for survival which has become a significant challenge over the last 100 years due to deforestation, habitat fragmentation, agricultural expansion, and poaching as a result of human-jaguar conflicts. These threats have led to the jaguar's classification as Near Threatened on the IUCN Red List. Corridors that connect isolated jaguar populations are critical to maintaining their genetic diversity and long-term viability. Jaguar conservationists emphasize the importance of protected areas, sustainable land use practices, and community engagement to mitigate threats and ensure a more peaceful coexistence between jaguars and humans.

In *Jaguar Passage* we meet two of these important jaguar conservationists, wildlife ecologist Ray Cal and conservation biologist Emma Sanchez. Ray Cal is a Maya person who grew up surrounded by nature in southern Belize. He is now the manager of Runaway Creek Nature Reserve in central Belize, which is an important part of the Maya Forest Corridor that connects the country's two major jaguar conservation units. At Runaway Creek Ray is in charge of field operations and maintaining security, so that the nature preserve continues to stay a model wildlife haven and important corridor for jaguar movement. Emma Sanchez grew up in northern Belize and joined the Panthera organization as an intern in 2011 while she was a student at the University of Belize. Panthera is a non-profit organization dedicated to the conservation of the world's wild cats and their ecosystems and works to protect all 40 species of wild cats and the landscapes they depend on. The seven big cats Panthera focuses on are cheetahs, leopards, lions, pumas, snow leopards, tigers, and jaguars. Emma coordinates the Panthera organization for Belize where she spends hours trekking in the field setting up camera traps and analyzing data at Panthera's Belize office to study how well the Maya Forest Corridor is functioning for the jaguars.

Ray and Emma are part of a team of organizations that are working to photograph, collar, and track jaguars to learn more about their movements. The large team also works to purchase, restore, and protect habitat that allows jaguars to move more freely and safely along habitat corridors throughout their range. Corridors can provide many important benefits for wide-ranging species like jaguars, not the least of which is genetic exchange through gene flow. Without genetic exchange, small and isolated populations can experience increased genetic drift and inbreeding which can negatively impact sperm production, female fecundity, and overall mating ability. These deleterious effects can reduce the overall fitness of a population and its adaptive potential which can increase its risk of extinction. However, as we learn more about in *Jaguar Passage*, the overall goal that Ray and Emma are a part of is to one day reconnect jaguar habitat from Mexico, through Belize, and all the way to Argentina.



BIODIVERSITY THREATS

The major threats to the Earth's biodiversity can be grouped into seven categories that spell the easily recalled acronym H.I.P.P.O.: Habitat destruction and fragmentation, Introduced species, Pollution, Population growth, and Overharvesting. Many species are threatened by a combination of these factors, but habitat loss is the greatest threat to biodiversity. In *Jaguar Passage* we learn that habitat loss and fragmentation has decimated the populations of the largest cat in the Americas, the jaguar, driving it to extinction in some locations. Jaguars used to be found from the Grand Canyon of Arizona all the way south to the grasslands of Argentina. However, this historic range has shrunk to 50% of what it used to be.

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DISCUSSION QUESTIONS

- [Before showing the film or telling students the title of the film] Have students work together to make a list of all the different species of cats they can think of. From this collective class list, have students identify which of the species they think are apex predators and which of those apex predators are of conservation concern: endangered or threatened.
- After showing the film, remind students that 35% of the land area of Belize is protected, then ask them to discuss why this large land area is not sufficient for jaguar conservation.
- Have students discuss what kinds of information about the jaguars are being provided by the use of GPS collars and camera traps. Then ask students to brainstorm what additional research they think could help with the conservation of the jaguar populations.
- As an extension activity, have students visit the Panthera organization website and read more about their conservation efforts of the jaguar. Students can also investigate the conservation concerns and efforts to preserve an additional 39 cat species from all over the world.
- As another extension activity, have students research the Yellowstone to Yukon Conservation Initiative (y2y.net) and determine the following: (i) the geographic area the y2y group is working to conserve and protect and what political and indigenous areas it encompasses; (ii) the species and types of habitat the group's efforts are focused on; (iii) the types of human communities the group is working with to achieve their goals; (iv) the vision of the *nature positive* approach.

Curriculum Connections

NGSS

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- LS2.D: Social Interactions and Group Behavior
- LS4.D: Biodiversity and Humans

HS-LS3 Heredity: Inheritance and Variation of Traits

- LS3.B: Variation of Traits
- HS-LS4 Biological Evolution: Unity and Diversity
 - LS4.C: Adaptation
- ETS1.B: Developing Possible Solutions

AP Biology (2021)

Enduring Understandings

- Energetics (ENE)
 - ENE-4: Communities and ecosystems change on the basis of interactions among populations and disruptions to the environment.
- Systems Interactions (SYI)
 - SYI-1: Living systems are organized in a hierarchy of structural levels that interact.



- SYI-2: Competition and cooperation are important aspects of biological systems.
- SYI-3: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

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IB Biology (First Exam May 2025)

A. Unity and Diversity: Common ancestry has given living organisms many shared features while evolution has resulted in the rich biodiversity of life on Earth.

- A3.1 Diversity of organisms
- A4.2 Conservation of biodiversity

B. Form and Function: Adaptations are forms that correspond to function. These adaptations persist from generation to generation because they increase the chances of survival.

- B4.1 Adaptation to environment
- B4.2 Ecological niches

C. Interaction and Interdependence: Systems are based on interactions, interdependence and integration of components. Systems result in emergence of new properties at each level of biological organization.

• C4.1 Populations and communities

D. Continuity and Change: Living things have mechanisms for maintaining equilibrium and for bringing about transformation. Environmental change is a driver of evolution by natural selection.

• D4.2 Stability and change

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CREDIT

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