



## Richest Places on Earth (Biodiversity Hot Spots)

Middle School/High School Research Project

Time: Dependent on class schedule

**Introduction:** Biodiversity hotspots are the most ecologically rich areas on Earth, and yet cover a small fraction of land area. It is important to protect these hotspots in order to save these unique communities for future generations as well as ensure the health of all species on the planet.

**Background:** By understanding the importance of protecting biodiversity hotspots, students will grasp the concept of habitat degradation, human impact on the environment, endemic species, and biodiversity. They will also grasp the concept that humans depend on these hotspots for survival, even when they are on the other side of the world. Ecosystems are fragile and with human impacts, can be damaged forever.

**Assessment Opportunity:** Create an interactive poster board, power point presentation, or research paper using research of a particular hotspot, with accurate research of a hotspot definition, location of the hotspot, and what type of wildlife they can find.

**Getting Ready:** Prepare class for a research project and complete the tasks outlined in the procedure. Read through outline and details of the program beforehand. Individually or as a class, assign a biodiversity hotspot from top 10 most threatened places listed in the procedure below. If working individually, choose from the 36 options listed.

### Title: The Richest Places on Earth

**Theme:** Biodiversity hotspots are a new concept in science, emerging between 1988-1990, arising in Norman Myers concept within two articles in "The Environmentalist". These unique regions must adhere to two major criteria, with 0.5% endemic plant species and have lost 70% of primary vegetation to qualify as a hotspot. Currently, there are 36 identified biodiversity hotspots around the world.

These hotspots are some of the most magnificent representations of biodiversity on the planet, and also the most threatened places on Earth. They represent roughly 2.3% of the Earth's land surface, but support more than HALF of the world's endemic species, and 43% of bird, mammal, reptile, and amphibian endemic species. In total, biodiversity hotspots support 60% of the world's species.

**Objective:** Students will understand the definition of biodiversity, hotspots, and know where the greatest concentration of wildlife will be found. They will use research, evidence, and science to identify the threats to a specific ecosystem. They will also grasp concepts of environmental stewardship and responsibility to protect the planet.

**Resources:** Vocabulary list, lesson plan for MS or HS, research page, access to the internet for research, poster boards, example projects. Please use citations appropriate for the grade level for sources.

\*Note: Lesson plans and example projects are for classroom/teacher use only. Do not reproduce, redistribute, or post online at any time. With any questions please contact TCWR's Education Department: [education@tcwr.org](mailto:education@tcwr.org)

### **Middle School NGSS:**

MS-LS1-4: Students will research and gain empirical evidence and scientific reasoning of the importance of biodiversity hotspots, and how the diminishing habitat affects the success of reproduction in these regions.

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability in biodiversity hotspots, and the diminishing resources organisms and populations can obtain in a particular ecosystem.

MS-LS2-4: Construct their own arguments aided by empirical evidence that the loss of habitat and destruction of biodiversity hotspots change the physical, biological, and ecosystem, effecting the populations in a particular hotspot.

MS-LS4-4: Construct an explanation of endemic species in a specific biodiversity hotspot, and how these species have adapted to specific ecosystems, increasing their chance of survival and reproducing in that specific environment.

### **High School NGSS:**

HS-LS2-6: Research and evaluate claims, evidence, and reasoning for the complex interactions within a biodiversity hotspot, and how changing conditions in these environment can result on change or loss of an ecosystem.

HS-LS2-7: Design, evaluate, and refine a solution for reducing impacts on biodiversity hotspots due to human activity on the environment and biodiversity in a specific area.

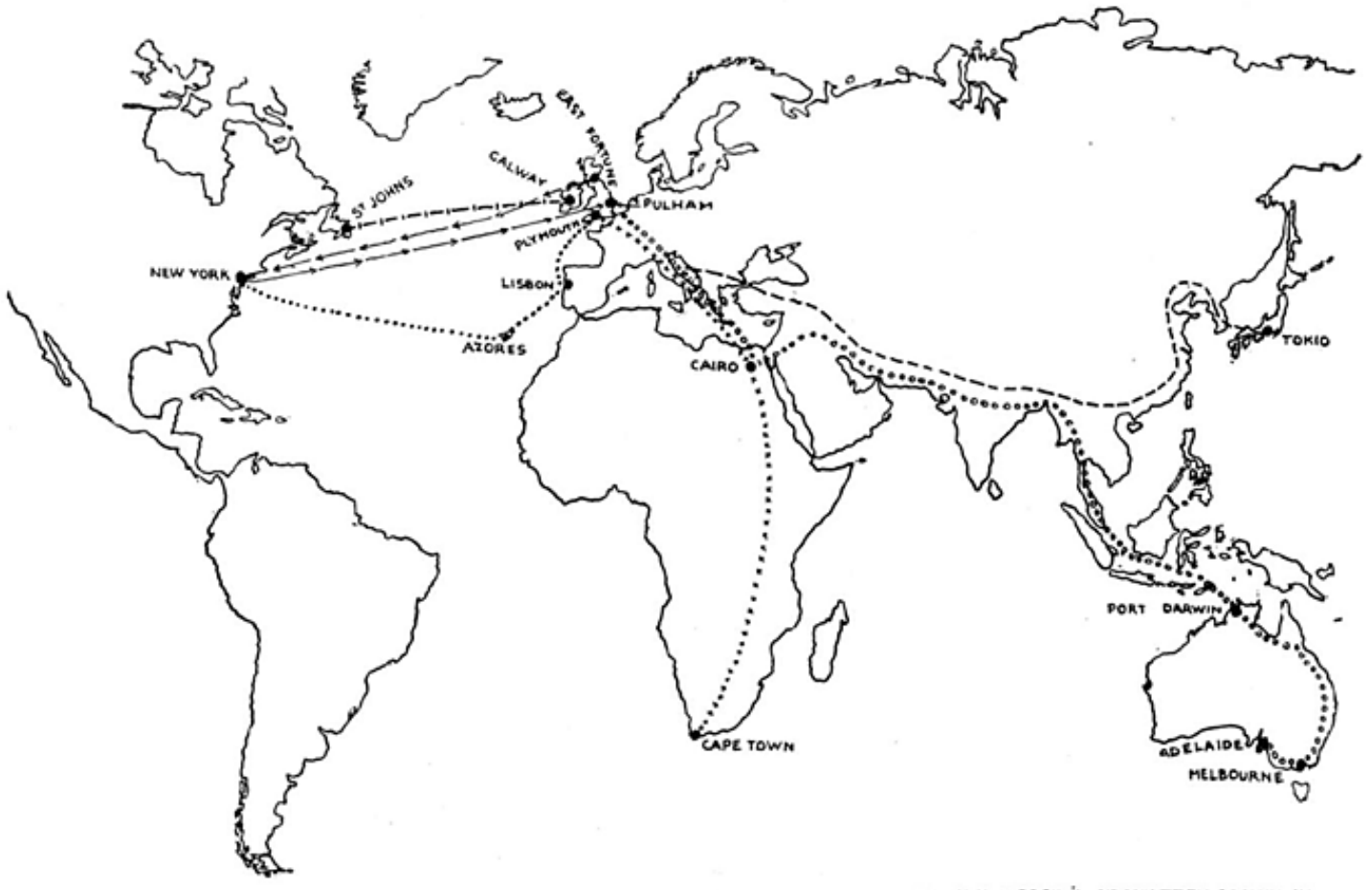
HS-LS3-3: Apply concepts of endemic species of a biodiversity hotspot, and explain the variation and distribution of these traits in a population within a specific hotspot.

HS-LS4-4: Construct an explanation based of evidence for how natural selection has led to endemic species within a particular hotspot, and how these species and populations have adapted to this ecosystem.

HS-LS4-5: Evaluate the evidence through individual or group research supporting the claims that changed in the environment within a biodiversity hot spot may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time (endemic), (3) the extinction of other species.



In the map of the world, circle which places you think that most of the plants and animals live on Earth.  
\*After completing the reading assignment, compare your map to the hotspot map provided.



Why did you pick these places?

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What about this part of the world made you think that species would live there?

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Do you think that the majority of species live where it is hot and humid, or cold and dry? Why?

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What do animals need for survival?

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How do the places on Earth that you picked provide what living things need to survive?

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## Student Research Procedure:

**Part A. Using the words below, research and define each vocabulary word, and use these definitions throughout your research project. Provide as much detail as possible for each definition.**

Biodiversity Hotspot, Biodiversity, Hotspot, Ecosystem, Biome, Exploitation, Urbanization, Endemic, Ecology, and Ecosystem Services.

**Part B:** Answer each question below pertaining to biodiversity hotspots through reading assignment provided.

- 1) When did the concept of biodiversity hotspots arise, and who discovered them?
- 2) Where are most biodiversity hotspots found in the world? Why do you think there is more biodiversity in these areas? (hint: near the equator)
- 3) What are the criteria for a biodiversity hotspot? Do you think that there are positive or negative consequences for these criteria?
- 4) How much land surface do biodiversity hotspots cover on Earth, and what percentage of species depend on these areas?
- 5) Why is biodiversity important? List 3 main reasons.
- 6) How would losing a biodiversity hotspot effect the human population?
- 7) What are the current conservation efforts pertaining to protecting biodiversity hotspots?
- 8) Brainstorm and discuss ways that we can protect these hotspots for the future.

**Part C. Choose as a group or individually which hotspot to conduct a research project. A project can include a power point presentation, a poster board, or a research paper.**

Top 10 World's Most Threatened Biodiversity Hotspots:

- 1) Atlantic Forest- Brazil Paraguay Argentina
- 2) Cape Floral Region-South Africa
- 3) Cerrado-Brazil
- 4) Coastal Forests Eastern Africa
- 5) Himalaya- Nepal, Buhtan, Pakistan, Bangladesh, Myanmar, China
- 6) Indo-Burma-Myanmar, Thailand, Cambodia, Vietnam, India, China
- 7) Madrean Pine-Oak Woodlands, Mexico
- 8) Mesoameria-Mexico, Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica, Panama
- 9) Polynesia-Micronesia, Southern Pacific Ocean
- 10) Philippines, Pacific Ocean





## Reading Assignment: Part B

The concept of biodiversity hotspots is new, arising in Norman Myers concept within two articles in “The Environmentalist” in 1988 and 1990. These regions must adhere to two major criteria, with 0.5% endemic plant species and have lost 70% of primary vegetation to qualify as a hotspot. Currently there are 36 areas that qualify throughout the world.

More species are found in tropical regions rather than temperate or polar regions. These are distinguished by the latitudinal biodiversity gradient. Many hotspots are located in the moist tropical forests, which exhibit the Earth’s most diverse and major biomes. Areas that are physically bounded by deserts or mountain regions have facilitated the evolution of endemic species by keeping species isolated. Hotspots also have a wide variety of topography, producing a broad range of climate conditions.

Without biodiversity and species, there would be no air to breathe, no food to eat, and no water to drink. Humans depend heavily on biodiversity and ecosystem services to survive. Biodiversity hotspots are critical for human survival. Gaining a better understanding for these ecological communities is crucial for conservation planning and maintaining these oases for future generations.

Hotspots are among the richest and most important ecosystems in the world. They are home to extremely vulnerable populations who are directly dependent on nature to survive. It is predicted that hotspots account for 35% of the ecosystem services in which the human population depends on.

Biodiversity hotspots are some of the most magnificent representations of biodiversity on the planet. They serve as important breeding grounds and foraging habitat for threatened and endangered flora and fauna. Hotspots represent roughly 2.3% of the Earth’s land surface, but support more than HALF of the world’s endemic place species as well as 43% of bird, mammal, reptile, and amphibian endemic species. In total biodiversity hotspots support 60% of the world’s species.

This area is continually shrinking due to many threats facing the location and species inhabiting them. These areas have become vital focuses on conservation efforts due to the vast array of species in such a small area.

There are around 2 billion people that live and directly depend on the health of surrounding ecosystems for their livelihood and overall wellbeing. The hotspots provide crucial ecosystem services for human life such as clean water, pollination, and climate regulation.

The most ecologically rich places on Earth are also the most threatened for survival. A biodiversity hotspot includes areas around the world that have a vast concentration of endemic species. The threats these hotspots face habitat destruction, fragmentation, human encroachment, the illegal exotic animal trade, and climate change.

Marine biodiversity hotspots are greatly threatened by human pollution due to land base sources, climate change causing an increase in water temperatures and increasing acidification, and downstream effects of forest loss, construction, and expansion of agriculture. Marine hotspots are more likely to occur in upwelling systems, coral reefs, and continental shelves where tropical and temperate habitats meet.



In the next 100 years, the predicted rate of extinction of fauna and flora in hotspots is an average of 11.6%. With an increase of severe weather events in the future, hotspots are incredibly vulnerable.

### **Why Protecting is Important:**

Species are the building blocks of the Earth's life-support systems, and we all depend on them for survival. Today, species are going extinct at an extremely fast rate since the mass extinction of dinosaurs, and we are entering the 6<sup>th</sup> mass extinction entirely caused by a single species, humans. This period in time is called the Anthropocene, where humans will have a direct impact on the fossil record.

Biodiversity is not evenly distributed around the planet, and identifying the hotspots or greatest concentration of species within a small area allows conservationists to prioritize the areas in need of the most protection. Securing the 36 regions has an enormous impact on conserving species that have the greatest impact on global biodiversity. This 2.3% of land surface on Earth is extremely important to ensure the health of all ecosystems and for humanity to continue to survive and thrive.

Human activity has driven extreme destruction of biological hotspots and are extremely threatened by development and unsustainable practices. Without active conservation and management activities, the risk of losing these hotspots will continue to increase until they disappear forever.

Hotspots are identified as areas of high biodiversity and support largely intact natural ecosystems, with a great representation of native species and associated communities are well represented. Since these hotspots are largely intact, undertaking action now to maintain these values has the potential to provide economic incentives for local populations as well as contribute to efforts in biodiversity conservation.

By focusing on protecting an entire ecosystem, the entire local species of plants and animals are in return protected as well. Everything is interconnected, and allows for the health and well-being for that ecosystem to thrive. For example, protecting the hotspot within Indo-Burma, India, and Myanmar also residually protects tigers and their native habitat. By protecting tigers, biodiversity hotspots are in return protected as well. This is called an "umbrella species", everything underneath it is protected.

### **Conservation Efforts:**

Conservation International (CI) has worked for two decades to protect conservation areas and biodiversity hotspots. The organization believes that protecting nature is a fundamental part of human society and vital for survival. By prioritizing smaller areas with a large abundance of biodiversity, hotspots have become a tool for setting conservation areas and allocation of funding.

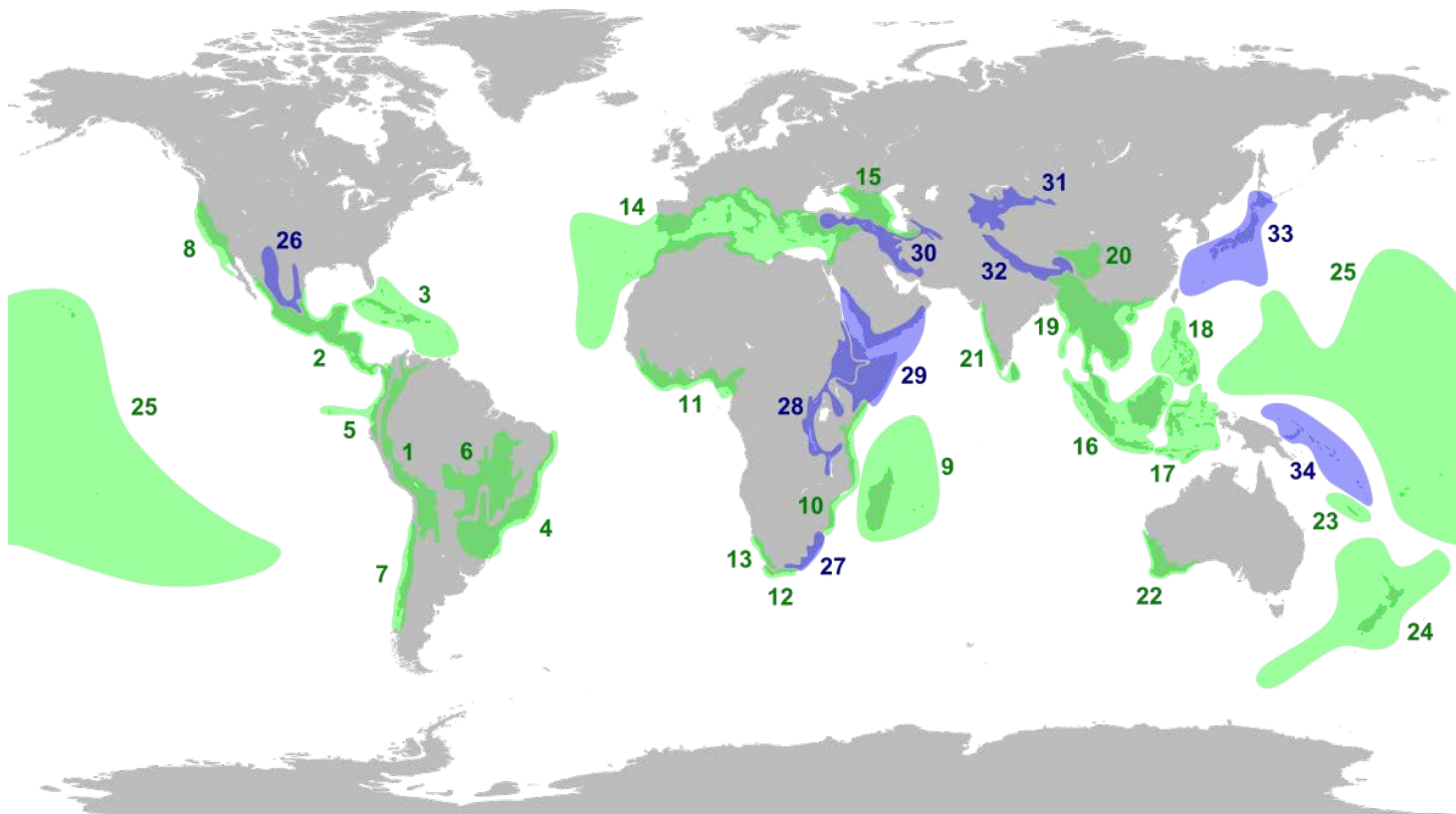
Biological hotspots have become a tool for setting conservation priorities and decision making for cost effective strategies to preserve terrestrial and marine ecosystems.

Organizations such as; the Critical Ecosystem Partnership Fund (CEPF), the World Wide Fund for Nature, Birdlife International, Plant Life International, and the National Geographic Society, have identified and are actively protecting high-biodiversity wilderness and marine regions.

The Australian government has allocated \$36 million for a conservation effort called Maintaining Australia's Biodiversity Hotspots Programme, which focuses on protecting private and leasehold land within hotspots and encourage biodiversity conservation.

**Global Biodiversity Hotspots:**

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| 1) Tropical Andes                            | 21) West Ghats, India, and Sri Lanka     |
| 2) Mesoamerica                               | 22) Southwest Australia                  |
| 3) Caribbean Islands                         | 23) New Caledonia                        |
| 4) Atlantic Forest                           | 24) New Zealand                          |
| 5) Tumbes-Choco-Magdalena                    | 25) Polynesia-Micronesia                 |
| 6) Cerrado                                   | 26) Madrean Pine-Oak Woodlands           |
| 7) Chilean Winter Rainfall-Valdivian Forests | 27) Maputaland-Pomdoland-Albany          |
| 8) California Floristic Province             | 28) Eastern Afromontane                  |
| 9) Madagascar and Indian Ocean Islands       | 29) Horn of Africa                       |
| 10) Coastal Forests of Eastern Africa        | 30) Irano-Anatolian                      |
| 11) Guinean Forests of West Africa           | 31) Mountains of Central Asia            |
| 12) Cape Floristic Region                    | 32) Eastern Himalaya, Nepal, India       |
| 13) Succulent Karoo                          | 33) Japan                                |
| 14) Mediterranean Basin                      | 34) East Melanesia Islands               |
| 15) Caucasus                                 | 35) Eastern Australian Temperate Forests |
| 16) Sundaland and Nicobar Islands of India   | 36) North American Coastal Plain         |
| 17) Wallacea                                 |  |
| 18) Philippines                              |  |
| 19) Indo-Burma, India, Myanmar               |  |
| 20) Mountains of Southwest China             |  |





## Research Assignment: Part C

- There are 35 distinguished biodiversity hotspots throughout the world, choose from the list of the 10 most threatened (each group should choose a different hotspot), or research the other 26.
- For your biodiversity hotspot, answer each of the questions below on your poster, power point, or research paper. Make sure to include your sources of where your research came from.
- Note: Do not plagiarize. Provide sources and credit for your research per your classroom guidelines. Please use citation formatting assigned by your teacher.

### Research Questions:

- 1) Where is your biodiversity hot spot located? –include a map of the region
- 2) What is the most unique aspect of this hotspot?
- 3) How many endemic species does this ecosystem contain?
- 4) How many threatened species belong to this hotspot?
- 5) List 3-4 vulnerable, threatened, or endangered species (plants or animals)
  - a. Include their scientific name, conservation status, number of the species left, and what is threatening their survival. Provide pictures of the species.
  - b. What do each of these classifications mean? ie. Vulnerable, threatened, endangered.
- 6) Research main threats to the specific biodiversity hotspot. Include all threats to the area, the reason for these threats in detail.
- 7) Are there currently any conservation efforts to protect this biodiversity hotspot?
- 8) As humans, what can we do to protect this ecosystem from further destruction?
- 9) Why do biodiversity hotspots matter to us?
- 10) Provide any additional unique or interesting facts about your biodiversity hotspot in your research.

Resources for research:

<https://www.iucnredlist.org>

<https://www.conservation.org/How/Pages/Hotspots.aspx>

<http://www.environment.gov.au/biodiversity/conservation/hotspots>

<http://www.perunature.com/about-tambopata/biodiversity-hotspot/>

<https://sustainabilitywriter.wordpress.com/2012/04/18/10-of-the-worlds-most-threatened-biodiversity-hotspots/>

<https://www.cepf.net/our-work/biodiversity-hotspots/hotspots-defined>

- List sources you have used either in your research paper, on the back of your poster, or at the end of your power point presentation.
- Include pictures of the species (plants, animals), maps, scientific data, charts, and pictures of habitat destruction if applicable in your presentation.





## Part D. Discussion

- For each group, present your findings of research pertaining to the biodiversity hot spot you had researched. Share with the class your poster or power point. If writing a research paper, discuss with the class the most important findings of your biodiversity hotspot.
- 1) Location and map of hotspot
  - 2) Why this location is designated as a biodiversity hotspot.
  - 3) Which species are threatened/endangered in the ecosystem.
  - 4) What are the biggest threats to this particular ecosystem?
  - 5) Are there any conservation efforts in place to protect this area?
- As a class, discuss what would happen if we no longer had biodiversity hotspots
  - Brainstorm together ways in which biodiversity hotspots and other ecosystem services can be protected. Write these ideas together on a white board or piece of paper as a class.
    - Suggest other options that are currently not in place to protect biodiversity.
    - What can we change in our daily lives and habitats to protect the natural world?
    - How can you help to spread awareness about protecting the Earth's biodiversity?
    - Are there any problems that we will face by losing biodiversity hotspots as humans?
    - Why does this research matter?

**Conclusion:** Our daily choices affect all of the natural world around us. What we consume, throw away, and the resources we use can either positively or negatively change the environment. To ensure that all living creatures are around for future generations, we must take action as individuals to ensure that we protect the natural world. Your actions and voice matter to help save species from extinction.



## Teacher Vocabulary Key:

**Biodiversity Hotspot:** A biogeographic region (place on Earth) that is a significant reservoir (has a lot) of biodiversity.

Criteria:

- 1,500 vascular plants as endemic: found nowhere else on the planet; irreplaceable
- 30% or less of its original natural vegetation; threatened (lost 70% original surface area)

**Biodiversity:** the variability among living organisms from all sources: terrestrial (land), marine (water), and other ecosystems (community of interacting organisms and their physical environment).

**Hotspot:** a place of significant activity or danger

**Ecosystem:** a large community of living organisms including plants, animals and microbes in a particular area. All living and physical cycles are connected through nutrient cycling and energy flows. They can vary in size and are in a particular area. Ex) Natural environment around us!

**Biome:** a large naturally occurring community of flora and fauna occupying major habitat ex) forest, tundra

**Exploitation:** action or fact of treating something unfairly in order to benefit from their work

**Urbanization:** process of making an area more urban

**Endemic:** native or restricted to a certain country or area

**Ecology:** branch of biology that deals with relations of organisms to one another and their physical surroundings

**Ecosystem Services:**

- Provisioning
  - Protection of food and water
- Regulating
  - Control of climate and disease
- Supporting
  - Nutrient cycles and crop pollination
- Cultural
  - Spiritual and recreational benefits









### Example Research:

1. Biodiversity Hotspot: Himalayan Hotspot: Nepal, Bhutan, Pakistan, Bangladesh, Myanmar, China.
2. This hotspot stretches over 1,864 miles throughout its region, and is said to be the “store house of biodiversity”. It has a rich spectrum of species of flora and fauna. This mountain chain is the youngest and highest on Earth. This ecosystem includes mountains, alpine meadows, alluvial grasslands, and subtropical broadleaf forests (Himalayan Biodiversity Hotspot, 2011).
3. Endemic plant species include 3,160 out of the 10,000 found in this hotspot, including 5 families of plants. This hotspot contains a zone of permanent rock and ice, and research has found that despite the harsh conditions, plants have occurred here in the highest elevation on Earth (between 5,500-6,000 meters). Out of 269 fish species, 33 of these are also endemic to the Himalayan Hotspot. Amphibian species 105 in the ecosystem with 42 endemics. There are 176 reptile species with 48 being endemic. There are many bird species found through this region, with 15 being endemic. There have been over 400 mammal species recorded, and 15 of these species are endemic (Himalayan Biodiversity Hotspot, 2011).
4. Out of the endemic species in the Himalayan hotspot, 4 amphibians are threatened, 8 bird species are threatened, and 4 mammal species are threatened (Himalayan Biodiversity Hotspot, 2011).
5. Tigers are endangered in this region (*Panthera tigris*) ~3,900 left across Asia. Asian elephants are endangered (*Elephas maximus*), Indian rhinoceros are vulnerable (*Rhinoceros unicornis*), the snow leopard is vulnerable (*Panthera uncia*), and the red panda is endangered (*Ailurus fulgens*).
  - a. An endangered species is classified as a species of animal or plant that is seriously at risk of extinction.
  - b. A vulnerable species is likely to become endangered unless something changes, such as greater protection.
  - c. A threatened species is likely to becoming endangered within the foreseeable future throughout a significant portion of its range. (IUCN Red List, 2020).
6. The main threats to the Himalayan Biodiversity Hotspot are climate change, habitat loss, species loss, infrastructure development, agriculture, and poaching. Only 25% of this hotspot remains. Tigers and rhinos are heavily poached in this area for their body parts used in traditional Asian medicines. Construction of roads as well as pollution is destroying the Himalayas. (CEPF, 2020).
  - a. Greater access to global markets has increased the demand for natural resources in this remote area. Increasing human population has cleared out much of the forests and grasslands for cultivation, logging, causing severe erosion.
  - b. Agriculture has led to large scale deforestation and habitat fragmentation in this region. The areas remaining are extremely degraded by overgrazing of livestock. The plants (flora) in the alpine meadows have been overharvested and overexploited for traditional medicines.
  - c. Collecting of fuelwood and forest materials for consumption and international export has caused extreme damage to the fragile ecosystem. Poorly managed tourism causes environmental degradation. Political turmoil in these areas also threatens some of the protected areas in the region.

- d. Poaching is also a serious problem in this hotspot. Endangered species such as tigers, one-horned rhinos, snow leopards, and red pandas are poached for their body parts for use in traditional Chinese medicines, as well as their pelts (CEPF, 2020).
7. The organization Critical Ecosystem Partnership Fund (CEPF) has outlined strategic efforts to save the ecosystem. Their four main goals for the Himalayan Biodiversity Hotspot is to build on existing landscape initiatives, secure the conservation of site outcomes of prioritized areas, leverage partnerships among donor agencies, governmental institutions, local communities, and to develop grant programs to protect globally threatened species within the eastern Himalayas (CEPF, 2020). There are also protected areas, around 15% of the land area of the hotspot, that is being targeted to protect. Projects are geared towards conservation of umbrella species and keystone species such as the snow leopard. In protecting a single species, the ecosystem will also be protected. There are also projects to target local communities to decrease poverty levels and increase awareness of ownership of resources to greater protect them. The Himalayan Biodiversity Hotspot also has 6 national parks that are protected. (Himalayan Biodiversity Hotspot, 2011).
  8. To protect this hotspot, I believe that we can create a greater awareness of the problems that face this area. By using advocacy campaigns, supporting charitable efforts to save these areas, as well as limiting our consumption of natural resources can help maintain the Himalayas for future generations.
  9. Biodiversity hotspots matter because they provide us with clean air, water, shelter, as well as ecosystem services. Without biodiversity, the human population would not be able to survive. Since these hotspots contain a majority of the biodiversity in such a small percentage of the Earth's surface, it is vital that these places are a focus of conservation efforts.
  10. The most unique thing that I have learned about the Himalayas is that despite its remote location and inaccessibility, humans are still able to exploit its resources. I believe that the increase in human population, technology, and transportation has caused the increase of exploitation of resources. I also learned about the importance of umbrella species, and by protecting a single species of animal, like the tiger, that everything around it in the ecosystem will also be protected.

Resources: Please use citation format assigned by your teacher.

<https://tech-organic.blogspot.com/2011/09/himalayan-biodiversity-hotspot.html>

<https://www.cepf.net/our-work/biodiversity-hotspots/himalaya>

<https://www.iucnredlist.org/search/stats?query=Asian%20Elephant%20&searchType=species>