Discover the power and value of biodiversity across the globe. Topics include:

- Biodiversity within ecosystems and how biodiversity can be measured.
- Ecosystem dynamics, resistance, recovery, and resilience.
- Global impact of environmental changes due to human activity.

### TEKS standards

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<th>SCIENCE.BIO.13.C</th>
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| Explain the significance of the carbon and nitrogen cycles to ecosystem stability and analyze the consequences of disrupting these cycles. | How do climate change and human activities impact the biodiversity and dynamics of ecosystems in Texas?  
Texas contains diverse ecosystems ranging from Big Bend Country to the Gulf Coast. However, climate change is affecting biodiversity and dynamics of these ecosystems, causing shifts in [phenology](https://usapan.org) migration, and species’ ranges. These changes present a lens through which to explore the broader impacts of climate change and human activities on biodiversity and ecosystem dynamics across different regions.  

**Prompts for students to consider:**  
- How does biodiversity support ecosystem dynamics in [ecosystem]?  
- How does enhancing biodiversity help ecosystem recovery from disturbance in [specific region]?
- How have human activities globally impacted biodiversity and ecosystems, and how are these impacts reflected in [specific region]?
- What kind of sustainable practices can be used to reduce the impact of human activities within [specific region]?

**Regional examples students can explore:**  
*Explore a Texas region’s endangered species (or statewide), analyzing climate and human impacts, ecological roles, and recovery and conservation strategies. For key ecosystem characteristics visit [TPWD](https://tpwd.texas.gov) and ([tpwd.texas.gov/education/resources](https://tpwd.texas.gov/education/resources)).  
- **Big Bend Country** - examine how climate change and land/water use changes impact species like bunched cory cactus (*Coryphantha ramillosa*), Davis green pitaya (*Echinocereus viridiflorus*), Mexican spotted owl (*Strix occidentalis lucida*), the greater long-nosed bat (*Leptonycteris nivalis*), and the Big Bend gambusia (*Gambusia gaigei*).
- **Hill Country** - explore climate changes’ impact on Texas snowbells (*Styrax texanus*), tobusch fishhook cactus, and the golden-cheeked warbler (*Setophaga chrysoparia*). Assess how ashe juniper (*Juniperus ashei*) woodlands support these species and how environmental shifts and land development threaten their survival.

- **South Plains** - examine the region's habitats from grasslands to woodlands, evaluating how shifts in phenology and habitat changes impact species like the black lace cactus (*Echinocereus reichenbachii*) and animals like the ocelot (*Leopardus pardalis*).

- **Panhandle Plains** - assess how habitat loss affects Plains yucca (*Yucca campestris*) and how the expansion of black-tailed prairie dog (*Cynomys ludovicianus*) towns impacts black-footed ferret (*Ferretus prairieus*) populations, triggering a cascade of effects.

- **Gulf Coast** - evaluate how changed habitats and migration patterns affect species like prairie dawn (*Hymenoxys texana*), whooping crane (*Grus americana*), eastern brown pelican (*Pelecanus occidentalis*), and attwater’s prairie chicken (*Tympanuchus cupido attwateri*).

- **Pineywoods** - link storm data to forest impacts, showing the effects on regeneration and adaptability on species like Texas trailing phlox and the red-cockaded woodpecker (*Picoides borealis*).

- **Prairies and Lakes** - examine how asynchronous blooming affects species like the Large-fruited Sand Verbena (*Abronia macrocarpa*), Navasota Ladies-tresses (*Spiranthes parksii*), Houston Toad (*Bufo houstonensis*), and Golden-cheeked Warbler (*Setophaga chrysoparia*).

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**Unit resources**

- For the videos in this unit, use the Learning summary video notetaking guide
- For the articles in this unit, use the Article notetaking guide
- For the exercises in this unit, use the Blank workspace template
- Vocabulary and notation notetaker
# Lesson overview

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<th>Lesson</th>
<th>Objective</th>
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| **Lesson 1: Biodiversity and ecosystem services**<br>TEKS standard: BIO.13.C. | Understand how biodiversity is quantified across different levels and its role in ecosystem stability. Differentiate between native, non-native, and invasive species, and assess their impacts on ecosystems. Explore ecosystem services' roles, their benefits to humans and nature, and evaluate ways to conserve them. | - Assessing biodiversity helps to track ecosystem changes, informing strategies for managing disturbances and environmental shifts.  
- Use a vocabulary organizer to differentiate ecological terms like species diversity vs. richness and resilience vs. resistance. Clarify with examples, focusing on types and measures of diversity.  
- Revisit Unit 6 to emphasize how genetic variations and environmental pressures drive new species formation and enhance biodiversity, highlighting genetic diversity's role in adaptation and survival.  
- Create a list of local species (mammals, reptiles, insects, fish, birds, plants) and classify each as native, non-native, or invasive. Extension: create posters for categories or individual species.  
- Use real-world data sets to analyze species richness, abundance, density, and distribution, from platforms like GBIF, iNaturalist, and NEON.  
- Link biology and social studies to highlight how human actions affect biodiversity by introducing key topics like the Industrial Revolution, conservation laws, and the Dust Bowl, preparing students for a deeper exploration in lesson 3. |
| **Lesson 2: Threats to biodiversity**<br>TEKS standard: BIO.13.D. | Understand the dynamic nature of ecosystems, recognizing how disturbance and various environmental changes influence ecosystems and biodiversity. Differentiate between ecosystem resistance, recovery, and resilience, exploring how disturbances affect ecosystems and the biodiversity within. Evaluate effects of | - Biodiversity faces threats from habitat loss, overexploitation, pollution, and invasive species, leading to loss and extinction, and disturbances that disrupt ecosystem balance and function.  
- Create a 4-door foldable to illustrate ecological disturbance scales: micro (fallen tree as nursery log), local (routine mowing), regional (urban development), and global (ocean acidification). Label and illustrate each scale outside; detail impacts on biodiversity and ecosystems inside.  
- Explore human effects on ecosystems through case studies like the Atlantic cod collapse and Burmese pythons in the Everglades, using simulations, water quality projects, and pet release debates. |
### Lesson 3: Disturbance in ecosystems

**TEKS standard:** BIO.13.D.

- **Explore how climate change, driven by human activities, disrupts global ecosystems through sea-level rise, heat waves, and ice loss.**
- **Examine the link between climate change, biodiversity loss, and ecosystem disturbances, using critical thinking to analyze real-world environmental scenarios.**
- **Identify sustainability-focused strategies to limit climate change and conserve biodiversity, emphasizing actionable solutions.**

### Lesson 4: Global change in biology

**TEKS standard:** BIO.13.D.

- **Evaluate the biological impacts of climate change on species and ecosystems.**
- **Apply principles of global change biology to real-world scenarios.**

### What can I do? Highlight sustainability actions like recycling, native planting, and mindful food and transport choices. Showcase local initiatives.
Best practices

COMMON MISCONCEPTIONS AND HOW TO ADDRESS THEM

“If an ecosystem is still functioning, it means biodiversity loss is not a serious issue.”
Ecosystems may seem functional after species loss, but this masks the real decline in biodiversity. Small losses accumulate, significantly altering ecosystem functionality and human reliance on them.

How to address this misconception
Begin with an overview of essential ecosystem functions, such as nutrient cycling and ecosystem services like water purification and storm damage protection, crucial across Texas's diverse ecosystems. For instance, native grasses in the Hill Country combat soil erosion, and the decline of the Monarch butterfly across prairies indicates broader pollination challenges. Overfishing the Red Drum in the Gulf Coast demonstrates the economic and ecological importance of individual species. The transformation of Texas's carbon-storing native prairies into agricultural and urban areas highlights how local biodiversity loss can have global repercussions. Engaging students in restoration efforts, such as replanting native flora, provides hands-on experience with the benefits of biodiversity for climate mitigation. Encourage student involvement in biodiversity monitoring to emphasize the crucial, yet often overlooked, roles species play in ecosystems.

"Climate change is a natural cycle. If there was global warming, everywhere would be warmer.”
Human activities, especially burning fossil fuels, have primarily driven climate change, causing rapid, uneven global effects like shifting temperature, precipitation, and wind patterns.

How to address this misconception
Start by explaining the Earth's natural climate cycles over millennia in contrast to the swift changes caused by human activities, such as burning fossil fuels, in recent decades. Point out that the current rate of climate change is unparalleled in human history. Use Texas as an example, where diverse climate impacts such as severe heatwaves, droughts, powerful hurricanes, and unexpected cold events like the February 2021 winter storm demonstrate the global yet variable nature of climate change effects. Encourage students to map climate change impacts globally—including polar ice melt and storm intensification along the equator—to visualize the geographic variability of these effects. This approach highlights climate change's urgency and deviation from natural patterns. Students can help limit climate change through local initiatives, such as planting native species, recycling, organizing local clean-up drives, and conserving energy usage.
CLASSROOM ACTIVITIES

Citizen Science
Join the global effort to track climate change by contributing real data through citizen science projects! In this activity, students will participate in climate-focused projects, collecting and analyzing data just like scientists studying environmental changes. This connects to biology concepts such as climate change, data collection, and the impact of human activities on ecosystems.

Materials (dependent on project): computers or tablets with internet access for research and data entry, projector and screen for instructional videos and student presentations, access to SciStarter, tools for data collection as required by the project.

- Other places to check out for projects: iNaturalist, NASA- Citizen Science, BudBurst, BioBlitz, Globe at Night, CoCoRaHS, Journey North, and Texas Stream Team.

- Introduce global climate change - begin with a lesson on global climate change, focusing on its causes, effects, and the roles of scientific research and public involvement in mitigating the issue.
- Explore climate-focused projects - navigate the class through SciStarter, showing how to find climate change projects suitable for local participation.
- Project selection - collaboratively select a suitable project that focuses on climate change.
- Prepare for data collection - depending on the selected project, conduct workshops to familiarize students with necessary tools and techniques for collecting climate data.
- Data collection - organize and oversee the data collection process.
- Analyze and reflect - help students analyze their findings and share in a class session, discussing observations and reflecting on climate change insights gained from their participation.
- Continued engagement - conclude with the importance of ongoing climate research and citizen science's role, encouraging students to continue climate action and contribute to sustainability.

Related activities that can be adapted to your students and community:
- Khan activity: how can we reduce our garbage footprint?
- Check out the multitude of resources for the activity, "Biodiversity Jenga," where blocks represent ecosystem elements, highlighting species loss's effect on stability.
- Students can search their community for invasive species using environmental sampling methods, which vary based on the species being stationary (like plants) or mobile (like animals).

Ocean acidification investigation
Investigate ocean acidification's impact on marine life by simulating its effects on calcifiers like eggshells or seashells. Students will observe how acidified water affects these organisms, connecting to concepts like ocean acidification, the carbon cycle, and human impacts on marine environments. Support resource: NOAA Ocean Acidification Program (oceanacidification.noaa.gov)

Materials: eggshells or seashells (to simulate marine calcifiers), vinegar (to simulate acidified ocean water), tap water (as a control), beakers or clear plastic cups, pH strips or pH meter. Optional materials: Limestone chips, marble chips, Plaster of Paris casts, clean small bones. Teacher Tip: consider covering vinegar-filled beakers or storing them in a cabinet to reduce odor.

- Preparation: divide students into small groups, distributing materials.
- Setup: prepare control (tap water) and experimental (vinegar-water) solutions and measure pH.
Data collection: place egg shells or seashells in solutions, observing changes over 24-48 hours and record any visible changes and pH changes.

Analysis: compare the control and experimental groups, assessing acidification's effects.

Post-lab activities:
- Diagram the carbon and nitrogen cycles, highlighting interactions with ocean chemistry.
- Research marine organisms affected by ocean acidification, focusing on biological, ecological, and economic implications.
- Lead discussions on how excess nitrogen and eutrophication worsen ocean acidification.
- Analyze case studies on regions affected by ocean acidification and eutrophication, like the Gulf of Mexico dead zone.
- Arrange a guest speaker with a marine biologist or climate scientist specializing in ocean acidification, preparing questions for a Q&A session.

EXPERT INSIGHTS
“Every individual matters. Every individual has a role to play. Every individual makes a difference.”
-Dr. Jane Goodall, renowned primatologist and environmentalist.

PRO TIPS
Finding common ground
When teaching the sensitive topic of climate change to students with varying views, prioritize creating an inclusive, respectful classroom environment. Start by revisiting (or establishing) classroom norms to encourage open discussions where all students feel comfortable sharing their perspectives. Then, focus on presenting scientific data and consensus from reputable sources (e.g., NASA) to establish a factual basis. Emphasize the practical aspects of climate science, such as conservation efforts and the benefits of sustainable practices, to find common ground and engage all students in constructive solutions-oriented conversations. Have students think about what they are already doing to help preserve natural resources and biodiversity, and easy steps they can take to improve preservation and conservation. Highlighting actionable solutions, like conservation and sustainable practices, can unite students in understanding the role they can play in environmental stewardship, regardless of their initial stance.

GENERAL CLASSROOM IMPLEMENTATION RESOURCES:
- **Weekly Khan Academy Quick Planning Guide**: Use this template to easily plan your week using Khan Academy.
- **Student Learning Templates**: Choose a template for students to record their learning. There are templates for watching videos, reading articles, and doing exercises.
- **Using Khan Academy in the Classroom**: Learn about teaching strategies and structures to support your students in their learning with Khan Academy.
- **Differentiation Strategies for the Classroom**: Read about strategies to support the learning of all students.