Patterns Biology
Unit 1: Ecosystems and Biodiversity

NOTE: Please make sure you are using materials located in the Patterns Biology - Open Access Google Shared Drive. If you do not have access to this Shared Drive (or its partner Restricted Access Shared Drive), request access by filling out our access application.

Unit 1-Ecosystems and Biodiversity-approximately 15, 90-minute class periods			
Social, Emotional, Learning tip: Hey teachers! This is the first unit of the school year. Consider building some positive classroom culture and community using these low stakes talk scripts.			
Unit Resources:	Vocabulary List (note: this list may not be in order that the terms will be presented in the tasks below. Teachers may wish to have students build their own vocab list in the word wall section of their INB.)	Unit Rubrics	Student Interactive Notebook (Docs) Student Interactive Notebook Example (Slides) Student Printable Packet
Ecological Interactions: Explain how ecosystems respond to disturbances and interactions			
Anchoring Phenomenon: Urban biodiversity is declining locally and globally. **Unit Essential Question:** How does the increase in the size of human populations impact biodiversity and how can we reduce those impacts?			
NGSS Performance Expectations with links to evidence statements: HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. **HS-LS2-2**: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-7**: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales **HS-LS2-6**: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent			

numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem **HS-ESS3-4**: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-3**: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **Note: Tribal History/Shared History Lesson "Seasonal Rounds & Ecosystems" is integrated into Task Set 1.2.** This lesson comes from a collaboration between the 9 federally recognized Tribes of Oregon and ODE, and supports implementation of Tribal History / Shared History, a law enacted by the Oregon legislature in 2017 . While it is officially designated a "10th grade" TH/SH lesson, ODE has granted schools/districts the permission to place high school lessons in the subject/grade level most closely aligned to the lesson's content. See the Tribal History / Shared History implementation website for more information about TH/SH. In preparation for teaching any TH/SH lesson, teachers should read Essential Understandings of Native Americans in Oregon. Professional Development resources can be found at the ODE Tribal History/Shared History site, including links to the original Seasonal Rounds and Ecosystems lesson plan and resources.
Practices: Planning and Conducting an investigation / Using Mathematics and Computational Thinking / Engaging in Argument from Evidence / Design, Evaluate, and Refine a Solution **Crosscutting Concepts:** Stability and Change; Scale, Proportion, and Quantity; Systems and System Models **Disciplinary Core Ideas:** Ecosystem Dynamics, Functioning, and Resilience; Interdependent Relationships in Ecosystems; Human Impacts on Earth Systems

Task Set # (Days)	Essential Question & Activities	Application & Extension	SEPs CCCs DCIs	Evidence of Student Learning/ Assessment
Engage				
0 (1 - 90 min session)	• Relationship Building Activity Options for Day 1: ○ **Option 1:** STEM Culture Collage. This activity empowers students to see themselves and their culture in STEM. Broadening definitions of identity, culture, and STEM knowledge and skills. (available in English and Spanish). If they did this last year, you can ask them to add to their older one and share it with you and the class. ○ **Option 2:** Do one or more of the following: ■ Cell phone network activity *(60 min. including debrief)*			Biodiversity Pre-Assessment

	● Debrief and formative assessment on Formative ■ Human Bingo ■ Name Tent Feedback Form ● Syllabus (sample syllabus) ● Biodiversity Pre-Assessment on Formative (15 min.) ○ After students answer, project answers for each question one at a time and discuss similarities and differences between student answers.			
1.1 (90 min)	**1.1 Teacher Notes** **EQ:** How has the land in the Portland Metro Area changed over time? **Phenomenon**: Portland Metro natural spaces are becoming increasingly smaller and isolated ● Teacher Notes for this activity - details teacher actions, student actions, talk moves and other suggestions. ● Students use the Timelapse function in Google Earth Engine to show the change of the Portland Metro Area (or your local region) over time. Students make observations and look at example data to generate questions about what the changes they observe might mean for biodiversity in the area. ● Access the 1.1 Map Investigation PRESENTATION to complete this activity. ● To help guide the unit phenomenon, students generate questions they have about the data in the Map Investigation Class Data spreadsheet. ● Questions are posted in a Canva Whiteboard (Map Investigation Question Board Canva Template). Teachers need to make a new copy of this Canva Whiteboard for each class period ○ Map Investigation Overview Video ○ Link to full Map Investigation folder ● Students make a copy of the Interactive Notebook and fill out TS1 boxes in Unit Tracker		**SEP:** Asking Questions, Carrying Out Investigations **CCC:** Scale, Proportion, and Quantity **DCI:** Human Impacts on Earth Systems	Students make observations about maps and data, make comparison statements, and generate questions.
1.2 (2 - 90 min sessions)	**EQ**: How do life and the physical environment interact? What is biodiversity and why does it matter? **Phenomenon**: Oregon's ecosystem looks different today than it did generations ago.	Amoeba Sisters video, Biological Levels	**SEP:** Obtaining, evaluating, and communicating information	Students complete Cornell Notes throughout the lesson (video and presentation) to

	• Biodiversity, Seasonal Rounds and Ecosystems PRESENTATION • Students use notes in the INB to follow along with the slides and interact with the following: ○ Students predict relative order of the 6 kingdoms in terms of biomass, then visualize this information in All life on Earth in one staggering chart ○ Introduce concept of biodiversity with Biodiversity, Ecosystems and Ecological Networks video ○ Go back to the 1.2 Biodiversity, Seasonal Rounds and Ecosystems PRESENTATION . Students pair share embedded questions and take notes in Cornell Notes doc or INB (Key to Cornell Notes) • Fill out Unit Tracker TS2 boxes in INB		**CCC:** Scale, Proportion and Quantity **DCI:** Ecosystem dynamics, functioning and resilience	organize information on biodiversity.
Explore and Explain				
3 (4 or 5 - 90 min sessions) *Depending on field trip timing, this TS can be done before or after TS4	**1.3 Teacher Notes** **EQ**: How can we measure biodiversity and what does it tell us about the health of ecosystems? **Phenomenon**: Arthropod biodiversity is declining locally and globally. ***Note to teachers***: In order to have time for the first three units in Semester 1, you will likely only have time to do one project in this unit. Choose between the Biodiversity Investigation in this task set or the Habitat Corridor conservation project in Task Set 6 (both concepts are taught in the unit outside of the project, but the projects go deeper into those topics. Choose based on you/your students' preference, and/or logistics of doing the field trip for the Biodiversity Inquiry.) • Wild Guess: How many different types of arthropods can be found at the Tualatin Hills Nature Park? What is the Simpson's Biodiversity Index at this location? • 1.3 Biodiversity Investigation PRESENTATION: Students pair share embedded questions (question answers in slide notes) and begin to brainstorm for their experimental design on their lab templates. This presentation will assist students throughout the entire inquiry. If you live outside the Tualatin Valley, you	Students will work on their lab reports for homework, to make sure they stay on track to complete the lab report by the end of the unit Optional Extension: Compare class data to Forest Park data (*45 minutes)*	**SEP:** Planning and Conducting an investigation, Analyzing and Interpreting Data **CCC:** Scale, Proportion and Quantity **DCI:** Ecosystem Dynamics, Functioning, and Resilience; Interdependent relationships in ecosystems	ALT8 - Inquiry. Students work to complete the project template by the following: Individual: Introduction Group: Methods (can be behavior or summative assessment, teacher's choice). Presentation of Data Individual: Graph, Results, Discussion

	will want to adapt these slides to be place-based for your region. ○ Potential Sites & Contact Info ■ Portland Area Parks (PPR and THPRD) ■ Outside THPRD and PPR ○ If you're in Oregon, you can apply for bus funding through OFRI ● 1.3 Biodiversity Investigation STUDENT DOC - Each student makes a copy. Can be chunked into Intro, Methods, Results, Conclusion at teacher's choice. ● 1.3 Biodiversity Investigation Student Data Template SHEETS - needed for the data analysis once raw data are collected ● **Optional:** Students present findings by editing the Biodiversity Presentation Template Slides ● Lab procedure support **videos**: ○ Lab equipment and sifting (Groups of four split into pairs. Each pair has one sifter, pillowcase, and bucket. Each pair sifts one site's predetermined area for a set amount of time. Pairs work together to sift third site and combine pillowcases for that third site). Each group ends up with three pillowcases of sifted material (1 for each site). (Shorter alternative - have groups only collect material from 2 sites instead of 3.) ○ Sample size and geotagging (How to tell if you have enough sifted material and geotag your site) ○ Collecting samples from sifted leaf litter (How to go through the sifted litter and collect invertebrates into vials. Each site gets one vial, so there are three vials per group) ○ Labeling vial and finishing sample collection (Leaf litter is sorted bit by bit on a white background. Once sheet is covered, fold up sheet to create more white space to dump more sample and sort. Make sure each vial is labeled with small paper labeled with pencil.) ○ Sorting samples: Students dump vials into well plates for identification. ○ Identifying and recording sample data: Students take a picture through the dissecting scope of each individual and catalog in the raw data collection table. Alternatively,	Biodiversity Project Teacher Notes 1.3 Biodiversity Investigation w/ Simulation **Arts Integration Lesson:** Draw an arthropod. ■ Draw an Arthropod Presentation ■ Draw an Arthropod Teacher Notes		

	students can do "catch and release" for this procedure, photographing the specimens and collecting them in a large collection container before releasing. ○ Summarizing data: Students describe data from each site into a summary data table and create graphs of morphospecies abundance and diversity by site. ● Biodiversity Mini-Test ● Fill out Unit Tracker TS3 boxes in INB			
4 (3 or 4 - 90 min sessions for full lab, 1 - 90 min session for Option 2)	**EQ**: How do populations grow, how can we predict growth, and what limits growth? ***Option 1 (shorter):*** **Phenomenon**: Population sizes change based on limitations placed on them in their environment. Students describe population data of elk and cougars to investigate carrying capacity and limiting factors. ● Investigating 1.4 Populations and Carrying Capacity STUDENT DOC ● Students observe videos detailing the history of human population growth on the planet, then observe the population fluctuations of elk and cougar populations in the Coast Range to track patterns between predators and prey and to understand the meaning of carrying capacity. ● Analysis questions drill down on how to identify carrying capacity from a graph and identifying biotic and abiotic factors that can have an effect on carrying capacity ● Ties back to human population growth in last question Note: A Desmos-based version of this task is in development. ***Option 2 (offers an inquiry opportunity if you are not doing the Biodiversity Investigation)*** **Phenomenon**: The human population on earth is growing rapidly. ● Population Growth Preassessment on Formative ● Human Population Growth Investigation Folder ○ 1.4 Human Population Growth Inquiry PRESENTATION ○ Each student gets a copy of 1.4 Human Population Growth STUDENT DOC.	Human Population / Exponential Growth Problems (KEY) Equation help sheet and population growth problem	**SEP:** Engaging in Argument from Evidence, Using Mathematics and Computational Thinking **CCC:** Stability and Change, Patterns, Systems and System Models **DCI:** Ecosystem dynamics, functioning and resilience	**Formative**: Population Growth Problems **Summative**: Lab Conclusion **Formative**: Cornell Notes on demographics article **Optional**: Population Growth Summary Paragraph OR Infographic **Summative**: Human Population Growth Mini-Test **Alternative Summative**: Human Population Growth C-E-R (use Stronger and Clearer protocol)

	○ Wild Guess: If the current world population is approximately 7,500,000,000 (7.5 billion) people, what will it be in 2050? ○ Data Mining / Graphing on whiteboards / Desmos: Idealized Total Fertility Rate in various countries (1 per group) ○ teacher.desmos Activity Share link ○ Use a data discussion to classify and analyze graphs, identify idealized population growth as following an exponential pattern (differentiation around math equation: base e exponential $P = P_0e^{rt}$ where r is rate of growth; more simplified $P = f^{G}$ where f is total fertility rate). This collaborative 1.4 Human Population Data Discussion STUDENT DOC document is helpful in a virtual setting or could be used by teachers in cases where students are not able to have in person discussions. (Data Discussion Notes KEY) ○ Class brainstorm on limiting factors for human population growth ○ Optional: 1.4 Cornell Notes STUDENT DOC on this Population Demographics Article ○ Return to Wild Guess: Estimate 2050 world population using published annual % growth figures ○ Write Lab Conclusion up through Limitations section ○ Compare estimate to demographers' predictions, calculate % error ○ Complete Lab Conclusion ● Fill out Unit Tracker 1.4 boxes in INB	Read United Nations World Population Prospects and complete summary paragraph OR infographic		
5 (2 - 90 min sessions for full activity, 1 - 90 min session for Option 2)	**EQ**: How do populations in a community affect each other? How can biodiversity change when humans intervene? **Phenomenon**: The presence of wolves dramatically changed the ecosystem of Yellowstone National Park. ***Option 1:*** 1.5 Ecosystem Interactions PRESENTATION Students interact with how communities affect each other in Yellowstone by looking through data and analyzing graphs and food webs. ● Introduce Wolves of Yellowstone phenomenon with the first	What is a Keystone Species? Carrying Capacity Case Studies - assign one (or more) per student for	**SEP:** Obtaining, evaluating and communicating information **SEP**: Engaging in Argument from Evidence **CCC:** Stability and change	Students make claims supported by evidence in case study. **Formative**: HW choice CC Case Studies

	few minutes of this PBS video. Stop video at 2:37. Follow with: ○ 1.5A Wolves of Yellowstone STUDENT DOC ○ (Teacher Guide for original PBS lesson plan, including key) ***Option 2 (shorter):*** ● Watch the PBS video or short summary video: How Wolves Change Rivers ● Make a flow diagram (LucidChart / Google Drawing / paper / whiteboard) (can use fill-in flow diagram from student template above, or have students make their own flow diagram with Google Drawing using this 1.5B Wolves of Yellowstone DRAW template ● OR Discuss this image (and/or read & answer questions from 1.5B Landscape of Fear STUDENT DOC) ● Fill out Unit Tracker 1.5 boxes in INB	additional support	**DCI:** Interdependent relationships in ecosystems **DCI**: Ecosystem Dynamics, Functioning, and Resilience	Students generate graphs and CER from predator-prey simulation GoFormative covering Yellowstone and Predator-Prey **Summative**: ● Community Interactions Mini-Test ●
6 (2 90-min periods)	**EQ:** What are the impacts of human population growth on environmental health? Are those impacts equally distributed? **Phenomenon:** Scientists and activists across the world are uncovering damage to local and global environments. ● Introduce urban biodiversity conservation strategies and the Environmental Justice (EJ movement) with this 1.6 Conservation Strategies & Environmental Justice PRESENTATION**.** ○ Students take notes and reflect in their INB. ○ At the end, students read an EJ article of their choice and summarize it in their INB. ○ Students use a collaborative slideshow, Jamboard, discussion board or other means to share what they learned with their peers.			Students reflect on conservation strategies and environmental justice by reading, listening, and doing their own research.
Elaborate and Evaluate				
7	**(SEE NOTE ON 1.3 - YOU MAY HAVE TO CHOOSE BETWEEN THE BIODIVERSITY INVESTIGATION AND THIS PROJECT)** **1.7 Teacher Notes** **EQ:** How can we reduce the impacts of urban human population growth on biodiversity?	● Supplemental reading for students: Nature in Neighborhoods and	**SEP**: Design a Solution **CCC**: Stability and change	Students make a design proposal for a solution to increase the population of a specific animal in a specific urban area

(3 - 90 min periods)	**Design Solution:** Habitat Corridors can be used to connect habitats to support animal populations. ● Introduce urban biodiversity conservation strategies with the 1.7 Habitat Corridor Engineering PRESENTATION. ● Students design a solution to increase the population of a specific animal in a specific urban area (project is written for Portland Metro, could easily be modified for other urban areas or areas with high levels of agricultural use, based on island biogeography theory). ○ 1.7 Habitat Corridor Engineering Project STUDENT DOC ○ Helpful book to aid students in identifying animal habitat and resource needs - Atlas of Oregon Wildlife ○ Student Habitat Corridor Presentation Template ○ Folder of Student Work Examples to be shared with students ○ Peer Review Form ● Career Highlight: Have students explore this career profile of an Environmental Scientist and watch the video. Discuss how this career relates to the work they just did to design a habitat corridor. ● Fill out Unit Tracker 1.7 boxes in INB	Oregon Conservation Strategy. ● Optional reading from NYT about human impact - also can refer back to palm oil video from TS2) **Arts Integration Lesson:** Create a landscape design that benefits wildlife. ● Wildlife Habitat Landscape Design - Teacher Notes ● Presentation	**DCI**:Human Impacts on Earth Systems	Food Webs Mini-Test
8 (1 day)	● Unit Review ● Unit Test Version 1, ● Unit Test Version 2 (incomplete) ● Alternate Summative Assessment: **Bye Bye Birdie**			Deliver test as mini-tests throughout the unit or a single end of unit test.

Summative Assessment Summary

Supporting Target & NGSS Performance Expectations	Possible Summative Assessments
HS-LS2-2: Plan and conduct an investigation that uses mathematical representations to support explanations about factors affecting biodiversity and populations in ecosystems of different scales	• Biodiversity Mini-Test (TS3) • Biodiversity Investigation (1.3) • Population Growth Mini-Test (1.4) (or unit test AST 1.1 section) • Human Population Growth Investigation • Human Population Growth CER
HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	• Human Population Growth Mini-Test (TS4) • Habitat Corridor Engineering Project (TS6) • Unit Test (AST 1.2 Section)
HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales	• Predator-Prey Simulation Activity (TS5) • Wolves of Yellowstone - Defining the Trophic Cascade (TS5) • Community Interactions Mini-Test (TS5) (or unit test AST 1.4 section)
HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem	• Food Webs Mini-Test (or unit test AST 1.5 section) • 1.5 Predator-Prey Simulation Activity • 1.5 Wolves of Yellowstone - Defining the Trophic Cascade
ALT 8 Uses the inquiry process as a controlled and data-driven means to investigate scientific questions.	• Biodiversity Inquiry Lab Report • Human Population Growth Lab Report
ALT 9 Uses the engineering design process as an iterative and productive means of problem solving.	• Habitat Corridor Engineering Lab

Science and Engineering Practice Look Fors:

Practice	Grades 9-12 Science and Engineering Practice "Look Fors"
Practice 3: Planning and Carrying Out Investigations	● Work as an individual or a team to produce data as evidence to revise models, support explanations or test solutions to problems. Students should consider confounding variables and evaluate design to ensure controls. ● Critically analyze the design of an investigation to decide the accuracy of data needed to produce reliable measurements and limitations of the data (number of trials, cost, risk, time etc.) ● Select appropriate tools to collect, record, and evaluate data. ● Make directional hypotheses about dependent and independent variable relationships.
Practice 5: Using Mathematics and Computational Thinking	● Create and/or revise a computational model or simulation of a phenomenon, designed device, process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world ● Use mathematical, computational, and/or algorithmic representation of phenomena or design solutions to describe and/or support claims and/or explanations. ● Apply techniques of algebra and functions to represent and solve scientific and engineering problems. For example, apply ratios, rates, percentages and unit conversions to problems involving quantities with derived or compound units.
Practice 6: Constructing Explanations and Designing Solutions	● Make a claim regarding the relationship between independent and dependent variables. ● Construct and revise an explanation based on reliable and varied evidence to describe the natural world and its laws. ● Apply scientific ideas, principles and/or evidence to explain phenomena and solve design problems, taking into account possible unanticipated effects. ● Apply scientific reasoning to link evidence to claims and assess the extent to which the reasoning and data support the conclusion. ● Design, evaluate and/or refine a solution to a complex real-world problem, based on scientific knowledge, evidence, criteria and tradeoff considerations.
Practice 7: Engaging in Argument from Evidence	● Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations, constraints, and ethical issues to determine the merits of arguments. ● Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. ● Construct, use, and/or present oral and written claims and arguments or counter-arguments based on data and evidence about the natural world or effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence,

	and/or logical arguments regarding relevant factors (economic, societal, environmental, ethical considerations).

Other Unit Resources

Island biogeography theory: MacArthur and Wilson describe a phenomenon that illustrates that distance from mainland and island size determine the number of species that will be present on a given island. Other scientists have validated this in “sky islands” in the desert southwest and urban “habitat islands” in cities. We will be working on this throughout the unit, first by quantifying biodiversity at a park and then by engineering possible solutions to isolation of urban habitat islands.

Planet Earth II: Cities: This episode does a good job of describing the challenge increasing urbanization poses to non-human populations and also shows possible engineering solutions for increasing urban biodiversity. Show in chunks (see time stamps above).

Arthropod Key: Built by Anne McHugh, this hyperdoc allows students to work through a user-friendly dichotomous key to introduce invertebrate identification. Note that the spider key has three parts and goes to the level of family, while the others are identified to class or order.

Ecosystem Videos by Cal Academy of Sciences: These are excellent, research-based short videos that describe a variety of ecosystem and biodiversity related topics.

Biodiversity Lab Notes and Suggestions

For the biodiversity lab data collection, you have a few options for the field data collection. You could walk to a nearby park or natural area and have each student group collect three samples. This would work by a team of four splitting into pairs (each pair has a sifter, pillowcase, and bucket). Each pair collects a sample from one of the three conditions. Examples being 5m , 10m and 15m from the path or high, medium or low light. Each pair collects samples by sifting for 20 minutes. They then take their samples back to the classroom and store their tied off pillowcase with a large sheet of white paper as a label. The next class day they will sort the macroinvertebrates from their sample and store it in ethanol vials. This is followed by identification and data collection and analysis. See videos for more detailed explanations of all procedures involved.