

BRIDGING CULTURES AND CONSERVATION: A CURRICULAR FRAMEWORK FOR
INTEGRATING INDIGENOUS STUDIES AND RESTORATION ECOLOGY

by

Chelsey Cecilia Pacanins

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

June 2026

©COPYRIGHT

by

Chelsey Cecilia Pacanins

2026

All Rights Reserved

DEDICATION

To my parents, Vicente and Natalie. Thank you for your strength and guidance. Having y'all as my parents has made me value being a hard worker, being persistent, and working for something I believe in. This is for you.

To my partner, Jess, thank you for being my rock. I love you.

ACKNOWLEDGEMENTS

Thank you to my advisor, Dr. Chris Pavlovich; my peer reviewers in my cohort; my science reader, Dr. David Willey; my Academic Advisor, Holly Thompson Reed; and to the MSSE Program Coordinator, Pilar Martland, for your guidance, support, and motivation throughout this process.

I also want to express my gratitude to my colleagues at CASEE - Irene, Chris, Jessica, Justine, Margaret, and Donna. Thank you for being my soundboard and biggest cheerleader, for encouraging me to enter this program and supporting my wild ideas for our program. Thank you. I acknowledge that this curriculum and paper were developed on the ancestral homelands of many Indigenous peoples, including the Cowlitz, Chinook, and Klickitat. The colonization of these lands has been profoundly detrimental to both the local ecosystems and the communities that have stewarded them for millennia. When an ecosystem is compromised, we risk losing not only native species but also the food sovereignty and living languages of Indigenous peoples. This work represents my commitment to honoring our local community and actively contributing to both ecological and cultural restoration.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND.....	1
Context of Study	1
Demographics	3
Focus Statement.....	4
2. CONCEPTUAL FRAMEWORK.....	5
Community Centered Education.....	5
Indigenous Participation	6
Totemic Species	8
Case Studies & Student Engagement.....	9
Inquiry-Based Pedagogy: The 5E Model.....	9
Cognitive Rigor and Bloom's Taxonomy	10
Conceptual Framework Summary	10
3. INSTRUCTIONAL STRATEGIES AND RESOURCES.....	12
Primary Learning Objective.....	12
5E Instructional Model	13
Phase 1: Engage- Phenomenon Based Inquiry	14
Phase 2: Explore- Glacial History and Anthropogenic Landscapes	16
Phase 3: Explain- Prairie Species Expertise	17
Phase 4: Elaborate- Field-Based Data Collection.....	19
Phase 5: Evaluate- The Biocultural Restoration Project.....	21
Synthesis of the 5E Framework	22
4. VALUE: REASONING AND REFLECTION	24
Instructional Significance	24
Conceptual Implications	25
Operationalizing Inquiry through Place.....	26
The Utility of the Two-Eyed Seeing Framework.....	26
Accessibility through Authentic Stewardship.....	27
Implications for Classroom Practice.....	27
Implications for Student Learning	28
Professional Reflection	29
Future Directions	30
Expanding Ecological and Technological Scope	31
Cultural Engagement and First Foods.....	31
Establishing Reciprocal Tribal Partnerships	32
Summary of Instructional Significance	32

REFERENCES CITED.....	34
APPENDICES	37
APPENDIX A: PHENOMENON HYPOTHESIS GALLERY WALK.....	38
APPENDIX B: STORYMAP SCAVENGER HUNT	44
APPENDIX C: QUADRAT PROMPT	47
APPENDIX D: REFLECTIVE JOURNALING	49
APPENDIX E: WESTERN WASHINGTON PRAIRIE SPECIES POSTER.....	52
APPENDIX F: POSTER PRESENTATION PEER-REVIEW.....	55
APPENDIX G: PRESENTATION RUBRIC.....	57
APPENDIX H: SOIL CHARACTERIZATION PROTOCOL	60
APPENDIX I: BIOCULTURAL RESTORATION PLAN	62

LIST OF TABLES

Table	Page
1. Table 1. 5E Curriculum Map and Indigenous Integration.	13
2. Table 2. Alignment with Bloom's Taxonomy	23
3. Table G1. Rubric for Student Oral Presentations on Their Prairie Species Poster.....	58

LIST OF FIGURES

Figure	Page
1. Figure 1. Photo of the Mima Mounds Natural Area in Thurston County, Washington.	15
2. Figure 2. A formula to calculate the percentage of soil composition.....	20
3. Figure 3. Soil Texture Triangle. From SoilComposition.png, by M. Kruszewski, 2011, Wikimedia Commons. CC BY-SA 3.0.	20
4. Figure A1. The Gopher Hypothesis. This hypothesis suggests that gophers are the cause for the formation of Mima Mounds due to their burrowing and social behaviors. Source: Washington Department of Natural Resources (2025).	39
5. Figure A2. The Glacial Melting Hypothesis. This hypothesis suggests that sediment-filled depressions in retreating ice sheets result in the current mound formation at the edge of the glacier. Source: Washington Department of Natural Resources (2025).	40
6. Figure A3. The Flood Hypothesis. This hypothesis suggests that flooding could be a major source behind the formation of the Mima Mounds. Source: Washington Department of Natural Resources (2025).	41
7. Figure A4. Traditional Oral Histories Hypothesis. The Chehalis people have oral histories of floods that brought in whales and porpoises onto the land and were left behind when the flood receded, leaving mounds in the landscape. Source: Washington Department of Natural Resources (2025).	41
8. Figure A5. The Frost Hypothesis. This hypothesis suggests that the Mima Mounds were created due to soil cracks caused by freezing temperatures. These cracks fill with water and expand with freezing temperatures. Source: Washington Department of Natural Resources (2025).	42
9. Figure A6. Erosion-Root Anchor Hypothesis. This hypothesis suggests that the weathering around roots caused the Mima Mounds. Source: Washington Department of Natural Resources (2025).	42
10. Figure A7. Earthquake Shaking Hypothesis. This hypothesis suggests that the ripples of the earthquakes, the combined ripples, create higher points and lower points, causing the formation of the Mima Mounds. Source: Washington Department of Natural Resources (2025).	43

ABSTRACT

The integration of Western scientific inquiry and Traditional Ecological Knowledge (TEK) remains a significant gap in secondary education, often leading to the marginalization of traditional ways of knowing. This educational scholarship addresses the need for culturally responsive curricula that honor Tribal sovereignty and land stewardship while meeting rigorous state science standards. The curriculum involves a 5E instructional framework centered on the declining Washington prairies. Using the Two-Eyed Seeing methodology, this work weaves Western ecological principles with Indigenous anthropological relationships to the land. The resulting scholarship provides a structured pedagogical model that utilizes Totemic Species and the geomorphic mystery of the Mima Mounds as focal points for student inquiry. This design process demonstrates that centering culturally and ecologically important species creates an accessible pathway for students to engage with restoration principles and intergenerational knowledge transfer. This scholarship concludes that by bridging these distinct knowledge systems, educators can challenge traditional hierarchies of evidence and foster a more inclusive environmental literacy that prepares students to address ecological challenges.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of Study

The Pacific Northwest region of the United States is well-known for its dense forested habitats. However, before Euro-American settlement, Western sections of the region were once dominated by expansive prairie habitats, specifically, the Willamette Valley and Puget Sound lowlands. These ecosystems were not just accidental remnants or relicts of a post-glacial climate but are anthropogenic landscapes. While the gravelly soils left behind by retreating glaciers ~15,000 years ago provided the foundation, the persistence of these 180,000 acres of prairie was shaped by the land management practices of Indigenous peoples, including the Cowlitz Indian Tribe (Washington Department of Fish and Wildlife, n.d.).

Land management is rooted in Traditional Ecological Knowledge (TEK), consisting of thousands of years of knowledge, practice, and belief regarding the relationships of living beings with one another and with their environment, offering long-term data regarding the response of Pacific Northwest flora to human intervention. Central to this stewardship is the practice of cultural burning, applying low-intensity fire to prevent forest encroachment and cycle nutrients to favor First Foods, like Camas (*Camassia quamash*) and the Garry Oak (*Quercus garryana*). Prairies once covered vast areas; these natural or “wild” ecosystems are now rarely found due to intensive agriculture, urban development, and aggressive fire suppression following European settlement. Today, Washington has an estimated 3% of original prairies remaining, with less than 1% considered in good condition (Washington Department of Fish and Wildlife, n.d.). To

approach the restoration of these lands without acknowledging the TEK that supported them is to ignore the primary ecological driver of the habitat.

Before entering the classroom, I worked for a Pacific salmon habitat restoration non-profit organization, where I curated planting plans and managed thousands of native plants for various restoration projects each year. In our area, salmon receive attention in education and within the environmental networks, rightfully so, as salmon have been considered a keystone species, are interlinked with the health of forests, and are culturally important to various Indigenous tribes. However, while salmon serves as a mascot for restoration, I felt a calling to explore terrestrial habitats that are equally in dire need of attention. This led my focus to the Washington prairies.

I developed a multidisciplinary curriculum focusing on the Western Washington prairies to provide students with a place-based understanding of this endangered habitat. By exploring the intersection of geological history, cultural importance, and ecological restoration, students engage in field-based inquiry, explore prairie systems through field-plot studies, explain specific species, elaborate on field data, and evaluate restoration plans. Although this unit is tailored to Western Washington, this curriculum provides an adaptable framework for exploring regional critical habitats and traditional knowledge elsewhere.

One of my first classes through Montana State University's Master of Science in Science Education (MSSE) program focused on inquiry through science and engineering practices with the professor and then-director of the program, Dr. John Graves. This coursework cemented the idea of using an anchoring phenomenon to begin a new unit, then challenging the students to explore complex mysteries that can't be explained simply. It was within this context that I was

introduced to the 5E instructional model, a constructivist framework that sequences learning through engagement, exploration, explanation, elaboration, and evaluation. As an educator transitioning from an industry background, these MSSE graduate studies provided the pedagogical structure I needed to connect my technical expertise with effective classroom practice. I began implementing these techniques in my classroom at the Center for Agriculture, Science, and Environmental Education (CASEE).

Demographics

CASEE is a half-day STEM program for high school students within Battle Ground Public Schools, located on 80 acres of Department of Natural Resources land in Brush Prairie, Washington. At CASEE, students earn a lab-science credit, a Career and Technical Education (CTE) credit, and an English credit. With the amount of outdoor physical activity CASEE provides, if students go all four years, 1.0 credit of their required physical education is waived for graduation. Students spend half of their day at CASEE with the same cohort of students, as they continue throughout their high school career. This creates a tight-knit community, providing moments of encouragement and building confidence among their own peers.

CASEE is a free public educational program where students within the district can apply to attend. The application process is not strenuous, but it gives staff an idea of students' interest in the program. Students who apply and attend are interested in the STEM pathway and choose to learn at CASEE for half of their school day. CASEE is meant to be inclusive to all students; we have a wide range of academic levels. CASEE has a smaller staff compared to the other schools in our district, consisting of four instructors, a facilitator, a lab technician, and a Special

Education Assistant (SEA). In the 2024-2025 school year, we had a total of 126 students enrolled.

Focus Statement

This project involves the design and implementation of a land-based restoration curriculum integrating local Indigenous knowledge with Western science. By developing a unit spanning glacial history to modern prairie stewardship, this project examines how the intersection of cultural history and field-based inquiry fosters a deeper sense of environmental agency and stewardship in high school STEM students.

CHAPTER TWO

CONCEPTUAL FRAMEWORK

This chapter establishes the conceptual foundation for the design and pedagogical approach of this unit, exploring four interrelated themes: community centered education, Indigenous participation, the role of totemic species, and student engagement. Together, these themes ground the curriculum in the understanding that cultural knowledge serves as a crucial link between restoration practices and environmental stewardship, providing a framework intended to deepen student learning.

Community Centered Education

Connecting students' understanding of complex ecological processes, e.g., climate change and global issues, to local knowledge and conservation efforts provides a meaningful framework for exploring regional environmental issues and contextualizing pathways into related career fields. Engaging students in a curriculum centered on local conservation efforts offers a pathway to foster collective social responsibility, cultivate an appreciation for Indigenous ecological knowledge, and emphasize the importance of conservation while exploring the intersections of biodiversity and cultural identity (Ajaps & Forh Mbah, 2022). By analyzing local habitats as a primary learning resource, students are provided opportunities to develop a sense of stewardship toward regional ecosystems and investigate sustainable practices for future development. Extending the concept of local connection, the next section examines how authentic partnerships with Indigenous communities serve to strengthen both conservation efforts and educational outcomes.

Indigenous Participation and Knowledge

Indigenous people hold millennia of accumulated knowledge on land stewardship and community well-being, yet their knowledge and communities have been marginalized for generations (McAllister, 2020). Climate change disproportionately affects Indigenous peoples' health, sovereignty, access to traditional foods and medicines, and overall cultural identity. Despite their leadership in environmental activism, Indigenous people hold only 1% of staff positions in non-profit environmental organizations (McAllister, 2020). The absence of Indigenous educators in public schools creates a significant gap in the factual and respectful integration of traditional knowledge systems into curricula. Some perspectives are deeply rooted in Indigenous experience and could become difficult for non-Indigenous educators to fully comprehend and effectively communicate traditional knowledge to students (McAllister, 2020). Even with the best intentions, non-Indigenous educators risk spreading inaccurate or harmful information. Meaningfully including Indigenous communities in the planning and implementation of Indigenous-based education is designed to foster stronger community connections and support the authentic representation of their knowledge. Rather than viewing this as an abstract curriculum requirement, the literature suggests that centering relational learning, such as engaging with local tribes through community events and listening to Tribal members, allows educators to ensure the information shared with students honors living traditions. A primary example of this community led identification of educational needs can be seen in the Cowlitz Tribe's recent efforts to assess food sovereignty.

In 2021, the Cowlitz Tribe conducted a 66-question survey through its Wellness and Diabetes Program to assess the Tribe's food sovereignty status. The Food Sovereignty

Assessment ($N = 525$) results revealed that two-thirds of the respondents reported they do not eat traditional foods due to a lack of knowledge regarding gathering and preparation, coupled with a lack of access to places where these foods grow. To address this, the Cowlitz Tribe is actively working to implement strategies to engage community members about the cultural importance of First Foods and medicine and to connect elders with youth to facilitate the transfer of intergenerational knowledge (Cowlitz Indian Tribe, 2022). By centering regional conservation and traditional land stewardship, this curriculum framework directly responds to these documented community needs, providing a scalable educational tool designed to help bridge this gap in intergenerational ecological knowledge.

Two-Eyed Seeing Framework

Traditional knowledge is dynamically shaped through millennia of lived experiences and reciprocal relationships with the local environment (Jeffery et al., 2021). Historically, Eurocentric academic frameworks have often, whether intentionally or not, marginalized this wealth of understanding. However, ecological paradigms are strengthened when Western Science and TEK are viewed as complementary systems. This interconnectedness is illustrated by Chief Charles Labrador of the Acadia First Nation, who utilized the metaphor of a diverse forest connected at the roots underground (Roher et al., 2021). To operationalize this harmony, Mi'kmaq Elders Albert and Murdena Marshall introduced the framework of Two-Eyed Seeing, derived from the Mi'kmaq word *Etuaptmumk*, meaning “the gift of multiple perspectives” (Roher et al., 2021). Developed in collaboration with biology professor Dr. Chery Bartlett to create an integrative science curriculum, recognizing that one perspective may offer greater applicability depending on the situational context (Jeffery et al., 2021). Ultimately, the Two-Eyed

Seeing method encourages us to view the world with one eye focused on the strengths of Indigenous knowledge systems and the other eye focused on the strengths of Western Scientific methodologies.

Totemic Species

Focusing on the cultural significance of species within an ecosystem can serve as a rich educational tool for students to learn about TEK and the importance of conservation (Ward et al., 2023). In Indigenous cultures, certain animals and species are celebrated for their significance, often through totems, symbols of a plant, an animal, or a natural object that represents a nation, clan, family unit, or a person (Turner & McKenzie, 2022). To directly address the knowledge and access gaps identified in Tribal assessments, such as the Cowlitz Food Sovereignty survey, the curriculum centers on cultural keystone species. In this context, a species like the common Camas (*Camassia quamash*) serves as a cultural keystone species for the tribes in this ecoregion. Historically a primary food source, *C. quamash* is a perennial purple flower that comes from bulbs; the bulbs are the edible component, containing high levels of carbohydrates (Henshaw, 2024). Indigenous peoples of the Pacific Northwest traditionally harvest these bulbs in late spring to early summer when the flowers are still present, slow roasting them for hours or days to prepare for immediate consumption or long-term storage (Henshaw, 2024). As regional prairie habitats face ongoing degradation, preserving access to and knowledge of these traditional First Foods becomes increasingly critical.

Case Studies & Student Engagement

To foster student engagement, curricular frameworks can be adapted to align with student interests, link to their community, and reflect their cultural experiences. Students who can connect with real-world material are uniquely positioned to find opportunities to deepen their understanding. Therefore, introducing students to documented experiences can create a connection that bridges between the classroom and outside the classroom (Perry, 2022).

Within this framework, case studies are leveraged beyond supplemental reading or simple narratives to become anchoring phenomena- an essential sense-making tool that initiates the learning process for students. Utilizing these real-world occurrences in the science classroom facilitates the integration of Disciplinary Core Ideas (DCIs) and Crosscutting Concepts (CCCs) through active Science Engineering Practices (SEPs) (NGSS Lead States, 2016). Unlike a traditional case study used as a culminating activity, an anchoring phenomenon is introduced at the start of a unit to create a need-to-know environment (NGSS Lead States, 2016). This intentionally shifts the student's role from a passive reader of information into an active investigator tasked with explaining a complex, real-world mystery.

Inquiry-Based Pedagogy: The 5E Model

While anchoring phenomena provides the need-to-know, the 5E Instructional Model provides the structural scaffolding necessary for conceptual change. Grau et al. (2021) demonstrate that the 5E Model, which consists of Engage, Explore, Explain, Elaborate, and Evaluate, supports deeper long-term conceptual learning when compared to traditional lecture-based methods. This model is particularly effective for restoration ecology because it allows

students to move from initial curiosity about a local landscape (Engage) to the technical application of data (Elaborate). By utilizing this framework, the curriculum supports educators in structuring the integration of diverse knowledge systems through a logical progression that mirrors professional scientific inquiry.

Cognitive Rigor and Bloom's Taxonomy

To promote deep conceptual understanding rather than surface-level memorization, the curriculum design is mapped against Bloom's Taxonomy of Educational Objectives. This framework categorizes cognitive tasks into a hierarchy, from lower-order thinking skills, such as remembering and understanding, to higher-order skills, such as analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). By aligning Bloom's Taxonomy with the Two-Eyed Seeing approach, the lessons are structured to be both culturally inclusive and academically rigorous, challenging students to synthesize complex, multi-disciplinary information to solve real-world ecological problems.

Conceptual Framework Summary

By synthesizing these four pillars, this conceptual framework provides the rationale for a Two-Eyed Seeing instructional design. If community centered education provides the location, and Indigenous participation supports the development of authentic content, then the use of cultural keystone species like Camas provides the narrative anchor. Finally, the application of case studies and anchoring phenomena provides the pedagogical engine designed to invite students to shift from passive observers to active stewards. Together, these concepts suggest that

restoration science is most effective when it is place-based, culturally informed, and inquiry-driven.

CHAPTER THREE

INSTRUCTIONAL STRATEGIES AND RESOURCES

This chapter serves as a practitioner’s guide for educators implementing a Two-Eyed Seeing approach to restoration ecology. By connecting Western ecological science with TEK, this unit positions students in the role of Lead Restoration Technicians, drawing on a pedagogical framework adapted from Grau et al. (2021). The unit is structured around a 0.5-acre campus prairie plot and Western Washington landscapes, providing the place-based context for an anchoring phenomenon that centers the Cowlitz peoples’ relationship with the landscape.

Primary Learning Objective

The primary learning objective requires students to construct a comprehensive site restoration proposal for a campus prairie plot. To achieve this, the unit is structured around the integration of quantitative empirical data from field-based soil studies with qualitative Indigenous management frameworks. The following curriculum map outlines the pedagogical progression of the unit, detailing the specific intersection of inquiry-based science and Indigenous knowledge across each phase of the learning cycle (Table 1).

Table 1. 5E Curriculum Map and Indigenous Integration.

Phase	Pedagogical Focus	Student Action	Indigenous Knowledge Integration
Engage	Phenomenon Based Inquiry	Hypothesizing Mima Mounds formation through Think-Pair-Share	Oral histories and traditional naming of the landscape
Explore	Geospatial and Historical Context	Mapping Glacial Retreat and Prairie Loss	Historical analysis of The Prairie People and cultural burning
Explain	Scientific Communication	Designing scientific posters for key species	Ethnobiological uses (Camas as food source/trade item)
Elaborate	Field-Based Data Collection	Soil testing and geospatial recording through ArcGIS	Comparing NPK pH needs of traditional soil management with Western NPK metrics
Evaluate	Synthesis and Professional Design	Drafting a formal restoration proposal for the campus site	Bridging TEK stewardship with modern restoration ecology

5E Instructional Model

The curriculum for this unit utilizes the 5E Instructional Model, a constructivist framework designed to facilitate conceptual change and deepen student inquiry. This model sequences learning through five distinct phases: Engage, Explore, Explain, Elaborate, and Evaluate. This model was selected because it provides the structure needed to implement a Two-Eyed Seeing approach, structuring opportunities for students to view restoration through the lenses of Western ecological science and TEK simultaneously. As established in the Conceptual Framework (Chapter 2), for restoration science to be effective, it must move beyond traditional repetition of memorization and instead be place-based, culturally informed, and inquiry-driven. The following sections detail how each phase bridges these two knowledge systems to achieve the unit's primary learning objectives.

Phase 1: Engage- Phenomenon Based Inquiry

This unit begins with an exploration of a local geological mystery, culminating in the Phenomenon Hypothesis Gallery Walk (Appendix A). The purpose of this phase is to prompt cognitive conflict by presenting a local geological mystery that cannot be easily explained by prior knowledge (Grau et al., 2021). Students analyze the Mima Mounds of Thurston County. This phase introduces the concept of land as a relative, structuring opportunities for students to transition from viewing soil as an objective commodity to viewing the landscape as a community of plants and geological features.

Before class begins, the instructor sets up a Phenomenon Hypothesis Gallery Walk with excerpts from the Washington DNR booklet *Guide to the Mima Mounds* onto large pieces of paper (Washington Department of Natural Resources, n.d.). The instructor begins the lesson with a hook by displaying a high-resolution image of the phenomenon, in this case, the Mima Mounds (Figure 1). The instructor provides students with several minutes of silent observation before prompting them to discuss their initial perceptions with a partner. The instructor then moves the discussion from partners to the whole class, with guiding questions such as: “What do you see?” and “How might these have been formed?” This strategy aligns with the anchoring phenomena framework discussed in Chapter 2, positioning the student as an active investigator of a local mystery.

Following the introduction, the instructor facilitates a Gallery Walk featuring the primary hypotheses regarding the formation of the Mima Mounds. Each station provides a concise description and visual aids for theories, including the Gopher Hypothesis, the Glacier Hypothesis, the Flood Hypothesis, the Traditional Ecological Perspective, the Frost Hypothesis, the Erosion-Root Anchor Hypothesis, and the Earthquake Shaking Hypothesis. Students rotate

through the stations in small groups, critically evaluating the provided evidence and recording their reasoning on graphic organizers. The activity culminates in a physical vote, where students stand near the hypothesis they find most credible based on the evidence reviewed. This kinesthetic approach is designed to cultivate student-led inquiry and makes the internal reasoning process visible to both the instructor and peers.



Figure 1. Photo of the Mima Mounds Natural Area in Thurston County, Washington.

By including Indigenous oral traditions alongside geophysical theories, the activity is structured to decenter traditional Western knowledge hierarchies, providing a framework where students can evaluate diverse ways of knowing as valid forms of evidence, fostering a more inclusive and comprehensive understanding of the local landscape.

Phase 2: Explore- Glacial History and Anthropogenic Landscapes

After engaging the students in the phenomenon of the Mima Mounds, students investigate the post-glacial formation of the Puget Trough and the development of prairies in Washington. The instructor begins by defining the Puget Trough, the low-lying physiographic region between the Cascade Range and the Olympic Mountains that was carved out by the Vashon Glacier approximately 15,000 years ago (Washington Department of Fish and Wildlife, n.d.). This phase addresses the critical conservation crisis of prairie loss, noting that Washington's prairies have been reduced to only 3% of their original extent. Central to this exploration is the concept of Cultural Burning, the intentional application of fire by Indigenous peoples, such as the Cowlitz and Chehalis, to promote the growth of First Foods and prevent the encroachment of Douglas fir (*Pseudotsuga menziesii*) forests.

To connect these historical and ecological concepts, the instructor introduces students to Geographic Information Systems (GIS) through the *Wolf Haven International StoryMap* and an accompanying scavenger hunt assignment (Appendix B). This StoryMap was created by Matt Einhorn and Melinda Wood, graduate students at the Evergreen State College, in collaboration with GIS professor Mike Ruth (Einhorn & Wood, 2022). Through this digital resource, students analyze a real-world restoration project of a nonprofit wolf sanctuary in Thurston County. Wolf Haven unintentionally became a steward of Mima Mound restoration after purchasing land to create a buffer for their facility. Upon clearing overgrowth on the new property, staff uncovered 36 acres of intact Mima Mounds. Through the StoryMap, students analyzed the restoration project, the ecological history of Indigenous prescribed burns, and the biodiversity of the site, including the Mazama pocket gopher (*Thomomys mazama*) and the endangered Taylor's

checkerspot butterfly (*Euphydryas editha taylori*). Currently, Wolf Haven partners with the Center for Natural Lands Management and the Ecostudies Institute to conduct annual prescribed burns to maintain the prairie's health.

The exploration phase culminates in a field study where the instructor facilitates a hands-on comparison between burned and unburned prairie sections at the Mima Mounds located at Wolf Haven. The instructor demonstrates the use of quadrats for field sampling, guiding students as they conduct comparative observation of vegetation density and percent coverage (Appendix C). Working in small research groups, students record primary data on the immediate impacts of fire on plant frequency. This phase concludes with reflective journaling (Appendix D). The instructor prompts students to synthesize their findings into a technical summary regarding the prairie's ecological resilience, specifically identifying visible signs of life that thrive following a prescribed burn.

By sequencing learning from digital mapping to physical field data, this phase is designed to guide students as they transition from observing the landscape to investigating the anthropogenic forces, both historical and modern, that maintain prairie biodiversity.

Phase 3: Explain- Prairie Species Expertise

To transition from broad landscape-level concepts to biological specifics, students moved into a targeted investigation of Washington prairie species, focusing on the Totemic Species framework where biological traits intersect with cultural significance (Wilder et al., 2016). The instructor facilitates this project by assigning each student a specific organism, many of which are threatened, endangered, or central to regional conservation.

To promote scientific communication and digital literacy, the instructor guides students in using Canva to produce a professional scientific poster (Appendix E). The instructor provides a unified 11”x18” poster format to support a consistent, professional aesthetic. A strategic color-coding system is implemented to help students visually categorize the prairie’s biodiversity:

- Green: Botanical species
- Purple: Mammalian/Avian species
- Yellow: Insect species

To balance visual design with academic rigor, the instructor requires students to include a QR code on their posters that links to a digital APA reference page, encouraging the use of digital databases and resource credibility checks. Students synthesize complex data points for their research, including:

- Morphological descriptions and life cycles
- Ecological roles and trophic interactions
- Anthropogenic threats and current conservation strategies
- Ethnobotanical significance and traditional uses of the species

This process requires the application of academic skills such as APA-style citation and technical writing.

The phase culminates in a transition from written research to oral presentation. After posters are printed and laminated, the instructor facilitates peer-review (Appendix F) rehearsals focusing on verbal and non-verbal communication skills. The final assessment for this phase is a Formal Classroom Presentation (Appendix G), where students present and articulate their species’ ecological and/or cultural importance to their peers. By shifting from broad inquiry to

specific biological expertise, the design aims to scaffold the specialized knowledge necessary to justify the management decisions required in the final restoration proposal.

Phase 4: Elaborate- Field-Based Data Collection

In this phase, the purpose is to apply ecological theory to a physical environment through campus-based fieldwork, identifying the soil variables that strongly influence the success or failure of prairie restoration, modeled within ArcGIS. In this phase, students engage in spatial data science by mapping the campus restoration site's soil textures (sand, silt, and clay) and chemical compositions (Nitrogen (N), Phosphorus (P), Potassium (K), and pH). This data provides a quantitative foundation for the Technical Justification Essay in the final assignment.

The instructor organizes the class into Technician Crews to perform random sampling across the 0.5-acre site. This methodology is selected to capture the heterogeneous nature of the soil rather than relying on a single data point. The instructor integrates the ArcGIS Field Maps app on the school's mobile tablets, allowing students to record precise geospatial coordinates for each sample site, mirroring professional stewardship practices.

Under the instructor's guidance, students excavate soil at a depth of 6-8 inches, avoiding organic matter. Following the Soil Characterization Protocol (Appendix H), students prepare their samples for two types of analysis:

1. Physical Analysis: Students process dried soil through a multi-layer sifter to mechanically separate particles, using the standardized formula (Figure 2). Students apply their findings to a Soil Texture Triangle (Figure 3) to determine the specific soil textural class of their plot.

2. Chemical Analysis: Using Rapitest Soil Test Kits, students perform colorimetric testing. Students use color-coded reagent capsules to induce color changes that are compared against standardized charts.

Once testing is complete, the instructor guides students in integrating these numerical values back into their ArcGIS layer in Field Maps.

$$\text{Percentage} = \left(\frac{\text{Mass of separated Particle (g)}}{\text{Initial Total Mass (100 g)}} \right) \times 100$$

Figure 2. A formula to calculate the percentage of soil composition.

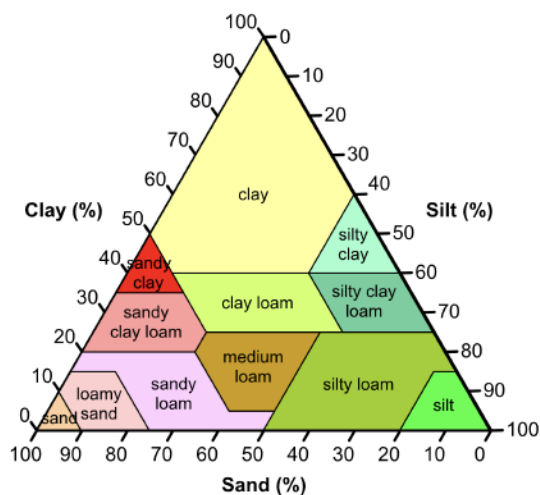


Figure 3. Soil Texture Triangle. From SoilComposition.png, by M. Kruszewski, 2011, Wikimedia Commons. CC BY-SA 3.0.

The technical crews share their standardized data to collaboratively compile a class-wide dataset and cross-verify results. This phase concludes with the generation of a site-specific student-made dataset, providing the empirical foundation necessary for students to justify their species selection and zonal logic in the final phase.

Phase 5: Evaluate- The Biocultural Restoration Project

The purpose of this final phase is to facilitate a high-level synthesis of Western restoration ecology and TEK, requiring students to apply the principle of Reciprocal Restoration to a real-world land management scenario (Senos et al., 2006). The instructor facilitates the summative assessment by framing students as Lead Restoration Technicians responsible for a 0.5-acre site. This phase serves as the primary evidence of learning, where students must justify management decisions that support both ecological health and the cultural sovereignty of local Tribes. The instructor provides a structured submission checklist (Appendix I) to ensure students manage the multi-modal nature of the project. To mirror professional environmental consulting, the instructor requires a rough draft, a hand-drawn zonal design, and a final draft (ArcGIS Digital Plan), emphasizing the importance of iterative design and spatial accuracy. Students construct a comprehensive four-part portfolio that demonstrates proficiency in the unit's core objectives:

1. The Species Trio: Selecting one First Food plant, one target mammal or bird, and one target insect, and justifying their ecological and cultural synergy.
2. Zonal Design: Sketching a 0.5-acre plot organized into gardens with a main focus for pollinators, First Foods, and habitat buffers, and including a low-impact trail for Tribal harvesting.
3. ArcGIS Digital Plan: Digitizing their design into a professional map layout featuring polygons, legends, scale bars, and scientific nomenclature.
4. Technical Justification Essay: Writing a 5-paragraph expository essay that synthesizes their soil data with the biocultural goals of supporting Tribal Sovereignty and the remaining 3% of Washington prairies.

This evaluation phase moves beyond traditional testing by requiring students to adopt the role of stewards. By bridging the gap between digital mapping and Traditional Ecological Knowledge, students apply complex scientific data to propose solutions for human and ecological problems simultaneously.

Synthesis of the 5E Framework

The progression of this unit ensures that students are not merely passive recipients of ecological facts. Instead, the instructional sequence intentionally engages the upper tiers of Bloom's Taxonomy (Table 2). Students transition from foundational field application during the Elaborate phase to high-level critical analysis and creative synthesis in the final Evaluate phase. By structuring the curriculum to demand both analytical justification and complex project design, the integration of Two-Eyed Seeing remains both culturally respectful and academically rigorous.

Table 2. Alignment with Bloom's Taxonomy

Bloom's Level	Learning Objective	Evidence of Learning (Assessment)
Create	Construct a restoration plan using scientific and Indigenous framework	Final Restoration Proposal Portfolio and ArcGIS map layout
Analyze	Compare Western restoration goals with Indigenous Reciprocal Restoration	Technical Justification Essay
Apply	Use ArcGIS and soil test kits to document current environmental conditions	Digital map layers and zonal logic justification

CHAPTER FOUR

VALUE: REASONING AND REFLECTION

This chapter serves as the bridge between the theoretical design of this curriculum and its practical utility within the secondary science classroom. This section illuminates how this curriculum addresses the dual need for ecological literacy and cultural humility. Ultimately, the following discussion explores the broader implications of this work, offering insights into how such integrated frameworks can help assist teaching practices and hopefully deepen student learning outcomes in the modern science laboratory and field.

Instructional Significance

Driven by historically Eurocentric frameworks in formal science education, Western ecological science is presented as an objective, data-driven discipline, while Indigenous knowledge systems are either related to social studies or omitted entirely. This omission disregards a millennium of empirical information, knowledge refined through centuries of trial, error, and ancestral wisdom. By excluding Traditional Ecological Knowledge (TEK), we teach students an incomplete version of the scientific method, a version that values the short-term experiment but ignores the observations of those who lived within the landscape for thousands of years. This framework addresses this gap by positioning Traditional Ecological Knowledge not as a historical curiosity, but as a sophisticated, complementary science necessary for modern conservation and restorative practice.

While exposing the historical exclusion of TEK establishes the critical need for curriculum reform, the true instructional significance of this framework lies in the

epistemological and cognitive shifts within students. By structurally pairing Western scientific methodologies with TEK through Two-Eyed Seeing lens, the curriculum systematically dismantles Eurocentric assumptions regarding scientific validity. Specifically, this integration fundamentally alters how secondary STEM students define scientific evidence and redefines what, and who, counts as a legitimate practitioner of science.

Although this unit is based on landscapes in Washington, the overall design helps resolve a critical learning challenge: the disconnect between abstract ecological concepts and the physical landscapes students inhabit. In this case, centering the 180,000 acres of lost and altered native Washington prairies, the curriculum transforms biodiversity from a textbook term into a localized mission. It responds to the instruction gap where students learn about ecosystems without understanding their own role as active participants in those systems.

Furthermore, this approach strengthened student learning by validating diverse ways of knowing. Using ArcGIS to map alongside local TEK develops a multidimensional perspective. This design matters because it prepares future land managers to enter the workforce with the cultural competency and technical skills set required to navigate the complex socio-ecological challenges of the Pacific Northwest. For students who want to pursue paths outside of natural resources, this framework will hopefully aid students to deepen their ecological literacy, fostering an understanding of interconnectedness, an appreciation for ancestral wisdom, and a commitment to the preservation of Indigenous knowledge and tribal visibility.

Conceptual Implications

The primary conceptual implication of this curriculum design is that it operationalizes the 5E Instructional Model not merely as a lesson plan structure, but as a vehicle for socio-ecological

inquiry. While traditional implementations often utilize the 5E framework to teach isolated biological formulas or disconnected content blocks, this design reveals that its true utility lies in its capacity to drive long-term, deep-seated conceptual learning by anchoring abstract science ideas within a localized, storied landscape (Grau et al., 2021).

Operationalizing Inquiry through Place

This curriculum design puts the critical theories of Place-Based Education (PBE) into practice, shifting the classroom's focus from the textbook to the local prairie ecosystem. This operationalization supports critical pedagogy of place, demonstrating that local habitats are essential tools for driving environmental conservation and fostering student engagement (Ajaps & Forh Mbah, 2022; Perry, 2022). Furthermore, these findings validate the premise that scientific inquiry is not a spontaneous student attribute but a practiced skill that must be heavily scaffolded through the strategic use of local anchoring phenomena (NGSS Lead States, 2016).

By utilizing local geographical mysteries, such as the formation hypotheses of the Mima Mounds, the curriculum enables students to utilize their direct observations as primary data (Washington Geological Survey, 2025). This intentional scaffolding shifts students up the cognitive hierarchy from passive recall to higher-order analysis and empirical knowledge construction (Anderson & Kathwohl, 2001). This transition suggests that conceptual understanding is deepest when students are not just learning about science but are acting as the primary investigators of their own immediate environment.

The Utility of the Two-Eyed Seeing Framework

The conceptual framework of Two-Eyed Seeing was essential to this design by providing a formal, respectful structure for the integration of the millennium of information inherent in

TEK. Rather than presenting Western scientific methods and TEK as competing or contradictory systems, this design positions them as complementary, mutually reinforcing lenses (Jeffery et al., 2021). In practice, this intersection is built into the curriculum structure where students utilize ArcGIS mapping to analyze the contemporary campus landscape, while simultaneously investigating the historical management practice that maintained the broader Puget Trough prairie ecosystems for millennia (Einhorn & Wood, 2022; Senos et al., 2006).

Accessibility through Authentic Stewardship

Finally, this design suggests that abstract science concepts become accessible when they are framed through restoration as pedagogy, by tasking students with the real-world problem of restoring native prairie species and analyzing soil (Kruszewski, 2011; Washington Department of Fish and Wildlife, n.d.). This framework shifts the student role from passive consumer of data to active steward, grounding complex ecological cycles in tangible, land-based practice. When students analyze soil chemistry or map native species populations, the scientific inquiry is directly tied to the survival and resurgence of an endangered ecosystem. For Career and Technical Education students, learning is most effective when the classroom is an active restoration plot, as it seamlessly connects academic theory with the authentic technical competencies and collaborative problem-solving required in professional field-based science.

Implications for Classroom Practice

This model informs broader secondary STEM pedagogy by illustrating how student engagement with the scientific method becomes more authentic when the outcomes have real-world stakes. By tasking students with designing and defending a restoration proposal for a

specific plot of land, they are participating in professional stewardship. This shift from learning about an ecosystem to active stewardship fosters a sense of agency beyond what is typically achieved through conventional instruction. Ultimately, this work provides a blueprint for integrating Career and Technical Education and state science standards with culturally responsive frameworks, demonstrating that technical rigor and Indigenous visibility can and should coexist in the modern science classroom.

Implications for Student Learning

A central implication of this design is that by centering lessons on local ecosystems, student science literacy could be strengthened through hands-on, real-world inquiry. It moves concepts off the page and into the field. By engaging in the physical work of collecting and analyzing soil samples, the curriculum positions students to move from passive observers to active data collectors. This technical rigor, combined with the science communication required in Phases 3-5, addresses a critical need for literacy in the field. The requirement to rehearse and present findings publicly shifts the focus from individual rote memorization to collaborative knowledge construction, simulating the real-world environment of a Career and Technical Education pathway. Having students rehearse their poster presentation, along with being peer-reviewed in small groups, students became more comfortable and confident with their findings and with speaking in front of all their classmates.

A significant implication for student learning is the connection between biological study and cultural visibility. While the curriculum focused on the ecological role of prairie species, the inclusion of Camas as a First Food allowed students to engage with the landscape as a managed cultural space rather than an untouched wilderness. For example, when students presented on the

cultural significance of Camas, it shifted the learner experience from analyzing a specimen to acknowledging a millennium of Indigenous stewardship. The inclusion of Traditional Ecological Knowledge has the potential to enhance student motivation. TEK provides a vital human hook for scientific inquiry, helping students see that science is not just an abstract collection of facts but a deeply human endeavor connected to community, history, and place.

This suggests that even a focused inclusion of TEK has the potential to deepen student motivation by providing a human hook for scientific inquiry. As noted by McAllister, centering these culturally important species can foster a sense of place-based agency (2020). By acknowledging ancestral wisdom alongside soil data and species information, students develop a more holistic understanding of interconnectedness. This shifts their perspective to recognize our local area as a storied landscape that requires both technical skill and cultural respect to manage effectively.

Professional Reflection

My professional evolution through this curriculum design process represents a synthesis of my background in habitat restoration and the pedagogical frameworks gained through Montana State University's Master of Science in Science Education program. While my previous career provided a deep technical understanding of Pacific Northwest ecosystems, this program provided the formal academic structure to center TEK and the visibility of local tribes within my natural resources curriculum. The research process allowed me to integrate the local Tribes' historical and ongoing stewardship as a foundational element of our scientific inquiry. With this capstone, I have grown in my ability to scaffold complex, real-world career competencies for

ninth-grade students, transforming high-level ecological management into a structured, inquiry-based learning experience.

Integrating TEK and local restoration sites with cultural burns through the 5E Instructional Model has allowed me to bridge my industry expertise with culturally responsive teaching. I have moved from being a transmitter of ecological facts to a facilitator of a multidisciplinary perspective approach, where students learn to value data found in the soil alongside the millennia of wisdom held by the land's original stewards. This process has reinforced my belief that effective science education is an opportunity to restore local narratives and ensure that the next generation of land managers recognizes the inseparable link between ecological health and Indigenous sovereignty. On a deeply personal level, this project allowed me to formally structure a curriculum that elevates the visibility of our local Tribes, something I have wanted to achieve for my students for a long time. Through this process, my core teaching philosophy has been reinforced: effective science education must honor the land as both the laboratory and a teacher. This is not just about teaching data; it is about preparing the next generation to manage our natural resources with a balance of technical proficiency and cultural respect.

Ultimately, this project represents a foundational step for my future practice. I hope that this unit serves as a practical, encouraging template for other educators, demonstrating how we can seamlessly weave TEK into real-world inquiry and build lasting, meaningful relationships within our local communities.

Future Directions

The curricular framework developed in this project provides a scalable model for

integrating Traditional Ecological Knowledge with technical field science. While this project focused specifically on the Puget Trough prairies of Washington, the restoration as a pedagogy approach is designed to be conceptually adaptable to other localized ecosystems and scientific disciplines, provided it is grounded in collaboration with the specific Indigenous communities of those regions.

Expanding Ecological and Technological Scope

Future iterations of this design could apply the same bridging framework to other at-risk habitats, using the Pacific Northwest as an example: riparian zones and salmon habitats. By utilizing the same inquiry-based structure, students could investigate the anthropogenic relationships affecting stream health, water temperature, and spawning success. This expansion would allow the curriculum to remain relevant throughout the school year as students move from upland prairie restoration to lowland aquatic conservation, reinforcing the concept of watershed interconnectedness.

To support this expanded fieldwork, a primary direction for refinement involves the deeper integration of ArcGIS Field Maps for real-time data collection. Future units could task students with mapping invasive species or identifying at-risk micro habitats on campus. By transitioning from static mapping to live field data collection, students would gain industry-standard experience in spatial data science, further strengthening the Career and Technical Education outcomes of the program.

Cultural Engagement and First Foods

Future materials could be extended to include the harvesting and preparation of First Foods, moving beyond the identification of native plants like Camas to the actual process of

harvesting and consuming. This transition from observation to participation seeks to offer students a more sensory-rich, culturally grounded framework to conceptualize the reciprocal relationship between humans and the environment that is central to many Indigenous knowledge systems. Ultimately, these future directions aim to evolve the curriculum into a permanent, multidisciplinary fixture of the STEM pathway, preparing students to be both technically proficient and culturally aware stewards of the land.

Establishing Reciprocal Tribal Partnerships

A vital, necessary direction for the ongoing evolution of this work is to move beyond an independently designed framework toward formalizing partnerships with local Indigenous-led restoration non-profits and tribal agencies. Because this curriculum has been developed from an educational scholarship lens, future iterations would be immensely enriched by a co-design or consultative model with tribal education and natural resource departments.

Integrating tribal members and Indigenous restoration professionals as project mentors and co-educators allows students to move from learning about Indigenous knowledge to learning directly from the communities that hold it. Crucially, these future partnerships must be approached through a framework of reciprocity, ensuring that student field projects and data collection align with and support the self-determined conservation priorities and ecological sovereignty of local tribes. In doing so, the classroom evolves into a collaborative space that respects regional tribal sovereignty while training culturally mindful environmental stewards.

Summary of Instructional Significance

In conclusion, the value of this instructional design lies in its framework for transforming the secondary science classroom into a space of both technical rigor and cultural restoration. By

bridging the empirical data of Western ecology with the millennium of wisdom held by the land's original stewards, this framework offers a more holistic pathway for student engagement. The implications of this work suggest that when science education is rooted in place and centered on active stewardship, students develop not only the skills required for the modern workforce but also a deeper sense of agency and interconnectedness. Ultimately, this project serves as a foundational step toward a science curriculum that honors the land as both the laboratory and a teacher, preparing the next generation to manage our natural resources with both technical proficiency and cultural respect.

REFERENCES CITED

- Ajaps, S., & Forh Mbah, M. (2022). Towards a critical pedagogy of place for environmental conservation. *Environmental Education Research*, 28(4), 508–523.
- Anderson, L. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives: Complete edition. New York: Longman.
- Cowlitz Indian Tribe. (2022). Food sovereignty assessment. <https://www.cowlitz.org/sites/default/files/2023-01/FoodSovereigntyAssessment2022.pdf>
- Einhorn M., & Wood, M. (2022). *Native Prairie Restoration at Wolf Haven International: Controlled burn ecological restoration at Wolf Haven International as seen by ArcGIS aerial drone imagery* [StoryMap]. <https://storymaps.arcgis.com/stories/ecce3f0c171f441da7ffbcbbade9aaa5>
- Grau, F., Valls, C., Piqué, N., & Martin, H. (2021). The long-term effects of introducing the 5E model of instruction on students' conceptual learning. *International Journal of Science Education*. *International Journal of Science Education*, 43(9), 1441-1458. <https://doi.org/10.1080/09500693.2021.1918354>
- Henderson, B. (2012). *Mima Mounds NA* [Photograph]. Flickr. <https://www.flickr.com/photos/stinkenroboter/7777697864>
- Henshaw, Melanie. (2024). Cowlitz Tribe plants thousands of camas bulbs. *Street Roots*. <https://www.streetroots.org/news/2024/01/24/cowlitz-tribe-plants-thousands-camas-bulbs>
- Jeffery, T., Kurtz, D. L. M., & Jones, C. A. (2021). Two-Eyed Seeing: Current approaches, and discussion of medical applications. *BCMJJ*, 63(8), 321-325. <https://bcmj.org/articles/two-eyed-seeing-current-approaches-and-discussion-medical-applications>
- Kruszewski, M. (2011). SoilComposition.png [Image]. Wikimedia Commons. <https://commons.wikimedia.org/wiki/File:SoilComposition.png>
- McAllister, E. (2020). *Stewarding Stolen Lands: Decolonizing Conservation Organizations* (Order No. 28258609). Available from ProQuest One Academic. (2484989599). <https://www.proquest.com/dissertations-theses/stewarding-stolen-lands-decolonizing-conservation/docview/2484989599/se-2>
- NGSS Lead States. (2016). *Using phenomena in NGSS-designed lessons and units*. Next Generation Science Standards. <https://www.nextgenscience.org/sites/default/files/Using%20Phenomena%20in%20NGS S.pdf>

- Perry, A. M. (2022). Student engagement, no learning without it. *Creative Education*, 13(4), 1312-1326. <https://doi.org/10.4236/ce/2022.134079>
- Roher, S. G., Yu, Z., Martin, D. H., & Benoit, A. C. (2021). How is Etuaptmuk/Two-Eye Seeing characterized in Indigenous health research? A scoping review. *PloS one*, 16(7), e0254612. <https://doi.org/10.1371/journal.pone.0254612>
- Senos, R., Lake, F. K., Turner, N., & Martinez, D. (2006). Traditional ecological knowledge and restoration practice. In: D. Apostol & M. Sinclair (Eds.), *Restoring the Pacific Northwest: the art and science of ecological restoration in Cascadia* (pp.393-426). Island Press.
- Turner, A., & McKenzie, K. (2022). *The role of Totems in conservation, kinship, and spiritual connectivity with the land*. Flow-MER. <https://www.flow-mer.org.au/stories/the-role-of-totems-in-conservation-kinship-and-spiritual-connectivity-with-the-land>
- Ward, N. M., Garrard, G., Gregg, E. A., May, B., Wandin, D., Harrison, M., Pascoe, M., McConachie, F., Moggridge, B., Kusmanoff, A., & Bekessy, S. A. (2023). “Totemic Species” can be an effective lens for engaging students with Indigenous knowledge and biodiversity conservation. *Conservation Science and Practice*, 5(4), e12904. <https://doi.org/10.1111/csp2.12904>
- Washington Department of Fish and Wildlife. (n.d.). *Westside Prairie*. <https://wdfw.wa.gov/species-habitats/ecosystems/westside-prairie#resources>
- Washington Geological Survey. (2025). *Guide to the Mima Mounds* [Booklet]. Washington State Department of Natural Resources. https://dnr.wa.gov/sites/default/files/2025-03/ger_mima_mounds_booklet.pdf
- Washington Office of Superintendent of Public Instruction. (n.d.). *Report Card: Battle Ground School District*. <https://reportcard.ospi.k12.wa.us/ReportCard/ViewSchoolOrDistrict/100018>
- Wilder, B. T., O’Meara, C., Monti, L., & Nabhan G. P. (2016). The Importance of Indigenous Knowledge in Curbing the Loss of Language and Biodiversity. *BioScience*, 66(6), 499-509. <https://doi.org/10.1093/biosci/biw026>

APPENDICES

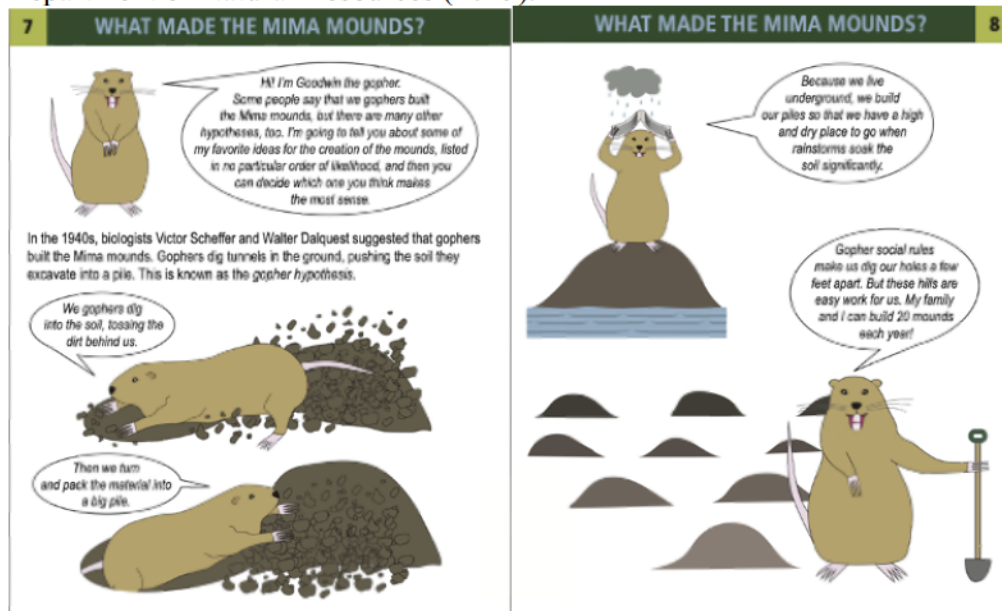
APPENDIX A: PHENOMENON HYPOTHESIS GALLERY

WALK

Overview: This activity utilizes excerpts from the Washington Department of Natural Resources (DNR) booklet *Guide to the Mima Mounds*. The instructor prints the following pages and places them throughout the room to facilitate a kinesthetic evaluation of geological and cultural hypotheses.

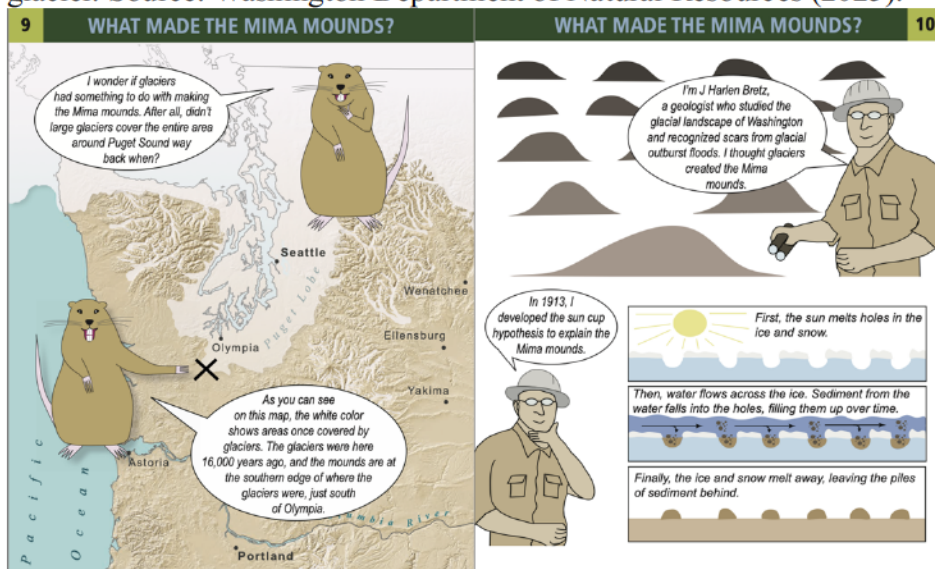
Station 1: The Gopher Hypothesis

Figure A1. The Gopher Hypothesis. This hypothesis suggests that gophers are the cause for the formation of Mima Mounds due to their burrowing and social behaviors. Source: Washington Department of Natural Resources (2025).



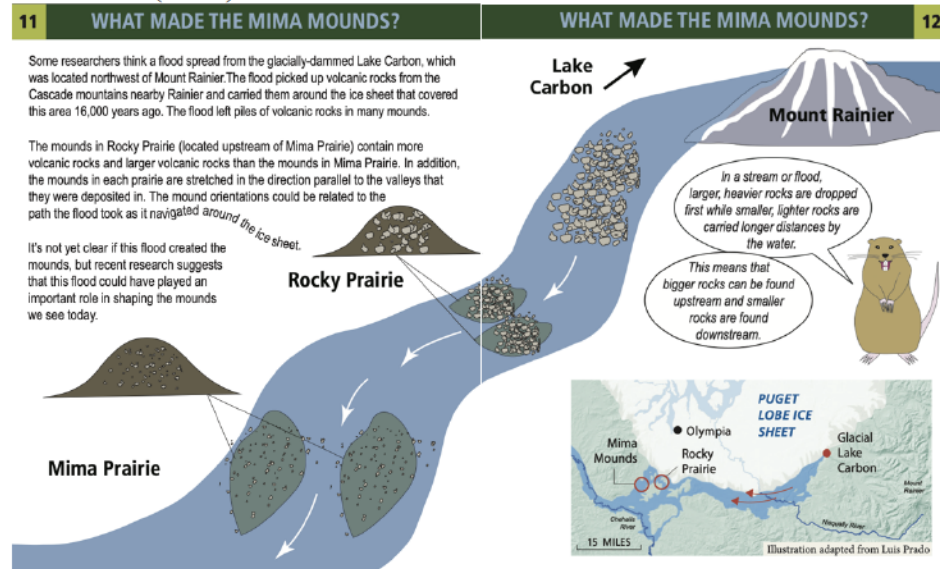
Station 2: The Glacier Hypothesis

Figure A2. The Glacial Melting Hypothesis. This hypothesis suggests that sediment-filled depressions in retreating ice sheets result in the current mound formation at the edge of the glacier. Source: Washington Department of Natural Resources (2025).



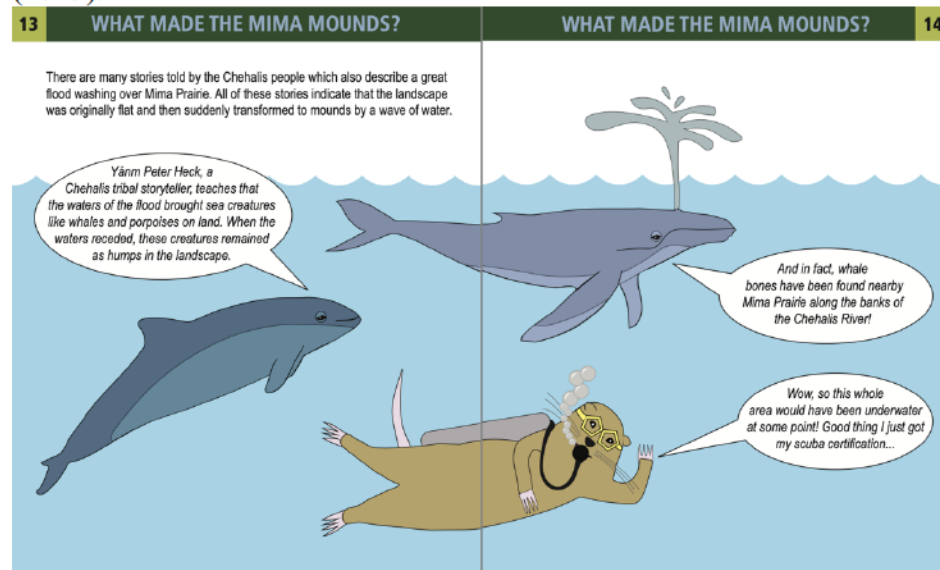
Station 3: The Flood Hypothesis

Figure A3. The Flood Hypothesis. This hypothesis suggests that flooding could be a major source behind the formation of the Mima Mounds. Source: Washington Department of Natural Resources (2025).



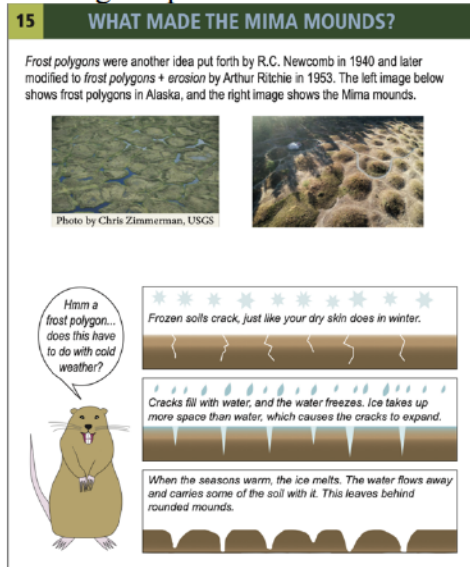
Station 4: Indigenous Oral Tradition and Cultural Knowledge

Figure A4. Traditional Oral Histories Hypothesis. The Chehalis people have oral histories of floods that brought in whales and porpoises onto the land and were left behind when the flood receded, leaving mounds in the landscape. Source: Washington Department of Natural Resources (2025).



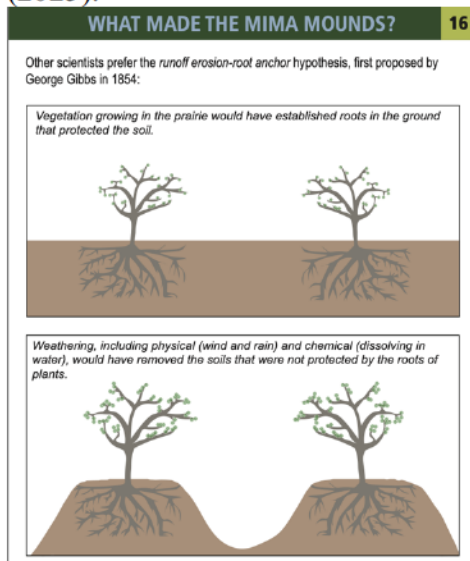
Station 5: The Frost Hypothesis

Figure A5. The Frost Hypothesis. This hypothesis suggests that the Mima Mounds were created due to soil cracks caused by freezing temperatures. These cracks fill with water and expand with freezing temperatures. Source: Washington Department of Natural Resources (2025).



Station 6: Erosion-Root Anchor Hypothesis

Figure A6. Erosion-Root Anchor Hypothesis. This hypothesis suggests that the weathering around roots caused the Mima Mounds. Source: Washington Department of Natural Resources (2025).

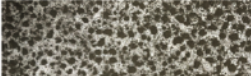


Station 7: Earthquake Shaking Hypothesis

Figure A7. Earthquake Shaking Hypothesis. This hypothesis suggests that the ripples of the earthquakes, the combined ripples, create higher points and lower points, causing the formation of the Mima Mounds. Source: Washington Department of Natural Resources (2025).

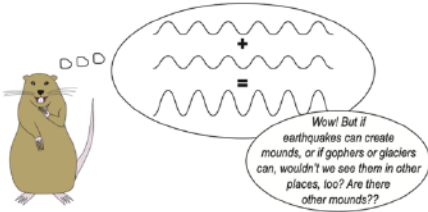
17 WHAT MADE THE MIMA MOUNDS?

In 1990, Andrew Berg proposed the *earthquake shaking hypothesis*. You can think of an earthquake like a drop of water that creates ripples in the water. An earthquake also sends ripples through the Earth. The image below shows what happens when you shake a table with Mima mound soil on it!



When a table of fine silt from the mounds is shaken with the strike of a hammer, mound-like piles form!

As the earthquake 'ripples' (seismic waves) travel around the Earth, they run into each other and combine. High points of the waves can combine into even higher points, and low points of the waves combine into even lower points. The really tall combined waves could create big piles of sediment like the Mima mounds.



Wow! But if earthquakes can create mounds, or if gophers or glaciers can, wouldn't we see them in other places, too? Are there other mounds??

APPENDIX B: STORYMAP SCAVENGER HUNT

Your mission is to find the answers to the following questions as you explore the [Native Prairie Restoration at Wolf Haven International](#) StoryMap. Please write in complete sentences.

1. The Wolf Haven prairie features unique, dome-shaped hills. What are these called, and what are two proposed theories for their mysterious origin?
2. The restoration efforts at Wolf Haven are crucial for supporting local wildlife. Name two native plant species that are part of the prairie ecosystem and one animal that benefits from these plants.
3. Prairies have a long history with local Indigenous communities. Based on the information available, what did prairies offer Indigenous people?
4. Wolf Haven uses specific methods to restore and maintain the prairie. What are two restoration activities mentioned in the Story Map, and why are they important for the ecosystem's health?
5. A specific endangered butterfly is the focus of restoration efforts. What is the name of this butterfly, and what is its connection to the prairie ecosystem?
6. One of the most prominent theories for the formation of the Mima mounds involves a burrowing rodent. What is this animal, and how is it believed to have built and

maintained the mounds?

7. Prescribed burns are a key part of prairie restoration. How do these controlled fires help native plants thrive and control invasive species like Scotch broom?
8. The golden paintbrush is a federally threatened plant species found here. What is a unique, almost parasitic, relationship this plant has with other plants in the ecosystem?
9. Wolf Haven's prairie is described as a "stepping stone" for native butterflies. What does this mean for the conservation of species like the rare Taylor's checkerspot butterfly?
10. Before European settlement, how did Indigenous communities, like the S'Klallam people, actively manage prairies to ensure they remained healthy and productive for gathering food and medicine? Name a specific plant they relied on.

APPENDIX C: QUADRAT PROMPT

Quadrat Study: Prescribed Burn vs. Unburned Area

Goal: To quantify the difference in ground cover and plant height between a recently burned area and an adjacent unburned area.

Data Collection Protocol (Using the Hula Hoop as a Quadrat)

1. Select Your Sites:

- Site A: An adjacent area that was *not* burned (tall, brown, standing grasses/plants).
- Site B: An area recently affected by the prescribed burn (charred ground, visible ash/stems).

2. Sampling: Drop the hula hoop randomly in Site A, and ten times in Site B, staying on the trail for placement. Record data for each drop.

3. Data: Ground Cover

- Categories:
 1. Standing Stems (Dead Biomass): How much area is covered by the stalks and blades of dried, upright plants?
 2. Bare Ground: How much area is just bare dirt, ash, or packed earth?
 3. Litter/Thatch: How much area is covered by loose, fallen, brown plant material? (Not attached stems, but loose bits).
 4. Green Shoots: How much area is covered by small, actively growing green plants? (Likely low in October, but important for burn areas!)

Non-Plant Objects: How much area is covered by rocks, gravel, or trail material?

APPENDIX D: REFLECTIVE JOURNALING

The Mystery of the Mounds (Ecology/Geology Focus)

The Mima Mounds are a unique feature of this landscape—small, mysterious hills dotting the prairie.

- Sensory Sketching: Find a single Mima Mound (a hill) and the flat area next to it (the depression). Draw a cross-section view (like slicing the earth in half) of the mound, estimating its height and width. Use your senses to compare the two areas:
 - Do the plants on the mound top look different (taller, shorter, different species) than the plants in the depression?
 - The Pocket Gopher Hypothesis: One theory is that the Mazama pocket gopher (a species found here) is responsible for building these mounds by burrowing. If you were a pocket gopher, why would the top of a mound be a better place to live than the low ground?
- Write a journal entry from the perspective of a pocket gopher on the Wolf Haven prairie, describing your home.

Prairie, People, and Place (Cultural/Historical Focus)

Prairies have been a foundational landscape for Indigenous peoples for thousands of years.

- Imagine you are an Indigenous person walking this land 300 years ago. What would the health of this prairie mean for your community's survival and culture? Write a descriptive paragraph contrasting that value with how most people value land today (for housing, agriculture, or conservation).

- The Long View: The prairie is often described as an "open" landscape. Stand on the prairie path, look to the horizon, and reflect on the concept of "place" and "home."
 - How does the vast, open sky and land make you feel compared to a dense forest or a crowded city?
 - In a short reflection, answer the question: "What is the cultural legacy of this prairie, and what is my responsibility to it as a visitor?"

APPENDIX E: WESTERN WASHINGTON PRAIRIE SPECIES
POSTER

Posted in Google Classroom

Each student will research an endangered, threatened, or important prairie species that is crucial to the Western Washington prairie ecosystem. Use credible sources and cite your references in APA format.

Poster Requirements:

1. Title: Common name and scientific name
2. 2 pictures minimum- specific highlight of your species
3. Include CASEE logo and Author (your first and last name)
4. Include information on your poster – be clear and concise with your writing! Include In-text citations where necessary.
 - Concise description of your species
 - Listed Status (if applicable)
 - Role in Prairie Ecosystem
 - Threats and Conservation Efforts
 - Cultural Importance and Interesting Fact(s)
 - QR Code directing to PDF of Reference Page (QR code can be made in Canva)
5. Make the poster look professional
 - Can add a design piece if it is appealing and not distracting.

Poster Parameters:

- Background and text colors:

- Green background for Plants
 - Purple background for Mammals/Birds
 - Yellow background for Insects
- Text Font
 - Source Sans Pro
- Text Size
 - Title: Common Name 90
 - Scientific Name 80; correct formatting
 - Subheadings: 40 and bold
 - Body Text: 40

APPENDIX F: POSTER PRESENTATION PEER-REVIEW

Presenter Name: _____

Species Subject: _____

Reviewer Name: _____

Public Speaking Skills

Rate the presenter on a scale of 1–3 for each category.

Category	3 (Great)	2 (Getting There)	1 (Needs Work)
Eye Contact (Looked at audience, not just screen)			
Volume & Clarity (Easy to hear and understand)			
Body Language (Stood tall, no distracting fidgeting)			

APPENDIX G: PRESENTATION RUBRIC

Table G1. Rubric for Student Oral Presentations on Their Prairie Species Poster.

Category	Exceptional (4)	Proficient (3)	Developing (2)	Emerging (1)
Introduction	Clear, confident intro of name & species. Sets a professional, scientific tone.	Introduces self and species clearly.	Introduces self but lacks detail or clear transitions.	Forgot to introduce self or species.
Scientific Content	Comprehensive details on species, its role in the ecosystem, and specific threats.	Covers species, role, and threats with good accuracy.	Missing one major requirement or info is very brief.	Significant gaps in species or ecosystem information.
Conservation & Facts	Insightful look at specific conservation efforts and unique, relevant facts.	Identifies conservation efforts and includes interesting facts.	Mentions conservation or facts, but with very little detail.	Did not address conservation or interesting facts.
Non-Verbal: Eye Contact	Maintains consistent eye contact; rarely looks at notes or the screen.	Maintains good eye contact, though occasionally relies on notes.	Minimal eye contact; spends most time reading from screen.	No eye contact made with the audience.

Non-Verbal: Body Language	Natural gestures; stands tall and faces the audience fully.	Uses some gestures; mostly faces the audience.	Fidgets or appears stiff; occasionally turns back to audience.	Back is turned to audience; distracting movements.
Vocal Delivery	Speaks clearly with great volume and tone. No filler words (um, like).	Clear and audible volume. Few filler words used.	Sometimes too quiet or fast. Frequent filler words.	Hard to hear; monotone delivery throughout.

APPENDIX H: SOIL CHARACTERIZATION PROTOCOL

Soil Lab

Step One: Measure out 100 grams of soil

Step Two: Use the mortar and pestle to crush any solid lumps of soil

Step Three: Place the massed and crushed soil in the topmost tray of the sifter and carefully shake the sifter from side to side, keeping the sifter upright

Step Four: Once separated, determine the mass of the sand, silt, and clay separately to determine the percentage of each present within the soil sample. As you determine the mass, record it in the data table.

Step Five: After obtaining the percentages, examine the soil triangle to determine what kind of soil this sample is. To do this, you will need to draw lines from each side and determine where they intersect. The area in which they intersect is the soil texture.

Location: _____

Soil Sample Mass: _____

Particle Size	Mass (grams)	Percentage (Mass/Sample Mass)*100
Sand		
Silt		
Clay		

Soil Type: _____



APPENDIX I: BIOCULTURAL RESTORATION PLAN

Project Site: Campus Prairie Unit (0.5 Acres) Technician Name: _____

You are the Lead Restoration Technician for this 0.5-acre site. This site must be engineered to support the recovery of an Endangered/Critical prairie species while providing First Food harvesting opportunities for local Tribal partners. Your plan must bridge the gap between digital mapping (ArcGIS) and Traditional Ecological Knowledge.

Part 1: The Trio (40 points)

Select your three focus species from the Species Menu located in Google Classroom. These must work together! Answer the prompts below by researching on your own, answer in complete sentences (3 sentences per prompt minimum), and provide APA citations in-text and a References page for sources used.

1. The Traditional Ecological Knowledge Plant (First Food/Medicinal): _____

How is this species used by local Tribes? What local Tribes consider this plant a First Food or medicinal?

2. The Target Mammal or Bird: _____

What is this species' role in the prairie? What is the habitat needed for this species to thrive? Consider their diet, shelter, lifespan to help answer this question.

3. The Target Insect: _____

What is this insect's role in the prairie? What is the habitat needed for this species to thrive? Consider diet, shelter, lifespan to help answer this question.

4. **Relationship:** Describe the relationship between your plant, mammal/bird, and insect.

How does the presence of one directly benefit the survival or life cycle of the others within this 0.5-acre plot?

Self-Reflection (10 Points)

1. Explain your selection of these three species. How does this "Trio" specifically meet the need to protect critical species while honoring Traditional Ecological Knowledge? What was the most important factor in your choice?

Resources (10 Points)

Part 2A: The Rough Draft (Zonal Design) (40 Points)

You will be given a piece of graph paper with the 0.5-acre plot outlined. You will use the graph paper to create a rough draft of your Zonal Design. The draft should be to scale, should have all three zones and a trail, and have symbols to represent each plant (total of 9 plant species) and where it is located. Instead of random planting, you will organize your design into Target Gardens. Use the Species Inventory table below to organize your plant selection.

Your three main zones and trail on your sketch:

- **The Pollinator Garden:** Focused on high-nectar flowers for your insect and/or bird.
- **The First Foods Garden:** Focused on calorie-rich roots and medicines for Tribal harvesting.

- **The Habitat Buffer:** A zone of native grasses and sturdy plants to provide shelter and protection.
- **The Trail:** A low-impact trail throughout the garden that allows the public to stroll, students to study certain gardens/plants, and for Tribal members to harvest

Part 2B: The Species Inventory (10 Points)

To prevent a monoculture, you must select a minimum of **8 additional plant species** from the Prairie Species Menu and include your focus plant species from Part 1. You must indicate their "Role" to ensure the prairie provides food all year long. Add the symbols to your draft as you select your species, be sure to consider which target garden they belong to.

Plant Species Name & Role	Early Season (Spring)	Mid- Season (Summer)	Late Season (Fall)	First Food	Symbol on Rough Draft
1.	[]	[]	[]	[]	
2.	[]	[]	[]	[]	
3.	[]	[]	[]	[]	
4.	[]	[]	[]	[]	
5.	[]	[]	[]	[]	
6.	[]	[]	[]	[]	

7.	☐	☐	☐	☐	
8.	☐	☐	☐	☐	
9.	☐	☐	☐	☐	

Self-Reflection (10 Points)

A successful biocultural restoration must balance human access with ecological quiet zones.

1. How did you use your Habitat Buffer to protect your target species from the traffic on the Trail?
2. If a pollinator or a harvester visited this site in the Late Season, what specific resources would be available to them? Why is it dangerous for a restoration site to have a "gap" in its blooming or harvesting schedule?

Part 3: ArcGIS Digital Plan (50 Points)

Using the Map Layer template provided for the 0.5-acre prairie plot, digitize your restoration rough draft on ArcGIS.

Your final map should reflect your hand-drawn draft, which must include:

- **Professional Elements:** Title, Your Name (Author), North Arrow, and Scale Bar.
- **Garden Polygons:** Clearly labeled areas for your **Pollinator Garden**, **First Foods Garden**, and **Habitat Buffer**.

- **Plant choices** with **Symbols** and labeled with scientific names
- **Low-impact Trail**
- **Legend:** A key explaining your symbols and colors for each plant species.

Self-Reflection (10 Points)

1. After digitizing your "Rough Draft," did the 0.5-acre site feel larger or smaller than you expected? How did the Scale Bar change where you placed your Low Impact Trail?
2. If this project were built today, how would you use your ArcGIS map to track if the restoration is working five years from now?
3. Look at your trail and your First Foods Garden on the map. Did you leave enough space or "buffer" between them so that Tribal partners can harvest in peace, or are they standing right next to the public trail?

Part 4. Technical Justification Essay (50 points)

Write a 5-paragraph expository essay (8-10 sentences per paragraph):

1. **Introduction:** Background information on Washington Prairies, CASEE, and the 0.5-acre plot.
2. **The Biocultural Goal:** Why does this 0.5-acre plot matter for the "3% remaining" prairie? How does it support Tribal Sovereignty?

3. **Species Trio Selection:** What species did you choose and why? How are these three species important/critical to Western Washington prairies and for local tribes?
4. **The Zonal Logic:** Why did you put your specific gardens and plants in their locations?
5. **Conclusion:** How do humans and animals help each other here? How can we become better stewards for critical prairie habitat? How can organizations take this plan and use it to restore original prairie sites?
6. **References:** Must use APA formatting for in-text citations and reference page at the end of your paper.

Self-Reflection (10 points)

1. What was the most challenging part of designing a space that works for both an endangered animal and human harvesters?
2. Now that you have finished the digital map and the technical essay, how has your view of the "Campus Prairie" changed? Do you see it as just a patch of grass, or as something more?