



This course was developed in 2017 by the Pacific Education Institute (PEI) with funding from Pacific Mountain Workforce Development Council and partnership with CTE teachers from four school Districts (Shelton, Aberdeen, South Bend, and the Muckleshoot Tribal School), Grays Harbor College, Green River College, Port Blakely Companies, Green Diamond Resource Company, Sierra Pacific Industries, and Rayonier Inc. It was then revised in 2022 by PEI with funding from Career Connect Washington and primary participation from teachers from Vashon School District Grays Harbor College, Spokane Community College, Manulife Forest Management, and OSPI’s Associate Director of Secondary Science. This working document will be periodically updated while working with CTE teachers across Washington to provide local resources and relevant materials and opportunities to engage youth in learning about forest practices in Washington State.

Introduction to Forest Management		
Course Title: Introduction to Forest Management		Total Framework Hours: 180 hours
Suggested CIP Code: 030506	<input checked="" type="checkbox"/> Exploratory Preparatory	Date Last Modified: 1/19/2023
Career Cluster: Agriculture, Food and Natural Resources		Cluster Pathway: Natural Resources Systems
Course Summary: This course applies scientific and forestry principles to forestry practices in Washington. The course includes units on safety and well-being; plant identification; tree measurement; diseases, insects, and pathogens; timber stand management and silviculture; fire ecology; mapping and land measurement; forest practice laws; and career planning. Students will complete a Supervised Agricultural Experience (SAE) in a local forest as part of the course.		
Requested Course Equivalency: 1 credit of lab science		Total Number of Units: 9
Course Resources: Forest Practices Illustrated (Department of Natural Resources); online folder to be shared with teacher		

Unit 1: Safety and Well-Being	Total Learning Hours for Unit: 10
Unit Summary: This unit will highlight the skills necessary to work safely and effectively on a restoration work crew.	
Competencies:	
<ol style="list-style-type: none"> 1. Understand the safe and proper use of tools for manual and chemical restoration practices (including cleaning, maintenance, and storage). 2. Engage in field safe field work procedures (ex: pacing, adequate food, water, sleep, and use of personal protective equipment, road rights-of-way). 	

3. Work on a crew successfully and safely (includes skills in listening, following directions, keeping other crew members safe).
4. Understand and adhere to community partner safety protocols.
5. Understand basic first aid relevant to restoration ecology.
6. Practice Leave No Trace and low ecological impact practices.
7. Practice basic navigation skills.

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students can:

- Perform field work safely and properly (ex: pacing, adequate food, water, sleep, and use of personal protective equipment, road rights-of-way).
- Practice safe crew practices (includes skills in listening, following directions, keeping other crew members safe).
- Practice safe and proper hand tool use for manual and chemical restoration practices.
- Adhere to community partner's safety plans and protocols.
- Practice first aid skills through role play activities.
- Use Leave No Trace and low ecological impact practices in the field.
- Practice first aid skills through role play activities.
- Locate and track locations using a compass, map and GPS.
- Read a weather report and make safety decisions based on forecast.
- Participate in orienteering course.
- Participate in geocaching activity.

Related to Supervised Agricultural Experience (SAE):

- Describe the importance of safety protocols in workplaces.
- Create a list of supplies and personal protective equipment needed to implement final project.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

Suggested skills include:

- 3.B.3 Assume shared responsibility for collaborative work, and value the individual contributions made by each team member
- 7.A.1 Adapt to varied roles, job responsibilities, schedules and contexts
- 4.B.1 Use information

Industry Standards and Competencies

Agriculture, Food, and Natural Resources (AFNR) Standards: Natural Resource Science (NRS)

NRS.03. Develop plans to ensure sustainable production and processing of natural resources

- NRS.03.02. Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

- NRS.03.02.01.a. Summarize how to use maps and technologies to identify directions and land features, calculate actual distance and determine the elevations of points.
- NRS.03.02.01.b. Apply cartographic skills and tools and technologies (e.g., land surveys, geographic coordinate systems, etc.) to locate natural resources.

AFNR Cluster Skills

- CS.03. Examine and summarize the importance of health, safety, and environmental management systems in AFNR workplaces.

Career Ready Practices (CRP) Strand

- CRP.09.03. Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community.

Unit 2: Plant Identification

Total Learning Hours for Unit: 25

Unit Summary: This unit will explore plant characteristics, with emphasis on major commercial timber species and their associated understory plant communities.

Competencies:

1. Use appropriate terminology to describe leaf and plant parts and plant life cycles.
 2. Understand the difference between *native*, *non-native*, *invasive*, and *noxious* plants.
 3. Understand basic plant taxonomy (ex: family, genus, species).
 4. Understand traits that allow plants to adapt and compete for resources.
1. Increase familiarity with ethnobotany-related topics (ex: tribal sovereignty, traditional and contemporary use of plants, cultural resources related to timber species and forest ecosystems.)

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students can:

- Describe the basic physiology of a plant in a local forest.
- Use plant characteristics and field identification keys (including dichotomous keys) to identify a plant in a local forest.
- Identify a common native tree or plant species in different stages of growth in a local forest.
- Identify a common nonnative tree or plant species in a local forest.
- Given specimens, use dichotomous keys to identify local plants in a taxonomic practicum.
- Identify traits that allow plants to adapt and compete for resources (ex: allelopathy, growth rates, seed viability and germination).
- Identify plants and their medicinal and traditional uses.
- Create an herbarium of local flora.
- Participate in traditional land use practices (ex: planting or harvest techniques).

- Identify culturally relevant resources with the help of local elders and tribal representatives.

Related to SAE:

- Use terminology and scientific names to accurately describe forests, trees, and vegetation.
- Research how organisms and populations at a local restoration site depend on and may compete for biotic and abiotic resources.
- Describe how the species that have been included in restoration proposal will impact ecology at a local restoration site.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

- Groups of five (5) students will each collect 2 samples for trees (live) or unique tools (pictures will work) and then identify each sample and present to the class their findings on their samples.

Industry Standards and Competencies

Agriculture, Food, and Natural Resources (AFNR) Standards: Natural Resource Science (NRS)

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned, and scientifically based solutions to natural resource issues and goals.

- NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.
 - NRS.01.02.01.a. Research and examine the characteristics used to identify trees and woody plants.
 - NRS.01.02.01.b. Apply identification techniques to determine the species of a tree or woody plant.
 - NRS.01.01.02.c. Conduct analyses of ecosystems and document the interactions of living species and non-living resources.
 - NRS.01.01.03.c. Evaluate biodiversity in ecosystems and devise strategies to enhance the function of an ecosystem and the availability of natural resources by increasing the level of biodiversity.
- NRS.01.02. Classify different types of natural resources in order to enable protection, conservation, enhancement, and management in a particular geographical region.
 - NRS.01.02.02.a. Research and examine the characteristics used to identify herbaceous plants.
 - NRS.01.02.02.b. Apply identification techniques to determine the species of an herbaceous plant.

Aligned Washington State Academic Standards

Science	<p>HS-LS2-1: Use mathematical and computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</p> <p>HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.</p>
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Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Using Mathematics and Computational Thinking Engaging in Argument from Evidence	LS2.A: Interdependent Relationships in Ecosystems LS4.B: Natural Selection LS4.C: Adaptation	Cause and Effect Scale, Proportion, and Quantity

Unit 3: Tree Measurement	Total Learning Hours for Unit: 25
<p>Unit Summary: This unit will establish the necessary skills required to accurately measure trees and assess timber volumes in a managed forest. Students will also explore carbon sequestration concepts.</p>	
<p>Competencies:</p> <ol style="list-style-type: none"> 1. Understand that the board foot is the unit of measure for most commercial timber volume and value. 2. Determine tree board foot volume using clinometers, diameter tapes, and Scribner and Tariff Access volume tables. 3. Work with local foresters to establish a fixed radius plot or a variable plot. 4. Make a claim about tree density and relative frequency of species. 5. Calculate the radius for various fixed plots. 6. Design sample plot grids. 7. Understand how technology is evolving to utilize the highest percentage of individual trees. 8. Understand characteristics of logs that impact domestic and export value (ex: size, wood grain). 9. Understand how identification tools and apps are used in forest practices 	
<p>Performance Assessments: <i>These can be locally developed or use the suggested assessments below.</i></p> <p>Assessments will be formal and informal, written, verbal and practical. Students can:</p> <ul style="list-style-type: none"> • Read and interpret a given volume table. • Calculate plot radius. • Establish a fixed radius plot and calculate trees per acre. • Use a clinometer and diameter tape to measure sample trees (ex: calculate heights, diameters, eventual board foot volume). • Use the National Tree Benefit Calculator to examine and explain the value of a tree. • Calculate cords of wood. • Estimate timber volume per acre and total volume. • Calculate relative density and frequency. • Estimate the amount of carbon in a tree using tree rings. • Observe a local forester in the field or sawmill. <p>Related to SAE:</p> <ul style="list-style-type: none"> • Describe relevant timber cruising and valuation data and observations in final SAE project. • Use tree rings and an Excel spreadsheet to create a model that predicts carbon sequestration rates in a tree stand. 	
<p>Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.</p>	

Suggested skills include:

- Students will be divided into cruising teams, be assigned an area in the forestry plot, create a report, and present it to the class. Team members will take on various leadership roles.
- Students will make judgments and decisions based on what they find when cruising their assigned area and communicate that to the class in their report. FFA forestry Career Development Event (CDE), Timber Cruising and Team Activity and economic principles, is a natural extension of this.

Industry Standards and Competencies

Agriculture, Food, and Natural Resources (AFNR) Standards: Natural Resource Science (NRS)

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned, and scientifically based solutions to natural resource issues and goals.

- NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.
 - NRS.01.01.01.b. Assess the characteristics of a natural resource to determine its classification.
 - NRS.01.01.01.c. Devise strategies for the preservation of natural resources based on their classification.
 - NRS.01.01.02.c. Conduct analyses of ecosystems and document the interactions of living species and non-living resources.
 - NRS.01.01.03.c. Evaluate biodiversity in ecosystems and devise strategies to enhance the function of an ecosystem and the availability of natural resources by increasing the level of biodiversity.
- NRS.01.02. Classify different types of natural resources in order to enable protection, conservation, enhancement, and management in a particular geographical region.
 - NRS.01.02.06.a. Research the purpose and value of resource inventories and population studies.
 - NRS.01.02.06.b. Apply procedures for conducting resource inventories and population studies.
 - NRS.01.02.06.c. Conduct an assessment of the resource inventories or population in a given area.
- NRS.02.01. Analyze the interrelationships between natural resources and humans.
- NRS.02.04. Examine and explain how economics affects the use of natural resources. Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities, at different levels of proficiency, to assess students' attainment of knowledge and skills related to this performance indicator. The topics represented by each strand are not all-encompassing.
 - NRS.02.04.01.b. Assess whether economic value increases or decreases the conservation, protection, improvement and enhancement of natural resources.

Aligned Washington State Academic Standards

Science	HS-ETS1-2 : Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
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Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Using Mathematics and Computational Thinking	ETS1.B: Developing Possible Solutions	Scale, Proportion, and Quantity

Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Asking Questions and Defining Problems		Patterns Cause and Effect
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Unit 4: Diseases, Insects, and Pathogens	Total Learning Hours for Unit: 25
<p>Unit Summary: Students will explore the role of diseases, insects, and pathogens in forest health, and their effect on both timber and ecosystem services.</p> <p>Competencies:</p> <ol style="list-style-type: none"> 1. Identify key primary and secondary diseases, insects, and pathogens (ex: mycorrhizae, fungi, pollination) that affect forest health. 2. Know the factors that may predict how diseases, insects, and pathogens impact forests (ex. presence of certain species, humidity, sunlight, soil type). 3. Make claims using climate projections supported by evidence for the increasing or decreasing likelihood of diseases. 4. Understand impacts of diseases, insects, and pathogens on forest health. 5. Understand protocols used in the field to prevent the spread of disease. <p>Performance Assessments: <i>These can be locally developed or use the suggested assessments below.</i> Assessments will be formal and informal, written, verbal and practical. Students can:</p> <ul style="list-style-type: none"> • Analyze a plant disease, insect, or pathogen based on symptoms in a local timber stand or forest. • Demonstrate the process used to identify a plant disease, insect, or pathogen. • Participate in insect collection activities in a timber stand or forest. • Describe the basic fungi life cycle, including fungi’s relationships with trees and forests. • Evaluate claims, evidence, and reasoning about the role of disease in complex ecosystem interactions. • Analyze a plant disease based on its symptoms, identify if the disease needs to be reported to authorities and determine which authorities it should be reported to. • Classify the cause of a disease in plants. • Research the agency or authority that should be notified of disease or pathogen presence. <p>Related to SAE:</p> <ul style="list-style-type: none"> • Investigate a disease, insect or pathogen’s impact on forest health. <p>Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.</p> <ul style="list-style-type: none"> • Divide the class into teams of 3 to 5 and have them present to the ownership group of the forestry plot a pest control plan for the forestry plot. FFA tie-in could be the “Prepared Public” speaking contest or agri-science fair. 	
<i>Industry Standards and Competencies</i>	

Agriculture Food and Natural Resources Standards (AFNR): Natural Resource Science (NRS)

- NRS.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.
- NRS.04.02. Diagnose plant and wildlife diseases and follow protocols to prevent their spread.
 - NRS.04.02.01.a. Classify causes of diseases in plants and the correct authorities to whom some diseases should be reported.
 - NRS.04.02.01.b. Analyze a plant disease based on its symptoms, identify if the disease needs to be reported to authorities and determine which authorities it should be reported to.
- NRS.04.03. Prevent or manage introduction of ecologically harmful species in a particular region.
 - NRS.04.03.01.a. Categorize harmful and beneficial insects, as well as signs of insect damage to natural resources.
 - NRS.04.03.01.b. Analyze signs of insect infestation, identify if it needs to be reported to authorities and determine which authorities it should be reported to.
 - NRS.04.03.01.c. Create a management plan to reduce spread of harmful insects in natural resource systems.
 - NRS.04.03.02.a. Identify and classify invasive species common to a particular region.
 - NRS.04.03.02.b. Analyze signs of the spread of invasive species, identify if it needs to be reported to authorities and determine which authorities it should be reported to.
 - NRS.04.03.02.c. Create a management plan to reduce spread of harmful invasive species in natural resource systems.
 - NRS.04.03.03.a. Research and summarize strategies and benefits of preventing the introduction of harmful species to a particular region.
 - NRS.04.03.03.b. Assess and implement a plan for preventing the spread of harmful species for its effectiveness.
 - NRS.04.03.03.c. Identify potentially invasive species and devise strategies to prevent ecological damage that would result from the introduction of that species.

Aligned Washington State Academic Standards

Science	<p>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.</p> <p>HS-LS2-6: Evaluate 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.</p> <p>HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*</p>
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Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Using Mathematics and Computational Thinking Engaging in Argument from Evidence Constructing Explanations and Designing Solutions	LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience	Scale, Proportion, and Quantity Stability and Change

Unit 5: Timber Stand and Silviculture Practices	Total Learning Hours for Unit: 25
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Unit Summary: This unit will introduce the student to the techniques used to manage timber stands for maximum total yield, with emphasis on a particular stand. Students will explore modern silviculture techniques and practices.

Competencies:

1. Explore how site conditions (ex: soil, local climate, topography) influence a particular stand's composition.
2. Understand how stand density affects growth and forest health.
3. Describe how organic matter decomposition impacts seedling development from seed scarification through year one.
4. Understand the importance of soil in forest management (ex: nutrient and water uptake, harvesting methods, planting).
5. Describe the impact of human activities on resources in a particular stand.
6. Understand harvesting methods and practices (ex: clear cuts, silviculture, thinning).
7. Understand why and how foresters use maps.
8. Describe the role of carbon in the biosphere (ex: photosynthesis, sequestration, decomposition, cellular respiration)

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students can:

- Engage in forestry work.
- Measure and evaluate soil site index.
- Conduct a basic soil test.
- Develop a model that shows how forest canopy levels influence light environment and photosynthesis.
- Complete seed scarification and seed germination lab.
- Conduct tree planting audit.
- Describe the importance of forest resource conservation (ex: old growth forests, stream riparian zones, carbon sequestration, protection from conversion).
- Compare environmental impacts of historical and current logging practices.
- Compare and contrast pre-colonial and contemporary forest management objectives and practices.
- Evaluate stand density by applying knowledge of forest inventory methods.
- Collect forest stand-related data (ex: disease, blowdown, roads to decommission).
- Describe how and why foresters use maps.
- Topographical map interpretation (ex: slope, aspect, scale, elevation).
- Participate in a topographical map lab.

Related to SAE:

- Choose a nutrient and follow its cycling process through the life cycle of a tree (ex: impact of nutrient's absence).
- Create a post-harvest forest regeneration model.
- Measure areas of interest with software tools built into Google Earth or similar software.
- Use Survey123 to acquire on-the-ground data and create maps showing healthy or diseased forests.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

Industry Standards and Competencies

Agriculture Food and Natural Resources Standards: Agriculture Food and Natural Resources Standards: Natural Resource Science (NRS)

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

- NRS.03.01. Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).
 - NRS.03.01.01.a. Summarize forest harvesting methods.
 - NRS.03.01.01.b. Assess harvesting methods regarding their economic value, environmental impact, and other factors.
 - NRS.03.01.01.c. Develop a forest harvesting plan that ensures economic, environmental and social sustainability.
- NRS.03.02. Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.
 - NRS.03.02.01.a. Summarize how to use maps and technologies to identify directions and land features, calculate actual distance and determine the elevations of points.
 - NRS.03.02.01.b. Apply cartographic skills and tools and technologies (e.g., land surveys, geographic coordinate systems, etc.) to locate natural resources.

NRS.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

- NRS.04.01. Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.
 - NRS.04.01.02.a. Identify and categorize characteristics of a healthy forest.
 - NRS.04.01.02.b. Assess and apply the methods used to improve a forest stand.
 - NRS.04.01.02.c. Create a timber stand improvement plan for a forest.
 - NRS.04.01.05.c. Evaluate the impact of recreational activities on natural resources and create an improvement plan.

Plant Science (PS).01. Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

- PS.01.01. Determine the influence of environmental factors on plant growth.
 - PS.01.01.01.a. Identify and summarize the three measurements of light – color, intensity and duration – that affect plant growth. PS.01.01.02.a. Identify and summarize the effects of air and temperature on plant metabolism and growth.
 - PS.01.01.02.b. Determine the optimal air and temperature conditions for plant growth.
 - PS.01.01.03.a. Identify and summarize the effects of water quality on plant growth, (e.g., pH, dissolved solids, etc.).

- PS.01.01.03.b. Analyze and describe plant responses to water conditions.
- PS.01.01.03.c. Analyze plant responses to water conditions and recommend modifications to water for desired plant growth.
- PS.01.03. Develop and implement a fertilization plan for specific plants or crops.
 - PS.01.03.01.a. Identify the essential nutrients for plant growth and development and their major functions (e.g., nitrogen, phosphorous, potassium, etc.).
 - PS.01.03.01.b. Analyze the effects of nutrient deficiencies and symptoms and recognize environmental causes of nutrient deficiencies.

Plant Science (PS).02. Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

- PS.02.02. Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems. PS.01.02. Prepare and manage growing media for use in plant systems.
 - PS.02.02.02.b. Analyze root tissues and explain the pathway of water and nutrients into and through root tissues.
 - PS.02.02.04.b. Analyze how leaves capture light energy and summarize the exchange of gases.
 - PS.02.02.04.c. Devise a plan for plant management practices that takes into account leaf structure and functions.
- PS.02.03. Apply knowledge of plant physiology and energy conversion to plant systems.
 - PS.02.03.01.b. Apply knowledge of photosynthesis to analyze how various environmental factors will affect the rate of photosynthesis.
 - PS.02.03.01.c. Evaluate the impact of photosynthesis and the factors that affect it on plant management, culture and production problems.

Plant Science (PS).03. Propagate, culture, and harvest plants and plant products based on current industry standards.

- PS.03.01. Demonstrate plant propagation techniques in plant system activities.
 - PS.03.01.01.c. Select and defend the use of pollination methods and practices used to maximize crop pollination.
 - PS.03.01.02.a. Demonstrate sowing techniques for providing favorable conditions to meet the factors of seed germination.
 - PS.03.01.02.b. Handle seed to overcome seed dormancy mechanisms and to maintain seed viability and vigor.
 - PS.03.01.02.c. Conduct tests associated with seed germination rates, viability and vigor.
- PS.03.04. Apply principles and practices of sustainable agriculture to plant production.
 - PS.03.04.01.c. Research, prepare and defend plans for a plant systems enterprise that aligns with USDA sustainable practices criteria.

Aligned Washington State Academic Standards

Science	<p>HS-LS2-6: Evaluate 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.</p> <p>HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. *</p> <p>HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*</p> <p>HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</p>
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HS-LS2-4 : Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.		
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Engaging in Argument from Evidence Constructing Explanations and Designing Solutions Using Mathematics and Computational Thinking Developing and Using Models	LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.D: Biodiversity and Humans ETS1.B: Developing Possible Solutions LS4.C: Adaptation LS1.C: Organization for Matter and Energy Flow in Organisms LS2.B: Cycles of Matter and Energy Transfer in Ecosystems PS3.D: Energy in Chemical Processes	Stability and Change Cause and Effect Energy and Matter Systems and System Models

Unit 6: Fire Ecology	Total Learning Hours for Unit: 25
<p>Unit Summary: This unit will introduce students to the ecological importance of fire, the role of prescribed fire in the management of commercial forests, and wildland fire suppression concepts.</p> <p>Competencies:</p> <ol style="list-style-type: none"> 1. Explore the role of fire as a nutrient cycling force and other forces that cycle nutrients in ecosystems that lack frequent fire. 2. Describe historical and contemporary relationships between humans and fire in forests and other ecosystems. 3. Explore historical fire suppression practices and policies' influence on forest health. 4. Describe how abiotic factors influence fire spread (ex: wind speed, stand density, atmospheric humidity, temperature, topography). <p>Performance Assessments: <i>These can be locally developed or use the suggested assessments below.</i></p> <p>Assessments will be formal and informal, written, verbal and practical. Students can:</p> <ul style="list-style-type: none"> • Model the fire triangle. • Create a model that demonstrates correlations between abiotic factors and fire. • Demonstrate use of sling psychrometer to determine relative humidity. • Describe the role of fire in the life cycle of one fire-adapted species. • Describe the cycle of succession after fires of different intensities. • Describe examples of the historical and current use of fire in forest management. <p>Related to SAE:</p> <ul style="list-style-type: none"> • Research historical and current fire management practices that have been used in a local forest. 	

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

- Divide the class into teams of 5 to 7 and present to the class in teams all sides of the use of fire in the forest. FFA tie-in would be the Ag Issues CDE.

Industry Standards and Competencies

Agriculture Food and Natural Resources Standards: Natural Resource Science (NRS)

NRS.01. Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

- NRS.01.01. Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.
 - NRS.01.01.01.c. Devise strategies for the preservation of natural resources based on their classification.
 - NRS.01.01.02.a. Summarize the components that comprise all ecosystems.
- NRS.01.03. Apply ecological concepts and principles to atmospheric natural resource systems.
 - NRS.01.03.02.a. Research and summarize how climate factors influence natural resource systems.
 - NRS.01.03.02.b. Analyze the impact that climate has on natural resources and debate how this impact has changed due to human activity.
- NRS.01.05. Apply ecological concepts and principles to terrestrial natural resource systems.
 - NRS.01.05.02.a. Compare and contrast the impact of habitat disturbances and habitat resilience.
 - NRS.01.05.02.b. Analyze and summarize examples of habitat disturbances and habitat resilience.

NRS.02.01. Analyze the interrelationships between natural resources and humans.

- NRS.02.01. Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).
 - NRS.02.02.01.a. Summarize the relationship between natural resources, ecosystems and human activity.
 - NRS.02.02.01.b. Assess and explain how different kinds of human activity affect the use and availability of natural resources (i.e., agriculture, industry, transportation, etc.).

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

- NRS.03.02. Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.
 - NRS.03.02.01.a. Summarize how to use maps and technologies to identify directions and land features, calculate actual distance and determine the elevations of points
 - NRS.03.02.01.b. Apply cartographic skills and tools and technologies (e.g., land surveys, geographic coordinate systems, etc.) to locate natural resources

- NRS.03.02.01.c. Evaluate the availability of and threats to natural resources using cartographic skills, tools, and technologies (e.g., spread of invasive species, movement of wildlife populations, changes to biodiversity of edge of habitat versus interior, etc.).
- NRS.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.
- NRS.04.04. Manage fires in natural resource systems.
 - NRS.04.04.01.a. Differentiate between desirable and undesirable fires and research the role fire plays in a healthy ecosystem.
 - NRS.04.04.01.b. Assess and apply techniques used to fight wildfires, manage prescribed fires and ensure human safety.
 - NRS.04.04.01.c. Develop a prevention plan for harmful fires for a particular region.
 - NRS.04.04.02.a. Research and summarize how fire management techniques have evolved.
 - NRS.04.04.02.b. Assess the effectiveness of techniques previously and currently used to prevent harmful fires.

Aligned Washington State Academic Standards

Science	<p>HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.</p> <p>HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.</p> <p>HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.</p>
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Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Using Mathematics and Computational Thinking	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter

Unit 7: Forest Practice Rules and Laws	Total Learning Hours for Unit: 25
<p>Unit Summary: In this unit, students will learn about the Forest Practices Act and corresponding rules outlined in Forest Practices Rules that are designed to protect forest resources and maintain a viable forest products industry. Forest Practices Illustrated is the suggested resource for this unit.</p> <p>Competencies:</p> <ol style="list-style-type: none"> 1. Understand how laws impact regulated forest practices (including growing timber, road maintenance, drainage, using fertilizers and pesticides). 2. Understand culturally significant resources important to local indigenous populations. 3. Understand the protection measures that are required for constructing and maintaining forest roads. 4. Understand how harvest activity can impact water quality and wildlife species. 	

5. Learn how to identify and delineate wetlands.
6. Manage and update student created Excel databases.

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students can:

- In the field, identify a Wetland Management Zone (WMZ) under Forest Practices Rules.
- Examine key components of a road maintenance inspection.
- Give examples of culturally significant resources and historic sites and artifacts that might be discovered in a forested area.
- Identify the key components of a SEPA Assessment by addressing what impacts the assessment mitigates for in terms of environmental impacts.
- Identify specific measures used to protect water quality from harvest activity.
- Measure width of streams to determine the RMZ boundaries for streams of different size classes under the Forest Practices Rules.

Related to SAE:

- Develop and host a student-led town hall or presentation for the city council, tribal council or other decision-making body addressing a current forestry issue using evidence from current forest practice or tribal rules.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

- Divide the students into teams, have them set up their team with specific responsibilities for a public presentation.
- FFA tie-in could be Forestry or Natural Resources CDEs.

Agriculture Food and Natural Resources Standards: Natural Resource Science (NRS)

NRS.02. Analyze the interrelationships between natural resources and humans.

- NRS.02.01. Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).
 - NRS.02.01.01.a. Distinguish between the types of laws associated with natural resources systems.
 - NRS.02.01.01.b. Analyze the structure of laws associated with natural resources systems.
 - NRS.02.01.01.c. Evaluate the impact of laws associated with natural resources systems (e.g., mitigation, water regulations, carbon emissions, game limits, invasive species, etc.).
 - NRS.02.01.02.a. Distinguish between the types of agencies associated with natural resources systems.
 - NRS.02.01.02.b. Analyze the specific purpose of agencies associated with natural resources systems.
 - NRS.02.01.02.c. Evaluate the impact and effectiveness of agencies associated with natural resources systems (e.g., regulation of consumption, prevention of damage to natural resources systems, management of ecological interactions, etc.).
- NRS.02.04. Examine and explain how economics affects the use of natural resources.
 - NRS.02.04.01.a. Compare and contrast how the economic value of a natural resource affects its availability.

- NRS.02.04.01.b. Assess whether economic value increases or decreases the conservation, protection, improvement and enhancement of natural resources.
- NRS.02.04.01.c. Devise a plan to improve the conservation, protection, improvement and enhancement of natural resources based on economic value and practices.
- NRS.02.04.02.c. Anticipate and predict how changes to the availability of natural resources because of human activity may impact a local, state and national economy.

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

- NRS.03.02. Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.
 - NRS.03.02.02.c. Use GIS data for a given area to devise a management plan for the management, conservation, improvement, and enhancement of its natural resources.

Aligned Washington State Academic Standards

Science

- [HS-ESS2-2](#): Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- [HS-ESS3-1](#): Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- [HS-ESS3-2](#): Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*
- [HS-ESS3-3](#): Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- [HS-ESS3-4](#): Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
- [HS-ESS3-5](#): Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- [HS-ESS3-6](#): Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- [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-LS2-6](#): Evaluate 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-LS2-7](#): Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
- [HS-LS4-6](#): Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*

<p>HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>		
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
<p>Constructing Explanations and Designing Solutions</p> <p>Analyzing and Interpreting Data</p> <p>Engaging in Argument from Evidence</p> <p>Using Mathematics and Computational Thinking</p> <p>Asking Questions and Defining Problems</p>	<p>ESS3.A: Natural Resources</p> <p>ESS3.B: Natural Hazards</p> <p>ESS2.A: Earth Materials and Systems</p> <p>ESS2.D: Weather and Climate</p> <p>ETS1.B: Developing Possible Solutions</p> <p>ESS3.C: Human Impacts on Earth Systems</p> <p>ESS3.D: Global Climate Change</p> <p>ESS2.D: Weather and Climate</p> <p>LS2.A: Interdependent Relationships in Ecosystems</p> <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <p>LS4.D: Biodiversity and Humans</p> <p>LS4.C: Adaptation</p> <p>ETS1.A: Defining and Delimiting Engineering Problems</p> <p>ETS1.C: Optimizing the Design Solution</p>	<p>Cause and Effect</p> <p>Stability and Change</p> <p>Systems and System Models</p> <p>Scale, Proportion, and Quantity</p>

Unit 8: Career Pathways	Total Learning Hours for Unit: 10
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Unit Summary: This unit will expose students to various career pathways in the natural resources profession and provide opportunities for students to develop and enhance their employability skills.

Competencies:

1. Outline the key components to include in applications, cover letters, and resumes.
2. Describe individual skills and experiences that are relevant to natural resource jobs.
3. Navigate the employment sections of natural resource organization websites (both public and private).
4. Learn about natural resource jobs that relate to the student's career goals.
5. Understand soft and hard skills that contribute to career success.
6. Understand the required skills, certifications and degrees required for various restoration ecology jobs.

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students will be able to:

- Complete a self-assessment to identify qualifications and reflect on opportunities for future job skill growth.
- Create a list of gained individual skills and experiences that are relevant to natural resource jobs.
- Write a resume and cover letter that integrate the skills learned through the course.
- Complete a practice job application.
- Prepare for, and participate in, a mock job interview for a natural resources position.
- Describe how course learning relates to the students' future academic and career goals.
- Research certifications, training, or postsecondary programs that relate to student's career goals.
- Conduct a job search.

Related to SAE:

- Present SAE project to the public and potential employers.
- List knowledge, skills, and abilities gained in the course.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed for all students.

Suggested skills include:

- 8.C.2 Demonstrates initiative to advance skill levels towards a professional level
- 8.A.2 Balance short-term and long-term goals

Industry Standards and Competencies

AFNR Cluster Skills

- CS.05 Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.
- CRP.10.01. Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

Career Ready Practices (CRP) Strand

- CRP.01.03. Identify and act upon opportunities for professional and civic service at work and in the community.
- CRP.02.01. Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
- CRP.04.01. Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.
- CRP.04.02. Produce clear, reasoned and coherent written and visual communication in formal and informal settings.

Aligned Washington State Academic Standards

Environment & Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems -- Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment -- Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p>
Social Studies	SSS2.9-12.3 Determine the kinds of sources and relevant information that are helpful, taking into consideration multiple points of view represented in the sources, the types of sources available, and the potential uses of the sources.

Unit 9: Supervised Agricultural Experience (SAE) Project**Total Learning Hours for Unit: 10**

Unit Summary: Students will demonstrate their learning by completing a Supervised Agricultural Experience Project (SAE). Students will work individually and, in a group, to consider their strengths as well as their areas for future learning in performing restoration work.

Competencies:

1. Understand the benefits of the SAE for skill development, leadership, and career success.
2. Understand the connection between SAE and FFA.
3. Describe the two types of SAE:
 - Foundational SAE (Career exploration & planning (high school and beyond plan), Personal financial planning and management, Workplace Safety, Employability skills for college and career readiness, agricultural or forestry literacy)
 - Immersion SAE (Entrepreneurship/Ownership, Placement/Internships, Research (Experimental, Analytical, Invention), School Business Enterprises, Service Learning)
4. Select an SAE topic that relates to course topics as well as the student's personal interests, academic goals, and career goals.
5. Develop procurement and funding plans.
6. Understand how presentation and reporting formats influence delivery of content to audiences.

7. Use systems thinking (interconnectedness, emergent properties, causality, feedback loops in an ecosystem) to develop SAE project.
8. Demonstrate flexibility.
9. Demonstrate self-directed learning skills.

Performance Assessments: *These can be locally developed or use the suggested assessments below.*

Assessments will be formal and informal, written, verbal and practical. Students will be able to:

- Select a final project format that effectively delivers content (ex: PowerPoint, YouTube video, report, radio public service announcement, poster, tri-fold display, brochure, map, website or blog, event, phone app, etc.)
- Write a report that investigates a topic covered in the course.
- Use Ag Experience Tracker (AET) System or equivalent utilized to track SAE Project.
- Outline the components to be used in final project:
 - Determine the goals of the SAE project.
 - Identify resources and data to be collected to meet project goals.
 - Select the types of data that will be meaningful.
 - Collect data to be used in the final project.
 - Keep records that pertain to the chosen SAE project.
 - Enter data into an Excel spreadsheet.
 - Create maps that display necessary data.
 - Cite sources that are included in the proposal.
- Prepare and deliver final project deliverables.

Leadership Alignment: Leadership activities should include 21st Century Skills embedded in curriculum and instruction for this unit of instruction. Include leadership skills that are being taught and assessed within the class for all students.

Suggested skills include:

- Students are responsible for entering their own data into the system and the data will be used in the annual Agriculture Education Report
- 8.C.2 Demonstrates initiative to advance skill levels towards a professional level
- 8.A.2 Balance short-term and long-term goals

Resources:

Future Farmers of America (FFA) Supervised Agricultural Experience (SAE) Washington FFA site: www.ffa.org

How to start a new chapter: <https://www.washingtonffa.org/starting-a-new-chapter>

SAE specific resources: <https://saeforall.org/> resources for students and teachers.

Industry Standards and Competencies

Agriculture Food and Natural Resources Standards: Natural Resource Science (NRS)

NRS.03. Develop plans to ensure sustainable production and processing of natural resources.

- NRS.03.01. Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).
 - NRS.03.02.01.b. Apply cartographic skills and tools and technologies (e.g., land surveys, geographic coordinate systems, etc.) to locate natural resources. Create GIS maps that show different projects in a forest and the ongoing results of those projects.

AFNR Cluster Skills

CS.01.05: Awareness: Desire purposeful understanding related to professional and personal activities.

Level 2

CS.01.05.01.b. Analyze the impact of trends and issues on the community.

Level 3

CS.01.05.01.c. Articulate current issues that are important to the local, state, national and global communities.

CS.01.05.02.c. Perform leadership tasks associated with citizenship.

Career Ready Practices (CRP) Strand

- CRP.01.03. Identify and act upon opportunities for professional and civic service at work and in the community.
- CRP.02.01. Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
- CRP.04.01. Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.
- CRP.04.02. Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
- CRP.10.01. Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

SAE

- SAE.01.01 Students will establish and conduct Supervised Agricultural Experience Projects (SAE).
 - SAE.01.01.b. Explain the benefits of SAE projects to skill development, leadership and career success.
 - SAE.01.01.c. Explain the connection between SAE and FFA.
 - SAE.01.01.d. Explain the five types of SAE. (Entrepreneurship, Placement, Research, Exploratory, Improvement)
 - SAE.01.01.e. Explore ideas for SAE projects.
 - SAE.01.01.f. Explain how SAE projects support academic achievement.
 - SAE.01.01.g. Select and establish an SAE project.
 - SAE.01.01.h. Explain and keep records on established SAE projects.
 - SAE.01.01.i. Explain SAE project Supervision, visitation and assessment.
 - SAE.01.01.l. Explain the three-circle concept for SAE, FFA Leadership, Classroom/Laboratory in an Agriculture Education program.

Aligned Washington State Academic Standards

Science	Standards will be based on the SAE selected by the student
Environment & Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems -- Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment -- Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p>

21st Century Skills

Check those that students will demonstrate in this course:

<p>LEARNING & INNOVATION</p> <p>Creativity and Innovation</p> <p><input checked="" type="checkbox"/> Think Creatively</p> <p><input checked="" type="checkbox"/> Work Creatively with Others</p> <p><input type="checkbox"/> Implement Innovations</p> <p>Critical Thinking and Problem Solving</p> <p><input checked="" type="checkbox"/> Reason Effectively</p> <p><input checked="" type="checkbox"/> Use Systems Thinking</p> <p><input checked="" type="checkbox"/> Make Judgments and Decisions</p> <p><input checked="" type="checkbox"/> Solve Problems</p> <p>Communication and Collaboration</p> <p><input checked="" type="checkbox"/> Communicate Clearly</p> <p><input checked="" type="checkbox"/> Collaborate with Others</p>	<p>INFORMATION, MEDIA & TECHNOLOGY SKILLS</p> <p>Information Literacy</p> <p><input checked="" type="checkbox"/> Access and /evaluate Information</p> <p><input checked="" type="checkbox"/> Use and Manage Information</p> <p>Media Literacy</p> <p><input checked="" type="checkbox"/> Analyze Media</p> <p><input type="checkbox"/> Create Media Products</p> <p>Information, Communications and Technology (ICT Literacy)</p> <p><input checked="" type="checkbox"/> Apply Technology Effectively</p>	<p>LIFE & CAREER SKILLS</p> <p>Flexibility and Adaptability</p> <p><input checked="" type="checkbox"/> Adapt to Change</p> <p><input checked="" type="checkbox"/> Be Flexible</p> <p>Initiative and Self-Direction</p> <p><input checked="" type="checkbox"/> Manage Goals and Time</p> <p><input checked="" type="checkbox"/> Work Independently</p> <p><input checked="" type="checkbox"/> Be Self-Directed Learners</p> <p>Social and Cross-Cultural</p> <p><input checked="" type="checkbox"/> Interact Effectively with Others</p> <p><input checked="" type="checkbox"/> Work Effectively in Diverse Teams</p> <p>Productivity and Accountability</p> <p><input checked="" type="checkbox"/> Manage Projects</p> <p><input checked="" type="checkbox"/> Produce Results</p> <p>Leadership and Responsibility</p> <p><input checked="" type="checkbox"/> Guide and Lead Others</p> <p><input checked="" type="checkbox"/> Be Responsible to Others</p>
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