

# Environmental Science and Sustainability Standards and Skills

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## Health & Safety Standards

### Standard 1: Safety and Health in an Environmental Science Environment

Students will apply essential health and safety practices for managing and maintaining equipment and tools required for various roles in Environmental Science careers, including proper use of personal protective equipment (PPE), adherence to safety protocols, safe handling of hazardous materials, and preparedness for emergency situations, in accordance with industry standards.

* Aligned Industry Recognized Credentials: OSHA10 – General Industry, First Aid Certification, CPR Certification

#### Skills:

1. Identify, describe, and demonstrate the effective use of Safety Data Sheets (SDS) to meet documentation requirements, including identifying hazards related to chemicals and materials used in environmental science work.
2. Locate emergency response equipment, e.g., first aid kit, fire extinguisher, and review the emergency action and response plan, including labels and signage following OSHA’s Hazard Communication Standard (HAZCOM).
3. Explain the importance of CPR and First Aid in emergency situations, with a focus on their application in the environmental science field, following the guidelines set by the American Heart Association (AHA).
4. Demonstrate effective first aid and CPR skills, including chest compressions, rescue breaths, the use of an Automated External Defibrillator (AED), and age-appropriate protocols, ensuring readiness for emergency response in the field.
5. Apply fire safety protocols, including identification of fire hazards, evacuation procedures, and the proper use of fire extinguishers in environmental and laboratory settings.
6. Identify and compile contact information for relevant emergency and safety agencies, including those managing natural disasters, hazardous material incidents, and local environmental health departments, for use in response plans.
7. Demonstrate proper dress and safe use of PPE in environmental science contexts, including gloves, eye protection, dust masks or respirators, protective clothing, footwear, hearing protection, and helmets.
8. Use safe body mechanics, including proper lifting techniques and ergonomics, when working with tools, sampling equipment, or heavy materials in field or lab settings.
9. Demonstrate safe use, inspection, maintenance, and storage of environmental science tools and equipment, including soil augers, sampling kits, water quality testing devices, GPS units, and basic hand tools, in accordance with manufacturer guidelines.
10. Explain OSHA’s four high-hazard categories (falls, electrocution, struck-by, caught-in/between) and describe how these can be mitigated in environmental science fieldwork and lab environments.
11. Describe safety practices for working with electricity in outdoor and lab settings, including the use of ground fault circuit interrupters (GFCI), safe extension cord use, and procedures for managing damaged cords or exposed wiring in environmental monitoring equipment.
12. Demonstrate workspace and equipment sanitation and disinfection procedures, including safe handling of organic waste and decontamination practices to ensure health and biohazard safety in labs or field operations.
13. Safely handle, apply, store, and dispose of chemicals such as fertilizers, pesticides, and soil amendments, following EPA, state, and local environmental safety regulations and best management practices.
14. Identify and apply proper storage and handling procedures for flammable and combustible materials, including fuels and solvents, to reduce fire and contamination risks in the field and laboratory.
15. Apply health and safety precautions for working in extreme weather conditions, including managing risks from heat exhaustion, UV exposure, hypothermia, dehydration, lightning, and storm events in outdoor environments.
16. Identify common outdoor environmental hazards, including insect-borne diseases, e.g., Lyme disease, West Nile virus, wildlife-related risks, e.g., bites, stings, rabies, and exposure to toxic or allergenic plants, e.g., poison ivy, oak, and describe preventive measures.
17. Assess environmental risks such as exposure to contaminated soil or water, pollutants, or biological agents encountered in the field, and implement safety strategies to minimize those risks.
18. Apply relevant federal, state, and local environmental regulations related to air quality, water safety, hazardous waste handling, and land use conservation to ensure safe and compliant practices.

## Technical & Integrated Academic Standards

### Standard 2: Role of Environmental Science Professionals in Society

Students will evaluate the evolving role of environmental science professionals in society, focusing on their contributions to environmental sustainability, biodiversity, climate resilience, and the influence of legislation, interdisciplinary collaboration, and technological innovation on safe and sustainable practices.

#### Skills:

1. Identify key milestones in the development of environmental and sustainability sciences as professional fields and assess the impact of emerging technologies, such as Geographic Information Systems (GIS), remote sensing, drones, artificial intelligence (AI), and digital environmental monitoring tools, on data collection, analysis, and evidence-based decision-making.
2. Identify and evaluate diverse careers within environmental science, including ecologists, environmental engineers, conservation biologists, urban planners, environmental educators, and sustainability consultants, and explain how these professionals collaborate across disciplines to address local and global environmental challenges.
3. Evaluate the contributions of environmental science professionals to sustainability initiatives, including climate resilience, ecosystem restoration, biodiversity conservation, and pollution reduction, with emphasis on informed practices addressing contemporary challenges such as climate change, invasive species, and land-use pressures.
4. Explain how environmental science professionals partner with experts in fields such as economics, public health, engineering, Indigenous studies, and urban planning to develop comprehensive, community-centered, and equitable environmental solutions.
5. Assess the influence of key environmental legislation, including the Clean Water Act, Clean Air Act, and Endangered Species Act, as well as state and local regulations such as the Massachusetts Environmental Policy Act (MEPA), Wetlands Protection Act, Pesticide Control Act, and Global Warming Solutions Act (GWSA), on public safety, conservation, and sustainable development.
6. Analyze the role of global environmental agreements and cross-border collaboration in addressing climate change and biodiversity loss and explore how U.S. environmental policies impact Tribal lands and how Indigenous knowledge systems contribute to environmental stewardship and conservation.
7. Identify and explore emerging environmental career pathways, such as environmental data scientists, climate risk analysts, regenerative agriculture specialists, and environmental policy advocates, and explain their roles in shaping the future of environmental justice, sustainability, and science-driven policy.

### Standard 3: Fundamentals of Environmental Science

Students will apply the core principles of Environmental Science, focusing on sustainability, resource management, and the interconnection between ecosystems, human activities, and global environmental challenges.

#### Skills:

1. Assess the primary goals of Environmental Science, evaluating the effectiveness of sustainable resource management, conservation efforts, and strategies for addressing global environmental challenges.
2. Identify and describe key fields of study within Environmental Science, such as biology, ecology, environmental chemistry, climate science, sustainability studies, environmental policy, and socio-environmental sciences.
3. Distinguish between the roles of conservation, restoration, and sustainable land management practices in maintaining healthy ecosystems.
4. Differentiate between renewable and non-renewable resources, with a focus on modern issues like renewable energy, resource depletion, and circular economies.
5. Explain the importance of biodiversity in ecosystem stability, resilience, and its role in mitigating environmental changes.
6. Explain sustainability as it relates to the economy, environment, and society, e.g., sustainable agriculture, aquaculture, environmental justice, and environmental ethics.
7. Explain the connection between public health policies and environmental issues, focusing on how environmental factors affect health outcomes, especially in vulnerable communities.
8. Assess the impact of invasive species on local ecosystems, biodiversity, and the economy, emphasizing modern case studies and global responses.
9. Evaluate the natural and human-enhanced greenhouse effect and its role in driving climate change, including long-term impacts on ecosystems, sea level rise, and human communities.

### Standard 4: Environmental Systems

Students will be able to apply how the Earth’s systems (hydrosphere, atmosphere, geosphere, and biosphere) interact with each other to assess the impacts of human activity on water, air, land, and ecosystems.

#### Skills:

1. Explain core concepts related to the Hydrosphere, focusing on the movement, distribution, and conservation of water on Earth.
2. Identify and describe the water cycle, including processes like evaporation, condensation, precipitation, and infiltration, and explain how these processes contribute to Earth's climate and ecosystems.
3. Illustrate the connection between groundwater and surface water, explaining how water moves between these two systems and their interdependence in maintaining freshwater resources.
4. Explain what an aquifer is and its role in supporting ecosystems, agriculture, and human water needs, highlighting the importance of sustainable groundwater management.
5. Describe the global distribution and use of freshwater resources, explaining regional disparities and the challenges of ensuring equitable access to clean water for both human and environmental needs.
6. Examine water conservation strategies and recommend practical ways for reducing water usage in both urban and rural settings, including techniques for efficient irrigation, waste reduction, and sustainable water management practices.
7. Differentiate between point source and non-point source pollution, providing examples of each and explaining their impact on water quality and ecosystem health.
8. Identify and categorize common sources of water pollution, e.g., agricultural runoff, industrial discharge, plastic waste, and explain their effects on both human health and biodiversity.
9. Explain core concepts related to the Atmosphere, focusing on air quality, weather, climate, and atmospheric processes.
10. Identify major air pollutants, including hydrocarbons, CFCs, sulfur dioxide, particulate matter, nitrogen oxides, ground-level ozone, and VOCs, and explain their sources and interconnected impacts on air quality, public health, and climate.
11. Explain acid rain, identify its major sources, e.g. sulfur dioxide and nitrogen oxides, explain how it forms and travels through the atmosphere, and describe its harmful effects on ecosystems, soil, and infrastructure.
12. Explain how the depletion of the ozone layer, primarily caused by CFCs, has consequences for UV radiation exposure, and describe how HFCs, while ozone-safe substitutes, contribute to climate change, prompting a transition towards more climate-friendly alternatives like HFOs.
13. Differentiate between weather and climate, explaining how each is influenced by factors such as temperature, precipitation, wind patterns, and geographical features.
14. Explain how the tilt of the Earth and its orbital rotation around the sun create the seasons and influence regional climate patterns.
15. Diagram the primary layers of the atmosphere, including the troposphere, stratosphere, mesosphere, thermosphere, and exosphere, and explain their roles in supporting life and weather patterns.
16. Distinguish between the four heat transfer mechanisms, conduction, convection, radiation, and latent heating, and explain how they influence weather systems and global climate patterns.
17. Explain fundamental concepts related to the Geosphere, focusing on Earth's structure, geological processes, and their effects on the environment.
18. Identify and describe the three major rock types, igneous, sedimentary, and metamorphic, and diagram the rock cycle, explaining how rocks change over time due to processes like weathering, erosion, and heat and pressure.
19. Explain how glaciers have shaped the landscape of Massachusetts, identifying specific landforms created by glacial activity, such as moraines, kettles, and erratics, and describe the impacts of these features on local ecosystems.
20. Describe the theory of plate tectonics and the concept of continental drift, explaining how the movement of Earth's tectonic plates shape the surface through phenomena like earthquakes, volcanic activity, and the creation of mountains and ocean basins.
21. Explain how extreme heat, fluid movement, and direct pressure affect both surface and subsurface rocks, leading to processes such as metamorphism, igneous intrusion, and the formation of mineral deposits.
22. Explain fundamental concepts related to the Biosphere, focusing on living organisms, their interactions with the environment, and how these systems evolve over time.
23. Identify and describe biotic (living) and abiotic (non-living) factors in an ecosystem, explaining how they interact and influence the survival and behavior of organisms.
24. Explain the principles of natural selection and evolution, describing how environmental pressures, genetic variation, and adaptation contribute to the survival of species over time.
25. Differentiate between evolution and adaptation, explaining how evolution refers to the long-term genetic changes in a population, while adaptation involves short-term adjustments in organisms that help them survive in specific environments.
26. Explain how the hydrosphere, atmosphere, geosphere, and biosphere influence each other within an integrated system.

### Standard 5: Principles of Ecology

Students will apply ecological principles to assess key processes such as nutrient cycles, energy flow, species interactions, and population dynamics within ecosystems, to understand how these processes support ecosystem stability and inform environmental management practices.

#### Skills:

1. Diagram the nitrogen cycle, identifying key processes and components that contribute to nitrogen transformation in ecosystems.
2. Describe the carbon cycle, emphasizing its role in global climate regulation and the importance of carbon sequestration in natural systems.
3. Illustrate the trophic pyramid for various ecosystems, analyzing energy transfer between trophic levels and the role of producers, consumers, and decomposers.
4. Compare and contrast various symbiotic relationships, such as mutualism, commensalism, parasitism, predation, and parasitoidism, evaluating their ecological significance and impact on biodiversity, and explain the concept of coevolution where interacting species can drive reciprocal evolutionary change.
5. Examine and describe population dynamics, analyzing the factors influencing population growth, decline, and stability in natural populations, including the significant impacts of habitat fragmentation and invasive species on these dynamics.
6. Evaluate predator-prey relationships within ecosystems, illustrating how these interactions influence species survival and population control.
7. Explain the relationship between harvest levels and resource sustainability, using real-world examples, e.g., sustainable fisheries management, responsible forestry, to assess the long-term impact of harvesting on ecosystems.
8. Distinguish between populations, communities, and ecosystems, analyzing their interrelationships and their roles in ecological balance.
9. Conduct a population estimate for a wild species, applying appropriate sampling methods and statistical tools to assess population density and distribution.

### Standard 6: Soil Science and Sustainable Land Management

Students will be able to classify soils based on their properties, assess their role in ecosystem health, and apply sustainable soil management practices.

#### Skills:

1. Classify soil particle sizes, e.g., sand, silt, clay, loam, using digital soil texture apps or traditional methods like the jar test, integrating both into soil analysis.
2. Create digital maps or 3D models of soil horizons using GIS or mapping software to represent soil properties and their impact on land use.
3. Assess soil fertility by conducting soil tests for pH, nitrogen (N), phosphorus (P), and potassium (K) using portable field test kits and analyzing the data to evaluate soil health.
4. Identify and describe soil conservation practices to prevent erosion, considering local conditions and environmental factors.
5. Utilize soil classification systems, e.g., USDA or Unified Soil Classification, to support land-use or agricultural planning of a specific site.
6. Explain the interaction between soil properties, e.g., drainage class, porosity, and permeability, and their role in water storage, transport, and availability, and how these factors influence soil health and ecosystem sustainability.
7. Perform a sieve analysis of a soil sample using traditional and digital tools, e.g., smartphone cameras or basic imaging software, to analyze and interpret soil texture.
8. Identify and categorize producers, consumers, and decomposers in local ecosystems using visual tools, e.g., food web diagrams.
9. Assess how soil quality and health, including the diversity of soil organisms, e.g., microbes, fungi, invertebrates, affect ecosystem services such as water filtration, carbon sequestration, nutrient cycling, and habitat provision for wildlife.
10. Examine how human activities, e.g., deforestation, agriculture, urbanization, impact soil health and fertility.

### Standard 7: Aquatic Ecosystems and Resource Stewardship

Students will apply natural resource management principles to assess aquatic ecosystems, focusing on sustainable practices for preserving freshwater and saltwater resources, evaluating ecological processes, and using modern tools for monitoring and conservation.

#### Skills:

1. Describe the characteristics of freshwater ecosystems, such as rivers, streams, lakes, and ponds, including their physical features, water chemistry, and common species.
2. Compare and contrast the ecological functions of freshwater ecosystems, such as water filtration, habitat provision, and nutrient cycling.
3. Investigate the impact of human activities, e.g., pollution, water extraction, and habitat destruction, on the health and sustainability of freshwater ecosystems.
4. Identify and compare the various types of saltwater ecosystems (estuaries, tide pools, brackish water, salt marshes), and explain their ecological roles, with a focus on the interactions between organisms and their environment.
5. Analyze the effects of human activities, e.g., overfishing, coastal development, pollution (including microplastic contamination and other emerging pollutants), on the health and resilience of saltwater ecosystems.
6. Explain the concept of a watershed and analyze its role in water distribution and ecosystem health, using available tools to map and study local watersheds.
7. Distinguish between natural and cultural eutrophication, using modern data, e.g., water quality sensors, to measure and assess eutrophication in local bodies of water.
8. Diagram and analyze the process of thermal stratification in lakes and the seasonal turnover effect on aquatic ecosystems, utilizing digital tools to track temperature and oxygen levels.
9. Collect aquatic organisms for study using modern field equipment, such as digital microscopes, DIY plankton sampler kits, plankton tows, D-nets, and kick seines, ensuring accurate identification and proper handling.
10. Identify common aquatic organisms and classify them using field guides and mobile apps, e.g., iNaturalist.
11. Identify wetland types, e.g., vernal pools, swamps, bogs, and explain their ecological functions, such as water filtration and habitat support.

### Standard 8: Wildlife Ecology and Conservation

Students will apply the principles of wildlife ecology, analyzing species interactions, conducting population studies, and assessing the effectiveness of wildlife conservation efforts through the study of regulations and endangered species protections.

#### Skills:

1. Distinguish between herbivores, carnivores, and omnivores, and analyze their roles in food chains and energy transfer within ecosystems.
2. Create and analyze local food webs to visualize species interactions and energy flow.
3. Identify signs of common New England wildlife species, e.g., tracks, scat, and confirm species identity using field guides and digital resources like iNaturalist.
4. Design and conduct wildlife population studies using both traditional methods, e.g., quadrat sampling, line transects, and mark-recapture, and modern technologies, e.g., GPS collars, camera traps, and genetic analysis, to estimate biodiversity, monitor population sizes, and assess the health and movement of wildlife populations.
5. Explain the role of wildlife in providing ecosystem services such as pollination, seed dispersal, pest control, and soil health.
6. Examine how human activities, including habitat destruction, climate change, e.g., altered migration patterns, phenological mismatches affecting food availability, pollution, and the introduction of invasive species, impact wildlife populations and ecosystems.
7. Explain the role of the federal and state Endangered Species Act and evaluate its effectiveness in protecting species and ecosystems.
8. Apply federal, state, and local wildlife regulations, and evaluate their effectiveness in supporting wildlife conservation efforts.
9. Explain conservation strategies, such as habitat restoration, protected areas, wildlife corridors, and captive breeding programs, which are used to safeguard species and ecosystems.

### Standard 9: Forest Ecology and Management

Students will apply the principles of forest ecology, including the identification of tree species, forest stratification, and the processes of forest succession, to understand ecosystem dynamics, promote forest conservation, and support sustainable land management practices.

#### Skills:

1. Identify common New England tree species using a dichotomous key.
2. Illustrate forest stratification and life zones and analyze forest ecosystems at a local scale using maps or other accessible tools.
3. Diagram primary and secondary forest succession and analyze the ecological factors influencing each stage.
4. Measure tree height and diameter using forestry tools, (clinometers, diameter tapes), and calculate the total board feet.
5. Measure the basal area of trees using tools like a basal area prism and apply these measurements to analyze forest health and density.
6. Examine the interactions between forest communities and wildlife, and analyze how ecological shifts, including climate change impacts, e.g., changes in species ranges, increased pest activity, tree species loss due to invasive pests and diseases, and other factors, impact forest biodiversity and ecosystem stability.
7. Identify and classify a variety of Non-Timber Forest Products (NTFPs), such as mushrooms, berries, medicinal plants, and maple syrup, and analyze their role in both the local economy and ecological balance.
8. Examine how natural disturbances, such as wildfires, insect outbreaks, or windstorms, influence forest dynamics and succession.
9. Assess the critical ecosystem services provided by forests, e.g., climate regulation through carbon sequestration, improved air and water quality, biodiversity support, and analyze how sustainable forest management practices, such as selective harvesting, prescribed burns, and reforestation, can enhance or maintain these services.

### Standard 10: Meteorology and Climate Systems

Students will assess meteorological processes and climate patterns to understand their impact on natural resource management, explaining how weather, atmospheric conditions, and air quality affect ecosystems, resource distribution, and human activities to inform decision making.

#### Skills:

1. Use weather apps, digital tools, or weather stations to classify various cloud types (cumulus, stratus, cirrus, etc., and explain how they correlate with different weather patterns, e.g., thunderstorms, rain, fair weather.
2. Analyze weather maps and interpret key indicators like pressure systems, fronts, and precipitation patterns to make weather predictions.
3. Understand the effects of ocean currents, e.g., Gulf Stream, El Niño, and sea surface temperatures on regional weather patterns and global climate, considering the impact on precipitation, temperature, and storm patterns.
4. Gather meteorological data using modern instruments, e.g., digital anemometers, barometers, thermometers, and a variety of techniques, e.g., Beaufort scale conversion, wind chill, cloud type, cloud-cover percentage, to monitor temperature, humidity, and other weather conditions for accurate weather predictions.
5. Collect air quality data, using real-time monitoring tools to measure pollutants, e.g., acid rain, particulates, and analyze their impact on environmental and human health.
6. Investigate how geographic features, e.g., mountains, valleys, bodies of water, create microclimates that influence local weather and ecosystem dynamics.
7. Examine the different stages of the water cycle (evaporation, condensation, precipitation) and analyze how these processes contribute to weather systems such as thunderstorms, rain, and snowfall, and their impact on local and global climate patterns.

### Standard 11: Applying Geospatial Technologies in Land Use Planning

Students will be able to use geospatial technologies, including GPS, GIS, and remote sensing, to gather and analyze data for land-use planning and natural resource management, creating maps and proposing best management practices for local ecosystems.

#### Skills:

1. Explain how remote sensing technology is used for data acquisition and describe its role in monitoring and managing local terrain and natural resources, using tools such as satellite imagery, drones, and LiDAR, e.g., Google Earth, ArcGIS.
2. Interpret topographic maps to identify elevation changes, landforms, and features relevant to land-use planning, while recognizing that modern GIS systems and online tools, like ArcGIS Online and QGIS, offer more efficient ways to analyze terrain, such as using digital elevation models (DEMs).
3. Utilize digital mapping tools and coordinate systems, e.g., Google Earth, ArcGIS Online, QGIS, to navigate, plan routes, and analyze geographic data for field studies.
4. Demonstrate the use of a traditional compass or digital compass tools, e.g., compass apps, GPS devices, to accurately determine directions and orient maps in the field.
5. Operate modern Global Positioning System (GPS) devices or smartphone-based GPS applications to gather precise geographic data, analyzing their role in land navigation and resource management.
6. Create a base map using modern geospatial data sources, such as aerial imagery, satellite data, and GIS tools, e.g., ArcGIS Online, Google Earth, to represent land features like conservation lands, farmland, and areas of critical environmental concern.
7. Determine and apply an appropriate scale for a base map of a local area, understanding how dynamic scaling in digital mapping tools, e.g., Google Earth, ArcGIS, allows for accurate representation of spatial relationships and distances at various zoom levels.
8. Import GPS waypoints into a Geographic Information Systems (GIS) platform, such as ArcGIS Online or Google Earth, to analyze, visualize, and manipulate spatial data for real-world mapping and land-use planning.
9. Conduct a natural resource inventory in local ecosystems, e.g., forests, freshwater, wetlands, by collecting environmental data with modern tools like mobile apps, drones, and GIS software, and analyzing the health of ecosystems through digital platforms.
10. Propose best management practices (BMPs) for local environmental areas, using GIS spatial analysis, remote sensing tools, and online platforms, e.g., Google Earth, ArcGIS, to assess and recommend sustainable land-use and water management solutions.
11. Evaluate the role of conservation commissions and local laws in land-use planning by using GIS applications and online resources to assess environmental regulations and propose recommendations for sustainable development and conservation efforts using modern data-driven tools.

### Standard 12: Environmental Sampling & Laboratory Services

Students will be able to implement accurate environmental sampling and laboratory techniques, including data collection, equipment calibration, sample preservation, and microbiological testing, while adhering to quality control and industry standards to ensure reliable environmental assessments.

#### Skills:

1. Implement environmental field sampling protocols using appropriate tools, techniques, and digital tools e.g., mobile apps for data logging, GPS-enabled sensors, to collect accurate and representative data from various ecosystems.
2. Use, maintain, calibrate, and ensure readiness of environmental sampling meters, e.g., pH, DO, specific conductivity, PID, spectrophotometers, and incorporate modern digital data loggers or Bluetooth-enabled sensors for real-time data collection in both field and laboratory settings, ensuring optimal performance and accurate measurements.
3. Collect and document representative environmental samples, ensuring sample integrity during transportation, and apply appropriate preservation techniques utilizing mobile apps or digital tools for real-time tracking and documentation of sample information until analysis.
4. Implement Standard Operating Procedures (SOPs) for both field and laboratory sampling activities, including Quality Assurance and Quality Control (QA/QC) measures, e.g., replicates, equipment blanks, trip blanks, to ensure the reliability and accuracy of collected data.
5. Analyze field notebook entries to ensure precise and consistent data recording, utilizing mobile apps or digital field notebooks, e.g., Evernote, OneNote, for synchronized data collection, validation, and future environmental assessments.
6. Demonstrate testing and assessing water quality using field test kits and portable digital devices, e.g., handheld photometers or colorimeters with Bluetooth capabilities, interpreting results to evaluate environmental conditions and inform decision-making processes.
7. Conduct microbiological testing, e.g., total coliform and fecal coliform, using modern rapid test kits, e.g., Colilert, while ensuring proper sample handling and testing techniques, and utilizing digital tools for faster results and reporting.
8. Utilize laboratory equipment, e.g., digital balances, pipettes, and volumetric flasks, to precisely measure, contain, and mix substances, ensuring consistency in chemical preparations for environmental analysis.
9. Prepare solutions of specific concentrations by diluting stock solutions of known concentrations, applying appropriate calculations and procedures to achieve desired concentrations for laboratory testing.
10. Demonstrate proper decontamination techniques for sampling equipment and tools to prevent cross-contamination and ensure sample integrity.
11. Construct a simulated Chain of Custody for samples, ensuring clear documentation of sample ownership and movement for legal or regulatory compliance, while utilizing digital platforms, e.g., QR codes or blockchain, for real-time tracking and documentation.
12. Understand and apply environmental regulations and quality control procedures in both field sampling and laboratory work, e.g., EPA standards, and Good Laboratory Practices (GLP).
13. Complete the training for the 40-Hour OSHA Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) certificate of completion, if available.
14. Complete the training for a Permit-Required Confined Space certificate of completion by OSHA, if available.

### Standard 13: Energy Technologies and Sustainability

Students will apply energy management and sustainability principles to evaluate the environmental impacts of energy use, recommend alternative energy sources, and propose strategies to improve energy efficiency and reduce pollution.

#### Skills:

1. Evaluate the energy savings from recycling materials and compare the environmental impacts of recycling versus the pollution generated by waste, emphasizing the role of recycling in reducing pollution.
2. Identify major sources of CO2 emissions and assess their contributions to global warming and environmental degradation, explaining the impact on air quality and climate change.
3. Explain the benefits and costs of alternative energy sources, e.g., geothermal, nuclear, photovoltaic, wind, biomass, for electricity production, considering their efficiency, environmental impact (including lifecycle assessment of material sourcing, manufacturing, operation, and disposal), and economic viability.
4. Assess the advantages and disadvantages of alternative fuels, such as biofuels, hydrogen, or electric vehicles, comparing their potential to reduce pollution and reliance on fossil fuels.
5. Identify key features of a LEED-certified building that promote energy efficiency, sustainability, and lower environmental impact.
6. Diagram the process of electricity distribution, from power generation plants, e.g., solar, coal, nuclear, to end use, and analyze the efficiency of the system in terms of energy loss and environmental impact.
7. Utilize a variety of modern tools to measure and assess energy use and its environmental impact, e.g., Kill-A-Watt meter, light meters, smart thermostats, energy tracking apps, hygrometers, online energy calculators.

### Standard 14: Environmental Site Management

Students will apply environmental site assessment and remediation techniques, understand key regulations governing hazardous waste management, and analyze and recommend effective strategies for solid waste management and recycling.

* Aligned Industry Recognized Credentials: Municipal Wastewater Operator Grade I (OIT) or (W&I)

#### Skills:

1. Inspect sites for evidence of oil or hazardous material releases, such as stained soil, stressed vegetation, and the presence of underground storage tanks, using visual indicators and digital tools for site mapping.
2. Analyze and apply key regulations such as the Massachusetts Contingency Plan (MCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to assess site compliance and guide remediation planning.
3. Classify hazardous chemicals of concern, such as petroleum products, VOCs, PCBs, metals, and PFAS (Per- and Polyfluoroalkyl Substances), and assess their potential impact on soil and groundwater.
4. Explain modern techniques like direct-push technology and rotary drilling for soil and groundwater sampling, and identify the basic equipment and tools commonly used for environmental data collection
5. Analyze site conditions (up-gradient, down-gradient, and background) and apply this information to identify optimal sampling points to ensure accurate environmental data.
6. Perform on-site tests, such as jar-headspace tests or similar field tests, to detect the presence of volatile organic compounds (VOCs) or other hazardous substances.
7. Conduct permeability tests, such as bail-down tests, slug tests, or packer tests, to evaluate soil and groundwater characteristics and inform the development of remediation strategies.
8. Use modern technology, such as electronic water-level meters and oil-water interface probes, to measure depth to groundwater and oil, ensuring precision and consistency.
9. Calculate groundwater elevations from measured depth data to inform the site’s hydrogeological understanding and modeling.
10. Create a groundwater elevation map by plotting measured groundwater data and analyzing the spatial distribution of water levels.
11. Analyze maps of the water table to calculate the hydraulic gradient and assess its impact on groundwater flow and potential contaminant transport.
12. Use hydraulic gradient and permeability data to calculate groundwater velocity, assisting in understanding contaminant migration and remediation needs.
13. Analyze factors, such as permeability, hydraulic conductivity, and chemical properties, to evaluate how contaminants move through groundwater and how they can be remediated effectively.
14. Recommend appropriate remediation methods for soil and groundwater contamination, such as bioremediation, pump-and-treat, or in-situ chemical treatment, based on hydrogeological and chemical assessments.
15. Interpret process and instrumentation diagrams (P&ID) to understand material and contaminant flow, aiding in site assessment and remediation planning.
16. Summarize field data into a clear, accurate technical report with findings and recommendations.
17. Analyze and explain key solid waste management laws, including those regulating landfill operations, recycling, and waste disposal practices at the federal and state levels.
18. Compare common waste disposal methods, e.g., landfilling, incineration, recycling, and assess their environmental impact, cost-effectiveness, and sustainability.
19. Propose actionable strategies to enhance recycling efforts, reduce waste, and conserve natural resources through innovative technologies and community-based initiatives.
20. Describe emerging environmental remediation technologies, such as phytoremediation, bioremediation, and nanotechnology, analyzing their principles and potential applications for treating contaminated soil and water as sustainable alternatives to traditional methods.

### Standard 15: Municipal Wastewater Treatment

Students will be able to apply their knowledge of municipal wastewater treatment processes, equipment, and regulations to conduct sample collection, laboratory analysis, and process optimization for effective wastewater management.

* Aligned Industry Recognized Credentials: Municipal Wastewater Operator Grade I (OIT) or (W&I)

#### Skills:

1. Explain the purpose and importance of wastewater treatment in protecting public health, emphasizing the role of treatment in preventing waterborne diseases and environmental contamination.
2. Identify the sources of municipal wastewater and explain the importance of industrial pretreatment to reduce harmful pollutants entering the wastewater treatment process.
3. Describe the key processes in a typical municipal wastewater treatment facility, including preliminary, primary, secondary, advanced (tertiary), disinfection, and de-chlorination, and their roles in improving water quality.
4. Explain the effective management of sludge from wastewater treatment through thickening, dewatering, stabilization, and appropriate disposal, in compliance with environmental regulations and best practices.
5. Demonstrate the proper procedures for wastewater sample collection, including tests for fecal coliform, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), settleable solids, pH, and chlorine.
6. Explain proper sample preservation techniques, e.g., Cooling, acidifying, etc., and quality control (QC) practices for accuracy and reliability.
7. Perform laboratory tests for wastewater parameters, e.g., coliform, DO, BOD, TSS, settleable solids, pH, chlorine, and interpret results to ensure regulatory compliance, taking corrective action if necessary.
8. Accurately document operational data, maintenance activities, and laboratory results, ensuring proper record-keeping for quality control, regulatory compliance, and effective communication with team members and management.
9. Explain the proper calibration procedures for instruments used to measure critical wastewater treatment parameters, DO, BOD, TSS, and pH, ensuring accuracy and reliability of measurements in compliance with industry standards.
10. Explain local, state, and federal regulations related to municipal wastewater treatment, including the Clean Water Act, NPDES Permit, and applicable Massachusetts regulations, e.g., 314 CMR, 310 CMR.
11. Identify and describe the parts, functions, and applications of pumps, valves, and other fluid movement components in wastewater treatment plants, and explain how automated systems, e.g., automated flow control, pressure monitoring, and real-time diagnostics, enhance the efficiency and operation of these components.
12. Monitor and interpret real-time data from SCADA (Supervisory Control and Data Acquisition) systems and other digital monitoring platforms, identifying trends, alerts, and anomalies to ensure the efficient operation of wastewater treatment processes and compliance with regulations.
13. Perform calculations related to municipal wastewater treatment, such as detention time, chemical dosage, percent efficiency, flow rate, velocity, and water pressure, using digital tools and software, e.g., Excel, specialized wastewater treatment software, or online calculators, to optimize treatment processes.
14. Perform hydraulic calculations to determine velocity, head loss, and flow control requirements at various stages of wastewater treatment, ensuring efficient system design and operation.
15. Identify, maintain, and troubleshoot mechanical equipment in a wastewater treatment plant to ensure optimal and efficient operation, while accurately documenting all maintenance activities and repairs for regulatory compliance and future reference.
16. Calculate the loading requirements for chemical dosing based on wastewater flow rates and concentrations, optimizing chemical treatment processes.
17. Identify the most common chemicals used in coagulation, pH adjustment, disinfection, and de-chlorination in wastewater treatment, and explain their role in each process integrating digital sensors and monitoring devices, e.g., pH meters, chlorine analyzers, for real-time process control and adjustment.
18. Identify and explain emerging and advanced technologies in municipal wastewater treatment, such as membrane bioreactors (MBR), ultraviolet (UV) disinfection, and advanced oxidation processes (AOP), identifying their current applications in treatment plants.
19. Examine resource recovery strategies in wastewater treatment, such as nitrogen, phosphorus, and energy recovery, with an emphasis on understanding their role and importance for sustainability and efficiency.

### Standard 16: Drinking Water Treatment

Students will apply their knowledge of drinking water treatment processes, key regulations, and best practices in water sampling, chemical dosing, and plant operations to ensure safe, high-quality drinking water and address emerging trends in the field.

* Aligned Industry Recognized Credentials: Drinking Water Treatment Grade 1 (T1), (OIT)

#### Skills:

1. Explain the purpose and importance of drinking-water treatment, emphasizing its critical role in protecting public health by removing contaminants, preventing waterborne diseases, and ensuring safe drinking water.
2. Identify sources of drinking water in Massachusetts, including groundwater and surface water, and explain the importance of protecting water supplies from contamination through watershed management and source protection practices.
3. Describe the key processes in a typical drinking water treatment facility, including coagulation, flocculation, filtration, disinfection, fluoridation, and taste/odor control, and explain the role of each in ensuring water quality.
4. Demonstrate proper procedures for water sampling and collection, including microbiological, lead, copper, organic, and radiological testing, and understand the importance of sample integrity for compliance with water quality standards.
5. Perform laboratory procedures related to drinking water analysis, such as measuring turbidity, chlorine levels, ammonia, iron, manganese, taste/odor, and algae/bacteria (including potential indicators of Harmful Algal Blooms), and interpret the results to assess water quality.
6. Identify emerging contaminants, e.g., pharmaceuticals, personal care products, microplastics, and PFAS (Per- and Polyfluoroalkyl Substances), and conduct preliminary tests for their presence in water samples.
7. Demonstrate awareness of the techniques and technologies, e.g., advanced chromatography, mass spectrometry, used to detect these contaminants.
8. Explain local, state, and federal regulations related to public water supplies, including the Safe Drinking Water Act, Total Coliform Rule, Lead and Copper Rule, Surface Water Treatment Rule, and Massachusetts regulations, e.g., 236 CMR, 310 CMR.
9. Generate and review water quality reports that comply with local, state, and federal regulations, e.g., Safe Drinking Water Act, Lead and Copper Rule.
10. Define a public water supply system and describe the regulatory requirements and administrative responsibilities of a public water supply provider, including reporting, monitoring, and public notifications.
11. Identify the parts, functions, and applications of pumps, valves, and other fluid movement components in drinking water treatment plants, and explain how automated systems, e.g., flow control, pressure monitoring, optimize plant operations.
12. Demonstrate proper operation and maintenance of mechanical equipment in a drinking-water plant, ensuring that all equipment functions efficiently and meets regulatory standards.
13. Compare and contrast the physical, chemical, and biological properties of groundwater and surface water sources, and explain how each source influences the design and operation of a drinking water treatment facility.
14. Perform calculations related to drinking water treatment, including determining chemical dosage, chlorine residual, flow rates, detention time, and water pressure, to optimize treatment processes.
15. Identify the most common chemicals used in coagulation, pH adjustment, disinfection, and fluoridation in typical drinking water treatment processes, and explain their roles and safe handling procedures.
16. Implement safety and security measures related to the protection of public drinking-water supplies, including contamination prevention, emergency preparedness, and response to potential threats to water quality.
17. Explain emerging and advanced technologies in drinking water treatment, such as membrane filtration, advanced oxidation processes (AOP), and UV disinfection, and evaluate their effectiveness in improving water treatment efficiency and sustainability.
18. Assess resource recovery opportunities within drinking water treatment systems, such as energy recovery from wastewater treatment processes or the reuse of treated water for industrial or agricultural purposes.
19. Identify career opportunities in drinking water occupations, including water operator, plant maintenance technician, and regulatory compliance officer, and understand the required certifications and educational pathways.

### Standard 17: Conservation Policy and Public Outreach

Students will apply data collection methods and statistical techniques to assess water quality and resource management issues, then present their findings to inform discussions on water policy and environmental practices.

#### Skills:

1. Demonstrate an understanding of research principles by explaining the purpose and importance of scientific data collection in resource conservation and management.
2. Collect data concerning resource status, such as water quality, wildlife populations, or habitat health, using appropriate tools and techniques to ensure accuracy and reliability.
3. Explain the importance of standard data collection methods and make consistent effort in ensuring that collected data is valid, reliable, and can be compared across different studies.
4. Explain how advancements in data validation technologies, e.g., automated sensors, remote sensing, GPS tracking, contribute to accuracy and consistency in environmental studies.
5. Maintain organized and up-to-date databases of resource data, demonstrating proficiency in data entry, retrieval, and management practices to ensure accessibility and ease of use.
6. Calculate measures of central tendency (mean, median, mode) to summarize and interpret resource data, identifying patterns or trends in resource availability or environmental conditions.
7. Describe the relationships between minimal sample size, standard deviation, and probability, and explain how these statistical concepts influence the accuracy and reliability of resource data and decision-making.
8. Explain the importance of statistical significance in research, demonstrating an understanding of how it relates to the reliability of research findings and their implications for resource management.
9. Explain the importance of using a random sample in research and describe how random sampling helps ensure that data is representative and free from bias.
10. Differentiate between a scientific paper and a lay article, explaining how each serves distinct purposes and the importance of understanding their differences when reviewing environmental research.
11. Identify the components of a scientific paper, e.g., abstract, introduction, methodology, results, discussion, conclusion and describe the purpose of each section in presenting research findings.
12. Demonstrate proper citation practices in research, ensuring the accurate attribution of sources using a consistent citation style, e.g., APA, MLA, Chicago, to avoid plagiarism and maintain academic integrity.
13. Evaluate new resources for public outreach including digital platforms, social media campaigns, podcasts, and interactive websites, alongside traditional scientific research papers.

### Standard 18: Natural Resource Policy and Administration

Students will be able to explain the roles and responsibilities of government agencies and non-governmental organizations (NGOs) in natural resource management to support sustainable practices and policies related to fisheries, forestry, wildlife, and outdoor recreation.

#### Skills:

1. Identify government agencies involved in inland fisheries management, such as state fish and wildlife departments and the U.S. Fish and Wildlife Service and explain their roles in conserving aquatic ecosystems.
2. Identify government agencies involved in forestry management, such as the U.S. Forest Service, and explain their role in forest conservation and sustainable timber harvesting.
3. Analyze the impacts of climate change on natural resource management, specifically in fisheries, forestry, and wildlife management.
4. Identify government agencies involved in outdoor recreation management, like the National Park Service and state park agencies, and describe their role in managing public recreation areas.
5. Identify government agencies involved in wildlife management, such as the U.S. Fish and Wildlife Service, and explain their role in wildlife conservation and regulating hunting and fishing.
6. Describe the role of municipal conservation commissions in local conservation efforts, land-use decisions, and environmental protection policies.
7. Define a Non-Governmental Organization (NGO), give examples, and explain their role in conservation advocacy and working with governments on environmental projects.
8. Explain how government agencies and non-governmental organizations (NGOs) are adapting their strategies to address climate change, including the development of policies and practices that mitigate climate-related risks to ecosystems.

### Standard 19: Outdoor Public Safety and Recreation Management

Students will be able to identify potential hazards, apply resource protection strategies, enforce relevant laws, and utilize conflict resolution techniques to ensure public safety and the effective management of recreation areas.

#### Skills:

1. Demonstrate safety enhancement techniques for recreation areas, including hazard identification, preventive measures, and emergency response strategies.
2. Identify and assess the impact of human activities on natural resources, considering factors such as overuse, pollution, and habitat disruption.
3. Conduct resource inventories and population studies, apply field research methods to assess the health of natural resources and wildlife populations.
4. Demonstrate proper techniques and equipment used when managing potential environmental health hazards, including wildlife disease vectors, e.g., ticks, mosquitoes, infected animal carcasses, and human waste in recreation areas, emphasizing risk assessment and the implementation of appropriate safety procedures.
5. Explain law enforcement procedures for managing public gatherings and handling secure, restricted, or closed areas, e.g., body cameras, drone surveillance for search and rescue or monitoring restricted areas, and digital communication systems, ensuring safety and legal compliance.
6. Describe appropriate precautions and communication strategies when interacting with the public regarding regulations and law enforcement in natural resource spaces.
7. Identify and explain security concerns related to managing restricted and closed areas, proposing solutions for enhancing safety and compliance.
8. Propose solutions to address public safety concerns, including crowd management, emergency response, and conflict resolution in outdoor spaces.
9. Identify the relevant law enforcement agencies responsible for natural resource areas and explain their role in maintaining public safety and enforcing regulations.
10. Explain the concept of public recreation as a product, including its economic, social, and environmental impacts, and how it is managed to balance safety and accessibility.
11. Complete the Certified Interpretive Guide (CIG) training course offered by the National Association for Interpretation (NAI) for educational programming and public engagement. (Optional, based on program availability.)

### Standard 20: Invasive Species Management and Ecosystem Restoration

Students will be able to assess the ecological impact of invasive species, apply management strategies, and implement pest management practices to maintain ecosystem balance and biodiversity.

#### Skills:

1. Identify common and potentially invasive species, analyzing their ecological impact on native biodiversity and ecosystem functions.
2. Distinguish between introduced and invasive species, evaluating their different levels of ecological threat and potential for spread.
3. Identify and evaluate the damage caused by invasive species, specifically focusing on invasive insects, plants, and other organisms in affected ecosystems.
4. Implement appropriate treatment methods for invasive species infestations, including the use of alternatives or substitutions when necessary to reduce environmental harm.
5. Apply modern non-chemical invasive species management methods, such as biological control, genetic interventions, and habitat restoration, to evaluate their effectiveness and environmental impact.
6. Using standardized procedures, report invasive species infestations, ensuring timely communication with regulatory bodies and stakeholders.
7. Measure, mix, and apply chemical treatments for invasive species control in accordance with safety protocols, ensuring compliance with environmental standards and regulations.
8. Analyze the pros, cons, and procedures of integrated pest management (IPM), explaining its efficacy and environmental considerations in managing invasive species.
9. Identify and manually remove invasive plant species following recommended protocols, ensuring minimal disruption to native plant communities.
10. Demonstrate the proper cleaning and maintenance of spray equipment post-treatment, following the industry’s best practices to prevent contamination and equipment failure.
11. Explain state pesticide regulations and protections under the Federal Worker Protection Standard, ensuring compliance with legal and safety requirements in pest management.

### Standard 21: Wildlife and Fisheries Biology

Students will be able to apply knowledge and skills in wildlife and fisheries biology, focusing on habitat enhancement, sustainable harvest practices, and utilizing modern technologies and methodologies to support conservation efforts and ensure the long-term health of ecosystems.

#### Skills:

1. Explain wildlife habitat enhancement techniques, such as controlled burns, and native vegetation restoration to improve ecosystem biodiversity.
2. Describe ethical wildlife harvest techniques and procedures, emphasizing sustainable practices and legal regulations that ensure the health of wildlife populations.
3. Distinguish between commercial, subsistence, and recreational use, analyzing their impact on wildlife management strategies and conservation goals.
4. Utilize modern telemetry technologies, including GPS and satellite tags, with and without triangulation, to track wildlife movements and habitat use, analyzing data to inform conservation and management decisions.
5. Operate a variety of measuring devices, e.g., digital balances, spring scales, calipers, to accurately collect data for wildlife studies.
6. Demonstrate safe and humane capture and handling techniques for a variety of species, ensuring minimal stress and injury using appropriate tools and methods.
7. Identify common fish species native to New England, analyzing their role in local ecosystems and fisheries.
8. Describe fisheries and differentiate consumptive (commercial, subsistence, recreational) and non-consumptive uses, evaluating their influence on fish populations and aquatic ecosystems.
9. Compare and contrast fishery management strategies, emphasizing the balance between consumptive and non-consumptive uses.
10. Classify fish species by reproductive strategies, e.g., R and K selection, diadromy, explaining the implications for population dynamics and conservation.
11. Demonstrate stream and pond enhancement techniques, including habitat restoration, water quality management, and fish population monitoring.
12. Describe fish harvest techniques and procedures, considering sustainability, legal restrictions, and ethical fishing practices.
13. Use a fish board to accurately measure fish specimens, recording biometric data for population studies and management.
14. Operate a haul seine and electroshocking equipment (backpack and boat-mounted) to conduct fisheries surveys, collecting data on fish populations and aquatic health.
15. Explain the use of genetic techniques, such as DNA barcoding, to monitor fish populations, assess genetic diversity, and inform management decisions.
16. Explain the five most common methods of commercial fishing, evaluating their environmental impacts and sustainability.

### Standard 22: Forest and Wetland Conservation

Students will apply ecosystem conservation principles, focusing on forests and wetlands, by evaluating the interrelationship between plant physiology, sustainable practices, and habitat restoration.

#### Skills:

1. Explain the relationship between respiration, transpiration, and photosynthesis, analyzing their roles in plant growth and ecosystem balance.
2. Explain plant nutrition and fertilization, emphasizing modern sustainable agricultural and forestry practices that minimize chemical inputs.
3. Identify and describe plant anatomy, focusing on the physiological adaptations that allow plants to thrive in diverse environmental conditions.
4. Distinguish between sexual and asexual plant reproduction, evaluating the ecological significance of both processes in natural plant populations.
5. Describe the effects of soil structure and texture on plant anatomy and physiology, including modern techniques for improving soil health and fertility in forestry operations.
6. Distinguish between monocots and dicots, identifying their roles and benefits in ecosystems and forestry management.
7. Distinguish between angiosperms and gymnosperms, evaluating their ecological functions and economic value in forestry.
8. Explain the rules for plant nomenclature, demonstrating the use of botanical classification systems in plant identification and ecological study.
9. Identify a variety of plants common to the New England region, providing both common and scientific names and their roles in local ecosystems.
10. Demonstrate the use of a key or reference guide to identify plants, employing field guides, digital tools, or apps for modern plant identification.
11. Identify woody and herbaceous plant species common to a geographical region, explaining their ecological significance in forest communities.
12. Identify plants used as habitat indicators, e.g., wetlands, uplands, sand plains, and analyze their role in monitoring ecosystem health and environmental conditions.
13. Explain concepts fundamental to wetlands delineation and protection, including the role of wetlands in ecosystem services and biodiversity.
14. Explain the characteristics of wetland plants, identifying key species and their role in maintaining wetland function and health.
15. Identify and explain the five wetland species indicator categories, and identify common species of each, understanding their importance in assessing wetland health.
16. Compare and contrast submergent, emergent, and floating vegetation, evaluating their role in wetland ecology and their ability to adapt to varying water conditions.
17. Diagram a wetland including littoral, limnetic, and aphotic zones, explaining the ecological functions of each zone in supporting wetland biodiversity.
18. Delineate a wetland including the vegetative buffer zone, incorporating modern techniques for wetland restoration and protection to maintain ecosystem services.
19. Examine and explain the ecological interactions between forests and wetlands in riparian zones, watersheds, and floodplains, analyzing their role in water filtration, flood regulation, and biodiversity maintenance.

### Standard 23: Forestry Management Techniques and Equipment

Students will apply sustainable forest management strategies, including safe operation of forestry equipment, forest stand improvement, and wildfire prevention techniques, focusing on maintaining forest health and promoting eco-friendly practices.

#### Skills:

1. Use a chainsaw in accordance with manufacturers and industry safety procedures, demonstrating competency in safe operation.
2. Maintain a chainsaw, following proper procedures to ensure operational safety and efficiency, while incorporating eco-friendly maintenance practices.
3. Explain the use of a range of forestry equipment, including traditional machinery like skidders and tree shears, as well as modern and specialized equipment such as forwarders (for minimizing soil disturbance), harvesters (for efficient cut-to-length systems), and drones (for inventory and monitoring), analyzing their specific applications in diverse forest management scenarios and sustainable harvest operations.
4. Operate eco-friendly forestry equipment, including electric chainsaws, ensuring efficiency and sustainability in forest management practices.
5. Determine forest stand improvement techniques appropriate for a given site, using modern techniques, such as selective logging and thinning, to enhance forest health.
6. Utilize GIS tools to map forest stands, monitor growth, and plan sustainable harvest strategies while minimizing ecological impact.
7. Analyze and compare various forest harvest techniques and sustainable forestry practices, e.g., selective logging, clear-cutting, shelterwood cutting, agroforestry, Continuous Cover Forestry, and Adaptive Forest Management, assessing their environmental impacts and effectiveness in balancing forest use with conservation and preservation goals.
8. Identify techniques and equipment needed to prevent wildfire, such as prescribed burns, firebreaks, and defensible space strategies.
9. Implement personal fire prevention precautions while working in natural environments, promoting safety, and reducing the risk of wildfires in forested areas.

### Standard 24: Marine Science

Students will assess the physical, biological, and ecological characteristics of marine environments, examining the impact of ocean currents, coastal ecosystems, and human activities on marine biodiversity.

#### Skills:

1. Identify and describe the major ocean basins, explaining the significance of each basin in the context of global ocean circulation, climate regulation, and marine biodiversity.
2. Define the key characteristics of seawater, including salinity, temperature, and density, and explain how these factors influence marine life and ocean currents.
3. Diagram the environmental conditions of the supratidal, intertidal, and subtidal zones, analyzing the adaptations of organisms that live in each zone.
4. Analyze the zonation of a rocky shore community, identifying organisms and their roles within the ecosystem and explaining how environmental factors influence distribution.
5. Identify the characteristics of estuaries and explain their critical role in supporting biodiversity, particularly their significance as nursery grounds for marine species.
6. Explain the relationship between ocean currents and global climate, focusing on how currents affect weather patterns, marine ecosystems, and global warming.
7. Use tide charts to predict tidal amplitude for specific dates, times, and locations, analyzing the relationship between tides, marine organisms, and coastal processes.
8. Evaluate emerging technology in marine science, such as satellite imagery and autonomous underwater vehicles, to monitor ocean health, track marine species, and assess coral reef conditions.
9. Analyze satellite data or real-time ocean temperature data to identify trends in ocean health and evaluate their implications for marine biodiversity.
10. Investigate the impact of human activities, such as overfishing, pollution (including microplastics, oil spills, and eutrophication), and habitat destruction, on oceanic health and propose sustainable solutions to mitigate these effects and promote marine ecosystem recovery.

### Standard 25: Marine Biology

Students will assess marine food webs, biodiversity, and ecosystems, evaluating factors such as human impact, climate change, and sustainable management practices that influence marine life.

#### Skills:

1. Diagram a marine food chain from primary producer through tertiary consumer, explaining energy transfer, trophic levels, and the impact of human activities, such as pollution (including the pervasive issue of ocean plastics and microplastic ingestion), on marine food webs.
2. Compare and contrast the environmental factors that contribute to coral reef development, emphasizing the importance of temperature, light, and water quality for reef health.
3. Explain the effects of ocean acidification and rising sea temperatures on marine biodiversity, including coral bleaching and the disruption of food webs.
4. Identify common marine reptiles, birds, and mammals, examining their ecological roles and adaptations to marine environments.
5. Compare and contrast the productivity differences between polar, tropical, and temperate waters, explaining how these differences affect marine biodiversity and fisheries.
6. Describe the characteristics of estuarine, coral reef, sandy beach, and rocky shore ecosystems, analyzing the unique features of each and their contributions to marine biodiversity, including the increasingly studied and vulnerable deep-sea ecosystems.
7. Identify common marine invertebrates and explain their crucial role in marine ecosystems, including their ecological importance in nutrient cycling (often mediated by microbial communities), food webs, and as indicators of environmental health.
8. Identify and describe the common marine producers, e.g., phytoplankton, seaweed, and their fundamental role in the ocean's carbon cycle, energy flow (influenced by associated microbial interactions), and as primary food sources for diverse marine life.
9. Analyze current marine conservation and restoration efforts, including coral reef restoration (potentially utilizing genetic techniques for resilience), mangrove rehabilitation, the creation of Marine Protected Areas (MPAs), and the application of genomic tools to understand population connectivity and genetic diversity.
10. Research and explain the status of the fisheries industry, examining the challenges of overfishing, and habitat destruction.
11. Evaluate sustainable fisheries management practices, including catch share systems, marine reserves, and eco-labeling certifications, e.g., Marine Stewardship Council, and their impact on fish populations and ecosystem health.

## Employability Standards

### Standard 26: Employability Skills

Students will apply essential employability skills in environmental science, focusing on effective communication, teamwork, and leadership while applying critical thinking and problem-solving techniques to address challenges in natural resource management and environmental sustainability.

#### Skills:

1. Demonstrate effective communication and interpersonal skills in engaging with stakeholders, e.g., landowners, governmental bodies, and conservation groups, to collaboratively address environmental and agricultural challenges.
2. Demonstrate active listening by giving full attention to conversations with colleagues, clients, and stakeholders, asking relevant questions to clarify needs and providing thoughtful responses in a timely manner.
3. Facilitate cross-disciplinary meetings for environmental and resource management projects, ensuring collaboration on issues such as land conservation, sustainable practices, and environmental technology applications.
4. Analyze complex challenges in natural resource management, such as sustainable land use, water conservation, and forest management, using critical thinking and problem-solving skills to propose solutions that balance ecological health with economic and community needs.
5. Apply time management techniques in environmental science and natural resource management settings, effectively prioritizing tasks, maintenance schedules, and operations to meet deadlines, ensure resource sustainability, and maintain a consistent workflow throughout seasonal cycles.
6. Demonstrate leadership skills by guiding teams in natural resource management projects, promoting collaboration, setting clear conservation goals, and resolving challenges to ensure effective management and positive environmental outcomes.
7. Demonstrate ethical behavior and adhere to environmental standards in all natural resource management activities, ensuring compliance with regulations for sustainable land use, water conservation, and wildlife protection practices, while maintaining workplace safety.

## Entrepreneurship Standards

### Standard 27: Entrepreneurship

Students will be able to identify entrepreneurial opportunities and evaluate the value proposition of business ownership across various sectors of the environmental science industry.

#### Skills:

1. Evaluate the licensing, regulatory, and tax implications of self-employment and business ownership in various sectors of environmental science and compare these factors to the implications of W-2 employment.
2. Conduct research on environmental trends, customer needs, and competitor strategies to develop business models that address emerging environmental challenges, regulatory changes, and eco-conscious consumer behavior.
3. Understand basic financial principles, including budgeting, forecasting, and managing cash flow, specifically for businesses with a focus on sustainability.
4. Explain environmental regulations, certifications, and permits required for sustainable business practices and how to comply with them, e.g., ensuring compliance with government regulations regarding waste disposal, water conservation, or renewable energy production.
5. Assess the impact of technological advancements on business opportunities and strategies in environmental science and natural resource management, focusing on the integration of new tools, software, and diagnostic equipment, and how these innovations can enhance efficiency and drive growth.

## Digital Literacy Standards

### Standard 28: Digital Literacy

Students will demonstrate digital literacy in environmental science and natural resource management by using diagnostic software, data management tools, environmental technologies, and digital communication to support conservation, sustainability, and resource management practices.

#### Skills:

1. Demonstrate effective electronic communication (written and oral), collaborating with team members, customers, and suppliers.
2. Utilize online resources, forums, and diagnostic software to troubleshoot and solve technical issues related to environmental monitoring equipment, such as soil health sensors, water quality monitors, and climate control systems used in sustainable practices.
3. Use digital tools and software for environmental business management, including project management platforms, resource allocation systems, and accounting software tailored for sustainable practices and conservation-focused businesses.
4. Analyze and interpret data from digital sensors and tools, e.g., soil moisture sensors, environmental impact trackers, wildlife monitoring cameras, to make data-driven decisions for resource management, conservation, and sustainability in both public and private sectors.
5. Utilize digital tools to track and optimize sustainability efforts, such as monitoring water usage, energy consumption, waste reduction, and carbon footprints.
6. Demonstrate the ability to use advanced environmental technologies, e.g., GIS, drones, remote sensing, for environmental monitoring, data collection, and sustainable resource management, including assessing habitats, tracking biodiversity, and supporting conservation efforts.