Listed below are LEAF lessons in the 9-12 grade lesson guide. They have been correlated to various formats of student learning standards. Included are: Wisconsin Model Academic Standards in Agriculture Education, Environmental Education, Social Studies, and Visual Arts; Common Core Standards for Mathematics and English Language Arts; Next Generation Science Standards. On the following pages, you will find the standards listed by lesson along with an explanation of how they are addressed by each lesson. Both current and previous versions of standards can be found on the LEAF website either in the original Lesson Guide pdfs or as addendums with the more recent standard formats.

LESSON 1: FOREST ODYSSEY

ENGLISH LANGUAGE ARTS RI.9-10.2 & RI.11-12.2

Reading for Informational Text

Standard is: Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
Standard is: Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

Students read Aldo Leopold's "Odyssey" tracing the progress of atoms x and y through the natural process. Students then present a summary of the process to the class.

ENGLISH LANGUAGE ARTS RI.9-10.3 & RI.11-12.3

Reading for Informational Text

Standard is: Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.
Standard is: Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Students discuss and evaluate Leopold's writing including style, clarity, and development of concepts and themes.

ENGLISH LANGUAGE ARTS W.9-10.3 (A-E) & W.11-12.3 (A-E)

Writing

Standard is: Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences

Students write a narrative essay from the perspective on an atom combining scientifically accurate and creative elements.

ENGLISH LANGUAGE ARTS W.9-10.7 & W.11-12.7

Writing

Standard is: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Students conduct research on their assigned forested ecosystem, synthesizing information from multiple sources.

ENGLISH LANGUAGE ARTS SL.9-10.4 & SL.11-12.4

Speaking and Listening

Standard is: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
Standard is: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Students present findings from their research in an organized manner that is appropriate to the audience.

ENVIRONMENTAL EDUCATION B.12.1

Energy and Ecosystems

Standard is: Evaluate the relationship of matter and energy and the flow of energy in natural, managed, and built systems.

Students correlate natural processes to the following ecosystem functions: fixation of energy, flow of energy, and cycling of matter. Students study common natural processes, historic changes, and prospects for sustainability of three different forest ecosystems. Students discuss changes in each ecosystem, caused both by human and natural influences.

ENVIRONMENTAL EDUCATION C.12.3

Environmental Issue Investigation Skills

Standard is: Maintain a historical perspective when researching environmental issues; include past, present, and future considerations.

Students study past and present changes in three different forest ecosystems and incorporate historic patterns of change into a science-based creative writing modeled after Aldo Leopold's "Odyssey."

SCIENCE HS-LS1-5

Interdependent Relationships in Ecosystems

Performance Expectation: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical

equations, and conceptual models.] [*Assessment Boundary: Assessment does not include specific biochemical steps.*]

Practices: Developing and Using Models

- Use a model based on evidence to illustrate the relationships between systems or between components of a system.

DCI: LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

CCC: Energy and Matter

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Students analyze the process of photosynthesis and discuss the role of producers in fixing energy in the systems. Students are presented with a scenario in which producers are removed from an ecosystem and discuss the impacts in would have on other organisms, including humans.

SCIENCE HS-LS1-6

Matter and Energy in Organisms and Ecosystems

Performance Expectation: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [*Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.*]

Practices: Constructing Explanations and Designing Solutions

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

DCI: LS1.C: Organization for Matter and Energy Flow in Organisms

- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

CCC: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Students discuss how plants and animals acquire and use nutrients. Students describe how a variety of natural processes contribute to the cycling of matter. They create a journey of an atom through a forest ecosystem based on the science-based creative essay "Odyssey" by Aldo Leopold.

SCIENCE HS-LS1-7

Matter and Energy in Organisms and Ecosystems

Performance Expectation: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds

in new compounds are formed resulting in a net transfer of energy. [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [*Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.*]

Practices: Developing and Using Models

- Use a model based on evidence to illustrate the relationships between systems or between components of a system.

DCI: LS1.C: Organization for Matter and Energy Flow in Organisms

- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.

CCC: Energy and Matter

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

Students describe how different natural processes contribute to the flow of energy in ecosystems. Students work in groups to research and create food webs for three different forest ecosystems.

SCIENCE HS-LS2-5

Matter and Energy in Organisms and Ecosystems

Performance Expectation: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [*Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.*]

Practices: Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or components of a system.

DCI: LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

CCC: Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Students discuss how plants and animals acquire and use nutrients. Students describe how a variety of natural processes contribute to the cycling of matter. They create a journey of an atom through a forest ecosystem based on the science-based creative essay “Odyssey” by Aldo Leopold.

LESSON 2: A HISTORY OF SUCCESSION

ENGLISH LANGUAGE ARTS RI.9-10.1 & RI.11-12.1

Reading for Informational Text

Standard is: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
Standard is: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

Students use lecture notes and handouts to create a forest timeline and tree profile for their assigned species.

ENGLISH LANGUAGE ARTS W.9-10.8 & W.11-12.8

Writing

Standard is: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
Standard is: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Students compile multiple resources to write a short summary describing a current influence on Wisconsin's forests.

ENVIRONMENTAL EDUCATION B.12.6

Energy and Ecosystems

Standard is: Predict population response to changes in environmental conditions.

Students predict whether populations of six different Wisconsin tree species will expand or decrease in distribution after disturbances.

ENVIRONMENTAL EDUCATION B.12.8

Energy and Ecosystems

Standard is: Relate the impact of human activities in ecosystems to the natural processes of change, citing examples of succession, evolution, and extinction.

Students relate large-scale social influences to human actions and ultimately to disturbances and stresses that influence plant and animal communities.

ENVIRONMENTAL EDUCATION C.12.3

Environmental Issue Investigation Skills

Standard is: Maintain a historical perspective when researching environmental issues; include past, present, and future considerations.

Students create a disturbance timeline that begins 64 million years before present. They discuss the similarities and differences between past and present forest disturbances.

SCIENCE HS-LS2-6

Interdependent Relationships in Ecosystems

Performance Expectation: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

Practices: Developing and Using Models

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments

DCI: LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability

CCC: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Students use a variety of resources to assert a claim based on the changes the populations of six different tree species have undergone throughout Wisconsin's history, and then present their evidence and reasoning to the class.

SOCIAL STUDIES A.12.1

Geography: People, Places, and Environments

Standard is: Use various types of atlases and appropriate vocabulary to describe the physical attributes of a place or region, employing such concepts as climate, plate tectonics, volcanism, and landforms, and to describe the human attributes, employing such concepts as demographics, birth and death rates, doubling time, emigration, and immigration.

Students are presented with information (maps, lecture, video, and text) about the human and natural influences that caused change on the Wisconsin landscape. Students use the information to describe the landscape and how it has changed through time.

SOCIAL STUDIES B.12.3

History: Time, Continuity, and Change

Standard is: Recall, select, and analyze significant historical periods and the relationships among them.

Students use a timeline to divide Wisconsin's history into four major periods of forest disturbance: Pre-Human, Native American, European Settlement and Exploitation, and Forest Conservation. Students describe the large-scale natural and social forces and the major events of each period and compare and contrast the disturbances in each.

LESSON 3: FOREST BIODIVERSITY: TREE CASE STUDIES

ENGLISH LANGUAGE ARTSL.9-10.5 & L.11-12.5

Speaking and Listening

Standard is: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

Students determine or clarify the meaning of unknown or multiple-meaning words and phrases related to biodiversity (see page 84 for full list) and forest structure (page 87).

ENGLISH LANGUAGE ARTS SL.9-10.1C & SL.11-12.1C

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students propel conversations by posing and responding to questions on several topics including, "What factors contribute to or limit forest biodiversity?" and "How do we know how much biodiversity a forest should have?"

ENGLISH LANGUAGE ARTS SL.9-10.1 & SL.11-12.1

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students participate in a small-group collaborative discussion focused on the question, "How does the climate and glacial history of Wisconsin affect the state's biodiversity?" Students use discussion to build on others' ideas and clearly express their own.

ENGLISH LANGUAGE ARTSSL.9-10.4 & SL.11-12.4

Speaking and Listening

Standard is: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
Standard is: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Students present summary of their tree profile in an organized manner that is appropriate to the audience.

ENVIRONMENTAL EDUCATION A.12.1

Questioning and Analysis

Standard is: Identify questions that require skilled investigation to solve current problems cited in literature, media, or observed through personal observations.
Students work in small groups to analyze case studies of specific tree species in Wisconsin and identify information and insights that help to answer questions about biodiversity and forest health.

ENVIRONMENTAL EDUCATION B.12.2

Energy and Ecosystem

Standard is: Describe the value of ecosystems from a natural and human perspective; e.g., food, shelter, flood control, water purification.

Students describe the role that forest biodiversity plays in meeting human and ecological needs in group discussion and visual presentation.

ENVIRONMENTAL EDUCATION C.12.3

Environmental Issue Investigation Skills

Standard is: Maintain a historical perspective when researching environmental issues; include past, present, and future considerations.

Students analyze case studies that describe how and why the populations of specific Wisconsin tree species have changed through time. Students discuss how populations, and ultimately forest biodiversity, are currently changing, and how they may change in the future.

SCIENCE HS-LS2-7

Interdependent Relationships in Ecosystems

Performance Expectation: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

Practices: Constructing Explanations and Designing Solutions

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

DCI: LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)*
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through

overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*

CCC: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

Students discuss and brainstorm questions about biodiversity, review case studies about biodiversity issues and specific Wisconsin trees, develop insights on the importance of biodiversity in forests, and participate with students from other case studies to form an answer to the question, "What is a healthy level of biodiversity?"

LESSON 4: THE FOREST MARKETPLACE

AGRICULTURE EDUCATION A.12.1

Global Agricultural Systems

Standard is: Identify how political policies and issues shape and influence food and fiber systems.

- Analyze environmental issues that influence the food and fiber system in Wisconsin, the nation, and the world.
- Understand how a country's infrastructure affects food and fiber distribution.
- Be aware of the involvement and influence of government agencies on marketing of food and fiber commodities.

Students describe the role of government in protecting environmental services, assisting businesses, and providing government services and infrastructure. Students compare the size of government in different nations and discuss how this can affect the business climate in each nation.

AGRICULTURE EDUCATION A.12.3

Global Agricultural Systems

Standard is: Describe how global interdependence benefits the production and distribution of food and fiber.

- Explain how the interdependence of food and fiber production impacts the price of consumer products.
- Understand the economic advantage of production of food and fiber in one country versus another country.

Students look at the supply of and demand for forest resources in Wisconsin, the Midwest, and the U.S. and identify the big suppliers and consumers of wood products. Students discuss how specialization and trade contribute to the supply of wood products.

AGRICULTURE EDUCATION F.12.1

Business Management and Marketing

Standard is: Describe how the production, distribution, and marketing of food and fiber is part of a complex economic system.

- Describe the impact of agriculture/forestry on the economy.
- Describe interrelationships that exist between local businesses that process or distribute food and fiber items used in their daily lives.
- Analyze the way in which supply and demand influence what food and fiber are produced and distributed.
- Discuss how national policy affects agricultural/ forestry business management and marketing at the local, regional, national, and international levels.

Students learn the economic fundamentals of trade and describe the forest market in Wisconsin, the Midwest, and the U.S. They describe the supply of and demand for forest resources in each scenario and discuss how decisions by government can influence global forest use.

ENGLISH LANGUAGE ARTS L.9-10.5 & L.11-12.5

Language

Standard is: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

Students determine or clarify the meaning of unknown or multiple-meaning words and phrases related to veneer, a market economy, and forest products and services.

ENGLISH LANGUAGE ARTSSL.9-10.2

Speaking and Listening

Standard is: Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

Students interpret and integrate information from diverse media or formats including a DVD and several charts and graphs.

ENGLISH LANGUAGE ARTS SL.9-10.1C & SL.11-12.1C

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students propel conversations by posing and responding to questions on several topics including: the impact of economics on forest management and relationships between price/profit and supply/demand.

ENGLISH LANGUAGE ARTS SL.9-10.1 & SL.11-12.1

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students participate in a small-group collaborative discussion focused on one factor that can affect forests in Wisconsin (discussion cards from teacher page 14). Students use discussion to build on others' ideas and clearly express their own.

ENGLISH LANGUAGE ARTS W.9-10.2 & W.11-12.2

Writing

Standard is: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

Students write a 1-2 page summary of their answer to one question from the discussion card. Their summary should state the potential impact(s) and provide information and evidence to support that claim.

ENGLISH LANGUAGE ARTS W.9-10.7 & W.11-12.7

Writing

Standard is: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Students research a variety of sources to address one of the scenarios outlined on the discussion cards.

ENVIRONMENTAL EDUCATION B.12.10

Natural Resources and Environmental Quality

Standard is: Identify and evaluate multiple uses of natural resources and how society is influenced by the availability of these resources.

Students differentiate between primary wood products, secondary wood products, non-wood forest products, and forest services. Students then look at how supply and demand determine the price and ultimately the availability of forest resources.

ENVIRONMENTAL EDUCATION B.12.11

Natural Resources and Environmental Quality

Standard is: Assess how changes in the availability and use of natural resources will affect society and human activities; such as, transportation, agricultural systems, manufacturing.

Students predict changes in Wisconsin and global forest use resulting from changes in social and environmental conditions.

ENVIRONMENTAL EDUCATION B.12.16

Natural Resources and Environmental Quality

Standard is: Analyze how natural resource ownership and trade influences relationships in local, national, and global economies.

Students analyze forest ownership in Wisconsin and discuss the objectives of different landowners. Students learn the economic fundamentals of global trade and use their knowledge

to determine how free trade and variability in production costs can influence forest use and economic relationships between nations.

MARKETING EDUCATION B.12.2

Free Enterprise

Standard is: Explain economic concepts that affect consumers and businesses in a free enterprise system.

Students define economic terms, learn how price is determined by supply and demand, and describe the factors that influence supply, demand, and cost of production.

MARKETING EDUCATION B.12.3

Free Enterprise

Standard is: Analyze the impact of government in a free enterprise system.
Students describe the role of government by using a circular flow diagram. Students discuss the role of government in protecting environmental services, assisting businesses, and providing government services and infrastructure.

MATHEMATICS N-Q.1

Quantities

Standard is: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Students use the profit equation using and interpreting units.

MATHEMATICS A-REI.3

Reasoning with Equations

Standard is: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Students solve the linear profit equation.

MATHEMATICS F-IF.4

Interpreting Functions

Standard is: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

Students interpret graphs to determine relationships involved in the profit equation.

MATHEMATICS F-BF.1 B&C

Building Functions

Standard is: Write a function that describes a relationship between two quantities.

Students describe the relationship between profit and loss using the profit equation.

MATHEMATICS F-LE.1
Linear, Quadratic, and Exponential Models
Standard is: Distinguish between situations that can be modeled with linear functions and with exponential functions.

Students use the profit equation with various charts, graphs, and tables to model situations.

MATHEMATICS F-LE.2
Linear, Quadratic, and Exponential Models
Standard is: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table.)

Students use the profit equation with various charts, graphs, and tables to construct a profit equation.

MATHEMATICS S-ID.1
Interpreting Categorical and Quantitative Data
Standard is: Represent data with plots on the real number line (dot plots, histograms, and box plots.)

Students plot the supply and demand of forest resources on graphs.

MATHEMATICS S-ID.5
Interpreting Categorical and Quantitative Data
Standard is: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies).

Students analyze the supply and demand data of forest resources.

SCIENCE HS-ESS3-2
Human Sustainability
Performance Expectation: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen

Practices: Engaging in Argument from Evidence

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

DCI:

ESS3.A: Natural Resources

- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)*
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*

Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
- Analysis of costs and benefits is a critical aspect of decisions about technology.

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Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

Students predict changes in Wisconsin and global forest use resulting from changes in social and environmental conditions.

SOCIAL STUDIES A.12.4

Geography: People, Places, and Environments

Standard is: Analyze the short-term and long-term effects that major changes in population in various parts of the world have had or might have on the environment.

Students use economic principles, supply and demand statistics, and global production cost data to discuss how increases in population might affect the use of forests in Wisconsin and other nations.

SOCIAL STUDIES A.12.5

Geography: People, Places, and Environments

Standard is: Use a variety of geographic information and resources to analyze and illustrate the ways in which the unequal global distribution of natural resources influences trade and shapes economic patterns.

Students analyze global supply and demand statistics and production costs and discuss the advantages and disadvantages that countries have in a global system of trade.

SOCIAL STUDIES D.12.3

Economics: Production, Distribution, Exchange, Consumption

Standard is: Analyze and evaluate the role of Wisconsin and the United States in the world economy.

Students use supply and demand statistics and relative production costs to predict how changes in social and environmental conditions will affect the use and trade of forest resource between Wisconsin and the nations of the world.

SOCIAL STUDIES D.12.10

Economics: Production, Distribution, Exchange, Consumption

Standard is: Analyze the ways in which supply and demand, competition, prices, incentives, and profits influence what is produced and distributed in a competitive market system.

Students read a newspaper article describe the economic conditions which determine the price, availability, origin, and type of products being bought and sold.

LESSON 5: FOREST SCIENCE AND TECHNOLOGY

AGRICULTURE EDUCATION E.12.1

Ecology/Environment

Standard is: Understand the application of agricultural/forestry technologies that can sustain production while reducing environmental impact.

Students review current technologies and innovations applied in the management of forests and production of forest products and use them to develop solutions that reduce environmental impacts.

AGRICULTURE EDUCATION E.12.6

Ecology/Environment

Standard is: Analyze benefits, costs, and consequences of processing food and fiber on the environment.
•Identify methods of producing various food or fiber commodities with sensitivity to the use of renewable and nonrenewable resources.

Students use life cycle analyses to analyze the environmental impact of the manufacture and use of wood. They describe the uses and benefits of wood with special emphasis on residential

construction. Students propose strategies that use renewable energy sources, technology, and human behavior modification to reduce its environmental impacts.

ENGLISH LANGUAGE ARTS L.9-10.5 & L.11-12.5

Language

Standard is: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

Students determine or clarify the meaning of various pollutants in "Pollutant Match Up" (student page 1).

ENGLISH LANGUAGE ARTS SL.9-10.1 & SL.11-12.1

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students initiate and participate in a range of collaborative discussions (partners, small groups, whole-class) about environmental impacts of wood, concrete and steel and the cost of wood production. Students work in groups to write a proposal that outlines solutions for reducing the environmental impact of forest products.

ENGLISH LANGUAGE ARTS SL9-10.4 & SL.11-12.4

Speaking and Listening

Standard is: Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
Standard is: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Students present a life cycle analysis for one of three materials (wood, steel, and concrete). Students also share their ideas for reducing pollution production and energy use in transportation.

ENVIRONMENTAL EDUCATION B.12.2

Energy and Ecosystem

Standard is: Describe the value of ecosystems from a natural and human perspective; e.g., food, shelter, flood control, water purification.

Students analyze a land use map for Ashland County, Wisconsin and discuss and identify the services that different land cover types can provide to human populations.

ENVIRONMENTAL EDUCATION B.12.9

Energy and Ecosystem
Standard is: Evaluate ways in which technology has expanded our ability to alter the environment and its capacity to support humans and other living organisms.

Students work in small groups to create a life cycle analysis that details the environmental impact of concrete, steel, and wood production. They look in depth at the technology and innovation used in wood production and write a proposal to use technology to reduce environmental impacts.

ENVIRONMENTAL EDUCATION B.12.14
Natural Resources and Environmental Quality
Standard is: Investigate how technological development has influenced human relationships and understanding of the environment.

Students learn how to develop and use life cycle analyses to evaluate the relative environmental impact of the production and use of materials. Students use a life cycle analysis to diagram production processes, identify areas of high energy demand and high pollution output, and develop solutions using available technologies.

ENVIRONMENTAL EDUCATION D.12.1
Decision and Action Skills
Standard is: Identify a variety of approaches to environmental issues, evaluate the consequences of each, and select and defend a position.

Students identify solutions to reduce the energy required and pollution emitted during a specific process involved in wood manufacture and use after creating a life cycle analysis for wood. Students work to build consensus in small groups and develop a project proposal for a specific solution.

ENVIRONMENTAL EDUCATION D.12.5
Decision and Action Skills
Standard is: Develop a plan to maintain or improve some part of the local or regional environment and enlist support for the implementation of that plan.

Students work in small groups to develop a proposal to reduce the environmental impact of wood manufacture and use. Groups present their proposal to the class to build support for their idea.

MARKETING EDUCATION D.12.2
Marketing Functions
Standard is: Analyze a product's life cycle.

Students develop simple life cycle analyses for concrete, steel, and wood.

MARKETING EDUCATION D.12.5

Marketing Functions

Standard is: Use research procedures and skills to develop an informed position on a consumer or business related issue.

Students study the benefits and costs of different energy sources, types of pollution, and the overall environmental impact of concrete, steel, and wood production. Students describe current challenges to forests and predict future impacts. Students use their knowledge to develop and discuss solutions.

MATHEMATICS N-Q.1

Quantities

Standard is: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Students determine how much energy is used to transport materials most efficiently using units and comparing different scenarios.

MATHEMATICS N-Q.2

Quantities

Standard is: Define appropriate quantities for the purpose of descriptive modeling.

Students determine how much energy is used to transport materials most efficiently using units and comparing different scenarios.

MATHEMATICS N-Q.3

Quantities

Standard is: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Students determine how much energy is used to transport materials most efficiently using units and comparing different scenarios and determine which method of shipment is best.

MATHEMATICS A-CED.1

Creating Equations

Standard is: Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

Students use equations to calculate energy used.

MATHEMATICS F-IF.4

Interpreting Functions

Standard is: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch graphs showing key feature given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

Students use the results of their calculations about energy use to interpret key features of graphs.

MATHEMATICS F-IF.5
Interpreting Functions
Standard is: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

Students use the results of their calculations about energy use to interpret key features of graphs.

MATHEMATICS F-IF.9
Interpreting Functions
Standard is: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Students use the results of their calculations about energy use and compare their equation and table.

MATHEMATICS F-BF.1B
Building Functions
Standard is: Write a function that describes a relationship between two quantities.

Students use the results of their energy calculations to build a function.

MATHEMATICS F-LE.1B
Linear, Quadratic, and Exponential Models
Standard is: Distinguish between situations that can be modeled with linear functions and with exponential functions.

Students use the results of their calculations about energy use construct models of energy use.

MATHEMATICS F-LE.5
Linear, Quadratic, and Exponential Models
Standard is: Interpret the parameters in a linear or exponential function in terms of a context.

Students interpret expressions based on the situation they model.

MATHEMATICS S-ID.1

Interpreting Categorical and Quantitative Data

Standard is: Represent data with plots on the real number line (dot plots, histograms, and box plots).

Students use charts and graphs to summarize their work.

SCIENCE HS-ESS3-2

Human Sustainability

Performance Expectation: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen

Practices: Engaging in Argument from Evidence

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

DCI:

ESS3.A: Natural Resources

- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)*
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*

Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
- Analysis of costs and benefits is a critical aspect of decisions about technology.

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Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
- Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

Students work in small groups to develop a proposal that sues technology to reduce the environmental impact of wood manufacture and use. Students present their proposal to the class.

SCIENCE HS-ESS3-4

Human Sustainability

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

Practices: Constructing Explanations and Designing Solutions

- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

DCI:

ESS3.C: Human Impacts on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*

CCC:

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

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Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Students analyze the benefits and costs of different sources of energy. They use life cycle analyses to describe the energy use and pollution output of concrete, steel, and wood manufacture and use. They attempt to use technology, forest management activities, and consumer actions to minimize the environmental cost of resource use.

CAREERS EXPLORATION

ENGLISH LANGUAGE ARTS L.9-10.5 & L.11-12.5

Language

Standard is: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

Students determine or clarify the meaning of unknown or multiple-meaning words and phrases related to jobs in natural resources (soil and water conservation, bachelor's degree, emphasis of study, etc.)

ENGLISH LANGUAGE ARTS SL.9-10.1C & SL.11-12.1C

Speaking and Listening

Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
Standard is: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Students propel conversations by posing and responding to questions on several topics including: jobs in the natural resource field and best qualifications for those jobs.

ENGLISH LANGUAGE ARTS W.9-10.7 & W.11-12.7

Writing

Standard is: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Students research natural resource career fields and vacancy announcements on the internet.

ENVIRONMENTAL EDUCATION B.12.21

Natural Resources and Environmental Quality

Standard is: Research the roles of various careers related to natural resource management and other environmental fields.

Students work in small groups to describe careers in natural resources. Students use profiles of actual college students to determine the knowledge, skills, and experience they will need to effectively compete for jobs in natural resources.