Marine Life

Lesson Summary

The Marine Life lesson will provide students with an understanding of the diversity of marine life and their habitats in the Puget Sound. Discussion of adaptation will help students appreciate the processes that determine the variety and viability of our local marine life forms. The lesson will combine discussion of marine life topics and observation of the surrounding environment.

Educators will make connections to relevant Ocean Literacy principles as well as other on-board lessons (e.g., Plankton, Marine Debris)

Learning Outcomes

Students will be able to...

10-15 minute station:

- Describe different marine habitats.
- Identify prominent species in the Salish Sea and which habitat they inhabit.
- Explain what physical adaptations allow the animals to live in their habitat

15-30 minute station:

- Explore the water quality of the immediate area.
- Hypothesize what pollutants may be entering the surrounding waters and from where.
- Discuss the effects of various water pollutants on marine species of the Salish Sea.

30+ minute station

- Explore marine life through adaptations - create your own animal to survive in a specific environmental conditions.
- Discover the connection between field observations, use of field guides and art. Use field guides and reference books on board to learn about what you're seeing around you and create artwork to reflect that.
- See what you might find on the beach during low tide or during belly biology on the dock/in the marina.

Grade Level: 3rd-12th

Lesson Vocabulary: habitat, adaptation, intertidal zone, open water (pelagic) zone, bottom (benthic) zone, river

Career Connections

- Marine Biologist/ Oceanographer
- Able Seafarer on Research Ship
- Wildlife Photographer
- Marine Educator
- Aquatic Veterinarian
- Fisheries Scientist

NGSS Components:

Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade):

- 3-LS2-1. Construct an argument that some animals form groups that help members survive.
- 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Middle School:

- LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

High School:

- LS2-8. Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Ocean Literacy Principals

5. The ocean supports a great diversity of life & ecosystems

Link for more information

Climate Literacy Principals

2. Climate is regulated by complex interactions among components of the Earth systems
3. Life on Earth depends on, is shaped by, & affects climate
6. Human activities are impacting the climate system
7. Climate change will have consequences for the Earth system & human life

Link for more information

Plankton

Lesson Summary

The Plankton lesson will provide students with an understanding of the definition of plankton, types of plankton found in Puget Sound waters, their place in the ocean ecosystem, their role in the food web, and their connection to environmental factors in the atmosphere and on land. Lesson activities will include plankton collection, observation of plankton with microscope-video system, identification of plankton types, and plankton behavior.

Shipboard educators will discuss connections to relevant Ocean Literacy Principals as well as other on-board lessons. (e.g., Marine Life, Ocean Acidification).

Learning Outcomes

Students will be able to...

10-15 minute station:

- Define plankton.
- Describe the two main plankton types (zooplankton, phytoplankton).
- Explain the differences between holoplankton and meroplankton.
- Describe connections between the Plankton lesson and other shipboard learning stations.

15-30 minute station:

- Explore and identify phytoplankton and zooplankton using evidence.
- Explain the role of phytoplankton in O_2 production and CO_2 absorption.
- Explain the role of plankton in the food web.

30+ minute station

- Explain concept of bio-accumulation.
- Understand how eating lower on the food chain uses less energy.
- Understand buoyancy principles through Plankton Races activity.

Grade Level: 3rd-12th

Lesson Vocabulary:
plankton, phytoplankton, algae, diatom, silica, zooplankton, copepod, barnacle, crustacean, larvae, holoplankton, meroplankton, current, oxygen, carbon dioxide

Career Connections

- Aquaculturalist
- Marine Ecologist
- Data Analyst
- Climate Scientist
- Marine Biologist
- Oceanographer

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

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Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade):

- 3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
- 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment
- 3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Middle School

- LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

High School

- LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

Ocean Literacy Principals

4. The ocean made Earth habitable

5. The ocean supports a great diversity of life & ecosystems

Link for more information

Climate Literacy Principals

3. Life on Earth depends on, is shaped by, & affects climate

Link for more information

Ocean Acidification

Lesson Summary

The Ocean Acidification lesson will help students understand the process of ocean acidification, its causes, and its increasingly damaging impact on marine life. Students will investigate the chemical properties of the Salish Sea through the basic understanding of acids and bases. Students will discover that changes to their daily behavior can impact the effects of ocean acidification on a local and global scale.

Educators will discuss connections to Ocean Literacy principles as well as other on-board lessons (e.g., Plankton, Marine Life, Marine Debris).

Learning Outcomes

Students will be able to...

10-15 minute station:

- Describe the ocean acidification process.
- Identify at least 2 sources of CO_2 pollution.
- Describe the harmful effects of ocean acidification on marine life (adult and planktonic forms).

15-30 minute station:

- Explain to concept of pH and the influence of added CO_2.
- Give examples of how to decrease ocean acidification by reducing CO_2 polluting emissions.

30+ minute station

- Explore acid and base chemistry.
- Describe the process of ocean acidification through chemical equations.

Grade Level: 5th-12th

Lesson Vocabulary:
acid, pH, ocean acidification, CO_2, calcium carbonate, exoskeleton, emissions, pollution, ecosystem, fossil fuel, sequestration, bases, carbon cycle, temperature

Career Connections

- Climate Scientist
- Chemist
- Geoscientist
- Research Diver
- Water Quality Scientist/Technician
- Chemical Oceanographer

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- 5-ESS3-1. Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
- 5-PS1-3. Make observations and measurements to identify materials based on their properties.
- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Middle School

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- ESS3.D. Global Climate Change

High School

- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Ocean Literacy Principals

2. The ocean & life in the ocean shape the features of the Earth
5. The ocean supports a great diversity of life & ecosystems
6. The ocean & humans are inextricably interconnected

Link for more information

Climate Literacy Principals

2. Climate is regulated by complex interactions among components of the Earth systems
3. Life on Earth depends on, is shaped by, & affects climate
4. Climate varies over space & time through both natural & man-made processes
6. Human activities are impacting the climate system

Link for more information

Life Aboard

Lesson Summary

The Life Aboard lesson will use the unique concept of living aboard a tall ship to engage participant in a discussion of conservation. It takes place below-deck and uses *Adventuress* to illustrate what a person really needs to subsist, identifying essential needs and exploring the implications of misusing resources. In this station we use *Adventuress* as a metaphor of Earth, a closed system in terms of matter cycling. On overnight programs, students directly experience and live in a closed system which allows them to investigate their own water/resource usage on the ship.

Educators will discuss connections to relevant Ocean Literacy principles (e.g., Plankton, Marine Debris)

Learning Outcomes

Students will be able to...

10-15 minute station:

- Define the difference between a closed and open system.
- Identify essential resources for living aboard.
- Discuss consequences of overusing *Adventuress*' resources.

15-30 minute station:

- Distinguish between systems and subsystems aboard *Adventuress*.
- Compare similarities of the closed system of *Adventuress* to the much larger closed system of the Earth.
- Assess the implications of misusing Earth's resources within their schools and communities.

30+ minute station

- Explore systems aboard *Adventuress* - engine, power, plumbing, etc.

Grade Level: 3rd-12th

Lesson Vocabulary: Systems, Subsystems, Open and Closed Systems, Inputs and Outputs, Matter, Energy. For higher grade levels: Positive and Negative Feedback.

Career Connections

- Deckhand
- Stewards Department
- Ship Medic
- Safety Officer
- Captain
- Engineer

NGSS Components:

Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

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Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment
- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Middle School

- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

High School

- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Ocean Literacy Principals

6. The ocean & humans are inextricably interconnected

Link for more information

Climate Literacy Principals

3. Life on Earth depends on, is shaped by, & affects climate
6. Human activities are impacting the climate system

Link for more information

Marine Debris

Lesson Summary

The Marine Debris lesson will allow students to investigate the definition of marine debris, the pervasiveness of plastics within marine debris, the various "lifespans" of marine debris, the potential environmental impacts of oceanic plastic pollution and ways to reduce everyday plastic usage.

Educators will discuss connections to relevant Ocean Literacy Principles as well as other on-board lessons (Plankton, Ocean Acidification, Marine life).

Learning Outcomes

Students will be able to...

10-15 minute station:

- Define 'marine debris'.
- Recognize the pervasiveness of plastics within marine debris.
- Identify the "Debris Decomposition Timeline".
- Illustrate ways to reduce the everyday use of plastic/contain plastic pollution before it reaches the ocean.
- Recognize that plastic is both beneficial and harmful.

15-30 minute station:

- Give examples of items used/seen everyday that contain plastic.
- Explain the difference between mineralization of debris vs. degradation.

30+ minute station

- Summarize the community/citizen science conducted on-board and how it is assessing the plastic pollution situation.
- Use a 'manta-net', or microplastics tow.
- Distinguish between microplastics, nanoplastics, and macroplastics

Grade Level: 3rd-12th

Lesson Vocabulary:
Marine debris, degrade, decompose, adsorb, nurdle, photodegrade, biodegrade, microplastics,

Career Connections

- Weather/Current Scientist
- Coastal Restoration Specialist
- Commercial Diver
- Spill Response Deckhand
- Marine Ecologist
- Chemist

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disiplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- ESS3.C. Human Impacts on Earth Systems: Students can begin to understand simple cause-and-effect relationships between human activities and their impact on the environment. For example, they can explore how pollution affects water quality in ponds or rivers.
- LS2.A. Interdependent Relationships in Ecosystems: Students can explore how living organisms depend on each other and their environment for survival, laying the foundation for understanding the impact of environmental changes on ecosystems.
- ETS1.A. Defining Engineering Problems: Elementary students can engage in simple engineering tasks related to environmental issues, such as designing solutions to reduce waste or conserve resources.
- 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. OA or MD

Middle School

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

High School

- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Ocean Literacy Principals

1. The Earth has one big ocean with many features

6. The ocean & humans are inextricably interconnected

Link for more information

Climate Literacy Principals

6. Human activities are impacting the climate system

Link for more information

Nautical Skills

Lesson Summary

This Nautical Skills lesson is intended to allow the watch groups to learn by working together, with a focus on cooperative actions, and feel the responsibility of steering *Adventuress*. As this is a very weather dependent station it is important to have many optional activities. Optional activities include: knot tying, sail setting and striking, navigation, sail theory and the ability to explain the mechanics of tacking and gybing. When appropriate, focusing on modality is encouraged, as this is the only station participants really get to use a kinesthetic approach.

This plan focuses on the hands-on, cooperative and communicative elements of the Nautical Skills lesson. See alternate lesson plan for explanation and preparation of the Navigation Lesson and associated outcomes.

Educators will discuss connections to relevant Ocean Literacy Principles with a focus on current and historic exploration as well as technological advents.

Learning Outcomes

Students will...

1. Identify tasks which need to be accomplished to successfully sail *Adventuress* and, with the guidance of the watch leader, take action.
2. Participate and take responsibility for steering *Adventuress.*
3. Recognize the necessity of cooperation to accomplish specific sail handling maneuvers.
4. Understand the importance of being safety conscious while on deck.

Grade Level: 3rd-12th

Lesson Vocabulary:
Knot tying, deck skills, line handling, sail theory, watch system, seamanship, helm

Career Connections

- Assistance Towing
- Rigger
- Electrician
- Historian
- Engineer
- Maritime Pilot
- Deckhand
- Maritime Instructor
- Uniformed Services

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

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Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes criteria for success and constraints.
- 5-ESS3-1**.** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

Middle School

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts.
- MS-ETS1-2.Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

High School

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics.

Ocean Literacy Principals

7. The ocean is largely unexplored.
Link for more information

Climate Literacy Principals

2. Climate is regulated by complex interactions among components of the Earth system.
Link for more information

Navigation

Lesson Summary

This Navigation lesson will teach the principles of inland navigation beginning with strengthening personal observation skills and then advancing to the use of maritime navigational equipment. The lesson is used to generate metaphoric connections to the concept of, “know where you are to be able to plan where you are going”.

Educators will discuss connections to relevant Ocean Literacy Principles with a focus on current and historic exploration as well as technological advents.

Learning Outcomes

Students will be able to...

10-15 minute station:

- Define and interpret the symbols and language on a navigational chart.
- Define terms ‘longitude’ and ‘latitude’.
- Differentiate charts from maps.

15-30 minute station:

- Understand how to use tools of navigation.
- Read a chart and determine location accurately using navigation tools.

30+ minute station

- Identify the difference between magnetic and true north
- Explore the importance of always knowing where you are which will help to better decide your course.
- Observe environmental conditions to determine proximity to landmarks like river deltas, islands, open ocean and underwater sills.

Grade Level: 3rd-12th

Lesson Vocabulary:
Chart, Compass Rose, Buoy, Marker, Longitude, Latitude, Magnetic North, True North, Range, Bearing, LOP (Line of Position), Triangulation

Career Connections

- Maritime Pilot
- Captain
- Mate
- Seamen Surveyors
- Hydrographic Survey Technician

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- 4-ESS2-2. Analyze and interpret data from maps to describe Earth's features.
- 5-ESS3-1. Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

Middle School

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

High School

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it into smaller, solvable steps.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ETS1-3 – Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs.

Ocean Literacy Principals

7. The ocean is largely unexplored.

Link for more information

Climate Literacy Principals

5. Our understanding of the climate system is improved through observations, theoretical studies, & modeling.

Link for more information

Mechanical Advantage

Lesson Summary

The Mechanical Advantage lesson will help students develop an understanding of mechanical advantage and how different systems such as pulleys, levers, wedges, and screws work to help ship-board systems function. Lesson activities will include use of a block and tackle and an inclined plane system, and identifying different simple machines used to work *Adventuress*.

Learning Outcomes

Students will be able to...

10-15 minute station:

- Understand that simple machines allow us to use less force through mechanical advantage.
- Be able to identify simple machines onboard *Adventuress* and what purpose they serve.

15-30 minute station:

- Compute the ratio of force to distance on various simple machines.
- Understand that work = force x distance.

30+ minute station

- Observe and describe interactions between sources of force without mechanical advantage and with mechanical advantage (Handy Billy tug-of-war).
- Discuss how simple machines can reduce reliance on carbon heavy practices through increased work using greater distance and less force.

Grade Level: 7th-12th

Lesson Vocabulary:
Work, Force, Distance, Block and tackle, Incline Plane, Screw, Lever

Career Connections

- Rigger
- Marine Engineer
- Naval Architect
- Crane Operator
- Marine Welding
- Deckhand

NGSS Components:
Science and Engineering Practices = Engaging in argument from evidence

Disciplinary Core Ideas = Ecosystem dynamics, functioning, and resilience

Crosscutting Concepts = Stability and change; Science addresses questions about the natural and material world.

Grade Specific Next Generation Science Standards (NGSS)

Elementary (3rd-5th grade)

- Lesson not available to participants under 7th grade.

Middle School

- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces and the mass of the object.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions.

High School

- HS-PS2-1. Analyze data to support the claim that Newton's Second Law of Motion describes the relationship among net force, mass, and acceleration.
- HS-PS3-3 – Design, build, and refine a device that works within constraints to convert one form of energy into another.

Ocean Literacy Principals

4. The ocean made Earth habitable

5. The ocean supports a great diversity of life & ecosystems

Link for more information

Climate Literacy Principals

3. Life on Earth depends on, is shaped by, & affects climate

Link for more information