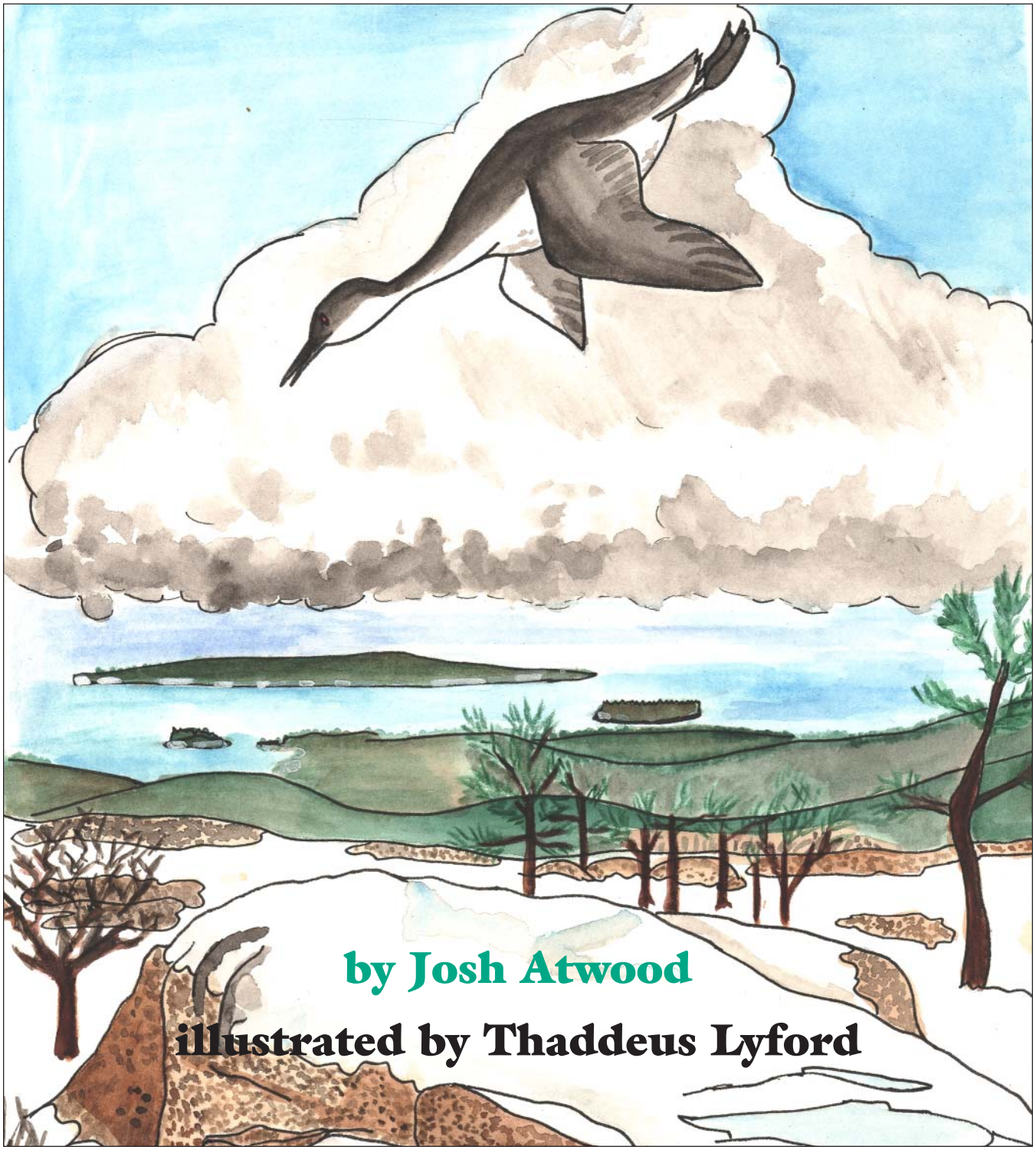
The Watershed Journey of Linus Loon: Educator Handbook



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Additional copies of the text are available online, as are the following handbooks:

The Watershed Journey of Linus Loon: Educator Handbook. This handbook provides educators with background information on the ecological processes presented in the text, as well as a detailed correlation to the State of Maine Learning Results.

The Watershed Journey of Linus Loon: Student Handbook. This handbook contains the vocabulary words and Troll Questions for each chapter, as well as the Watershed Review. Each set of Troll Questions is accompanied by a worksheet that is formatted as a letter from the student to a Troll, providing answers to the Troll's inquiries. This handbook may be freely copied for each student in the class.

For any of these texts, please visit the Linus Loon website:
http://www.maine.gov/spo/mcp/resources/linus/index.php
Or contact Lorraine Lessard of the Maine Coastal Program, at
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The Watershed Journey of Linus Loon: Educator Handbook

Contents:

An Introduction to the Text

The Watershed Journey of Linus Loon introduces students to the fundamentals of watershed ecology. Students are introduced to such concepts as food chains, nutrients, primary and secondary production, the water cycle, biodiversity, and conservation. A central theme of the text is non point source pollution. This concept is first presented through two common examples: biomagnification of a toxin, and eutrophication due to the presence of excess nutrients. Later in the text, characters discuss non point source pollution and ask students to consider how they may contribute to or help manage the entrance of pollutants into the environment.

Non point source pollution is form of pollution in which pollutants are released into the environment in small amounts by many diffuse sources. Though no one source releases a large amount of pollutant, the combination of many different sources adds up to a significant environmental impact. Non point source pollution is a particularly difficult form of pollution to combat, as there is no one location where the influx of pollutants may be mitigated. The amelioration of non point source pollution relies on the education and goodwill of the populace.

In addition to providing information on watershed ecology and non point source pollution, the text attempts to foster understanding and love of natural habitats. This is accomplished through the descriptive and adventurous story of Linus' journey. Linus observes many plants and animals along his way, and discovers different types of ecosystems. Though Linus is scared at first to travel in the watershed alone, he soon develops deep respect for the watershed and appreciates its beauty and complexity.

The story takes place in Maine and introduces students to Maine flora and fauna. Because students will be reading about ecosystems, organisms, and concepts that occur in their own state, their experience will be more practical and less abstract. This should make it easier to imagine themselves on the journey with Linus, to understand the concepts, and to develop an appreciation for the natural world around them.

In addition to the book, there is a Student Handbook that students may use instead of having a copy of the book for each student. The Student Handbook contains a list of vocabulary words and the Troll Questions from each chapter. There is also a sheet for each chapter that is formatted as a letter from the student to the appropriate Troll. This sheet may be used to record student answers to Troll Questions. The Student Handbook also contains the Watershed Review from Chapter six, which is a comprehensive look back at the terms and concepts presented in the story. This handbook is free and may be downloaded at http://www.state.me.us/spo/mcp/resources/download_center.php

Developmentally Appropriate Education

David Sobel, a professor at Antioch New England Graduate School, argues that education should be designed to match the developing cognitive abilities of students of different ages. In terms of environmental education, Sobel suggests that early elementary students should focus on simply appreciating the environment. This allows students to create a solid foundation of environmental empathy and respect. Late elementary students should build on this foundation by focusing on exploration of the environment and the processes occurring therein. Middle school and secondary students should further expand their education by using their knowledge to become environmentally active in their communities.

The Watershed Journey of Linus Loon attempts to address all of these developmental stages by functioning on several levels. Though originally designed for a fourth or fifth grade audience, the book may be used for grades one through eight depending on how the educator uses the text.

Early elementary grades may enjoy *The Watershed Journey of Linus Loon* by focusing primarily on the story. The text is descriptive, and students will enjoy following the adventure of young Linus Loon as he explores different ecosystems and sees a variety of plants and animals (not to mention gnomes and trolls). Educators in early elementary grades need not discuss complex processes presented in the text, such as biomagnification or eutrophication. Without completely understanding what these concepts are, students will still enjoy the story and grasp the idea that the environment is a great place that ought to be cared for.

Late elementary grades will also enjoy the adventure of Linus, but should explore the concepts presented in each chapter in detail. Students should understand the basics of watershed ecology, and should be able to explain ecological processes and problems, especially non point source pollution.

Middle school students should explore the concepts presented in each chapter in greater detail than late elementary students. Middle school students should have a good grasp on the ecological terms and processes. Middle school educators may choose to focus more on what students can do to help the environment in their daily lives.

By shifting the focus of the book from environmental appreciation to exploration and action, *The Watershed Journey of Linus Loon* should be developmentally appropriate for almost any primary classroom.

Linus Loon and the State of Maine Learning Results

To assist in the integration of *The Watershed Journey of Linus Loon* into the existing classroom curriculum, the text has been correlated to the State of Maine Learning Results. Below are the performance indicators that are addressed by using *The Watershed Journey of Linus Loon* as an education tool. Where necessary, notes have been integrated into the list to describe how the text addresses given performance indicators. These notes are in italics.

The Watershed Journey of Linus Loon addresses performance indicators in four sections of the State of Maine Learning Results: English Arts, Science and Technology, Social Studies, and Mathematics.

English Arts

A. Process of Reading

Early Elementary (K-2)

1. Seek out and enjoy experiences with books and other print materials.
4. Recognize and use reading as an aid to developing fluency and to understanding appropriate material.

Late Elementary (3-4)

1. Determine the meaning of unknown words by using a dictionary, glossary, or other reference sources.

Each chapter has a glossary of vocabulary words.

B. Literature and Culture

Early Elementary (K-2)

1. Understand the basic plot of simple stories.

Late Elementary (3-4)

1.Demonstrate awareness of the culture and geography pertinent to the texts they read.

The story takes place in Maine. The ecosystems and the flora and fauna therein can be found in our state. Linus' adventure ends on Cadillac Mountain, on Mount Desert Island. These are specific cultural and geographic references that students should be able to recognize.

D. Informational Texts

Early Elementary (K-2)

1. Understand the main idea of simple expository information

Early elementary classrooms should not discuss the more complex concepts presented in the text (e.g., biomagnification, eutrophication, etc). They may appreciate the plot of the story, and should understand that the main idea of the information presented is that we should care for our environment.

Late Elementary (3-4)

2. Use various informational parts of a text (e.g., glossary)

Each chapter has a glossary and question section.

3. Read for a variety of purposes.

"Linus" readers are reading both for the plot of the story and the information presented.

4. Summarize informational texts

When students answer the Troll Questions at the end of each chapter, they will be summarizing the information presented in the text.

6. Understand common technical terms used in instructional and informational texts.

The text presents many technical terms from the field of ecology. Students will need to understand these terms in order to process the information given in the text.

7. Recognize when and how new information in a text connects to prior knowledge.

Most students will already have a basis of ecological knowledge and a familiarity with Maine's ecosystems, flora and fauna. They should be able to connect prior knowledge to the new information presented.

Middle Grades (5-8)

6. Describe new knowledge presented in informational texts and how it can be used.

8. Use the various parts of a text (glossary) to locate specific information.

Each chapter has a glossary of vocabulary words.

E: Process of Writing and Speaking

Early Elementary (K-2)

1. Tell about experiences and discoveries, both orally and in writing.

Some Troll Questions ask students to tell about their own experiences and how they relate to the text. For example, question 4 in chapter one asks students to describe their own "migrations." Question 3 in chapter three asks students to describe their connection to the water cycle.

2. Respond to stories orally and in writing.

Educators may choose to have students respond to Troll Questions orally or through writing.

Late Elementary (3-4)

6. Summarize central concepts from oral presentations.

If the educator is reading the story aloud to the class, answers to Troll Questions will be summarizations of an oral presentation.

G: Stylistic and Rhetorical Aspects of Writing and Speaking

Late Elementary (3-4)

1.Write pieces and make remarks that begin to use descriptive language that clarifies, enhances, and develops ideas.

Students should use vocabulary words in their responses to Troll Questions.

Middle Grades (5-8)

7. Write pieces and make remarks that begin to use descriptive language that clarifies, enhances, and develops ideas.

Students should use vocabulary words in their responses to Troll Questions.

H: Research-related writing and speaking

Early Elementary (K-2)

1. Develop a search strategy that uses appropriate and available resources.

The first Troll Question in chapter two asks students to research carnivorous plants in Maine. Students will need to develop a strategy to find the answer.

2. Record and share information gathered.

Once students have discovered the identity of Maine's other carnivorous plant, they will record their answer, and may share it with the class.

Late Elementary (3-4)

1. Ask and seek answers to questions.

The first Troll Question in chapter two asks students to research carnivorous plants in Maine.

Science and Technology

A. Classifying Life Forms

Early Elementary (K-2)

1. Identify the differences between living and non-living things.

The first chapter defines "ecology" as the study of interactions between the living and physical parts of the environment. Each chapter introduces a new ecosystem and its accompanying flora and fauna. Students should understand the difference between plants, animals, and the environments that they live in.

2. Describe characteristics of different living things.

Each chapter introduces many plants and animals for students to compare and contrast. For example, chapter two introduces the pitcher plant, and discusses how its method of getting energy differs from most plants.

Late Elementary (3-4)

1.Describe the different living things within a given habitat.

Each chapter introduces many plants and animals living in an ecosystem. Students should recognize that certain organisms live in certain ecosystems.

4. Compare and contrast the life cycles, behavior, and structure of different organisms.

Middle Grades (5-8)

1. Describe some structural and behavioral adaptations that allow organisms to survive in a changing environment.

Migration is a behavioral adaptation that allows loons and many other species to live in a changing environment.

Chapter three briefly discusses some structural adaptations that allow organisms to live in streams. Linus sees streamlined brook trout, whose hydrodynamic bodies enable them to swim in rapid currents. He also sees caddisfly larvae, which have hooks on their bodies that allow them to remain anchored to rocks on streambeds.

B. Ecology

Early Elementary (K-2)

1. Identify ways that organisms depend upon their environment.

Chapter one discusses food chains, which illustrate how organisms depend on other organisms in their environment. Chapter two illustrates the dependence of plants on mineral nutrients.

2. Describe how almost all animals' food can be traced back to plants.

Chapter one states that plants are at the bottom of all food chains, as they are the primary producers.

3. Give examples of how one change in a system affects other parts of the system.

Each chapter addresses this is some way. Chapter one discusses the entrance of toxic chemicals into the ecosystem and how it impacts various trophic levels. Chapter two discusses how an increase in mineral nutrients affects dissolved oxygen concentrations. Chapter three asks students to consider how water shortages in one part of the water cycle would affect other parts. Chapter four illustrates how different

parts of the ecosystem (in this case, different species) depend on each other through biodiversity. Chapter four discusses non point source pollution, and how the entrance of pollutants into one part of the ecosystem may affect other parts.

4. Describe different ecological systems on earth.

Each chapter introduces a new ecosystem. Ecosystems discussed include lakes, bogs, rivers, estuaries, and the ocean.

Late Elementary (3-4)

1. Describe a food web and the relationships within a given ecosystem.

Though this text uses the simplified food "chain" rather than "web," the fundamental concept of species interacting through predator/prey relationships remains constant.

2. Explain the difference between produces and consumers, and decomposers, and identify examples of each.

Chapters one and two discuss these concepts in detail.

3. Compare and contrast physical and living components of different biomes- i.e., regions characterized by their climate and plant life.

Students should be able to compare and contrast the different ecosystems presented in the text: lake, bog, river, estuary, and ocean.

4. Investigate the connection between major living and nonliving components of a local ecosystem.

Each chapter explores the connection between living and nonliving components of an ecosystem, and all of the ecosystems presented in the story are local (they all occur in Maine).

Middle Grades (5-8)

3. Describe succession and other ways that ecosystems can change over time.

Chapter two discusses eutrophication, a process by which ecosystems change over time to contain more plant material and less aqueous dissolved oxygen.

4. Generate examples of the variety of ways that organisms interact (e.g., competition, predator/prey, parasitism/mutualism).

Chapters one and two discuss the differences between predators and prey.

5. Describe various mechanisms found in the natural world for transporting living and nonliving matter and the results of such movements.

Chapter five discusses the troubles of non point source pollution in a watershed, namely that moving water transports pollutants and to different ecosystems.

Secondary Grades (9-12)

1. Analyze the impact of human and other activities on the type and pace of change in ecosystems.

This is a recurring theme in the book. It may be most obvious in chapter two, which discusses the anthropogenic introduction of excess nutrients into the environment via fertilizers, and the resulting potential for eutrophication.

D: Continuity and Change

Early Elementary (K-2)

2. Identify characteristics that help organisms live in their environment.

F: The Earth

Late Elementary (3-4)

2. Demonstrate an understanding that many things about the earth occur in cycles that vary in length and frequency.

Chapter three discusses the water cycle.

4. Illustrate how water and other substances go through a cyclic process of change in the environment.

Chapter three discusses the water cycle and the changes that occur to water as it cycles.

Middle Grades (5-8)

7. Demonstrate factors affecting the flow of groundwater.

The Troll Questions in chapter three ask students to consider what would happen to different parts of the water cycle if there were no rain.

H: Energy

Early Elementary (K-2)

2. Explain why living things need energy.

Chapter two discusses the need to obtain energy in order to create and maintain living tissue.

Late Elementary (3-4)

2. Explain ways different forms of energy can be produced.

Chapter two discusses primary and secondary production. These processes refer to the production of tissue, but students should understand that the energy involved in this production is obtained by photosynthesis and consumption, respectively.

M: Implications of Science and Technology

Early Elementary (K-2)

3. Identify commonly used resources, their sources, and where waste products go.

Chapter five discusses waste products, where they are generated, and where they go.

4. Demonstrate some practices for recycling and care of resource.

Chapter six discusses conservation and the need to protect the environment.

Late Elementary (3-4)

4. Explain practices for conservation in daily life, based on a recognition that renewable and nonrenewable resource have limits.

Chapter six asks students to consider how they might practice conservation in their daily lives.

Middle Grades (5-8)

4. Describe an individual's biological and other impacts on an environmental system.

The Watershed Review in chapter six asks students to consider their impacts on the environment.

6. Give examples of actions that may have expected or unexpected consequences that may be positive, negative, or both.

Unexpected consequences are discussed in chapters one and two through biomagnification and eutrophication, respectively. Non point source pollution,

introduced in chapter five, is the most prominent example of unexpected consequences. The text states that people often do not realize that small inputs of pollution may add up to large impacts.

7. Explain the connections between industry, natural resources, population, and economic development.

Chapter two discusses the connection between agriculture and aquatic ecosystems. Chapter five discusses the connection between the general population and the environment, through non point source pollution.

Secondary Grades (9-12)

1. Demonstrate the importance of resource management, controlling environmental impacts, and maintaining natural ecosystems.

Chapter six discusses conservation and the importance of protecting the environment.

Social Studies: Geography

B: Human interaction with environments
Early Elementary (K-2)

1. Describe the human and physical characteristics of the immediate environment.

Mathematics

A. Numbers and number sense
Early Elementary (K-2)

1. Demonstrate an understanding of what numbers mean.

In chapter one, the Lake Gnome describes biomagnification using multiplication to show how toxins can accumulate in a food chain. While early elementary students may not understand multiplication, they may understand the meaning of increasing numbers representing amounts of toxin.

Middle Grades (5-8)

1. Apply concepts of ratios, proportions, percents, and number theory (e.g., primes, factors, and multiples) in practical and other mathematical situations.

Middle school students should be able to understand the multiplication involved in the Lake Gnome's description of biomagnification (Chapter one). Educators may assess multiplication skills by creating scenarios with varying food chain lengths and varying amounts of introduced toxin, and then asking students to calculate the amount of toxin in the top consumer.

Background Information

Chapter One:
Leaving the Lake

Chapter description: "Leaving the Lake" introduces Linus Loon and describes the migratory journey he is about to take. This chapter also introduces the Lake Gnome, who gives the scientific background for the chapter's main topics: the food chain and biomagnification.

Background Information: Biomagnification

Toxic chemicals that accumulate in the bodies of organisms can undergo the phenomenon of biomagnification as they pass through the food chain. Through biomagnification, the concentration of the toxic substance increases exponentially as organisms eat multiple other organisms to sustain themselves.

A historic reference for biomagnification is the use of DDT (dichlorodiphenyltrichloroethane). Like many toxics, DDT undergoes bioaccumulation, the sequestering of a substance in the fatty tissue of an organism. Synthetic organic molecules are highly soluble in fats, so they reside in the fatty tissue and are not metabolized by the body. Once this occurs, consumers of the poisoned organism will ingest and sequester the toxics in their own bodies. Because organisms typically eat multiple individuals as part of their diet, the amount of the toxic chemical is compounded in the consumer, resulting in a much higher concentration of the toxic substance.

A theoretical, quantitative example of biomagnification is given in *Environmental Science*, by Nebel & Wright, 2000. Given a polluted water body with a DDT concentration of 0.000003 parts per million (ppm), the concentration of DDT in the bodies of phytoplankton would be approximately 0.04 ppm. This is more than 10,000 times the concentration of DDT in the water surrounding the phytoplankton. Bioaccumulation is already at work. The concentration of DDT in zooplankton, due to their feeding on many phytoplankton, would be approximately 0.20 ppm. The concentration has increased five-fold in one step on the food chain. The concentration of DDT in small fish eating many zooplankton would be approximately 2.0 ppm, a ten-fold increase. The concentration of DDT in the bodies of fish eating birds, such as the bald eagle, would be approximately 20.00 ppm. This is another ten-fold increase from the previous step in the food chain. If those numbers are not shocking enough, consider the change in concentration along the whole of the food chain: the concentration of DDT in the birds is about10,000,000 times the concentration of DDT in the water.

The concentration of the toxic substance is compounded at each step in the food chain. This means that the more steps there are in a food chain, the greater the effects of biomagnification will be. Biomagnification is therefore a serious threat to aquatic ecosystems, because aquatic food chains have, on average, more trophic levels (or "steps") than terrestrial food chains.

Chapter Two:
From Pond to Bog

***Chapter Description**:* Linus travels through the pond that lies to the south of his lake and enters a bog. Linus is amazed by the bog and notices many creatures, but few fish for his dinner. He visits the Bog Gnome to find out why there are few fish. The Bog Gnome tells Linus about nutrients and eutrophication.

Background Information: Eutrophication

Plants and algae take nutrients from the environment in order to grow and maintain their bodies. Two key nutrients used by plants and algae are nitrogen and phosphorous.

Eutrophication occurs in bodies of water that have an amount of nutrients larger than what plants and algae would need to maintain a sustainable population. The excess nutrients promote more growth in the ecosystem than would be seen normally. As the concentration of phytoplankton increases, less light reaches the bottom of the body of water. Submerged vegetation dies due to lack of sunlight and stops producing oxygen. Plants and algae continue to grow on the surface. This is commonly referred to as an algal bloom. Eventually some of the surface plants and algae begin to die. When the dead organisms sink to the bottom of the body of water, bacteria decompose them. The bacteria use oxygen during this decomposition. The bacteria take dissolved oxygen out of the water around them. The water becomes anoxic, and organisms living in the water suffocate.

Eutrophication can occur naturally, but it can also be commenced or sped up by nutrient loading, which is the influx of excess nutrients into an ecosystem due to human activities. Fertilizers contain nitrogen and phosphorous, so run-off from farms can often lead to eutrophic bodies of water.

It is important to note that while algae are major players in eutrophication, the focus in *The Watershed Journey of Linus Loon* is kept on aquatic plants for the sake of simplicity.

Chapter Three:
Into the Current

***Chapter description**:* In this chapter, Linus leaves the bog and enters into a stream. Later, the stream enters into a river. The flowing of water makes Linus consider the origins and destinations of water. A visit to the River Gnome provides Linus with an explanation of the water cycle and describes how this cycle connects water bodies, the atmosphere, and all living things.

Background information: The Water Cycle

The water cycle describes the path water molecules take as they change state and travel through bodies of water and the atmosphere.

Boiling water turning into steam is a common example of evaporation, but it is important to understand that water need not be boiling in order to evaporate. Evaporation happens continually at all temperatures above freezing, but the amount of liquid that evaporates into gas increases as temperature increases. Even on a cool spring day, some water will evaporate out of any water body. It should be stressed to students that evaporation is not a synonym of boiling. Rather, boiling is a condition of matter during which rapid evaporation will take place. Evaporation is merely the state change of water from liquid to gas, and can be as simple as a water molecule becoming excited and disassociating from a sample of liquid water in favor of floating around as vapor.

Once liquid water evaporates into gaseous water, it is called water vapor. Having a lot of water vapor in the air means the air will be moist, like on a muggy day. Water in the air will combine with dust to form clouds in the atmosphere. Eventually, the water vapor in clouds will condense due to dropping temperatures or changes in atmospheric pressure. At this point, water vapor turns back into liquid and returns to the earth as rain. Rain enters groundwater or bodies of water such as lakes, ponds, etc, and the process begins again.

As water travels around the water cycle, it can carry pollutants with it. A classic example is atmospheric pollution falling to the earth as acid rain. In Maine, we experience acid rain due in large part to pollution coming from large factories in the Midwest. However, pollutants are not transported when water evaporates. Students should understand that when water evaporates, it leaves behind everything that was dissolved in it. This is why water that evaporates out of the ocean is fresh water: salt is left behind.

The water cycle connects bodies of water with each other and also with the atmosphere. What happens in one body of water (e.g. drought, pollution) or in the atmosphere (e.g. pollution) will affect other bodies of water. Because all living creatures depend on water in one way or another, the water cycle also connects all living things.

Chapter Four:
Salty Water

***Chapter description**:* Linus travels from the river into an estuary. Here he sees many organisms and notices that the water becomes slightly salty. He meets the Estuary Gnome, who tells him about biodiversity.

Background information: Biodiversity

Biodiversity refers to the number of species in a given area. Areas with high biodiversity have many different species living together in one ecosystem.

Biodiversity is important because it ensures a healthy, functioning ecosystem that can withstand a variety of environmental pressures. Biodiversity operates by a principle called the portfolio effect. Imagine investing in the stock market: a portfolio with only one stock can de decimated by a drop in that stock. In contrast, a diverse portfolio will not crash all at once. Different stocks respond to different current events, so during any one market crash only some of the stocks will drop. The more diverse portfolio is more stable and better able to defend itself against market crashes.

In nature, the portfolio effect is realized in that different species have different strengths and weaknesses: they have differing abilities to respond to different environmental pressures. Thus, an ecosystem with only one species (a monoculture) will be destroyed if a single catastrophe occurs to which the species is susceptible. In contrast, an ecosystem with a lot of biodiversity will not be completely destroyed by a single catastrophe. Some species will be affected more than others, but it is unlikely that all species will perish at once. A biodiverse ecosystem is more stable and better able to defend itself against environmental catastrophes, such as floods, droughts, or fluctuations in temperature.

Chapter Five:
A Day at the Beach

***Chapter description**:* Linus leaves the estuary and strolls along the beach, where he finds a lot of debris. Linus swims to the ocean and talks with the Ocean Gnome, who tells him about non point source pollution.

Background Information: Non-point Source Pollution

In most cases, pollution can be categorized as being either point source pollution or non point source pollution. Point source pollution is pollution that originates at a single source. Factories and large farms that empty chemicals and nutrients into bodies of water are contributing to point source pollution.

Non point source pollution is pollution that originates from many different sources. Usually, these sources make only small contributions of pollutants, but the contributions add up to create a significant pollution problem. People discarding trash or washing chemicals down a sink are contributing to non point source pollution.

Point source pollution is relatively easy to mitigate when compared to non point source pollution. The release of pollutants may be eliminated or managed at the point of origin.

Non point source pollution is much more difficult to mitigate because there is no single point of origin where a management system may be applied. Amelioration depends on the management of each origin. This means that individual people would have to be monitored to ensure a minimization of pollution. This simply is not possible. Laws can be made to manage populations as a whole, but responsibility ultimately relies on the individual. The greatest weapon against non point source pollution is therefore education. Given the necessary information, individuals may change their behavior to pollute less.

Troll Question Answer Key

Chapter 1: Leaving the Lake

Answers to questions from the Lake Troll

1. Since there are no species for which humans fill the role of prey, there is no "right" answer to this question. Simply look for the recognition that a potential predator of humans would need to be a large carnivore.
2. Answers will vary. Each food chain must begin with a plant.
3. This is a very open-ended question intended to make students think about the origins of their food and food issues in their communities. Answers should be more in depth than "We get our food from the grocery store." Students should consider the links between agriculture and the dinner table.
4. The animals that are higher up in the food chain have a much higher concentration of the toxic chemical than do their prey.
5. Answers will vary. Responses are likely to include visual cues, such as "we follow road signs," or "we follow a map." A bird finds its way using a combination of visual cues and an internal magnetic compass.

Chapter 2: From Pond to Bog

Answers to questions from the Bog Troll

1. There are approximately 15 carnivorous plants in Maine, though they are quite rare. The most common species, aside from the pitcher plant, are the sundew and the bladderwort. The sundew traps insect with tiny projections covered in a sticky substance, and then closes upon them. Bladderworts have tiny "bladder" traps to capture insects. When the trigger-hairs at the opening of the trap are disturbed, a slight vacuum is created, sucking the offending insect into the trap. Digestive juices inside the trap finish the job.
2. "Consumer" and "secondary producer" are the only terms that should apply to students.
3. Both primary production and secondary production produce tissue. Primary production occurs only in photosynthetic organisms, and thus produces plant tissues. Secondary production usually refers to the production of animal tissues.
4. Answers will be variations on the theme "too much of a good thing."
5. Primary production would stop. Without the conversion of solar energy into plant tissue and sugars, consumers would eventually run out of food sources.
6. Answers will vary.

Chapter 3: Into the Current

Answers to questions from the River Troll

1. Answers will vary.
2. Answers will vary. It is likely that students get their water either from a private well or a town water supply. Water that goes down the drain either filters into a leach field or enters a town sewage system.
3. Melting snow in the spring contributes to higher water levels than are experienced during the rest of the year.

4. Without rain, the groundwater lost to evaporation would not be replenished. Rather than cycling, water would simply transfer from the ground and from bodies of water into the atmosphere. Less water would be left in our lakes, streams, and oceans, and more water would be in the atmosphere, existing as vapor.
5. Salts and other dissolved solutes do not evaporate with water vapor. Evaporating water leaves salt behind.
6. The name of your watershed will also be the name of whatever stream, lake, or river that your town's water flows into. You may choose to look at this concept on a small or large scale: you could simply name the nearest stream, or you could name the larger river system that that stream flows into. There is an excellent map of large scale watersheds in the Gulf of Maine online, at http://www.gulfofmainesummit.org/watershed.html

Chapter 4: The River Meets the Sea

Answers to questions from the Estuary Troll

1. The picture of the Bog Troll has higher biodiversity. The picture of the Bog Troll has 6 species: a troll, lily pads, a dragonfly, tall grass, an evergreen tree, and a deciduous tree (in the upper right corner). The picture of the River Troll has 4 species: a troll, tall grass, short grass (on the River Gnome's lawn), and the trees on the shoreline in the distance. Assume that the tree in which the River Gnome lives is the same species as the trees on the far shore. Make sure that students count multiple organisms of the same species only once. For example, students should count the lily pads in the bog as one species, not as three lily pads.
2. Answers will vary.
3. Answers will vary, though students are likely to have heard the term "diversity" in reference to cultural, ethnic, or racial diversity. Students should understand that "diversity," like "biodiversity," is a measure of the differences between members of a group.
4. The water in the middle of the estuary is brackish: it is roughly half saltwater, half freshwater.
5. Answers will vary.

Chapter 5: The Edge of the Ocean

Answers to questions from the Ocean Troll

1. People contributing to nonpoint source pollution have trouble understanding their impacts because each person is contributing a very small amount of pollution. People often do not connect these small inputs with the larger, collective problem.
2. Answers will vary. Correct answers will be types of pollution that are left in small amounts, but over time add up to a larger problem.
3. Answers will vary.
4. Point source pollution comes in a large amount from a single source. Factories and farms are examples of point sources. Nonpoint source pollution comes in small amounts from many different sources. Individual citizens are examples of nonpoint sources.

5. Point source pollution can be lessened by dealing with the source (for example, installing a filter on a sewage pipe at a factory). With nonpoint source pollution, there is no single source to manage.

The Watershed Review
Answer Key

1. Answers will vary.
2.
    a. Coyote: Consumer, carnivorous, secondary production, predator.
    b. Rabbit: Consumer, secondary production.
    c. Clover: Producer, primary production.
3.
    a. While a **monoculture** only has one type of organism in it, an ecosystem with lots of different species has a lot of **biodiversity**.
    b. **Brackish** water isn't very salty, but it's not fresh water either. Its **salinity** is somewhere in between ocean and fresh water.
    c. **Eutrophication** can happen when people put too much fertilizer on their lawns.
    d. Another word for trash is **debris.**
4.
    a. Though answers will vary considerably, Picture #1 should show a food chain that has been contaminated by a pollutant. Some reference should be made to the increasing concentration of the pollutant in the food chain (biomagnification).
    b. Picture #2 should show nutrients flowing into a body of water and causing excess plant growth. Preferably, there should be a reference to bacteria taking oxygen out of the water.
    c. Picture #3 should show the difference between these two concepts. For example, students might draw a farm or factory to illustrate point source pollution. To illustrate nonpoint source pollution, students might draw several people each throwing away a small piece of trash, or dumping a small amount of chemicals down a drain.
5. Answers will vary, but should be some variation on the theme of nonpoint source conservation, wherein many people contribute a small amount of time or effort towards a cleanup or conservation effort.